Contents

Preface

The failure to arrive at a singularity free solution for a general N-body problem for nearly 300 years has led people to treat this case of N-body simulations as being very turbulent. But I would like to reiterate and say that there is no reason for chaos here in Dynamic Universe Model. I am able to say this confidently after having worked on this Model for the last 18 years and creating 100,000 simulations using this SITA algorithm.

The trick here is to follow the law of Newtonian Gravitation fully without any deviation to calculate the Universal Gravitational force (UGF) on each mass. Other N-body simulations either deviated from this law or did not calculate UGF.

Apprehensions abound in any new field. As pointed earlier, my work in the last 18 years has given me enough confidence and I can say that the solution proposed hereunder will work almost in any physical situation and explain all the anomalies which arose due to the earlier theories. I can prove the working of the algorithm to any technical team.

Many people asked me the reason for selecting 133 masses. There are many reasons for this ‘why133 masses?’ question.

It was in the beginning of the 1990's that the Dynamic Universal Model project began. The common man had minimal access to computers during this period in India. Processor 8088 prevailed. PC with two floppy drives was becoming redundant and was being slowly replaced by the hard drive. This resulted in limitations to data handling capacity. Computers used to take a few hours to calculate something like 50 iterations. Today, these iterations can be done in 8 to 10 minutes with a five – year old laptop.

The Milkyway, our Galaxy has 10^{11} Stars approximately with number of planets being an additional 10 times. Estimated number of dwarf planets would be 1000 times the number of planets, say about to 10^{15}. Chunks of planets and asteroids may be a million times the number of planets, say about 10^{18}. All these figures are on the lower side. Hence, about 10^{19} masses and their positional data is required to simulate a Galaxy. The total number of masses required to simulate would be about 10^{25} to 10^{28}. Is there any Super computer on Earth, which can handle such huge amount of data, today? Do we have all such data to feed the computer?

May be 133 masses are too less a number to begin a simulation. However, even 3 body problem is not simple to solve directly with the usual differential equations method. Even if we create a simulation with a million or 10 million masses, it will approximately be 10^{20} less than what is required for simulating the universe. My resources being limited and having no access to higher computers, the best I can do is testing this SITA algorithm of Dynamic Universe model for the various situations within the available resources and time. I have carried out this work out of my own interest and have not sought any Government or University funding for the same.

I came up with the Dynamic Universe Model after 18 years after much effort and hard work. The Model uses Newtonian Gravitation for calculating the resultant

Universal Gravitational force on every mass. No special assumptions have been made for arriving at the Model. In those days I did not think of lower side at all like N=2,3 4..etc. What I was aiming is to accommodate as many numbers of masses as possible. I did not take it in the way of mathematical induction process, i.e., if it is true for n=2, and n=3, then test for n and n+1. I have no way of testing that approach.

People asked me why I worked with only 133 masses. The SITA simulations can be done with higher number of masses on any Supercomputer provided funds and resources are available. I have successfully tested the SITA solution for 2, 3, 4, 133, 25000 point masses. I am sure we can arrive at the same results when tried with higher masses also.

Now I can say, this Dynamic Universe model is no more a fantasy, but it is reality …………..

Prelude

Summary

In this Monograph, I present a solution to N-body problem – called Dynamic Universe Model; which is singularity free, inter body collision free and dynamically stable. This N-body problem solution can be used in many places like presently unsolved applications like Pioneer anomaly at the Solar system level, Missing mass due to Star circular velocities and Galaxy disk formation at Galaxy level etc.

The book begins with history of N-body problem, mathematical background that lead to the development of Dynamic universe Model, and the implementation of this Model with SITA simulations, SITA results and comparisons with other models.

Basic structure of this monograph

Following is the basic structure of the monograph. In chapter 1, we discuss the History of N-body problem before the Newtonian period up to year 1900. Claims made for King Oscar Prize and Poincare also have been discussed. Claim for singularity free and collision free N-body problem solution for Dynamic Universe Model was made.

In Chapter 2 the Dynamic universe model as a Universe model was discussed and it’s General Introduction, initial conditions were explained. Why anisotropic density distributions were taken? What are these Huge great walls, other Large-scale structures and large voids that make the universe lumpy? Their effects on general isotropy and homogeneity conditions were also discussed. Supporting Observations for assumed Initial conditions in Dynamic Universe Model like Anisotropy and heterogeneity of Universe were shown.

Chapter 3 discusses the theoretical Mathematical Background that lead to the formulation of Dynamic Universe Model framework and tensors for this N-body model.

Chapter 4 gives Numerical Results and Outputs of Dynamic Universe model, using one of the possible implementations of Equations 25 of Dynamic Universe model: SITA Simulations (Simulation of Inter-intra-Galaxy Tautness and Attraction forces). The chapter also discusses the methods of calculation used in SITA simulations including starting values and time step. Incidentally the data shown here in input and the output was used for successful calculation of trajectory of New Horizons satellite going to Pluto.

Chapter 5 talks about SITA and its ‘no singularity’ calculations. Six cases were considered: Specific relative angular momentum (velocity position vector cross product) is Constant, non-zero Angular Momentum: (MASS Velocity Position Vector cross product), Dynamic Universe Model is stable: showing ‘Total Energy = h=T-V” is NEGATIVE’, Non-zero polar moment of inertia and the non-zero Internal Distance between all pairs of point masses. That is how we can say this model is Singularity free and stable.

Chapter 6 compares the Dynamic Universe Model with other N-body models (errors in models after 1900). Errors in N-body simulations like input and output errors, chaotic results obtained with large astrophysical N-body problem and Exponential divergence were discussed.

Chapter 7 makes a comparison of SITA with NVIDIA’s CUDA implementation. The comparison allows a better understanding of SITA. Comparison with existing methods used with CUDA N-body simulation has been discussed. At present, it is to be noted that CUDA implementation is not singularity free. This comparison is done to have a better understanding of SITA; no part of CUDA is used in SITA.

Chapter 8 carries general FAQs on differential equations Dynamic Universe model as N-body problem solution, Initial accelerations, Variable time step.

Chapter 9 makes a comparison with other present day cosmologies. This chapter shows a table depicting differences between Bigbang based cosmologies and the Dynamic Universe Model

The other results of Dynamic Universe Model are listed in Chapter 10. This chapter lists of various results obtained in the Dynamic Universe Model using the same set of equations and the same SITA setup for 133 masses.

The last two chapters carry the acknowledgments and chapter-wise references made. A table of tables at the end gives the page numbers of all tables in the book.

1.History of N-body problem till year 1900

Newton: Two-body problem

How it all started

Around 1543, Copernicus first proposed the planetary paths. He pointed out that all Planets including the Earth moved around the SUN in *De revolutionibus orbium coelestium.* This was a major step forward during that period. Eventually, the circular planetary paths proposed by Copernicus were soon disproved by accurate astronomical observations [2].

The famous astronomer Tycho Brahe made accurate astronomical observations and after his death in 1601, Kepler worked on those observations. Kepler published two laws in 1609 in *Astronomia Nova* – the first law talks about the elliptical path of planets around the Sun, where SUN is one of the two foci of the planetary path. The second law states that the line joining the SUN and planets sweeps equal areas in equal intervals of time. Kepler published a third law in *Harmonice mundi* in 1619 which states that the squares of the periods of planets are proportional to the cubes of the mean radii of their paths. The third law was surprisingly accepted from the very first day it appeared in the journal.

Kepler orbit

Johannes Kepler’s laws of planetary motion around 1605, from astronomical tables detailing the movements of the visible planets. Kepler's First Law is:

> *"The orbit of every planet is an ellipse with the sun at a focus."*

The mathematics of ellipses is thus the mathematics of Kepler orbits, later expanded to include parabolas and hyperbolas.

Sir Isaac Newton’s law of universal gravitation (1687):

Every point mass attracts every other point mass by a force pointing along the line intersecting both points. The force is proportional to the product of the two masses and inversely proportional to the square of the distance between the point masses:

$$F = G\frac{m_1 m_2}{r^2},$$

where:

F is the magnitude of the gravitational force between the two point masses,

G is the gravitational constant,

m_1 is the mass of the first point mass,

m_2 is the mass of the second point mass,

r is the distance between the two point masses.

Newton: Two-body problem

In mechanics, the two body problem is a special case of the n-body problem with a closed form solution. This problem was first solved in 1687 by Sir Isaac Newton [1] who showed that the orbit of one body about another body was either an ellipse, a parabola, or a hyperbola, and that the center of the mass of the system moved with constant velocity. If the common center of mass of the two bodies is considered to be at rest, each body travels along a conic section which has a focus at the common center of the mass of the system. If the two bodies are bound together, both of them will move in elliptical paths. If the two bodies are moving apart, they will move in either parabolic or hyperbolic paths. The two-body problem is the case that there are only **two** point masses (or homogeneous spheres); If the two point masses ($\mathbf{r}_1$, m_1) and ($\mathbf{r}_2$, m_2) having masses m_1 and m_2 and the position vectors $\mathbf{r}_1$ and $\mathbf{r}_2$ relative to a point with respect to their common centre of mass, the equations of motion for the two mass points are :

$$m_1\ddot{\mathbf{r}}_1 = -\frac{\partial U}{\partial \mathbf{r}_1} = -G\frac{m_1 m_2}{r^2}\hat{\mathbf{r}} \qquad \& \qquad m_2\ddot{\mathbf{r}}_2 = \frac{\partial U}{\partial \mathbf{r}_2} = G\frac{m_1 m_2}{r^2}\hat{\mathbf{r}}$$

Where $r = |\boldsymbol{r}_1 - \boldsymbol{r}_2|$ is the distance between the bodies; U (|$\mathbf{r}_1 - \mathbf{r}_2$|) is the potential energy and

$$\hat{\boldsymbol{r}} = \frac{\boldsymbol{r}_1 - \boldsymbol{r}_2}{r}$$

is the unit vector pointing from body 2 to body 1. The acceleration experienced by each of the particles can be written in terms of the differential equation

$$\ddot{\boldsymbol{r}} = \mu.\frac{\hat{\boldsymbol{r}}}{r^2} \qquad (1)$$

Where $\mu = G.M$; M being the mass of the body causing the acceleration (i.e m_1 or the acceleration on body 2). The mathematical solution of the differential equation (1) above will be: *Like for the movement under any central force, i.e. a force aligned with $\hat{\boldsymbol{r}}$, the specific relative angular momentum $\boldsymbol{H} = \mathbf{r} \times \dot{\boldsymbol{r}}$ stays constant:*

$$\dot{\boldsymbol{H}} = \overset{\cdot}{\overbrace{\boldsymbol{r} \times \dot{\boldsymbol{r}}}} = \dot{\boldsymbol{r}} \times \dot{\boldsymbol{r}} + \boldsymbol{r} \times \ddot{\boldsymbol{r}} = \mathbf{0} + \mathbf{0} = \mathbf{0}$$

Sir Isaac Newton published the Principia in 1687. Halley played an important role in getting Principia published. Sir Isaac discussed the inverse square law of force and solved it in Prop. 1-17, 57-60 in Book I [31]. In Book I, Newton argued that orbits are elliptical, parabolic or hyperbolic due to inverse square law. Newton also deduced Kepler's third law in the Principia.

Newton had fully solved the theoretical problem of the motion of two- point masses. For more than two- point masses, only approximate values of motion could be found. The quest to find values of motion for more than two- point masses led mathematicians to develop methods to attack the three- body problem. However, the other factors which influenced the actual motion of the planets and moons in the solar system made the whole exercise complicated.

What were the problems that actually arose at this point? Even if the Earth – Moon system was considered to be a two-body problem which had been theoretically solved in the Principia, the orbits would not be simple ellipses. Neither the Earth nor the Moon is a perfect sphere so does not behave as a point mass. This led to the development of mechanics of rigid bodies. But, even this would not give a completely accurate picture of the two-body problem, since neither the Earth nor the Moon is rigid due to the presence of tidal forces.

The ***shell theorem*** by Newton says that the magnitude of this force is the same as if all mass was concentrated in the middle of the sphere, even if the density of the sphere varies with depth. Smaller objects, like asteroids or spacecraft often have a shape strongly deviating from a sphere. But the gravitational forces produced by these irregularities are generally small compared to the gravity of the central body. The difference between an irregular shape and a perfect sphere also diminishes with distances, and most orbital distances are very large when compared with the diameter of a small orbiting body. Thus for some applications, shape irregularity can be neglected without significant impact on accuracy.

Sir Isaac Newton published the efforts made to study the problem of the movements of three bodies subject to their mutual gravitational attractions in the

Principia. His descriptions were more geometrical in nature see Book I, Prop.65, 66 and its corollaries [31]. Newton briefly studies the problem of three bodies. However, Newton later declared that an exact solution to the three-bodies problem was beyond the realm of the human mind.

The data which Newton used in the Principia was provided by the Royal Greenwich Observatory. However, modern scholars such as Richard Westfall claim that Newton sometimes adjusted his calculations to fit his theories. Certainly, the observational data could not be used to prove the inverse square law of gravitation. Even while Newton was penning the Principia, many problems relating observation to theory arose and more would arise in future.

The observational data used by Newton in the *Principia* was provided by the Royal Greenwich Observatory. However modern scholars such as Richard Westfall claim that Newton sometimes adjusted his calculations to fit his theories. Certainly the observational evidence could not be used to prove the inverse square law of gravitation. Many problems relating observation to theory existed at the time of the *Principia* and more would arise.

Halley ’s Comet

Halley adopted Newton’s method to compute the almost parabolic orbits of a number of comets. He was able to prove that the comet which appeared in the year 1537, 1607 and 1682 (which was previously thought to be three different comets) was only one comet which had followed the same orbit. He was later able to identify it with the one which appeared in 1456 and 1378. He was able to compute the elliptical orbit for the comet, and he noticed that Jupiter and Saturn were perturbing the orbit slightly between each return of the comet. Taking the perturbations into account, Halley predicted that the comet would return and reach perihelion (the point nearest the Sun) and it would appear again on 13 April, 1759 plus or one month. The comet actually appeared in 1759 reaching the perihelion on 12 March.

The purpose here is simply to point to the complex formal descriptions of the dynamic relationships in each case. Note that simpler satisfactory solutions may be found in each case if particular constraints are allowed. Many mathematicians have given considerable attention to the solution of the equations of motions for N gravitationally interacting bodies.

Cotes , d'Alembert and Euler

The second edition of the *Principia* was released in 1713, edited by Roger Cotes [3]. Cotes wrote a preface defending the theory of gravitation given in the *Principia*. Steps for finding the derivatives of the trigonometric functions were derived by Cotes and published after his death.

Euler [4] developed methods of integrating linear differential equations in 1739 and made known Cotes' work on trigonometric functions. He drew up lunar tables in 1744, clearly already studying gravitational attraction between the Earth, Moon, and Sun system. Clairaut and d'Alembert were also studying perturbations of the Moon and, in 1747, Clairaut proposed adding a $\mathbf{1/r^4}$ term to the gravitational law to explain the observed motion of the perihelion, the point in the orbit of the Moon where it is closest to the Earth.

However, by the end of 1748, Clairaut [5] had discovered that a more accurate application of the inverse square law came close to explaining the orbit. He published his findings in 1752 and two years later, d’Alembert published his calculation calculations going to more terms in his approximation than Clairauts’ work was instrumental in making Newton’s inverse square law of force to be accepted in Continental Europe. In 1767, Euler found the collinear periodic orbits, in which three bodies of any mass move such that they oscillate along a rotation line. In 1772, Lagrange [6] discovered some periodic solutions which lie at the vertices of a rotating equilateral triangle that shrinks and expands periodically. These solutions led to the study of *central configurations* for which $\ddot{q} = kq$ for some constant $k>0$.

Moon's perihelion:

Perihelion of Moon also has some small periodic effects which are generally called *nutation.* This was first observed by Bradley in 1730, but he waited 18 years before he publicized it, as he wanted to observe a full cycle of 18.6 years. D'Alembert [7] used Newton's inverse square law and proved it. Euler further made Newton's inverse square law more clear in the 1750s. Lagrange [6] won the won the *Académie des Sciences* Prize in 1764 for a work on the libration of the Moon. This is a periodic movement in the axis of the Moon pointing towards the Earth, which allows more than 50% of the surface of the Moon to be seen over a period of time..

In 1772, Euler first introduced a synodic (rotating) coordinate system. Jacobi (1836) subsequently discovered an integral of motion in this coordinate system (which he independently discovered) that is now known as the Jacobi integral [7.A] Hill (1878) used this integral to show that the Earth-Moon distance remains bounded from above for all time (assuming his model for the Sun-Earth-Moon system is valid), and Brown (1896) gave the most precise lunar theory of his time.

Herschel: Uranus

In 1776, Lagrange introduced the arbitrary constant variations method for use in celestial mechanics. This had been used earlier by him, Euler and Laplace [9]. Lagrange published major papers in 1783. In 1784, he published a paper on the theory of perturbations of orbits and in 1785, he applied his theory to the orbits of Jupiter and Saturn.

An important development took place on 13 March, 1781 when the astronomer William Herschel [8] observed either a nebulous star or a comet in his private observatory in Bath, England. Almost immediately, it was realized to be a planet and named Uranus. Within a year of its discovery, it was shown to have an almost circular orbit.

Stability of the solar system and planet Ceres of Bode

In November 1785, Laplace presented a paper to the *Academie des Sciences*. He gave a theoretical explanation of all the remaining major discrepancies between theory and observation of all the planets and their moons excluding Uranus. His work on the stability of the solar system was published in 1799 in *Mecanique celeste*. Later observational discrepancies in the motion of the Moon were completely explained by Laplace in 1787, Adams [10] in 1854 and later in Delaunay's [11] work.

J D Titus in 1766 and J E Bode in 1772 had noted that **(1+4)/10, (3+4)/10, (6+4)/10, (12+4)/10, (24+4)/10, (48+4)/10, (96+4)/10** gave the distances of the 6 known planets from the Sun (taking the Earth's distance to be 1) except that there was no planet at distance 2.8 (times the Earth –Sun distance). The discovery of Uranus at a distance of 19.2 was close to the next term of the sequence at 19.6. A search was made for a planet at a distance of 2.8 and on January 1, 1801 Piazzi discovered such a body. It was named as Ceres by Piazzi, a minor planet. This new planet had not been observed by other astronomers since it passed behind the Sun. Its distance from the Sun fitted exactly the 2.8 prediction of the Titus-Bode law. However, Guass [12] was able to compute the orbit of this planet from a small number of observations in a brilliant piece of work. In fact, Gauss's method requires only 3 observations and is still essentially used even today to calculate orbits.

Neptune and Uranus

Many astronomers and astrophysicists between 1830 and 1840 observed and tried to explain the discrepancies in the orbit of Uranus as it had departed 15'' from the best fitting ellipse. Alexis Bouvard (a collector of planetary data), the English Astronomer, Royal Airy [13], Bessel [14], Delaunay [11] in 1842, Arago [15] and Le Verrier [16] in 1846, the English Astronomer Challis, John Couch Adams [10] of Cambridge University in 1845 and John Herschel [8] were some of them. The astronomer Galle in Berlin discovered the new planet on 26 September 1846 remarkably close to the position predicted by Le Verrier. The observations were confirmed on 29 September, 1846 at the Paris observatory. This was a remarkable achievement for Newton's [1] theory of gravitation and for celestial mechanics. Finally after many claims and arguments in the scientific community, the new planet was named Neptune.

Liouville [17] studied planetary theory, the three-body problem and the motion of the minor planets Ceres and Vesta in 1836. Many mathematicians studied these problems at this time. Liouville made a number of very important mathematical discoveries while working on the theory of perturbations including the discovery of Liouville's theorem – 'when a bounded domain in phase space evolves according to Hamilton's equations, its volume is conserved'.

Celestial & Analytic mechanics

Work on the general three-body problem during the 19th century had begun to maintain two distinct lines. One was the highly complicated method of approximating the motions of the bodies (celestial mechanics). The other was to produce a sophisticated theory to transform and integrate the equations of motion (rational or analytic mechanics). Both the theory of perturbations and the theory of variations of the arbitrary constants were of immense mathematical significance as well as they contributed greatly to the understanding of planetary orbits.

Papers published by Hamilton [18] in 1834 and 1835 made major contributions to the mechanics of orbiting bodies as did the significant paper published by Jacobi [19] in 1843. Jacobi reduced the problem of two actual planets orbiting a sun to the motion of two theoretical point masses. The first approximation was that the theoretical point masses orbited the centre of gravity of the original system in ellipses. He then used a method first discovered by Lagrange to compute the perturbations. Bertrand [20] extended Jacobi's work in 1852.

Mercury perihelion

Le Verrier [17] had published an account of his theory of Mercury in 1859; there was a discrepancy of 38" per century between the predicted motion of the perihelion (the point of closest approach of the planet to the Sun) which was 527" per century and the observed value of 565" per century. The actual discrepancy was 43" per century and this was pointed out by later by Simon Newcomb [21]. Le Verrier was convinced that a planet or ring of material lay inside the orbit of Mercury but being close to the Sun had not been observed.

Le Verrier’s search proved in vain and by 1896, Tisserand had concluded that no such perturbing body existed. Newcomb explained the discrepancy in the motion of the perihelion by assuming a minute departure from the inverse square law of gravitation. This was the first time that Newton’s theory had been questioned for a long time. In fact, this discrepancy in the motion of the perihelion of Mercury was to pave the way for Einstein’s theory of relativity.

Stability of Saturn's Rings

JC Maxwell showed among other things that a ring of moons in circular orbit around Saturn could be stable if the number of satellites does not exceed a number which depends on the mass ratio of the ring and the planet in his Essay which won him the Adams Prize in 1865.

N-body & 3-body problem

Three body problem:

Euler was the first to study the general n-body and in particular restricted 3-body problem, instead of planets in the solar system in the 1760s. He found it is difficult to solve the general 3-body problem as already said by Newton. He tried to solve the restricted 3-body problem in which one body has negligible mass and it is assumed that the motion of the other two can be solved as a two-body problem, the body with negligible mass having no effect on the other two. The problem is to determine the motion of the third body attracted to the other two bodies which orbit each other. Even this assumption does not seem to lead to an exact solution. Very little is known about the n-body problem for $n \geq 3$. Many of the early attempts to understand the 3-body problem were quantitative in nature, aiming at finding explicit solutions for special situations. Attempts to arrive at a solution to the 3-body problem started with Sir Isaac Newton in 1687 in *Principia*. [23]

Euler, Lagrange, Liouville & Delaunay: Restricted three body problem

Euler found a solution in 1767 with all three bodies in a straight line (collinear periodic orbits), in which all the three bodies of different masses move in such a way that they oscillate along a rotation line. This was a solution that already won the *Academie des Sciences* prize jointly by Lagrange and Euler in 1772 for work on the Moon’s orbit. Lagrange submitted *Essai sur le problème des trois corps* in which he showed that Euler's restricted three body solution held for the general three body problem.

In the circular problem, there exist five equilibrium points. Three are collinear with the masses (in the rotating frame) and are unstable. The remaining two are located on the third vertex of both equilateral triangles of which the two bodies are the first and second vertices. This may be easier to visualize if one considers the more massive body (e.g., Sun) to be "stationary" in space, and the less massive body (e.g., Jupiter) to orbit around it, with the equilibrium points maintaining the 60 degree-spacing ahead of and behind the less massive body in its orbit (although in reality neither of the bodies is truly stationary; they both orbit the center of mass of the whole system). For sufficiently small mass ratio of the primaries, these triangular equilibrium points are stable, such that (nearly) massless particles will orbit about these points as they orbit around the larger primary (Sun). The five equilibrium points of the circular problem are known as the Lagrange points.

Lagrange also found another solution where the three bodies were at the vertices of an equilateral triangle, which is similar to the above circular problem. Lagrange found some periodic solutions which lie at the vertices of a rotating equilateral triangle that shrinks and expands periodically. Lagrange thought that his solutions were not applicable to the solar system. But, now we know that both the Earth and Jupiter have asteroids sharing their orbits in the equilateral triangle solution configuration discovered by Lagrange. The asteroids sharing their orbits with Jupiter are called Trojans. The first Trojan to be discovered was the Achilles in 1908. The Trojan planets move 600 in front and 600 behind Jupiter as discovered by Lagrange.

Later In 1836 Jacobi brought forward an even more specific part of the three body problem, namely that in which one of the planets has a very small mass. This system is called the *restricted three-body problem*. It is a conservative system with two degrees of freedom, which gained extensive study in mechanics. The restricted three-body problem assumes that the mass of one of the bodies is negligible; the circular restricted three-body problem [23] is the special case in which two of the bodies are in circular orbits (approximated by the Sun-Earth-Moon system and many others). For a discussion of the case where the negligible body is a satellite of the body of lesser mass, see Hill sphere [24]; for binary systems, see Roche lobe [25]; for another stable system, see Lagrangian point [23]. The restricted problem (both circular and elliptical) was worked on extensively by many famous mathematicians and physicists, notably Lagrange in the 18th century and Poincaré [26] at the end of the 19th century. Poincaré's work on the restricted three-body problem was the foundation of deterministic chaos theory [27].

Most of the solutions for three-body problems have yielded results which show chaotic motion without repetitive paths. Charles-Eugene Delaunay studied the problem of sun-moon-earth system around 1866 and came out with the perturbation theory which hints at chaos. Delaunay [11] worked on the lunar theory and he also worked on the perturbations of Uranus. He treated it as a restricted three-body problem and used transformation to produce infinite series solutions for the longitude, latitude and parallax for the Moon. This perturbation theory was initially published in 1847. A more refined theory was published in 2 volumes of 900 pages each in 1860 and 1867. Though it was extremely accurate, its only drawback was the slow convergence of the infinite series the work already hints at chaos, and problems in small denominations.

Delaunay detected discrepancies in his observations of the Moon. Le Verrier said that Delaunay’s [11] methods were not right but Delaunay claimed that the discrepancies in his predictions were due to unknown factors. In fact, in 1865, Delaunay said that the discrepancies arose from a slowing of the Earth’s rotation due to tidal friction, an explanation which is believed to be correct today!

3-Body final Steps: Bruns Poincaré.

Bruns proved in 1887 that there were a maximum of only 10 classical integrals, 6 for the centre of gravity, 3 for angular momentum and one for energy. In 1889, Poincare proved that except for the Jacobian, no other integrals exist for the restricted three-body problem. In 1890, Poincare proved his famous recurrence theorem which says that in any small region of phase, space trajectories exist and pass through the region often infinitely. Poincare published 3 volumes of *Les methods nouvelle de la mecanique celeste* between 1892 and 1899. He showed that convergence and uniform convergence of the series solutions discussed by earlier mathematicians was not uniformly convergent. The stability proofs offered by Lagrange and Laplace became inconclusive after this result.

Poincare discovered more topological methods in 1912 for the theory of stability of orbits in the three-body problem. In fact, Poincare essentially invented topology in his attempt to answer stability questions in the three-body problem. He thought that there were many periodic solutions to the restricted problem which was later proved by Birkhoff [28]. The stability of the orbits in the three-body problem was also investigated by Levi-Civita, Birkhoff and others.

King Oscar II Prize & Poincaré

King Oscar II of Sweden announced a prize to a solution of N-body problem with advice given by Gösta Mittag-Leffler in 1887. He announced '*Given a system of arbitrarily many mass points that attract each according to Newton's law, under the assumption that no two points ever collide, try to find a representation of the coordinates of each point as a series in a variable that is some known function of time and for all of whose values the series* ***converges uniformly****.' As in Wikipedia.* [30]. The announced dead line that time was1st June 1888. And after that dead line , on 21st January 1889, Great mathematician Poincaré claimed that prize. The prize was finally awarded to Poincaré, even though he did not solve the original problem. (The first version of his contribution even contained a serious error; for details see the article by Diacu). The version finally printed contained many important ideas which led to the theory of chaos.

Later he himself sent a telegram to journal *Acta Mathematica* to stop printing the special issue after finding the error in his solution. Yet for such a man of science reputation is important than money [31]. He realized that he has been wrong in his general stability result! However, until now nobody could solve that problem or claimed that prize. Later all solutions resulted in singularities and collisions of masses, given by many people…..

Now I can say that the Dynamic Universe Model solves this classical N-body problem where only Newtonian Gravitation law and classical Physics were used. The solution converges at all points. There are no multiple values, diverging solutions or divided by zero singularities. Collisions of masses depend on physical values of masses and their space distribution only. These collisions do not happen due to internal inherent problems of Dynamic universe Model. If the mass distribution is homogeneous and isotropic, the masses will colloid. If the mass distribution is heterogeneous and anisotropic, they do not colloid. This approach solves many problems which otherwise cannot be solved by General relativity, Steady state universe model etc…

2. Dynamic universe model as an Universe model

Dynamic universe model is different from Newtonian static model, Einstein’s Special & General theories of Relativity, Hoyle’s Steady state theory, MOND, M-theory & String theories or any of the Unified field theories. It is basically computationally intensive real observational data based theoretical system. It is based on non-uniform densities of matter distribution in space. There is no space time continuum. It uses the fact that mass of moon is different to that of a Galaxy. No negative time. No singularity of any kind. No divide by zero error in any computation/ calculation till today. No black holes, No Bigbang or no many minute Bigbangs. All real numbers are used with no imaginary number. Geometry is in Euclidian space. Some of its earlier results are non-collapsing, non-symmetric mass distributions. It proves that there is no missing mass in Galaxy due to circular velocity curves. Today it tries to solve the Pioneer anomaly. It is single closed Universe model.

Our universe is not a Newtonian type static universe. There is no Big bang singularity, so “What happened before Big bang?” question does not arise. Ours is neither an expanding nor contracting universe. It is not infinite but it is a closed finite universe. Our universe is neither isotropic nor homogeneous. It is LUMPY. But it is not empty. It may not hold an infinite sink at the infinity to hold all the energy that is escaped. This is closed universe and no energy will go out of it. Ours is not a steady state universe in the sense, it does not require matter generation through empty spaces. No starting point of time is required. Time and spatial coordinates can be chosen as required. No imaginary time, perpendicular to normal time axis, is required. No baby universes, black holes or warm holes were built in.

This approach solves many prevalent mysteries like Galaxy disk formation, Missing mass problem in Galaxy–star circular velocities, Pioneer anomaly, etc. Live New horizons satellite trajectory predictions are very accurate and are comparable to their ephemeris.

This universe exists now in the present state, it existed earlier, and it will continue to exist in future also in a similar way. All physical laws will work at any time and at any place. Evidences for the three dimensional rotations or the dynamism of the universe can be seen in the streaming motions of local group and local cluster. Here in this dynamic universe, both the red shifted and blue shifted Galaxies co-exist simultaneously.

Dynamic universe Model: General Introduction

Dynamic Universe Model of Cosmology is a singularity free N-body solution. It uses Newton's law of Gravitation without any modification. The initial coordinates of each mass with initial velocities are to be given as input. It finds coordinates, velocities and accelerations of each mass UNIQUELY after every time-step. Here the solution is based on tensors instead of usual differential and integral equations. This solution is stable, don't diverge, did not give any singularity or divided by zero errors during the last 18 years in solving various physical problems. With this model, it was found with uniform mass distribution in space, the masses will colloid but no singularities. With non-uniform mass densities, the masses trend to rotate about each other after some time-steps and they don't colloid. SITA (*Simulation* of *Inter-intra-Galaxy Tautness and Attraction_forces*) is a simple computer implementable solution of Dynamic Universe Model and other solutions were possible. An arbitrary number of 133 masses were taken in SITA simulations using the same framework in solving various problems.

Euclidian space, real number based coordinate axes, no space-time continuum, non-uniform mass distribution, no imaginary dimensions, simple Engineering achievable physics are basis. This SITA simulation is a calculation method using a math framework and where we input values of masses, initial distances and velocities to get various results. Based on these it achieves a non-collapsing and dynamically balanced set of masses i.e. a universe model without Bigbang & Black-hole singularities. This approach solves many prevalent mysteries like Galaxy disk formation, Missing mass problem in Galaxy –star circular velocities, Pioneer anomaly, New Horizons trajectory calculations and prediction, Blue shifted Galaxies in Expanding Universe... etc. With this Dynamic Universe model, we show Newtonian physics is sufficient for explaining most of the cosmological phenomena.

In Dynamic Universe Model, there are no singularities and no collisions if we use heterogeneous mass distributions. When homogeneous mass distributions are used, there are collisions but no singularities. Resultant Universal Gravitational Force is calculated for each body for every timestep in all the three dimensions. Conservation of energy, moment etc, were taken into consideration as shown in the Mathematical formulation. Using exactly same setup of mathematics and SITA algorithm and same number of 133 masses, all the results are derived, in the last 18 years.

Dynamic Universe Model is a mathematical framework of cosmology of N-body simulations, based on classical Physics. Here in Dynamic Universe Model all bodies move and keep themselves in dynamic equilibrium with all other bodies depending on their present positions, velocities and masses. This Dynamic Universe Model is a finite and closed universe model. Here we first theoretically find the Universal gravitational force (here after let us call this as UGF) on each body/ particle in the **mathematical formulation** section in this book. Then we calculate the resultant UGF vector for each body/ particle on that body at that instant at that position using computer based *Simulation* of *Inter-intra-Galaxy* *Tautness and Attraction_forces* (here after let us call this as SITA simulations) which simulate Dynamic universe model. Basically SITA is a calculation method where we can use a calculator or computer; real observational data based theoretical simulation system. Initially 133 masses were used in SITA about 18 years back, after theoretical formulation of Dynamic universe model. Using higher number of masses is difficult to handle, which was a limitation of 386 and 486 PCs available at time in the market. I did not change the number of masses until now due to two reasons. Firstly getting higher order computers is difficult for my purse as well as additional programming will also be required. Secondly, I want to see and obtain the different results from the same SITA and math framework. There are many references by the author presenting papers in many parts of the world [20, 23].

Initial conditions for Dynamic Universe Model

Supporting Observations for Initial conditions: Anisotropy and heterogeneity of Universe:

Our universe is not having a uniform mass distribution. Isotropy & homogeneity in mass distribution is not observable at any scale. We can see present day observations in ‘2dFGRS survey’ publications for detailed surveys especially by Colless et al in MNRAS (2001) [see 28] for their famous DTFE mappings, where we can see the density variations and large-scale structures. The universe is lumpy as you can see in the picture given here in Wikipedia.

The universe is lumpy as you can see the voids and structures in the picture given by Fairall et al (1990) [see 29] and in Wikipedia for a better picture. WMAP also detected cold spot see the report given by Cruz et al (2005) [see 27]. They say ‘*A cold spot at (b = -57, l = 209) is found to be the source of this non-Gaussian signature’ which* is approximately 5 degree radius and 500 million light years. This is closely related with Lawrence Rudnick et al’s (2007) [see 30] work, which says that there are no radio sources even in a larger area, centered with WMAP cold spot. It is generally known as ‘Great void’, which is of the order of 1 billion light years wide; where nothing is seen. They saw*…" little or no radio sources in a volume that is about*

280 mega-parsecs or nearly a billion light years in diameter. The lack of radio sources means that there are no galaxies or clusters in that volume, and the fact that the CMB is cold there suggests the region lacks dark matter, too. There are other big voids also up to 80 mpc found earlier which are optical.”

There is the Sloan Great Wall, the largest known structure, a giant wall of galaxies as given by J. R. Gott III et al., (2005); [see 26] ‘Logarithmic Maps of the Universe’. They say “*The wall measures 1.37 billion light years in length and is located approximately one billion light-years from Earth….The Sloan Great Wall is nearly three times longer than the Great Wall of galaxies, the previous record-holder”.*

. Hence such types of observations indicate that our Universe is lumpy. After seeing all these we can say that uniform density as prevalent in Bigbang based cosmologies is not a valid assumption. Hence, in this paper we have taken the mass of moon as moon & Galaxy as Galaxy employing non uniform mass densities.

Here in this model the present measured CMB is from stars, galaxies and other astronomical bodies. We know that the CMB isotropy is not entirely due to Galaxies. Nevertheless, there are other factors also. The stars and other astronomical bodies also contribute for CMB. Moreover, factors like Scattering of rays done by ISM and sidelobe gains & backlobe gains of Microwave dish antenna cannot be excluded they are not less. There are CMB cold spots, where nothing is seen. Observed anisotropies of CMB are in the order of 1 to 20 in million, whereas the anisotropies of in large scale structures are coming up to 7% in the observational scales.

Explanation of table of Initial values

Different masses of astronomical bodies were taken from the various published data. Table 1 below gives masses, XYZ positions of Planets, Moon, Sun, near stars, Galaxy center, Globular cluster Groups, Andromeda, Milkyway and Triangulum Galaxies. Initial values were taken from NASA and from many published data like S.Samurovic et al ‘*Mond vs Newtonian dynamics GC*’ see Ref[31]. This data was used in Pioneer anomaly simulations. Data for other simulations can be obtained from me. I have not given those details here due to length of paper limitation. The distance component XYZ in a Sun-centered coordinate system, in kilo-parsecs (kpc), later converted to meters, where X points towards the Galactic center, Y points in the direction of the Galactic rotation, and Z points towards the North Galactic Pole. Using the equations developed in the above mathematical formulation section, calculations are done to find vectorial resultant forces on each mass for above configuration.

Table of Initial values for this simulation:

Table 1 gives the initial values used in SITA calculations. The name column gives list of various point masses. Later columns give RA, DEC, Distances, serial number of mass, Type, and Helio centric coordinates (x ecliptic, y ecliptic, z ecliptic) for solar system as on 01.01.2009 @ 00.00:00 hrs in meters. All the data used in these calculations use MKS system of units, where distance is in meters, mass is in kilo grams, time is in seconds.

Table 1 : This table describes the initial values used in SITA calculations. The name field gives list of various point masses. Later columns give RA, DEC, Distances, Type, and Helio centric coordinates.

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
New Horizons				1	Satellite	4.78E+02	18831630939	-1.80368E+12	4.85E+10
Mercury	planets	I		2	Mercury	3.30E+23	50644179263	8540296134	-3.9E+09
Venus	planets	II		3	Venus	4.87E+24	69657878862	82614198079	-2.9E+09
Earth ZX	planets	III		4	Earth	5.97E+24	-29565785818	1.44096E+11	-286944

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
									6
Mars	planets	IV		5	Mars	6.42E+23	-3275068912	-2.17902E+11	-4.5E+09
Jupiter	planets	V		6	Jupiter	1.90E+27	4.09177E+11	-6.46362E+11	-6.5E+09
Saturn	planets	VI		7	Saturn	5.68E+26	-1.35874E+12	3.39522E+11	4.82E+10
Uranus	planets	VII		8	Uranus	8.68E+25	2.97521E+12	-4.32376E+11	-4E+10
Neptune	planets	VIII		9	Neptune	1.02E+26	3.61461E+12	-2.66852E+12	-2.8E+10
Pluto	planets	IX		10	Pluto	1.27E+22	69315882273	-4.69858E+12	4.83E+11
Moon ZX	moons	I		11	Moon	7.35E+22	-29191657344	1.43975E+11	16609650
Sun ZX	system(SUN)	-		12	SUN	1.99E+30	0	0	0
HIP 70890	217.4489	-62.68135207	3.9952E+16	13	near star	3.97658E+29	-3.07379E+16	-2.48085E+16	5.99E+15
HIP 71681	219.9141	-60.83947139	4.15783E+16	14	near star	1.88888E+30	-1.70141E+16	-4.49612E+13	3.79E+16

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
HIP 71683	219.9204	-60.83514707	4.15783E+16	15	near star	2.18712E+30	-1.71774E+16	-1.53305E+14	3.79E+16
HIP 87937	269.454	4.66828815	5.62032E+16	16	near star	7.95317E+29	-1.85801E+15	1.6393E+15	-5.6E+16
HIP 54035	165.8359	35.98146424	7.86343E+16	17	near star	8.94731E+29	9.02924E+15	-7.13182E+15	-7.8E+16
HIP 32349	101.2885	-16.71314306	8.13694E+16	18	near star	1.73976E+31	-3.1682E+16	-2.99664E+16	6.87E+16
HIP 92403	282.454	-23.83576457	9.17026E+16	19	near star	8.94731E+29	2.37665E+16	-7.07555E+15	8.83E+16
HIP 16537	53.23509	-9.45830584	9.92956E+16	20	near star	1.88888E+30	9.77757E+16	-1.69837E+16	3.33E+15
HIP 114046	346.4465	-35.8562971	1.01534E+17	21	near star	8.94731E+29	-1.75629E+16	-2.0874E+16	9.78E+16
HIP 57548	176.9335	0.80752617	1.02998E+17	22	near star	3.97658E+29	3.82107E+16	6.00795E+16	7.44E+16
HIP 104214	316.7118	38.74149446	1.07464E+17	23	near star	1.82923E+30	-4.50486E+16	3.01003E+16	9.28E+16
HIP 37279	114.8272	5.22750767	1.07915E+17	24	near star	3.28068E+30	-8.42312E+15	5.24915E+16	-9.4E+16

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
HIP 104217	316.7175	38.73441392	1.08108E+17	25	near star	1.19298E+30	-4.60396E+16	3.03873E+16	9.3E+16
HIP 91772	280.7021	59.62236064	1.08465E+17	26	near star	7.95317E+29	4.90495E+16	9.64605E+16	7.36E+15
HIP 91768	280.7009	59.62601593	1.1009E+17	27	near star	8.94731E+29	4.99158E+16	9.78689E+16	7.07E+15
HIP 1475	4.585591	44.02195597	1.10094E+17	28	near star	7.95317E+29	-1.39114E+16	-1.09124E+17	4.37E+15
HIP 108870	330.8227	-56.77980602	1.11895E+17	29	near star	1.82923E+30	-6.28738E+16	-8.89396E+16	-2.6E+16
HIP 8102	26.02136	-15.93955597	1.12544E+17	30	near star	2.18712E+30	-6.90623E+16	-8.50246E+16	2.58E+16
HIP 5643	18.12459	-17.00053959	1.14685E+17	31	near star	3.97658E+29	-2.35768E+16	2.08864E+16	1.1E+17
HIP 36208	111.8507	5.23476432	1.17208E+17	32	near star	7.95317E+29	1.86257E+16	-5.54342E+16	-1E+17
HIP 24186	77.89672	-45.00448677	1.20881E+17	33	near star	8.94731E+29	-5.04468E+16	3.78032E+16	-1E+17
HIP 105090	319.3238	-38.86457451	1.21783E+17	34	near star	1.19298E+30	2.09805E+16	-4.31965E+16	-1.1E+17
HIP 110893	337.0017	57.69702005	1.23662E+17	35	near star	5.96488E+29	-3.34107E+16	-3.81344E+16	1.13E+17

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
HIP 30920	97.34581	-2.81247539	1.27037E+17	36	near star	5.96488E+29	1.20105E+17	-5.23499E+15	-4.1E+16
HIP 72511	222.3896	-26.1060337	1.31169E+17	37	near star	8.94731E+29	-5.81398E+16	4.54439E+16	-1.1E+17
HIP 80824	247.5755	-12.65971367	1.31577E+17	38	near star	6.95902E+29	-1.07352E+17	7.50846E+16	-1.2E+16
HIP 439	1.334556	-37.3516811	1.34549E+17	39	near star	9.94146E+29	2.96095E+16	1.22996E+17	4.58E+16
HIP 3829	12.28824	5.39519773	1.3596E+17	40	near star	2.90291E+30	8.24904E+16	-2.35538E+16	-1.1E+17
HIP 72509	222.3862	-26.11117761	1.39117E+17	41	near star	8.94731E+29	-6.10305E+16	4.80435E+16	-1.2E+17
HIP 86162	264.11	68.34222717	1.39715E+17	42	near star	8.94731E+29	9.76996E+16	2.14625E+16	-9.8E+16
HIP 85523	262.1644	-46.89305173	1.39981E+17	43	near star	7.95317E+29	2.15194E+16	1.34558E+17	-3.2E+16
HIP 57367	176.4136	-64.84067419	1.42588E+17	44	near star	5.64675E+30	-5.35209E+16	-2.81642E+16	-1.3E+17
HIP	343.3	-	1.4507	45	near	6.95902E	1.14625E+16	1.39712E+16	-

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
113020	173	14.26205842	5E+17		star	+29			1.4E+17
HIP 54211	166.3839	43.52448449	1.49106E+17	46	near star	8.94731E+29	-1.32781E+17	1.60851E+16	-6.6E+16
HIP 49908	152.8473	49.45546425	1.50356E+17	47	near star	1.19298E+30	-4.78813E+16	9.19484E+16	-1.1E+17
HIP 85605	262.4008	24.65322144	1.52233E+17	48	near star	1.65028E+30	1.04974E+16	-1.34655E+17	-7E+16
HIP 106440	323.3917	-49.007018	1.52353E+17	49	near star	8.94731E+29	-4.59519E+16	8.94752E+15	1.45E+17
HIP 86214	264.2677	-44.31693542	1.55587E+17	50	near star	5.96488E+29	1.36804E+17	5.36738E+16	-5.1E+16
HIP 19849	63.82349	-7.64455846	1.5565E+17	51	near star	2.00817E+30	1.77107E+16	2.7082E+16	-1.5E+17
HIP 112460	341.7096	44.33510774	1.55784E+17	52	near star	8.94731E+29	-1.0952E+17	9.68318E+16	5.38E+16
HIP 88601	271.3634	2.50243928	1.56933E+17	53	near star	1.88888E+30	-4.72306E+16	-1.16764E+17	9.36E+16
HIP 97649	297.6945	8.86738491	1.58692E+17	54	near star	5.09003E+30	9.79121E+16	-9.2465E+16	8.39E+16
HIP 1242	3.865281	-16.13230	1.60826E+17	55	near star	3.97658E+29	1.09829E+17	9.70466E+16	6.62E+16

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
		661							
HIP 57544	176.9132	78.68999275	1.66358E+17	56	near star	7.95317E+29	-9.10748E+16	-1.36971E+17	-2.5E+16
HIP 67155	206.4279	14.89505746	1.67578E+17	57	near star	1.09356E+30	-7.0043E+16	9.14497E+16	1.22E+17
HIP 103039	313.1384	-16.9748128	1.69399E+17	58	near star	5.96488E+29	-2.64948E+16	4.32255E+16	1.62E+17
HIP 21088	67.79186	58.98205252	1.70137E+17	59	near star	1.49122E+30	-3.16721E+16	1.25283E+17	1.11E+17
HIP 33226	103.7061	33.26914569	1.70175E+17	60	near star	7.95317E+29	4.73982E+16	1.59067E+15	1.63E+17
HIP 53020	162.7189	6.81011677	1.73876E+17	61	near star	5.96488E+29	1.20195E+17	-9.0224E+16	8.74E+16
HIP 25878	82.86229	-3.67214214	1.75598E+17	62	near star	8.94731E+29	-5.75703E+16	-1.4009E+17	8.89E+16
HIP 82817	253.8718	-8.33420783	1.771E+17	63	near star	7.95317E+29	6.76572E+16	-4.60048E+16	-1.6E+17
HIP 96100	293.0858	69.66540172	1.77937E+17	64	near star	2.12747E+30	-9.2162E+16	-1.20447E+17	9.31E+16
HIP 29295	92.64459	-21.86290752	1.78163E+17	65	near star	8.94731E+29	5.72296E+15	1.76608E+17	-2.3E+16
HIP	85.53	12.49315	1.7858	66	near	5.96488E	-1.34996E+17	-1.16182E+17	-

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
26857	364	5	6E+17		star	+29			1.3E+16
HIP 86990	266.6477	-57.31575508	1.79313E+17	67	near star	5.96488E+29	-1.19512E+17	4.88067E+16	-1.2E+17
HIP 94761	289.2316	5.17214064	1.81229E+17	68	near star	9.94146E+29	7.87302E+16	1.638E+16	-1.6E+17
HIP 73184	224.364	-21.4112809	1.82235E+17	69	near star	1.82923E+30	3.91777E+16	1.47326E+17	-1E+17
HIP 37766	116.1682	3.55354943	1.83024E+17	70	near star	6.95902E+29	1.67294E+17	-1.18466E+16	-7.3E+16
HIP 76074	233.0577	-41.27308564	1.83101E+17	71	near star	8.94731E+29	-1.39077E+17	-9.10857E+16	7.67E+16
HIP 3821	12.27125	57.8165477	1.83678E+17	72	near star	2.78361E+30	5.24234E+16	-1.59364E+16	1.75E+17
HIP 84478	259.057	-26.54341625	1.8415E+17	73	near star	1.65028E+30	3.6434E+15	2.91335E+16	-1.8E+17
HIP 117473	357.2998	2.40357651	1.84205E+17	74	near star	9.94146E+29	-9.07771E+16	1.01639E+17	1.24E+17
HIP 84405	258.8387	-26.60004896	1.84679E+17	75	near star	1.88888E+30	6.41076E+15	1.79687E+16	-1.8E+17

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
HIP 99461	302.7984	-36.09738423	1.86735E+17	76	near star	1.88888E+30	-2.06314E+15	-5.39393E+15	1.87E+17
HIP 15510	49.97177	-43.07154929	1.86984E+17	77	near star	2.18712E+30	1.0974E+17	-3.31921E+16	1.48E+17
HIP 99240	302.1744	-66.17932101	1.88457E+17	78	near star	2.18712E+30	-1.54154E+17	-1.01333E+17	3.85E+16
HIP 71253	218.5709	-12.52100145	1.88711E+17	79	near star	5.96488E+29	4.30221E+16	-1.83542E+17	8.56E+15
HIP 86961	266.5528	-32.10277328	1.90741E+17	80	near star	9.94146E+29	-1.30645E+17	6.84493E+16	-1.2E+17
HIP 86963	266.5603	-32.10165681	1.90741E+17	81	near star	1.09356E+30	-1.31276E+17	6.75268E+16	-1.2E+17
HIP 45343	138.6011	52.6879927	1.90953E+17	82	near star	1.19298E+30	-1.33898E+17	-5.20951E+16	1.26E+17
HIP 99701	303.4698	-45.16363153	1.91451E+17	83	near star	1.09356E+30	-2.19059E+16	6.93128E+16	-1.8E+17
HIP 116132	352.966	19.93741103	1.92778E+17	84	near star	1.49122E+30	3.99999E+16	8.00904E+16	1.71E+17
HIP 74995	229.8648	-7.72203834	1.93431E+17	85	near star	6.95902E+29	-2.19758E+16	-1.28321E+16	-1.9E+17

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
HIP 120005	138.6091	52.68797118	1.93479E+17	86	near star	1.09356E+30	-1.3524E+17	-5.38681E+16	1.27E+17
HIP 84140	258.0317	45.66984247	1.95082E+17	87	near star	8.94731E+29	-2.07383E+16	-9.28974E+15	1.94E+17
HIP 34603	107.509	38.53176545	1.96236E+17	88	near star	5.96488E+29	1.01434E+17	8.45481E+16	1.45E+17
HIP 82809	253.8571	-8.32039997	2.00416E+17	89	near star	5.96488E+29	7.37726E+16	-5.17702E+16	-1.8E+17
HIP 114622	348.3114	57.16763844	2.01358E+17	90	near star	1.82923E+30	-1.50711E+17	6.46728E+16	1.17E+17
HIP 80459	246.3508	54.30451781	2.03094E+17	91	near star	6.95902E+29	-3.30768E+16	-1.22256E+17	-1.6E+17
	-1.2E+21	-1.04245E+21	9.31497E+19	92	Glob Clus Group	1.20578E+37	-1.16925E+21	-1.04245E+21	9.31E+19
	-1.8E+20	-3.61781E+20	-1.42253E+19	93	Glob Clus Group	7.43305E+36	-1.79414E+20	-3.61781E+20	-1.4E+19
	1.49E+19	2.77665E+19	-7.91706E+19	94	Glob Clus Group	9.58802E+36	1.48744E+19	2.77665E+19	-7.9E+19
	6.94E+19	-4.44352E+18	7.944E+17	95	Glob Clus Group	7.05555E+36	6.94375E+19	-4.44352E+18	7.94E+17
	9.11E	-4.39257E	1.8903	96	Glob Clus	6.46631E	9.11252E+19	-4.39257E+19	1.89E+

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
	+19	+19	2E+20		Group	+36			20
	1.05E+20	2.06504E+19	8.97721E+19	97	Glob Clus Group	7.23385E+36	1.05314E+20	2.06504E+19	8.98E+19
	1.26E+20	6.15542E+19	3.76993E+19	98	Glob Clus Group	6.79923E+36	1.25702E+20	6.15542E+19	3.77E+19
	1.53E+20	2.40773E+19	-1.58338E+19	99	Glob Clus Group	8.07244E+36	1.5288E+20	2.40773E+19	-1.6E+19
	1.75E+20	1.35743E+19	-3.13919E+19	100	Glob Clus Group	9.57827E+36	1.74887E+20	1.35743E+19	-3.1E+19
	1.86E+20	5.87126E+19	1.50955E+19	101	Glob Clus Group	8.2981E+36	1.85602E+20	5.87126E+19	1.51E+19
	2.01E+20	1.02368E+20	7.89348E+19	102	Glob Clus Group	1.03904E+37	2.00762E+20	1.02368E+20	7.89E+19
	2.21E+20	1.03194E+19	-1.15685E+20	103	Glob Clus Group	8.99599E+36	2.21232E+20	1.03194E+19	-1.2E+20
	2.41E+20	2.38732E+19	8.08095E+18	104	Glob Clus Group	8.5572E+36	2.40926E+20	2.38732E+19	8.08E+18
	2.53E+20	-1.04214E+19	-1.90968E+18	105	Glob Clus Group	9.81786E+36	2.52521E+20	-1.04214E+19	-1.9E+18

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
	2.64E+20	1.58631E+19	2.36248E+19	106	Glob Clus Group	9.86105E+36	2.63724E+20	1.58631E+19	2.36E+19
	2.8E+20	4.57404E+18	-5.62166E+18	107	Glob Clus Group	8.93192E+36	2.80244E+20	4.57404E+18	-5.6E+18
	2.94E+20	-2.52379E+19	6.36066E+18	108	Glob Clus Group	1.00965E+37	2.93615E+20	-2.52379E+19	6.36E+18
	3.14E+20	-1.18077E+18	1.46617E+19	109	Glob Clus Group	1.37127E+37	3.13834E+20	-1.18077E+18	1.47E+19
	3.35E+20	-1.68075E+20	-3.47826E+19	110	Glob Clus Group	1.01466E+37	3.35306E+20	-1.68075E+20	-3.5E+19
	3.72E+20	1.37362E+19	-1.25647E+20	111	Glob Clus Group	1.11914E+37	3.72364E+20	1.37362E+19	-1.3E+20
	4.87E+20	1.74393E+20	8.66073E+19	112	Glob Clus Group	1.02218E+37	4.87315E+20	1.74393E+20	8.66E+19
	6.49E+20	1.82615E+18	9.06719E+19	113	Glob Clus Group	9.30663E+36	6.49171E+20	1.82615E+18	9.07E+19
	1.02E+21	1.53107E+20	4.80442E+20	114	Glob Clus Group	9.89727E+36	1.0232E+21	1.53107E+20	4.8E+20
Galactic	255.7	-	2.3450	11	Galax	7.164E+3	4.79211E+19	1.67483E+20	1.57E+

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
center	611	29.00780556	6E+20	5	y center	6			20
	11.25	0	2.34506E+20	116	Milkyway part	3.84731E+40	-1.63642E+20	1.47838E+20	-8E+19
	33.75	0	2.34506E+20	117	Milkyway part	4.80914E+40	1.54517E+20	8.22578E+19	1.56E+20
	56.25	0	2.34506E+20	118	Milkyway part	5.77096E+40	-1.14673E+19	4.68166E+19	2.29E+20
	78.75	0	2.34506E+20	119	Milkyway part	6.73279E+40	-8.86592E+19	-1.0611E+19	2.17E+20
	101.25	0	2.34506E+20	120	Milkyway part	7.69462E+40	5.62463E+19	-1.61296E+20	-1.6E+20
	123.75	0	2.34506E+20	121	Milkyway part	8.65645E+40	-1.1565E+20	2.03896E+20	6.68E+18
	146.25	0	2.34506E+20	122	Milkyway part	9.61827E+40	-3.63423E+19	1.12347E+19	-2.3E+20
	168.75	0	2.34506E+20	123	Milkyway part	1.05801E+41	-1.72238E+20	-7.67886E+19	1.39E+20
	191.25	0	2.34506E+20	124	Milkyway part	1.05801E+41	-2.05075E+19	-2.19577E+20	7.97E+19
	213.75	0	2.34506E+20	125	Milkyway part	9.61827E+40	-1.58373E+20	7.45639E+19	-1.6E+20
	236.25	0	2.34506E+20	126	Milkyway part	8.65645E+40	-3.06445E+19	-3.72049E+19	-2.3E+2

name	ra_deg	dec_deg	Dist. meters from Sun	Sl no.	Type	Mass (kg) -------	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009 @ 00.00:00 hrs in meters		
							xecliptic	yecliptic	zecliptic
									0
	258.75	0	2.34506E+20	127	Milkyway part	7.69462E+40	6.156E+19	-6.46792E+19	-2.2E+20
	281.25	0	2.34506E+20	128	Milkyway part	6.73279E+40	9.55613E+19	1.41591E+20	1.61E+20
	303.75	0	2.34506E+20	129	Milkyway part	5.77096E+40	2.32564E+20	-2.93704E+19	-6.7E+18
	326.25	0	2.34506E+20	130	Milkyway part	4.80914E+40	3.07501E+19	2.23922E+19	2.31E+20
	348.75	0	2.34506E+20	131	Milkyway part	3.84731E+40	4.15581E+19	1.83944E+20	-1.4E+20
	0.712306	44.26916667	2.4006E+22	132	Andromeda	1.4129E+42	1.74266E+22	1.50487E+22	6.79E+21
	1.564139	30.66	2.65362E+22	133	Triangulum Galaxy	1.41E+41	1.28546E+20	1.93083E+22	-1.8E+22

3. Mathematical Background

Theoretical formation (Tensor):

Let us assume an inhomogeneous and anisotropic set of N point masses moving under mutual gravitation as a system and these point masses are also under the gravitational influence of other systems with a different number of point masses in different other systems. For a broader perspective, let us call this set of all the systems of point masses as an Ensemble. Let us further assume that there are many Ensembles each consisting of a different number of systems with different number of point masses. Similarly, let us further call a group of Ensembles as Aggregate. Let us further define a Conglomeration as a set of Aggregates and let a further higher system have a number of conglomerations and so on and so forth.

Initially, let us assume a set of N mutually gravitating point masses in a system under Newtonian Gravitation. Let the α^{th} particle has mass m_α, and is in position x_α. In addition to the mutual gravitational force, there exists an external ϕ_{ext}, due to other systems, ensembles, aggregates, and conglomerations etc., which also influence the total force F_α acting on the particleα. In this case, the ϕ_{ext} is not a constant universal Gravitational field but it is the total vectorial sum of fields at x_α due to all the external to its system bodies and with that configuration at that moment of time, external to its system of N particles.

Total Mass of system $= M = \sum_{\alpha=1}^{N} m_\alpha$ (1)

Total force on the particle α is Fα , Let $F_{\alpha\beta}$ is the gravitational force on the α^{th} particle due to β^{th} particle.

$$F_{\alpha} = \sum_{\substack{\alpha=1 \\ \alpha\neq\beta}}^{N} F_{\alpha\beta} - m_{\alpha}\nabla_{\alpha}\Phi_{ext}(\alpha) \qquad (2)$$

Moment of inertia tensor

Consider a system of N particles with mass m_α, at positions X_α, α=1, 2,…N; The moment of inertia tensor is in external back ground field ϕ_{ext}.

$$I_{jk} = \sum_{\alpha=1}^{N} m_{\alpha} x_j^{\alpha} x_k^{\alpha} \qquad (3)$$

Its second derivative is

$$\frac{d^2 I_{jk}}{dt^2} = \sum_{\alpha=1}^{N} m_{\alpha}\left(\ddot{x}_j^{\alpha} x_k^{\alpha} + \dot{x}_j^{\alpha} \dot{x}_k^{\alpha} + x_j^{\alpha} \ddot{x}_k^{\alpha} \right) \qquad (4)$$

The total force acting on the particle α is and $\hat{F}$ is the unit vector of force at that place of that component.

$$F_j^{\alpha} = m_{\alpha} \ddot{x}_j^{\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_{\alpha} m_{\beta} \left(x_j^{\beta} - x_j^{\alpha} \right) \hat{F}}{\left| x^{\beta} - x^{\alpha} \right|^3} - \nabla\Phi_{ext,j} m_{\alpha} \qquad (5)$$

Writing a similar formula for F^{α}_{k}

$$F_k^{\alpha} = m_{\alpha} \ddot{x}_k^{\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_{\alpha} m_{\beta} \left(x_k^{\beta} - x_k^{\alpha} \right) \hat{F}}{\left| x^{\beta} - x^{\alpha} \right|^3} - \nabla\Phi_{ext,k} m_{\alpha} \qquad (6)$$

OR =>
$$\ddot{x}_j^{\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_{\beta} \left(x_j^{\beta} - x_j^{\alpha} \right) \hat{F}}{\left| x^{\beta} - x^{\alpha} \right|^3} - \nabla\Phi_{ext} \qquad (7)$$

And => $$\overset{\circ\circ}{x}{}_k^{\alpha} = \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N} \frac{Gm_\beta\left(x_k^\beta - x_k^\alpha\right)}{\left|x^\beta - x^\alpha\right|^3} - \nabla\Phi_{ext} \tag{8}$$

Lets define Energy tensor (in the external field ϕ_{ext})

$$\frac{d^2 I_{jk}}{dt^2} = 2\sum_{\alpha=1}^{N} m_\alpha \left(\overset{\circ}{x}{}_j^\alpha \overset{\circ}{x}{}_k^\alpha \right) + \sum_{\substack{\alpha=1\\ \alpha\neq\beta}}^{N} \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N} \frac{Gm_\alpha m_\beta\left\{ \left(x_k^\beta - x_k^\alpha\right)x_j^\alpha + \left(x_j^\beta - x_j^\alpha\right)x_k^\alpha \right\}}{\left|x^\beta - x^\alpha\right|^3}$$
$$- \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_j^\alpha - \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_k^\alpha \tag{9}$$

Lets denote Potential energy tensor = Wjk =

$$\sum_{\substack{\alpha=1\\ \alpha\neq\beta}}^{N} \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N} \frac{Gm_\alpha m_\beta\left\{ \left(x_k^\beta - x_k^\alpha\right)x_j^\alpha + \left(x_j^\beta - x_j^\alpha\right)x_k^\alpha \right\}}{\left|x^\beta - x^\alpha\right|^3} \tag{10}$$

Lets denote Kinetic energy tensor = 2 K_{jk} = $2\sum_{\alpha=1}^{N} m_\alpha \left(\overset{\circ}{x}{}_j^\alpha \overset{\circ}{x}{}_k^\alpha \right)$ (11)

Lets denote External potential energy tensor = 2 Φ_{jk}

$$= \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_j^\alpha + \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_k^\alpha \tag{12}$$

Hence $$\frac{d^2 I_{jk}}{dt^2} = W_{jk} + 2K_{jk} - 2\Phi_{jk} \tag{13}$$

Here in this case

$$F(\alpha) = \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N} F_{\alpha\beta} - \nabla_\alpha \Phi_{ext}(\alpha) m_\alpha$$
$$= \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N} \frac{Gm_\alpha m_\beta\left(x^\beta - x^\alpha\right)}{\left|x^\beta - x^\alpha\right|^3} - \nabla\Phi_{ext} m_\alpha \tag{14}$$

$$= \left\{ \overset{\circ\circ\,\alpha}{x}(\text{int}) - \nabla_{\alpha}\Phi_{ext}(\alpha) \right\} m_{\alpha} \qquad (15)$$

$$\overset{\circ\circ}{x}(\alpha) = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{Gm_{\beta}\left(x^{\beta} - x^{\alpha}\right)}{\left|x^{\beta} - x^{\alpha}\right|^{3}} - \nabla\Phi_{ext} \qquad (16)$$

We know that the total force at $x(\alpha) = F_{tot}(\alpha) = -\nabla_{\alpha}\Phi_{tot}(\alpha) m_{\alpha}$

Total PE at $\alpha = m_{\alpha}\Phi_{tot}(\alpha) = -\int F_{tot}(\alpha)dx$

$$= -\int \left\{ \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \overset{\circ\circ\,\alpha}{x}_{\text{int}} m_{\alpha} - \nabla_{\alpha}\Phi_{ext}(\alpha) m_{\alpha} - \right\} dx$$

$$= \int \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{Gm_{\beta}m_{\alpha}\left(x^{\beta} - x^{\alpha}\right)}{\left|x^{\beta} - x^{\alpha}\right|^{3}} dx - \int \nabla\Phi_{ext} m_{\alpha} dx \qquad (17)$$

Therefore total Gravitational potential ϕ_{tot} (α) at x (α) per unit mass

$$\Phi_{tot}(\alpha) = \Phi_{ext} - \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{Gm_{\beta}}{\left|x^{\beta} - x^{\alpha}\right|} \qquad (18\text{-s})$$

Lets discuss the properties of ϕ_{ext} :-

ϕ_{ext} can be subdivided into 3 parts mainly

ϕ_{ext} due to higher level system, ϕ_{ext} -due to lower level system, ϕ_{ext} due to present level. [Level : when we are considering particles in the same system (Galaxy) it is same level, higher level is cluster of galaxies, and lower level is planets & asteroids].

ϕ_{ext} due to lower levels : If the lower level is existing, at the lower level of the system under consideration, then its own level was considered by system equations. If this lower level exists anywhere outside of the system, center of (mass) gravity outside systems (Galaxies) will act as unit its own internal lower level practically will be considered into calculations. Hence consideration of any lower level is not necessary.

SYSTEM – ENSEMBLE:

Until now we have considered the system level equations and the meaning of ϕ_{ext} Now let's consider an ENSEMBLE of system consisting of N_1, N_2 … Nj particles in each. These systems are moving in the ensemble due to mutual gravitation between them. For example, each system is a Galaxy, then ensemble represents a local group. Suppose number of Galaxies is j, Galaxies are systems with particles N1, N2 ….NJ, we will consider ϕ_{ext} as discussed above. That is we will consider the effect of only higher level system like external Galaxies as a whole, or external local groups as a whole.

Ensemble Equations (Ensemble consists of many systems)

$$\frac{d^2 I^{\gamma}{}_{jk}}{dt^2} = W^{\gamma}_{jk} + 2K^{\gamma}_{jk} - 2\Phi^{\gamma}_{jk} \qquad \text{(18-E)}$$

Here $^{\gamma}$ denotes Ensemble.

This Φ^{γ}jk is the external field produced at system level. And for system

$$\frac{d^2 I_{jk}}{dt^2} = W_{jk} + 2K_{jk} - 2\Phi_{jk} \qquad (13)$$

Assume ensemble in a isolated place. Gravitational potential $\phi_{ext}(\alpha)$produced at system level is produced by Ensemble and $\phi^{\gamma}{}_{ext}(\alpha) = 0$ as ensemble is in a isolated place.

$$\Phi^{\gamma}_{tot}(\alpha) = \Phi^{\gamma}_{ext} - \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N^{\gamma}} \frac{Gm^{\gamma}_{\beta}}{\left|x^{\gamma\beta} - x^{\gamma\alpha}\right|} \qquad (19)$$

There fore

$$\Phi^{\gamma}_{tot} = \Phi_{ext}(\alpha) = -\sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\gamma}} \frac{Gm^{\gamma}_{\beta}}{\left|x^{\gamma\beta} - x^{\gamma\alpha}\right|} \tag{20}$$

And $$2\Phi_{jk} = -\frac{d^2 I_{jk}}{dt^2} + W_{jk} + 2K_{jk} \tag{13}$$

$$= \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_{\alpha} x^{\alpha}_{j} + \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_{\alpha} x^{\alpha}_{k} \tag{21}$$

AGGREGATE Equations(Aggregate consists of many Ensembles)

$$\frac{d^2 I^{\delta\gamma}_{jk}}{dt^2} = W^{\delta\gamma}_{jk} + 2K^{\delta\gamma}_{jk} - 2\Phi^{\delta\gamma}_{jk} \tag{18-A}$$

Here $^{\delta}$ denotes Aggregate.

This $\Phi^{\delta\gamma}$jk is the external field produced at Ensemble level. And for Ensemble

$$\frac{d^2 I^{\gamma}{}_{jk}}{dt^2} = W^{\gamma}_{jk} + 2K^{\gamma}_{jk} - 2\Phi^{\gamma}_{jk} \tag{18-E}$$

Assume Aggregate in an isolated place. Gravitational potential ϕ_{ext} (α) produced at Ensemble level is produced by Aggregate and $\phi^{\delta\gamma}{}_{ext}(\alpha) = 0$ as Aggregate is in a isolated place.

$$\Phi^{\delta\gamma}_{tot}(\alpha) = \Phi^{\delta\gamma}_{ext} - \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\delta\gamma}} \frac{Gm^{\delta\gamma}_{\beta}}{\left|x^{\delta\gamma\beta} - x^{\delta\gamma\alpha}\right|} \tag{22}$$

Therefore $$\Phi^{\delta\gamma}_{tot}(\,_{Aggregate}) = \Phi^{\gamma}_{ext}(\alpha)(\,_{Ensemble}) = -\sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\delta\gamma}} \frac{Gm^{\delta\gamma}_{\beta}}{\left|x^{\delta\gamma\beta} - x^{\delta\gamma\alpha}\right|} \tag{23}$$

And $$\Phi^{\gamma}_{jk} = \sum_{\alpha=1}^{N^{\gamma}} \nabla\Phi^{\delta}_{ext}\, m_{\alpha} x^{\delta\alpha}_{j} + \sum_{\alpha=1}^{N} \nabla\Phi^{\delta}_{ext}\, m_{\alpha} x^{\delta\alpha}_{k} \tag{24}$$

Total AGGREGATE Equations :(Aggregate consists of many Ensembles and systems)

Assuming these forces are conservative, we can find the resultant force by adding separate forces vectorially from equations (20) and (23).

$$\Phi_{ext}(\alpha) = -\sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N^{\gamma}} \frac{Gm_{\beta}^{\gamma}}{\left|x^{\gamma\beta} - x^{\gamma\alpha}\right|} - \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N^{\delta\gamma}} \frac{Gm_{\beta}^{\delta\gamma}}{\left|x^{\delta\gamma\beta} - x^{\delta\gamma\alpha}\right|} \qquad (25)$$

This concept can be extended to still higher levels in a similar way.

Corollary 1:

$$\frac{d^2 I_{jk}}{dt^2} = W_{jk} + 2K_{jk} - 2\Phi_{jk} \qquad (13)$$

The above equation becomes scalar Virial theorem in the absence of external field, that is $\phi=0$ and in steady state,

i.e. $$\frac{d^2 I_{jk}}{dt^2} = 0 \qquad (27)$$

$$2K + W = 0 \qquad (28)$$

But when the N-bodies are moving under the influence of mutual gravitation without external field then only the above equation (28) is applicable.

Corollary 2:

Ensemble achieved a steady state,

i.e. $$\frac{d^2 I_{jk}^{\gamma}}{dt^2} = 0 \qquad (29)$$

$$W^{\gamma}_{jk} + 2K^{\gamma}_{jk} = 2\Phi^{\gamma}_{jk} \quad (30)$$

This Φjk external field produced at system level. Ensemble achieved a steady state; means system also reached steady state.

i.e. $$\frac{d^2 I_{jk}}{dt^2} = 0 \quad (27)$$

$$W_{jk} + 2K_{jk} = 2\Phi^{\gamma}_{jk} \quad (31)$$

4. Dynamic Universe model: Numerical Results & Outputs

One of the possible implementations of Equations 25 of Dynamic Universe model: SITA (*Simulation of Inter-intra-Galaxy Tautness and Attraction forces*)

Method of Calculations

SITA is very simple and straightforward. SITA uses equation no 25 as shown in the Mathematical formulation for calculating the resultant Universal Gravitational Force on the mass, in the basis of equations 13 (or 18-A or 18-E). We repeat this for every time step and for every mass. We do not require any complicated programming. Simple recursive programming can be used. All these were computed on a 486 based PC about 18 years back for 133 masses. The same setup was used on the current PCs & Laptops now. I didn't want to change anything, as I want to test the same setup for all the different applications.

Computer and Accuracies

The values of outputs can be calculated using calculator or computer. For higher accuracies, the iterations and value of timestep are to be optimized. Higher number of iterations takes a long time even for the 133 masses. For example, my laptop took about 5 hours to compute the Pioneer anomaly model with 1 sec time step and 2000 iterations. Double precision floating-point values have roughly 16 significant digits of precision. I have not used any number with further higher precision. I used higher time step values, if no trends are observed in the movement of point masses at 16-digit precision. If the data is just simulation data, it can be observed further also. However, for the real data the higher time step resulting values are meaningless. Again, we should know that accuracies of our results depend on the accuracy of the input data, such as distances, masses of astronomical bodies and their positions etc.

Time step

In this Dynamic Universe Model (in SITA simulations), time step is amount of time between iterations. Here we can change time step for every iteration and specify the number of iterations it has to compute. At each step this SITA simulation tracks and gives out lists of Accelerations, velocities (initial and final) and positions of each mass, with 16 digit accuracies. If the differences in velocities are small, at that accuracy level, we have to use higher time step vales for testing the trend of large-scale structures.

SITA Calculation OUTPUTS: OUTPUTS after 220 iterations with 24hrs Time-step

The SITA calculated outputs of non-collapsing point masses after 220 iterations of 24 hour time-steps are given below in the table 2. ux, uy, uz are x, y, z velocities. sx, sy, sz are x, y, z positions for each mass # in the first column.

Table 2: This table describes SITA outputs velocity and positions after 220 iterations of 24 hour time-step

Mass No.	u x (b1) velocity x m/sec	u y (b2) velocity y m/sec	u z (b3) velocity z m/sec	s x (a1) Position x meters	Sy (a2) Position y meters	Sz (a3) Position z meters
1	5910.475287	-15727.84869	602.0358627	1.31442E+11	-2.10854E+12	60123860323
2	1515.491698	-31300.09708	-2695.918095	-1.08644E+11	-62585674556	4859539426
3	-1828.169074	31741.76598	540.3752709	1.27107E+11	9429186696	-7205348169
4	21967.05386	17694.02539	-0.7613474	1.07025E+11	-1.22802E+11	3983952.514
5	-15140.39422	20071.13526	792.4411952	1.61332E+11	1.51712E+11	-782015907.2
6	7997.051973	10844.24963	-223.9644393	5.90358E+11	-4.69402E+11	-11262026007
7	-1603.042402	-9612.751852	230.898668	-1.40105E+12	1.58683E+11	52994601955
8	661.9794762	6461.3927	15.46063671	2.99041E+12	-3.09864E+11	-39882635995
9	3101.241258	4483.443198	-163.7665483	3.67452E+12	-2.58398E+12	-31471133568
10	5556.287859	-819.2750731	-1509.729058	1.74961E+11	-4.71521E+12	4.54158E+11
11	22681.82274	16251.78272	18.70934883	1.04161E+11	-1.30332E+11	-135710382.3
12	2.209718569	-3.110434811	-0.033286597	17900665.41	-28360265.62	-205941.1773
13	-0.002464296	0.000158851	-0.001357868	-3.07379E+16	-2.48085E+16	5.99014E+15
14	-0.051559836	-0.032426184	-0.023584373	-1.70141E+16	-4.49612E+13	3.79378E+16
15	0.039925529	0.028281984	0.017840304	-1.71774E+16	-1.53305E+14	3.78638E+16
16	-0.002468035	0.000155086	-0.001369146	-1.85801E+15	1.6393E+15	-5.61485E+16
17	-0.002470093	0.000156481	-0.001368848	9.02924E+15	-7.13182E+15	-7.77879E+16
18	-0.002464736	0.000159942	-0.001362136	-3.1682E+16	-2.99664E+16	6.86968E+16
19	-0.00247557	0.000154419	-0.001362404	2.37665E+16	-7.07555E+15	8.82862E+16
20	-0.002474501	0.000155611	-0.001364599	9.77757E+16	-1.69837E+16	3.32855E+15
21	-0.00247535	0.000153146	-0.001377383	-1.75629E+16	-2.0874E+16	9.78004E+16
22	-0.002472328	0.000151414	-0.001360985	3.82107E+16	6.00795E+16	7.44241E+16
23	-0.003770704	0.000528384	-0.00114056	-4.50486E+16	3.01003E+16	9.28066E+16
24	-0.002469496	0.000151538	-0.001370699	-8.42312E+15	5.24915E+16	-9.39112E+16
25	-0.000458862	-0.000430361	-0.001701167	-4.60396E+16	3.03873E+16	9.29744E+16
26	-0.00226571	0.000487014	-0.001433322	4.90495E+16	9.64605E+16	7.35909E+15
27	-0.002656395	-0.000148102	-0.001302004	4.99158E+16	9.78689E+16	7.06783E+15
28	-0.002467785	0.000162973	-0.001364166	-1.39114E+16	-1.09124E+17	4.36506E+15
29	-0.002463355	0.000161052	-0.001364647	-6.28738E+16	-8.89396E+16	-2.56335E+16
30	-0.002461652	0.000162513	-0.001362628	-6.90623E+16	-8.50246E+16	2.58319E+16
31	-0.002470225	0.000152094	-0.001364984	-2.35768E+16	2.08864E+16	1.10275E+17
32	-0.002468653	0.000163712	-0.001374114	1.86257E+16	-5.54342E+16	-1.01576E+17
33	-0.002470083	0.000160161	-0.001375966	-5.04468E+16	3.78032E+16	-1.03142E+17

Mass No.	u x (b1) velocity x m/sec	u y (b2) velocity y m/sec	u z (b3) velocity z m/sec	s x (a1) Position x meters	Sy (a2) Position y meters	Sz (a3) Position z meters
34	-0.002470303	0.000156063	-0.001368508	2.09805E+16	-4.31965E+16	-1.11915E+17
35	-0.002464204	0.000162214	-0.001371535	-3.34107E+16	-3.81344E+16	1.12791E+17
36	-0.002475725	0.000154628	-0.001366885	1.20105E+17	-5.23499E+15	-4.10595E+16
37	-0.002465069	0.000154167	-0.001382799	-5.81398E+16	4.54439E+16	-1.08443E+17
38	-0.00246217	0.000152771	-0.001365415	-1.07352E+17	7.50846E+16	-1.2264E+16
39	-0.002470801	0.000149511	-0.001362427	2.96095E+16	1.22996E+17	4.58116E+16
40	-0.002473992	0.000156306	-0.001370733	8.24904E+16	-2.35538E+16	-1.05478E+17
41	-0.002455634	0.000145773	-0.001353434	-6.10305E+16	4.80435E+16	-1.15415E+17
42	-0.002475274	0.000151941	-0.001370158	9.76996E+16	2.14625E+16	-9.75422E+16
43	-0.002470582	0.000149549	-0.001365984	2.15194E+16	1.34558E+17	-3.20268E+16
44	-0.002463954	0.000158212	-0.001371579	-5.35209E+16	-2.81642E+16	-1.29127E+17
45	-0.002467273	0.000161697	-0.001377826	1.14625E+16	1.39712E+16	-1.43945E+17
46	-0.002460056	0.000156195	-0.001369196	-1.32781E+17	1.60851E+16	-6.59031E+16
47	-0.002465861	0.000148898	-0.001370511	-4.78813E+16	9.19484E+16	-1.08903E+17
48	-0.002468003	0.000161818	-0.001369019	1.04974E+16	-1.34655E+17	-7.02332E+16
49	-0.002463514	0.000155674	-0.001361333	-4.59519E+16	8.94752E+15	1.44982E+17
50	-0.002476396	0.000151568	-0.001367355	1.36804E+17	5.36738E+16	-5.10992E+16
51	-0.00247321	0.000150497	-0.00137338	1.77107E+16	2.7082E+16	-1.52249E+17
52	-0.002462189	0.000152107	-0.001361353	-1.0952E+17	9.68318E+16	5.3829E+16
53	-0.002465966	0.000162993	-0.001362435	-4.72306E+16	-1.16764E+17	9.36129E+16
54	-0.002471562	0.000160008	-0.001360401	9.79121E+16	-9.2465E+16	8.39443E+16
55	-0.002475072	0.000151017	-0.001360692	1.09829E+17	9.70466E+16	6.62157E+16
56	-0.002461614	0.000163698	-0.0013662	-9.10748E+16	-1.36971E+17	-2.48893E+16
57	-0.002465938	0.00015296	-0.001358948	-7.0043E+16	9.14497E+16	1.2171E+17
58	-0.002466413	0.000152901	-0.001358625	-2.64948E+16	4.32255E+16	1.61635E+17
59	-0.002467701	0.000150113	-0.00135869	-3.16721E+16	1.25283E+17	1.1067E+17
60	-0.002469958	0.000149831	-0.001353449	4.73982E+16	1.59067E+15	1.63433E+17
61	-0.002486007	0.000158052	-0.001362158	1.20195E+17	-9.0224E+16	8.74395E+16
62	-0.002463479	0.000168337	-0.001361111	-5.75703E+16	-1.4009E+17	8.88539E+16
63	-0.002472191	0.000157459	-0.001373348	6.76572E+16	-4.60048E+16	-1.57068E+17
64	-0.002459786	0.000163753	-0.001362046	-9.2162E+16	-1.20447E+17	9.30606E+16
65	-0.00246969	0.000148106	-0.001365606	5.72296E+15	1.76608E+17	-2.27853E+16
66	-0.002458931	0.00016218	-0.001365342	-1.34996E+17	-1.16182E+17	-1.30636E+16
67	-0.002463545	0.000158208	-0.001370658	-1.19512E+17	4.88067E+16	-1.2445E+17
68	-0.002474649	0.000153073	-0.001372424	7.87302E+16	1.638E+16	-1.62411E+17
69	-0.002472006	0.000148725	-0.001369484	3.91777E+16	1.47326E+17	-9.98492E+16
70	-0.002477317	0.000154541	-0.001368672	1.67294E+17	-1.18466E+16	-7.32836E+16
71	-0.00245805	0.000161237	-0.001362751	-1.39077E+17	-9.10857E+16	7.67253E+16
72	-0.002471747	0.000158632	-0.001358174	5.24234E+16	-1.59364E+16	1.75315E+17
73	-0.002464528	0.000136412	-0.001373551	3.6434E+15	2.91335E+16	-1.81794E+17
74	-0.00246106	0.000151041	-0.001358995	-9.07771E+16	1.01639E+17	1.23937E+17
75	-0.002472696	0.000168957	-0.001368515	6.41076E+15	1.79687E+16	-1.83691E+17
76	-0.002469123	0.000156481	-0.001356802	-2.06314E+15	-5.39393E+15	1.86646E+17
77	-0.002474453	0.000156791	-0.001357453	1.0974E+17	-3.31921E+16	1.4771E+17
78	-0.002457421	0.000161794	-0.001363087	-1.54154E+17	-1.01333E+17	3.85252E+16
79	-0.002468827	0.000163094	-0.001365212	4.30221E+16	-1.83542E+17	8.55871E+15
80	-0.003064845	-0.00073147	-0.001213938	-1.30645E+17	6.84493E+16	-1.20949E+17
81	-0.001911056	0.000955296	-0.001515176	-1.31276E+17	6.75268E+16	-1.20784E+17
82	-0.002544975	4.55475E-05	-0.00125307	-1.33898E+17	-5.20951E+16	1.2578E+17
83	-0.002467079	0.000149942	-0.00137282	-2.19059E+16	6.93128E+16	-1.77114E+17

Mass No.	u x (b1) velocity x m/sec	u y (b2) velocity y m/sec	u z (b3) velocity z m/sec	s x (a1) Position x meters	Sy (a2) Position y meters	Sz (a3) Position z meters
84	-0.002470795	0.0001521	-0.001356021	3.99999E+16	8.00904E+16	1.70731E+17
85	-0.002465991	0.00015764	-0.00137283	-2.19758E+16	-1.28321E+16	-1.9175E+17
86	-0.002364476	0.000284116	-0.001477228	-1.3524E+17	-5.38681E+16	1.27447E+17
87	-0.002460653	0.000158651	-0.001359271	-2.07383E+16	-9.28974E+15	1.93754E+17
88	-0.002474235	0.000151901	-0.001356412	1.01434E+17	8.45481E+16	1.45159E+17
89	-0.002473009	0.00015774	-0.001372248	7.37726E+16	-5.17702E+16	-1.79009E+17
90	-0.002459571	0.000154979	-0.001359061	-1.50711E+17	6.46728E+16	1.16827E+17
91	-0.002465589	0.000160901	-0.001373995	-3.30768E+16	-1.22256E+17	-1.58766E+17
92	0.000442375	0.000401049	-3.83557E-05	-1.16925E+21	-1.04245E+21	9.31497E+19
93	0.003803614	0.006914201	0.000806221	-1.79414E+20	-3.61781E+20	-1.42253E+19
94	-0.005142607	-0.002815937	-0.006321059	1.48744E+19	2.77665E+19	-7.91706E+19
95	-0.004177973	4.22769E-06	-0.000857872	6.94375E+19	-4.44352E+18	7.944E+17
96	-0.011074725	0.010619145	-0.003161483	9.11252E+19	-4.39257E+19	1.89032E+20
97	-0.004617405	0.004756623	0.004092354	1.05314E+20	2.06504E+19	8.97721E+19
98	-0.005388578	-0.001972755	0.004089945	1.25702E+20	6.15542E+19	3.76993E+19
99	-0.00250151	-0.004719761	0.001341646	1.5288E+20	2.40773E+19	-1.58338E+19
100	0.000225841	-0.00751807	0.004236846	1.74887E+20	1.35743E+19	-3.13919E+19
101	-0.006134485	-0.006635199	0.001264402	1.85602E+20	5.87126E+19	1.50955E+19
102	-0.013101028	-0.005222574	0.00549374	2.00762E+20	1.02368E+20	7.89348E+19
103	-0.00945309	-0.003136138	0.005509283	2.21232E+20	1.03194E+19	-1.15685E+20
104	-0.012321318	-0.022091125	-0.005180265	2.40926E+20	2.38732E+19	8.08095E+18
105	-0.07519431	-0.062663543	-0.015628882	2.52521E+20	-1.04214E+19	-1.90968E+18
106	-0.017779846	-0.012897603	-0.008292059	2.63724E+20	1.58631E+19	2.36248E+19
107	-0.025314774	-0.012074075	5.23593E-05	2.80244E+20	4.57404E+18	-5.62166E+18
108	-0.025794071	-0.000356102	-0.003810407	2.93615E+20	-2.52379E+19	6.36066E+18
109	-0.015869851	-0.002534395	-0.002083119	3.13834E+20	-1.18077E+18	1.46617E+19
110	-0.007252176	0.004112963	0.000270041	3.35306E+20	-1.68075E+20	-3.47826E+19
111	-0.007365087	-0.000783614	0.002306391	3.72364E+20	1.37362E+19	-1.25647E+20
112	-0.004300378	-0.00150414	-0.000566818	4.87315E+20	1.74393E+20	8.66073E+19
113	-0.003009127	-2.84509E-07	-0.00040234	6.49171E+20	1.82615E+18	9.06719E+19
114	-0.000960474	-0.000135681	-0.000435451	1.0232E+21	1.53107E+20	4.80442E+20
115	0.022331439	-0.02454065	-0.000613689	4.79211E+19	1.67483E+20	1.56991E+20
116	0.00979823	-0.008827718	-0.000857414	-1.63642E+20	1.47838E+20	-7.97417E+19
117	-0.016704981	0.004379317	-0.00200246	1.54517E+20	8.22578E+19	1.56049E+20
118	0.01641827	-0.018142947	-0.008728068	-1.14673E+19	4.68166E+19	2.29499E+20
119	0.007962355	0.00239502	-0.009089229	-8.86592E+19	-1.0611E+19	2.16841E+20
120	-0.004725189	0.015212276	-0.00143162	5.62463E+19	-1.61296E+20	-1.60665E+20
121	0.001924444	-0.00983119	-0.004423332	-1.1565E+20	2.03896E+20	6.68227E+18
122	0.007592531	-0.047727693	0.011034148	-3.63423E+19	1.12347E+19	-2.31401E+20
123	0.009900964	0.004602247	-0.001206977	-1.72238E+20	-7.67886E+19	1.39394E+20
124	-0.001120434	0.008630702	-0.001917258	-2.05075E+19	-2.19577E+20	7.97417E+19
125	0.010418358	-0.001777057	0.004612008	-1.58373E+20	7.45639E+19	-1.56049E+20
126	0.003362474	0.048739087	0.007204163	-3.06445E+19	-3.72049E+19	-2.29499E+20
127	-0.019723626	0.003782918	0.006688347	6.156E+19	-6.46792E+19	-2.16841E+20
128	-0.001112943	-0.013565064	-0.002595701	9.55613E+19	1.41591E+20	1.60665E+20
129	-0.008689886	0.001084915	2.68665E-05	2.32564E+20	-2.93704E+19	-6.68227E+18
130	-0.030867413	0.015779962	-0.010710298	3.07501E+19	2.23922E+19	2.31401E+20
131	-0.005956795	-0.009299515	0.002980751	4.15581E+19	1.83944E+20	-1.39394E+20
132	-1.94105E-06	-1.5556E-06	-8.69493E-07	1.74266E+22	1.50487E+22	6.79254E+21
133	1.0555E-06	-1.77064E-06	2.96274E-06	1.28546E+20	1.93083E+22	-1.82029E+22

5. SITA- ‘no singularity’ calculations

Introduction

In N-body calculations singularities (collisions) are two types. They are Binary collisions and Triple or more than three bodies, simultaneous collisions. There are other types of singularities that happen due to Input data like, zero initial data or collisions due to uniform distribution of matter, which are not dependent on fundamental process of Dynamic Universe Model, but on input data. These input data dependent singularities are not discussed here. Moreover, in the earlier models, there is no criterion known to be put on the initial state in order to avoid collisions for the corresponding solution from that model.

Here we tried to show resulting values from Dynamic Universe Model using some of the theorems developed by earlier Giants. Many of these theorems developed are for three bodies and very few (almost nil) are available for N > 3. In this scenario, some of the Dynamic Universe Model output calculations are shown here depicting some snap shots. Even though there results are verified for every iteration only one iteration input and output results are shown in the following tables in this chapter. The non-zero velocity position vector cross product, the non-zero angular momentum i.e., mass velocity position vector cross product (this angular momentum c = 0 at collision: Sundman), The non-zero Polar moment of inertia, and the non-zero internal distances between all pairs of bodies *total energy h = T –V is negative condition for stability* are results using earlier theorems. Whereas ‘velocity unit vectors for all masses will be directed towards the center of mass if all the point masses fall toward collision’ is the proposition by Dynamic universe model.

In all the earlier models the singularities are big hurdles. That's why those authors proposed the regularization methods. This regularization is nothing but introduction of '**ε**', a small constant to increment the distance between two bodies to avoid a collision, which changes the Newton's Gravitation law. Basic problem with all these earlier models is they totally ignore the resultant Universal Gravitational Force acting on the particular point mass at that place and at that time.

Many authors like Thiele (1892), Painlevé (1897), Levi-Civita (1903), Burrau (1906), Sundman (1912), and Birkhoff (1915) etc considered regularization is the only possible solution to avoid collision. And by the introduction of this regularization additional non-linearity's were introduced into the solution. Sundman found a uniformly convergent infinite series involving a known function that "solves" the restricted three-body problem in the whole plane with the singularities are removed through the process of regularization. But this Sundman's solution involves calculations using irrationally large number of terms of the order of $10^{8000000}$ for achieving any practical accuracies required for observations using telescopes. However, many of these "solutions" do not address issues of stability, allowed regions of motion, and so on, and so is of limited practical utility (Szebehely 1967).

What to see in following tables:

The results from earlier theorems:

1. The Sum of the non-zero velocity position vector cross product,for testing singularities in output" for START (Table 4) and END (Table 5) positions & velocities for the present iteration, These results are from equations from earlier theorems [see table 3]

2. The non-zero angular momentum i.e., mass velocity position vector cross product (this angular momentum c = 0 at collision: Sundman 1912), Calculations are done to show that no singularities exist in Dynamic Universe model. Position and velocity data from Iteration END (Table 8) & START (table 7) were taken calculating the non-zero "Angular Momentum" which is nothing but MASS Velocity Position Vector cross product "

3. The non-zero Polar moment of inertia for Iteration END (Table 9) & START (table 10).
4. Dynamic Universe Model is stable is shown in this section [see Table 11]. “Total Energy = h=T-V” is NEGATIVE as discussed in their book by Vladimir Igorevich Amold, Kozolov, Neishtadt. (2003)
5. The velocity unit vectors for all masses will be directed towards the center of mass at and before the time of collision. If there is a non alignment then there is NO collision which is self evident: [see table 12] This Non alignment of present velocity UNIT vectors with UNIT vectors towards Center of Mass of all point masses, shows that Dynamic Universe Model is stable and non-collapsing.
6. The non-zero internal distance between all pairs of point masses [see table 13 to 26]. The zeros in these tables show the distance when starting point and ending point are same. These distances are shown for the iteration END positions and prove that there are no Binary collisions.
7. The chaotic situations encountered in the earlier large scale N-body problem solutions as discussed by Wayne Hayes can be seen in Chapter 6. All these problems are not apparent in Dynamic Universe Model.

The constant specific relative angular momentum (velocity position vector cross product)

Theory and requirement

The two body problem equation from Chapter 1(History)

$$\ddot{\boldsymbol{r}} = \mu.\frac{\hat{\boldsymbol{r}}}{r^2} \qquad (1)$$

Where $= G.M$; M being the mass of the body causing the acceleration (i.e m_1 for the acceleration on body 2) . This problem was completely solved by Newton. Like for the movement under any central force, i.e. a force aligned with $\hat{\boldsymbol{r}}$, the specific relative angular momentum $\boldsymbol{H} = \boldsymbol{r} \times \dot{\boldsymbol{r}}$ stays constant and…

$$\dot{\boldsymbol{H}} = \overbrace{\boldsymbol{r} \times \dot{\boldsymbol{r}}}^{\cdot} = \dot{\boldsymbol{r}} \times \dot{\boldsymbol{r}} + \boldsymbol{r} \times \ddot{\boldsymbol{r}} = \mathbf{0} + \mathbf{0} = \mathbf{0}$$

$$(\mathbf{a} \times \mathbf{b} = \mathbf{i}a_2b_3 + \mathbf{j}a_3b_1 + \mathbf{k}a_1b_2 - \mathbf{i}a_3b_2 - \mathbf{j}a_1b_3 - \mathbf{k}a_2b_1.)$$

Results conclusions and Inferences

This result is existing in the scientific literature almost from the Newtonian times. This theorem says that the time derivative of specific relative angular momentum of the N-body system (2–body) is zero and specific relative angular momentum H stays constant. So, ‘sum’ and ‘individual position and velocity cross products H’ were calculated for many iterations, they were staying constant.

One example was given below. The Sum of the velocity position vector cross product or the specific relative angular momentum, for START positions and velocities of present iteration is given in Table 4. Table 5 gives the same for positions & velocities of the END of the present iteration. First column in table 4 and 5 gives lists the point mass number and later x, y & z values for each point mass. It can be observed the x, y & z values and their totals are non-zero and not changing much in value. We can cross check from table to table. Further grand totals and essence can be seen in see table 3. Their vector sum is also same. Hence this test implies the Dynamic universe model is stable and Newtonian.

Table 3: This table is a comparison table: This table compares "sum of the constant specific relative angular momentum (velocity position vector cross product) for testing singularities in output" using the positions & velocities for the present iteration at the START of iteration (Table 4) and after the END of iteration (Table 5).

Constant specific relative angular momentum (Velocity and position vector cross product sum)				
Iteration	X	Y	Z	Vector sum
End of Itr	-2.64218E+18	3.73712E+18	-3.4955E+19	3.52534E+19
Start of Itr	-2.64218E+18	3.73711E+18	-3.4955E+19	3.52534E+19

Table 4 This table describes "Sum of the constant specific relative angular momentum (velocity position vector cross product) for testing singularities in output" using the positions & velocities for the present iteration at the START of iteration.

Constant specific relative angular momentum at START of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
1	3.238E+14	2.76228E+14	1.03952E+16
2	-3.20913E+14	-2.85604E+14	3.49632E+15
3	-2.33861E+14	-5.5526E+13	4.0528E+15
4	-23004170095	1.69019E+11	4.59181E+15
5	-1.35925E+14	-1.16011E+14	5.53534E+15
6	-2.27258E+14	4.21562E+13	1.01558E+16
7	-5.46064E+14	2.38547E+14	1.37223E+16
8	-2.52907E+14	-7.26351E+13	1.95273E+16
9	-5.64269E+14	5.04164E+14	2.4488E+16
10	-7.49076E+15	2.78758E+15	2.60557E+16
11	2.32919E+11	-5.0275E+12	4.64948E+15
12	-303475.4905	140788.2491	6990283.702
13	-3.27351E+13	-5.64994E+13	-6.60182E+13
14	-1.23124E+15	-2.35733E+15	5.49384E+14
15	1.0736E+15	1.81818E+15	-4.79689E+14
16	-6.4634E+12	1.36033E+14	3.75771E+12
17	-2.19347E+13	2.04503E+14	-1.62034E+13
18	-2.98307E+13	-2.12475E+14	-7.89264E+13
19	3.99333E+12	-1.86179E+14	-1.3846E+13
20	-2.2658E+13	1.25188E+14	-2.68113E+13
21	-1.37738E+13	-2.66281E+14	-5.43602E+13
22	9.30362E+13	-1.31997E+14	1.54322E+14
23	8.33688E+13	-4.01327E+14	8.96965E+13
24	5.77189E+13	2.20368E+14	1.28351E+14
25	1.16813E+13	-1.20984E+14	3.37572E+13
26	1.41843E+14	5.36301E+13	2.42439E+14
27	1.26379E+14	4.62156E+13	2.52586E+14

Constant specific relative angular momentum at START of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
28	-1.48152E+14	-2.97495E+13	-2.71563E+14
29	-1.25499E+14	-2.26561E+13	-2.29216E+14
30	-1.11659E+14	-1.57695E+14	-2.20525E+14
31	4.52818E+13	-3.04587E+14	4.80082E+13
32	-9.28022E+13	2.76351E+14	-1.33798E+14
33	3.54966E+13	1.85356E+14	8.52974E+13
34	-7.65805E+13	3.05176E+14	-1.03434E+14
35	-3.40064E+13	-3.23763E+14	-9.93907E+13
36	-1.35046E+13	2.65822E+14	5.61121E+12
37	4.61215E+13	1.86923E+14	1.03059E+14
38	1.00648E+14	-1.16384E+14	1.68471E+14
39	1.74422E+14	-7.28506E+13	3.08325E+14
40	-4.87728E+13	3.74024E+14	-4.53782E+13
41	4.81993E+13	2.00816E+14	1.09081E+14
42	1.45863E+13	3.75308E+14	6.79701E+13
43	1.79015E+14	1.0852E+14	3.35656E+14
44	-5.90589E+13	2.44754E+14	-7.7863E+13
45	-4.02561E+12	3.70946E+14	3.63242E+13
46	1.17298E+13	-1.96778E+13	1.88304E+13
47	1.09801E+14	2.02918E+14	2.19603E+14
48	-1.9571E+14	1.87707E+14	-3.3063E+14
49	3.47505E+13	-4.19722E+14	1.48889E+13
50	6.56462E+13	3.13602E+14	1.53653E+14
51	1.42809E+13	4.00868E+14	6.9645E+13
52	1.4001E+14	-2.81633E+14	2.21759E+14
53	-1.43825E+14	-2.95195E+14	-2.95634E+14
54	-1.12358E+14	-7.42737E+13	-2.12866E+14
55	1.4205E+14	-1.44449E+13	2.56784E+14
56	-1.91204E+14	-6.31586E+13	-3.52077E+14
57	1.42892E+14	-3.95313E+14	2.14796E+14
58	8.34414E+13	-4.34654E+14	1.02561E+14
59	1.86833E+14	-3.16133E+14	3.04406E+14
60	2.66403E+13	-3.39522E+14	1.10306E+13
61	-1.09079E+14	-5.36501E+13	-2.053E+14
62	-1.75721E+14	-2.97249E+14	-3.54801E+14
63	-8.79123E+13	4.81219E+14	-1.03079E+14
64	-1.48816E+14	-3.54438E+14	-3.11366E+14
65	2.37802E+14	6.40879E+13	4.37014E+14
66	-1.60747E+14	-1.52194E+14	-3.07578E+14
67	4.72083E+13	1.42779E+14	1.0133E+14
68	-2.38053E+12	5.09961E+14	5.25861E+13
69	1.86911E+14	3.00481E+14	3.70018E+14
70	-2.75395E+13	4.10517E+14	-3.49416E+12
71	-1.11756E+14	-3.78122E+14	-2.46318E+14
72	6.16626E+12	-3.62135E+14	-3.10748E+13
73	1.52175E+13	4.5304E+14	7.22973E+13
74	1.56846E+14	-4.28381E+14	2.36429E+14
75	-6.44536E+12	4.62984E+14	4.55142E+13
76	2.1888E+13	-4.63651E+14	-1.36411E+13
77	-2.18971E+13	-2.16535E+14	-6.4926E+13

Constant specific relative angular momentum at START of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
78	-1.31892E+14	-3.04799E+14	-2.73959E+14
79	-2.49178E+14	3.76043E+13	-4.46116E+14
80	1.71564E+14	2.12095E+14	3.05349E+14
81	-1.30697E+13	3.19199E+13	3.64049E+12
82	-5.95499E+13	-4.8789E+14	-1.3868E+14
83	6.85971E+13	4.0688E+14	1.67715E+14
84	1.34572E+14	-3.676E+14	2.03971E+14
85	-4.78437E+13	4.42684E+14	-3.5108E+13
86	-4.33657E+13	-5.01125E+14	-1.65793E+14
87	1.8112E+13	-5.0495E+14	-2.6149E+13
88	1.36732E+14	-2.21572E+14	2.246E+14
89	-9.92785E+13	5.43925E+14	-1.16391E+14
90	1.06E+14	-4.92171E+14	1.3571E+14
91	-1.93525E+14	3.46004E+14	-3.06756E+14
92	-2.62636E+15	-3.6404E+15	-7.77316E+15
93	1.93319E+17	9.05399E+16	1.35569E+17
94	3.98453E+17	5.01165E+17	1.00907E+17
95	-3.80862E+15	5.62495E+16	-1.82714E+16
96	1.86849E+18	-1.80539E+18	4.81206E+17
97	3.42503E+17	-8.45497E+17	5.96291E+17
98	-3.26125E+17	-7.1726E+17	8.371E+16
99	4.24284E+16	-1.65502E+17	-6.61325E+17
100	1.78495E+17	-7.48058E+17	-1.31788E+18
101	-1.74398E+17	-3.27279E+17	-8.71336E+17
102	-9.74627E+17	-2.13706E+18	2.92633E+17
103	3.0595E+17	-1.25252E+17	-5.96263E+17
104	-5.4848E+16	1.14849E+18	-5.02818E+18
105	-4.32071E+16	4.09022E+18	-1.66075E+19
106	-1.73166E+17	1.76677E+18	-3.11936E+18
107	6.76369E+16	1.27638E+17	-3.26789E+18
108	-9.84317E+16	9.54726E+17	-7.55545E+17
109	-3.96181E+16	4.21074E+17	-8.14117E+17
110	-9.76723E+16	1.61703E+17	1.60192E+17
111	6.6778E+16	6.65869E+16	-1.90621E+17
112	-3.14205E+16	-9.62252E+16	1.69652E+16
113	7.08936E+14	-1.16556E+16	5.31042E+15
114	1.48389E+15	-1.58995E+16	8.22709E+15
115	-3.74988E+18	3.53524E+18	-4.91616E+18
116	8.30695E+17	-9.21636E+17	-3.96419E+15
117	8.48106E+17	-2.29738E+18	2.0508E+18
118	-3.75518E+18	3.66789E+18	-5.60597E+17
119	4.22893E+17	9.20725E+17	-1.27852E+17
120	-2.675E+18	8.39696E+17	9.34819E+16
121	8.36206E+17	-4.98699E+17	7.44591E+17
122	1.09203E+19	-1.35591E+18	1.64923E+18
123	5.48846E+17	1.17225E+18	-3.24001E+16
124	2.67242E+17	-1.28663E+17	-4.23015E+17
125	-6.65814E+16	-8.95355E+17	-4.95395E+17
126	-1.09176E+19	-5.50917E+17	-1.36849E+18
127	-3.87696E+17	3.86516E+18	-1.04283E+18

Constant specific relative angular momentum at START of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
128	-1.8119E+18	6.92377E+16	-1.13871E+18
129	-6.46062E+15	5.182E+16	-2.91325E+15
130	3.89132E+18	-6.8134E+18	1.17642E+18
131	7.48011E+17	7.0647E+17	7.09245E+17
132	2.51829E+15	1.96769E+15	2.10144E+15
133	-2.49747E+16	-1.95939E+16	-2.06074E+16

Table 5: This table describes "sum of the constant specific relative angular momentum (velocity position vector cross product) for testing singularities in output" using the positions & velocities for the present iteration after the END of iteration (Table 5)

Constant specific relative angular momentum at END of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
1	3.23799E+14	2.76228E+14	1.03952E+16
2	-3.2083E+14	-2.85531E+14	3.49541E+15
3	-2.33806E+14	-5.55128E+13	4.05183E+15
4	-23002515312	1.68999E+11	4.59128E+15
5	-1.35919E+14	-1.16006E+14	5.53508E+15
6	-2.27258E+14	4.21561E+13	1.01558E+16
7	-5.46064E+14	2.38547E+14	1.37223E+16
8	-2.52907E+14	-7.26351E+13	1.95273E+16
9	-5.64269E+14	5.04164E+14	2.4488E+16
10	-7.49076E+15	2.78758E+15	2.60557E+16
11	2.329E+11	-5.02695E+12	4.64899E+15
12	-303450.1217	140780.1897	6989352.704
13	-3.27351E+13	-5.64994E+13	-6.60182E+13
14	-1.23124E+15	-2.35733E+15	5.49384E+14
15	1.0736E+15	1.81818E+15	-4.79689E+14
16	-6.4634E+12	1.36033E+14	3.75771E+12
17	-2.19347E+13	2.04503E+14	-1.62034E+13
18	-2.98307E+13	-2.12475E+14	-7.89264E+13
19	3.99333E+12	-1.86179E+14	-1.3846E+13
20	-2.2658E+13	1.25188E+14	-2.68113E+13
21	-1.37738E+13	-2.66281E+14	-5.43602E+13
22	9.30362E+13	-1.31997E+14	1.54322E+14
23	8.33688E+13	-4.01327E+14	8.96965E+13
24	5.77189E+13	2.20368E+14	1.28351E+14
25	1.16813E+13	-1.20984E+14	3.37572E+13
26	1.41843E+14	5.36301E+13	2.42439E+14
27	1.26379E+14	4.62156E+13	2.52586E+14
28	-1.48152E+14	-2.97495E+13	-2.71563E+14
29	-1.25499E+14	-2.26561E+13	-2.29216E+14
30	-1.11659E+14	-1.57695E+14	-2.20525E+14
31	4.52818E+13	-3.04587E+14	4.80082E+13
32	-9.28022E+13	2.76351E+14	-1.33798E+14

Constant specific relative angular momentum at END of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
33	3.54966E+13	1.85356E+14	8.52974E+13
34	-7.65805E+13	3.05176E+14	-1.03434E+14
35	-3.40064E+13	-3.23763E+14	-9.93907E+13
36	-1.35046E+13	2.65822E+14	5.61121E+12
37	4.61215E+13	1.86923E+14	1.03059E+14
38	1.00648E+14	-1.16384E+14	1.68471E+14
39	1.74422E+14	-7.28506E+13	3.08325E+14
40	-4.87728E+13	3.74024E+14	-4.53782E+13
41	4.81993E+13	2.00816E+14	1.09081E+14
42	1.45863E+13	3.75308E+14	6.79701E+13
43	1.79015E+14	1.0852E+14	3.35656E+14
44	-5.90589E+13	2.44754E+14	-7.7863E+13
45	-4.02561E+12	3.70946E+14	3.63242E+13
46	1.17298E+13	-1.96778E+13	1.88304E+13
47	1.09801E+14	2.02918E+14	2.19603E+14
48	-1.9571E+14	1.87707E+14	-3.3063E+14
49	3.47505E+13	-4.19722E+14	1.48889E+13
50	6.56462E+13	3.13602E+14	1.53653E+14
51	1.42809E+13	4.00868E+14	6.9645E+13
52	1.4001E+14	-2.81633E+14	2.21759E+14
53	-1.43825E+14	-2.95195E+14	-2.95634E+14
54	-1.12358E+14	-7.42737E+13	-2.12866E+14
55	1.4205E+14	-1.44449E+13	2.56784E+14
56	-1.91204E+14	-6.31586E+13	-3.52077E+14
57	1.42892E+14	-3.95313E+14	2.14796E+14
58	8.34414E+13	-4.34654E+14	1.02561E+14
59	1.86833E+14	-3.16133E+14	3.04406E+14
60	2.66403E+13	-3.39522E+14	1.10306E+13
61	-1.09079E+14	-5.36501E+13	-2.053E+14
62	-1.75721E+14	-2.97249E+14	-3.54801E+14
63	-8.79123E+13	4.81219E+14	-1.03079E+14
64	-1.48816E+14	-3.54438E+14	-3.11366E+14
65	2.37802E+14	6.40879E+13	4.37014E+14
66	-1.60747E+14	-1.52194E+14	-3.07578E+14
67	4.72083E+13	1.42779E+14	1.0133E+14
68	-2.38053E+12	5.09961E+14	5.25861E+13
69	1.86911E+14	3.00481E+14	3.70018E+14
70	-2.75395E+13	4.10517E+14	-3.49416E+12
71	-1.11756E+14	-3.78122E+14	-2.46318E+14
72	6.16626E+12	-3.62135E+14	-3.10748E+13
73	1.52175E+13	4.5304E+14	7.22973E+13
74	1.56846E+14	-4.28381E+14	2.36429E+14
75	-6.44536E+12	4.62984E+14	4.55142E+13
76	2.1888E+13	-4.63651E+14	-1.36411E+13
77	-2.18971E+13	-2.16535E+14	-6.4926E+13
78	-1.31892E+14	-3.04799E+14	-2.73959E+14
79	-2.49178E+14	3.76043E+13	-4.46116E+14
80	1.71564E+14	2.12095E+14	3.05349E+14
81	-1.30697E+13	3.19199E+13	3.64049E+12
82	-5.95499E+13	-4.8789E+14	-1.3868E+14

Constant specific relative angular momentum at END of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1- a1b3	z=sxuy-syux=a1b2- a2b1
83	6.85971E+13	4.0688E+14	1.67715E+14
84	1.34572E+14	-3.676E+14	2.03971E+14
85	-4.78437E+13	4.42684E+14	-3.5108E+13
86	-4.33657E+13	-5.01125E+14	-1.65793E+14
87	1.8112E+13	-5.0495E+14	-2.6149E+13
88	1.36732E+14	-2.21572E+14	2.246E+14
89	-9.92785E+13	5.43925E+14	-1.16391E+14
90	1.06E+14	-4.92171E+14	1.3571E+14
91	-1.93525E+14	3.46004E+14	-3.06756E+14
92	-2.62636E+15	-3.6404E+15	-7.77316E+15
93	1.93319E+17	9.05399E+16	1.35569E+17
94	3.98453E+17	5.01165E+17	1.00907E+17
95	-3.80862E+15	5.62495E+16	-1.82714E+16
96	1.86849E+18	-1.80539E+18	4.81206E+17
97	3.42503E+17	-8.45497E+17	5.96291E+17
98	-3.26125E+17	-7.1726E+17	8.371E+16
99	4.24284E+16	-1.65502E+17	-6.61325E+17
100	1.78495E+17	-7.48058E+17	-1.31788E+18
101	-1.74398E+17	-3.27279E+17	-8.71336E+17
102	-9.74627E+17	-2.13706E+18	2.92633E+17
103	3.0595E+17	-1.25252E+17	-5.96263E+17
104	-5.4848E+16	1.14849E+18	-5.02818E+18
105	-4.32071E+16	4.09022E+18	-1.66075E+19
106	-1.73166E+17	1.76677E+18	-3.11936E+18
107	6.76369E+16	1.27638E+17	-3.26789E+18
108	-9.84317E+16	9.54726E+17	-7.55545E+17
109	-3.96181E+16	4.21074E+17	-8.14117E+17
110	-9.76723E+16	1.61703E+17	1.60192E+17
111	6.6778E+16	6.65869E+16	-1.90621E+17
112	-3.14205E+16	-9.62252E+16	1.69652E+16
113	7.08936E+14	-1.16556E+16	5.31042E+15
114	1.48389E+15	-1.58995E+16	8.22709E+15
115	-3.74988E+18	3.53524E+18	-4.91616E+18
116	8.30695E+17	-9.21636E+17	-3.96419E+15
117	8.48106E+17	-2.29738E+18	2.0508E+18
118	-3.75518E+18	3.66789E+18	-5.60597E+17
119	4.22893E+17	9.20725E+17	-1.27852E+17
120	-2.675E+18	8.39696E+17	9.34819E+16
121	8.36206E+17	-4.98699E+17	7.44591E+17
122	1.09203E+19	-1.35591E+18	1.64923E+18
123	5.48846E+17	1.17225E+18	-3.24001E+16
124	2.67242E+17	-1.28663E+17	-4.23015E+17
125	-6.65814E+16	-8.95355E+17	-4.95395E+17
126	-1.09176E+19	-5.50917E+17	-1.36849E+18
127	-3.87696E+17	3.86516E+18	-1.04283E+18
128	-1.8119E+18	6.92377E+16	-1.13871E+18
129	-6.46062E+15	5.182E+16	-2.91325E+15
130	3.89132E+18	-6.8134E+18	1.17642E+18
131	7.48011E+17	7.0647E+17	7.09245E+17
132	2.51829E+15	1.96769E+15	2.10144E+15

Constant specific relative angular momentum at END of iteration			
Mass No.	x=szuy-syuz=a3 b2- a2 b3	y=szux-sxuz=a3b1-a1b3	z=sxuy-syux=a1b2-a2b1
133	-2.49747E+16	-1.95939E+16	-2.06074E+16
Sum of cross pr	-2.64218E+18	3.73712E+18	-3.4955E+19

Non-zero Angular momentum (MASS Velocity Position Vector cross product)

Theory and requirement

Sundman's theorem for the 3-body problem

In 1912, the Finnish mathematician Karl Fritiof Sundman studied the possible singularities of the 3-body problems. The only singularities in the 3-body problem are binary collisions and triple collisions. He first was able, using an appropriate change of variables, to continue analytically the solution beyond the binary collision, in a process known as regularization. He then proved that triple collisions only occur *when the angular momentum c vanishes.*

Simultaneous Collisions

In their book Vladimir Igorevich Amold, Kozolov, and Neishtadt in section 2.2.2, say [see ref]… Continuing……… ***Theorem:*** *If* $\boldsymbol{I}(t) \to 0$ *as* $t \to t_o$ *, then the constant vector of angular momentum is equal to zero:*

$$K = \sum m_i \, (r_i \times \dot{r}_i) = 0$$

Weierstrass also mentioned this result in his works.

Results conclusions and Inferences

Referring the above three citations, angular momentum are to be checked for possible singularities. So, sum and individual mass position and velocity cross product (angular momentum) was calculated many times, it was never zero or it tends to zero. One example was given below. It can be observed the x, y & z sums are non-zero and have same value. Their vectorial sum is also similar. Hence results of this test implies the Dynamic universe model is singularity and collision free.

Position and velocity data from Iteration END (Table 8) & START (table 7) were taken calculating the non-zero “Angular Momentum”. First column in table 7 and 8 gives lists the point mass number and later x, y & z values for each point mass. It can be observed the x, y & z values and their totals are non-zero and not changing much in value. We can cross check from table to table. Further grand totals and essence can be seen in see table 6. Their vector sum is also same.

These non-zero Angular Momentum calculation results show that no singularities exist in Dynamic Universe model.

Table 6 This table shows results of calculations to prove that no singularities exist in Dynamic Universe model: Compare Iteration END (Table 8) & START (table 7) for “non-zero Angular Momentum : MASS Velocity Position Vector cross product”

Angular momentum (Mass.vel.pos. cross product) Compare Iteration END & START				
X	Y	Z	Vector sum	
-3.175770E+45	1.580220E+45	-2.822440E+44	3.558409E+45	Iteration END
-3.175765E+45	**1.580217E+45**	**-2.822438E+44**	3.558403E+45	Iteration START

Table 7 This table describes non-zero Angular Momentum : MASS Velocity Position Vector cross product for iteration Start

Angular momentum (Mass.vel.pos. cross product) at START of Itr			
Mass no	x	y	z
1	1.547762E+17	1.320368E+17	4.968900E+18
2	-1.059012E+38	-9.424941E+37	1.153784E+39
3	-1.138905E+39	-2.704116E+38	1.973713E+40
4	-1.373349E+35	1.009045E+36	2.741311E+40
5	-8.726371E+37	-7.447909E+37	3.553685E+39
6	-4.317898E+41	8.009669E+40	1.929607E+43
7	-3.101642E+41	1.354946E+41	7.794254E+42
8	-2.195230E+40	-6.304728E+39	1.694972E+42
9	-5.755541E+40	5.142471E+40	2.497781E+42
10	-9.513271E+37	3.540222E+37	3.309074E+38
11	1.711955E+34	-3.695210E+35	3.417371E+38
12	-6.039162E+35	2.801686E+35	1.391066E+37
13	-1.301739E+43	-2.246747E+43	-2.625270E+43
14	-2.325657E+45	-4.452711E+45	1.037719E+45
15	2.348092E+45	3.976588E+45	-1.049139E+45
16	-5.140449E+42	1.081890E+44	2.988569E+42
17	-1.962564E+43	1.829753E+44	-1.449766E+43
18	-5.189817E+44	-3.696540E+45	-1.373127E+45
19	3.572954E+42	-1.665803E+44	-1.238847E+43
20	-4.279826E+43	2.364651E+44	-5.064332E+43
21	-1.232388E+43	-2.382501E+44	-4.863778E+43
22	3.699662E+43	-5.248956E+43	6.136742E+43
23	1.525005E+44	-7.341189E+44	1.640753E+44
24	1.893573E+44	7.229565E+44	4.210788E+44
25	1.393546E+43	-1.443303E+44	4.027150E+43
26	1.128101E+44	4.265294E+43	1.928160E+44
27	1.130752E+44	4.135052E+43	2.259965E+44
28	-1.178281E+44	-2.366030E+43	-2.159785E+44
29	-2.295672E+44	-4.144328E+43	-4.192880E+44
30	-2.442116E+44	-3.448989E+44	-4.823140E+44
31	1.800669E+43	-1.211214E+44	1.909085E+43
32	-7.380714E+43	2.197865E+44	-1.064122E+44
33	3.175990E+43	1.658441E+44	7.631825E+43
34	-9.135865E+43	3.640668E+44	-1.233942E+44
35	-2.028441E+43	-1.931207E+44	-5.928531E+43
36	-8.055320E+42	1.585593E+44	3.347018E+42
37	4.126635E+43	1.672457E+44	9.221022E+43
38	7.004126E+43	-8.099161E+43	1.172393E+44
39	1.734011E+44	-7.242416E+43	3.065202E+44
40	-1.415829E+44	1.085758E+45	-1.317286E+44
41	4.312547E+43	1.796762E+44	9.759785E+43
42	1.305086E+43	3.357995E+44	6.081497E+43
43	1.423737E+44	8.630779E+43	2.669528E+44
44	-3.334905E+44	1.382065E+45	-4.396729E+44
45	-2.801428E+42	2.581423E+44	2.527811E+43
46	1.049506E+43	-1.760633E+43	1.684814E+43
47	1.309897E+44	2.420758E+44	2.619805E+44

Angular momentum (Mass.vel.pos. cross product) at START of Itr			
Mass no	x	y	z
48	-3.229772E+44	3.097691E+44	-5.456334E+44
49	3.109236E+43	-3.755382E+44	1.332152E+43
50	3.915712E+43	1.870597E+44	9.165196E+43
51	2.867860E+43	8.050138E+44	1.398593E+44
52	1.252713E+44	-2.519856E+44	1.984151E+44
53	-2.716672E+44	-5.575868E+44	-5.584155E+44
54	-5.719036E+44	-3.780553E+44	-1.083494E+45
55	5.648749E+43	-5.744137E+42	1.021121E+44
56	-1.520674E+44	-5.023110E+43	-2.800131E+44
57	1.562611E+44	-4.322990E+44	2.348920E+44
58	4.977174E+43	-2.592658E+44	6.117624E+43
59	2.786095E+44	-4.714230E+44	4.539360E+44
60	2.118744E+43	-2.700272E+44	8.772831E+42
61	-6.506453E+43	-3.200161E+43	-1.224592E+44
62	-1.572233E+44	-2.659584E+44	-3.174516E+44
63	-6.991817E+43	3.827218E+44	-8.198081E+43
64	-3.166015E+44	-7.540574E+44	-6.624231E+44
65	2.127687E+44	5.734144E+43	3.910097E+44
66	-9.588364E+43	-9.078170E+43	-1.834662E+44
67	2.815918E+43	8.516616E+43	6.044204E+43
68	-2.366592E+42	5.069758E+44	5.227829E+43
69	3.419025E+44	5.496485E+44	6.768472E+44
70	-1.916479E+43	2.856795E+44	-2.431597E+42
71	-9.999184E+43	-3.383177E+44	-2.203881E+44
72	1.716444E+43	-1.008043E+45	-8.650010E+43
73	2.511317E+43	7.476447E+44	1.193110E+44
74	1.559282E+44	-4.258737E+44	2.350445E+44
75	-1.217449E+43	8.745200E+44	8.597077E+43
76	4.134370E+43	-8.757791E+44	-2.576640E+43
77	-4.789154E+43	-4.735882E+44	-1.420010E+44
78	-2.884647E+44	-6.666313E+44	-5.991808E+44
79	-1.486314E+44	2.243049E+43	-2.661029E+44
80	1.705594E+44	2.108539E+44	3.035615E+44
81	-1.429256E+43	3.490639E+43	3.981096E+42
82	-7.104155E+43	-5.820402E+44	-1.654412E+44
83	7.501511E+43	4.449481E+44	1.834070E+44
84	2.006769E+44	-5.481724E+44	3.041655E+44
85	-3.329455E+43	3.080646E+44	-2.443174E+43
86	-4.742306E+43	-5.480107E+44	-1.813052E+44
87	1.620540E+43	-4.517946E+44	-2.339632E+43
88	8.155896E+43	-1.321652E+44	1.339710E+44
89	-5.921838E+43	3.244444E+44	-6.942601E+43
90	1.938985E+44	-9.002927E+44	2.482451E+44
91	-1.346745E+44	2.407848E+44	-2.134721E+44
92	-3.166816E+52	-4.389529E+52	-9.372730E+52
93	1.436948E+54	6.729878E+53	1.007693E+54
94	3.820373E+54	4.805180E+54	9.674939E+53
95	-2.687186E+52	3.968710E+53	-1.289144E+53
96	1.208225E+55	-1.167422E+55	3.111627E+54
97	2.477617E+54	-6.116197E+54	4.313479E+54

Angular momentum (Mass.vel.pos. cross product) at START of Itr			
Mass no	x	y	z
98	-2.217397E+54	-4.876820E+54	5.691636E+53
99	3.425006E+53	-1.336004E+54	-5.338507E+54
100	1.709668E+54	-7.165096E+54	-1.262297E+55
101	-1.447172E+54	-2.715795E+54	-7.230438E+54
102	-1.012676E+55	-2.220491E+55	3.040574E+54
103	2.752324E+54	-1.126763E+54	-5.363974E+54
104	-4.693454E+53	9.827887E+54	-4.302715E+55
105	-4.242013E+53	4.015719E+55	-1.630500E+56
106	-1.707598E+54	1.742216E+55	-3.076014E+55
107	6.041268E+53	1.140049E+54	-2.918856E+55
108	-9.938118E+53	9.639359E+54	-7.628332E+54
109	-5.432712E+53	5.774059E+54	-1.116373E+55
110	-9.910431E+53	1.640738E+54	1.625409E+54
111	7.473364E+53	7.451986E+53	-2.133311E+54
112	-3.211751E+53	-9.835983E+53	1.734152E+53
113	6.597811E+51	-1.084739E+53	4.942213E+52
114	1.468647E+52	-1.573612E+53	8.142573E+52
115	-2.686411E+55	2.532647E+55	-3.521936E+55
116	3.195941E+58	-3.545819E+58	-1.525145E+56
117	4.078658E+58	-1.104842E+59	9.862554E+58
118	-2.167098E+59	2.116729E+59	-3.235186E+58
119	2.847253E+58	6.199048E+58	-8.607982E+57
120	-2.058307E+59	6.461141E+58	7.193073E+57
121	7.238569E+58	-4.316959E+58	6.445510E+58
122	1.050340E+60	-1.304152E+59	1.586277E+59
123	5.806844E+58	1.240255E+59	-3.427968E+57
124	2.827443E+58	-1.361271E+58	-4.475541E+58
125	-6.403979E+57	-8.611766E+58	-4.764842E+58
126	-9.450725E+59	-4.768987E+58	-1.184622E+59
127	-2.983173E+58	2.974096E+59	-8.024199E+58
128	-1.219917E+59	4.661627E+57	-7.666717E+58
129	-3.728402E+56	2.990515E+57	-1.681229E+56
130	1.871389E+59	-3.276655E+59	5.657585E+58
131	2.877828E+58	2.718009E+58	2.728685E+58
132	3.558085E+57	2.780147E+57	2.969126E+57
133	-3.528673E+57	-2.768423E+57	-2.911624E+57

Table 8 : This table describes non-zero Angular Momentum : MASS Velocity Position Vector cross product for iteration END

Angular momentum (Mass.vel.pos. cross product) at END of Itr			
Mass no	x	y	Z
1	1.54776E+17	1.32037E+17	4.9689E+18
2	-1.05874E+38	-9.42251E+37	1.15349E+39
3	-1.13863E+39	-2.70347E+38	1.97324E+40

Angular momentum (Mass.vel.pos. cross product) at END of Itr			
Mass no	x	y	Z
4	-1.37325E+35	1.00892E+36	2.741E+40
5	-8.72597E+37	-7.44757E+37	3.55352E+39
6	-4.31789E+41	8.00966E+40	1.92961E+43
7	-3.10164E+41	1.35495E+41	7.79425E+42
8	-2.19523E+40	-6.30473E+39	1.69497E+42
9	-5.75554E+40	5.14247E+40	2.49778E+42
10	-9.51327E+37	3.54022E+37	3.30907E+38
11	1.71181E+34	-3.69481E+35	3.41701E+38
12	-6.03866E+35	2.80153E+35	1.39088E+37
13	-1.30174E+43	-2.24675E+43	-2.62527E+43
14	-2.32566E+45	-4.45271E+45	1.03772E+45
15	2.34809E+45	3.97659E+45	-1.04914E+45
16	-5.14045E+42	1.08189E+44	2.98857E+42
17	-1.96256E+43	1.82975E+44	-1.44977E+43
18	-5.18982E+44	-3.69654E+45	-1.37313E+45
19	3.57295E+42	-1.6658E+44	-1.23885E+43
20	-4.27983E+43	2.36465E+44	-5.06433E+43
21	-1.23239E+43	-2.3825E+44	-4.86378E+43
22	3.69966E+43	-5.24896E+43	6.13674E+43
23	1.52501E+44	-7.34119E+44	1.64075E+44
24	1.89357E+44	7.22957E+44	4.21079E+44
25	1.39355E+43	-1.4433E+44	4.02715E+43
26	1.1281E+44	4.26529E+43	1.92816E+44
27	1.13075E+44	4.13505E+43	2.25997E+44
28	-1.17828E+44	-2.36603E+43	-2.15979E+44
29	-2.29567E+44	-4.14433E+43	-4.19288E+44
30	-2.44212E+44	-3.44899E+44	-4.82314E+44
31	1.80067E+43	-1.21121E+44	1.90909E+43
32	-7.38071E+43	2.19787E+44	-1.06412E+44
33	3.17599E+43	1.65844E+44	7.63182E+43
34	-9.13586E+43	3.64067E+44	-1.23394E+44
35	-2.02844E+43	-1.93121E+44	-5.92853E+43
36	-8.05532E+42	1.58559E+44	3.34702E+42
37	4.12663E+43	1.67246E+44	9.22102E+43
38	7.00413E+43	-8.09916E+43	1.17239E+44
39	1.73401E+44	-7.24242E+43	3.0652E+44
40	-1.41583E+44	1.08576E+45	-1.31729E+44
41	4.31255E+43	1.79676E+44	9.75979E+43
42	1.30509E+43	3.35799E+44	6.0815E+43
43	1.42374E+44	8.63078E+43	2.66953E+44
44	-3.33491E+44	1.38206E+45	-4.39673E+44
45	-2.80143E+42	2.58142E+44	2.52781E+43
46	1.04951E+43	-1.76063E+43	1.68481E+43
47	1.3099E+44	2.42076E+44	2.6198E+44
48	-3.22977E+44	3.09769E+44	-5.45633E+44
49	3.10924E+43	-3.75538E+44	1.33215E+43
50	3.91571E+43	1.8706E+44	9.1652E+43
51	2.86786E+43	8.05014E+44	1.39859E+44
52	1.25271E+44	-2.51986E+44	1.98415E+44
53	-2.71667E+44	-5.57587E+44	-5.58415E+44

Angular momentum (Mass.vel.pos. cross product) at END of Itr			
Mass no	x	y	Z
54	-5.71904E+44	-3.78055E+44	-1.08349E+45
55	5.64875E+43	-5.74414E+42	1.02112E+44
56	-1.52067E+44	-5.02311E+43	-2.80013E+44
57	1.56261E+44	-4.32299E+44	2.34892E+44
58	4.97717E+43	-2.59266E+44	6.11762E+43
59	2.7861E+44	-4.71423E+44	4.53936E+44
60	2.11874E+43	-2.70027E+44	8.77283E+42
61	-6.50645E+43	-3.20016E+43	-1.22459E+44
62	-1.57223E+44	-2.65958E+44	-3.17452E+44
63	-6.99182E+43	3.82722E+44	-8.19808E+43
64	-3.16601E+44	-7.54057E+44	-6.62423E+44
65	2.12769E+44	5.73414E+43	3.9101E+44
66	-9.58836E+43	-9.07817E+43	-1.83466E+44
67	2.81592E+43	8.51662E+43	6.0442E+43
68	-2.36659E+42	5.06976E+44	5.22783E+43
69	3.41903E+44	5.49649E+44	6.76847E+44
70	-1.91648E+43	2.85679E+44	-2.4316E+42
71	-9.99918E+43	-3.38318E+44	-2.20388E+44
72	1.71644E+43	-1.00804E+45	-8.65001E+43
73	2.51132E+43	7.47645E+44	1.19311E+44
74	1.55928E+44	-4.25874E+44	2.35045E+44
75	-1.21745E+43	8.7452E+44	8.59708E+43
76	4.13437E+43	-8.75779E+44	-2.57664E+43
77	-4.78915E+43	-4.73588E+44	-1.42001E+44
78	-2.88465E+44	-6.66631E+44	-5.99181E+44
79	-1.48631E+44	2.24305E+43	-2.66103E+44
80	1.70559E+44	2.10854E+44	3.03562E+44
81	-1.42926E+43	3.49064E+43	3.9811E+42
82	-7.10415E+43	-5.8204E+44	-1.65441E+44
83	7.50151E+43	4.44948E+44	1.83407E+44
84	2.00677E+44	-5.48172E+44	3.04165E+44
85	-3.32945E+43	3.08065E+44	-2.44317E+43
86	-4.74231E+43	-5.48011E+44	-1.81305E+44
87	1.62054E+43	-4.51795E+44	-2.33963E+43
88	8.1559E+43	-1.32165E+44	1.33971E+44
89	-5.92184E+43	3.24444E+44	-6.9426E+43
90	1.93898E+44	-9.00293E+44	2.48245E+44
91	-1.34674E+44	2.40785E+44	-2.13472E+44
92	-3.16682E+52	-4.38953E+52	-9.37273E+52
93	1.43695E+54	6.72988E+53	1.00769E+54
94	3.82037E+54	4.80518E+54	9.67494E+53
95	-2.68719E+52	3.96871E+53	-1.28914E+53
96	1.20822E+55	-1.16742E+55	3.11163E+54
97	2.47762E+54	-6.1162E+54	4.31348E+54
98	-2.2174E+54	-4.87682E+54	5.69164E+53
99	3.42501E+53	-1.336E+54	-5.33851E+54
100	1.70967E+54	-7.1651E+54	-1.2623E+55
101	-1.44717E+54	-2.71579E+54	-7.23044E+54
102	-1.01268E+55	-2.22049E+55	3.04057E+54
103	2.75232E+54	-1.12676E+54	-5.36397E+54

Angular momentum (Mass.vel.pos. cross product) at END of Itr			
Mass no	x	y	Z
104	-4.69345E+53	9.82789E+54	-4.30272E+55
105	-4.24201E+53	4.01572E+55	-1.6305E+56
106	-1.7076E+54	1.74222E+55	-3.07601E+55
107	6.04127E+53	1.14005E+54	-2.91886E+55
108	-9.93812E+53	9.63936E+54	-7.62833E+54
109	-5.43271E+53	5.77406E+54	-1.11637E+55
110	-9.91043E+53	1.64074E+54	1.62541E+54
111	7.47336E+53	7.45199E+53	-2.13331E+54
112	-3.21175E+53	-9.83598E+53	1.73415E+53
113	6.59781E+51	-1.08474E+53	4.94221E+52
114	1.46865E+52	-1.57361E+53	8.14257E+52
115	-2.68641E+55	2.53265E+55	-3.52194E+55
116	3.19594E+58	-3.54582E+58	-1.52515E+56
117	4.07866E+58	-1.10484E+59	9.86255E+58
118	-2.1671E+59	2.11673E+59	-3.23519E+58
119	2.84725E+58	6.19905E+58	-8.60798E+57
120	-2.05831E+59	6.46114E+58	7.19307E+57
121	7.23857E+58	-4.31696E+58	6.44551E+58
122	1.05034E+60	-1.30415E+59	1.58628E+59
123	5.80684E+58	1.24026E+59	-3.42797E+57
124	2.82744E+58	-1.36127E+58	-4.47554E+58
125	-6.40398E+57	-8.61177E+58	-4.76484E+58
126	-9.45072E+59	-4.76899E+58	-1.18462E+59
127	-2.98317E+58	2.9741E+59	-8.0242E+58
128	-1.21992E+59	4.66163E+57	-7.66672E+58
129	-3.7284E+56	2.99052E+57	-1.68123E+56
130	1.87139E+59	-3.27666E+59	5.65759E+58
131	2.87783E+58	2.71801E+58	2.72869E+58
132	3.55809E+57	2.78015E+57	2.96913E+57
133	-3.52867E+57	-2.76842E+57	-2.91162E+57
Sum for 133 masses	-3.17577E+45	1.58022E+45	-2.82244E+44

Non-zero Polar moment of Inertia

Theory and requirement

In their book Vladimir Igorevich Amold, Kozolov, Neishtadt in section 2.2.2, say [see ref]… '*If the position vectors $r_i(t)$ of all the points have one and the same limit r_o as t →t_o then we say a simultaneous collision takes place at time t_o. The point r_o clearly must coincide with the centre of mass , that is r_o =**0.** A simultaneous collision occurs **if and only if the polar moment of inertia I(t) → 0 as t →t_o .**'*

$$\textbf{Polar Moment of Inertia} = \sum m_i r_i^2$$

Results conclusions and Inferences

Referring the above citation; ***polar moment of inertia*** was checked for zero for possible singularities. So, sum of *polar moment of inertia* was calculated many times, it was never zero or it tends to zero. One example was given below. The vectorial sum is also same. One example was shown for Iteration END (Table 9) & START (table 10). In table 9 & 10 first column gives the point mass number, the second third and fourth columns give the positions (sx, sy, sz) at the start in table 9 and positions at the end in table 10. For calculating the moment of inertia each x, y, z position is multiplied by its respective mass and are given as mass*x, mass*y and mass*z in fifth sixth and seventh columns respectively. In the row after the row # 133 gives the sums of these entire x, y & z MI values. And the next row coordinates of the Center of mass for this 133 body system, with respect to this point will proceed to calculate the polar moment of inertia for each point mass. Finally the calculated polar moment of Inertia for each mass is shown in the eighth column. The sum of PMI is calculated in the end of eighth column for the start set as 4.5943978E+86 and for the END set it as 4.5943978E+86, in the tables 9 and 10 below.

Hence results of non-zero polar moment of inertia test imply the Dynamic universe model is simultaneous collision singularity free.

Table 9: This table describes Polar Moment of Inertia for iteration Start

		moment of Inertia for the START of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
1	1.309E+11	-2.107E+12	6.007E+10	6.259E+13	-1.007E+15	2.871E+13	8.0182445E+46
2	-1.088E+11	-5.990E+10	5.094E+09	-3.590E+34	-1.977E+34	1.681E+33	5.5356081E+67
3	1.273E+11	6.688E+09	-7.254E+09	6.199E+35	3.257E+34	-3.533E+34	8.1692156E+68
4	1.051E+11	-1.243E+11	4.050E+06	6.277E+35	-7.423E+35	2.418E+31	1.0014418E+69
5	1.626E+11	1.500E+11	-8.505E+08	1.044E+35	9.629E+34	-5.460E+32	1.0769274E+68
6	5.897E+11	-4.703E+11	-1.124E+10	1.120E+39	-8.936E+38	-2.136E+37	3.1871683E+71
7	-1.401E+12	1.595E+11	5.297E+10	-7.957E+38	9.060E+37	3.009E+37	9.5279558E+70
8	2.990E+12	-3.104E+11	-3.988E+10	2.596E+38	-2.694E+37	-3.462E+36	1.4560327E+70
9	3.674E+12	-2.584E+12	-3.146E+10	3.748E+38	-2.636E+38	-3.209E+36	1.7110061E+70
10	1.745E+11	-4.715E+12	4.543E+11	2.216E+33	-5.988E+34	5.769E+33	2.1303704E+66
11	1.022E+11	-1.318E+11	-1.373E+08	7.513E+33	-9.684E+33	-1.009E+31	1.2329309E+67
12	1.771E+07	-2.809E+07	-2.031E+05	3.524E+37	-5.590E+37	-4.041E+35	3.3381394E+74
13	-3.074E+16	-2.481E+16	5.990E+15	-1.222E+46	-9.865E+45	2.382E+45	6.6705871E+73
14	-1.701E+16	-4.496E+13	3.794E+16	-3.214E+46	-8.493E+43	7.166E+46	3.1685128E+74
15	-1.718E+16	-1.533E+14	3.786E+16	-3.757E+46	-3.353E+44	8.281E+46	3.6688044E+74
16	-1.858E+15	1.639E+15	-5.615E+16	-1.478E+45	1.304E+45	-4.466E+46	1.3341121E+74
17	9.029E+15	-7.132E+15	-7.779E+16	8.079E+45	-6.381E+45	-6.960E+46	1.5008767E+74
18	-3.168E+16	-2.997E+16	6.870E+16	-5.512E+47	-5.213E+47	1.195E+48	2.9183781E+75
19	2.377E+16	-7.076E+15	8.829E+16	2.126E+46	-6.331E+45	7.899E+46	1.5008666E+74
20	9.778E+16	-1.698E+16	3.329E+15	1.847E+47	-3.208E+46	6.287E+45	3.1684824E+74
21	-1.756E+16	-2.087E+16	9.780E+16	-1.571E+46	-1.868E+46	8.751E+46	1.5008751E+74
22	3.821E+16	6.008E+16	7.442E+16	1.519E+46	2.389E+46	2.960E+46	6.6704634E+73
23	-4.505E+16	3.010E+16	9.281E+16	-8.240E+46	5.506E+46	1.698E+47	3.0684488E+74
24	-8.423E+15	5.249E+16	-9.391E+16	-2.763E+46	1.722E+47	-3.081E+47	5.5031931E+74
25	-4.604E+16	3.039E+16	9.297E+16	-5.492E+46	3.625E+46	1.109E+47	2.0011624E+74
26	4.905E+16	9.646E+16	7.359E+15	3.901E+46	7.672E+46	5.853E+45	1.3340888E+74
27	4.992E+16	9.787E+16	7.068E+15	4.466E+46	8.757E+46	6.324E+45	1.5008495E+74
28	-1.391E+16	-1.091E+17	4.365E+15	-1.106E+46	-8.679E+46	3.472E+45	1.3341269E+74
29	-6.287E+16	-8.894E+16	-2.563E+16	-1.150E+47	-1.627E+47	-4.689E+46	3.0685045E+74
30	-6.906E+16	-8.502E+16	2.583E+16	-1.510E+47	-1.860E+47	5.650E+46	3.6688592E+74
31	-2.358E+16	2.089E+16	1.103E+17	-9.376E+45	8.306E+45	4.385E+46	6.6705283E+73
32	1.863E+16	-5.543E+16	-1.016E+17	1.481E+46	-4.409E+46	-8.079E+46	1.3341190E+74
33	-5.045E+16	3.780E+16	-1.031E+17	-4.514E+46	3.382E+46	-9.228E+46	1.5008804E+74
34	2.098E+16	-4.320E+16	-1.119E+17	2.503E+46	-5.153E+46	-1.335E+47	2.0011761E+74
35	-3.341E+16	-3.813E+16	1.128E+17	-1.993E+46	-2.275E+46	6.728E+46	1.0005865E+74
36	1.201E+17	-5.235E+15	-4.106E+16	7.164E+46	-3.123E+45	-2.449E+46	1.0005711E+74
37	-5.814E+16	4.544E+16	-1.084E+17	-5.202E+46	4.066E+46	-9.703E+46	1.5008807E+74
38	-1.074E+17	7.508E+16	-1.226E+16	-7.471E+46	5.225E+46	-8.535E+45	1.1673508E+74
39	2.961E+16	1.230E+17	4.581E+16	2.944E+46	1.223E+47	4.554E+46	1.6676078E+74
40	8.249E+16	-2.355E+16	-1.055E+17	2.395E+47	-6.837E+46	-3.062E+47	4.8694850E+74
41	-6.103E+16	4.804E+16	-1.154E+17	-5.461E+46	4.299E+46	-1.033E+47	1.5008811E+74
42	9.770E+16	2.146E+16	-9.754E+16	8.741E+46	1.920E+46	-8.727E+46	1.5008587E+74
43	2.152E+16	1.346E+17	-3.203E+16	1.711E+46	1.070E+47	-2.547E+46	1.3340890E+74
44	-5.352E+16	-2.816E+16	-1.291E+17	-3.022E+47	-1.590E+47	-7.291E+47	9.4723000E+74
45	1.146E+16	1.397E+16	-1.439E+17	7.977E+45	9.723E+45	-1.002E+47	1.1673480E+74
46	-1.328E+17	1.609E+16	-6.590E+16	-1.188E+47	1.439E+46	-5.897E+46	1.5008955E+74
47	-4.788E+16	9.195E+16	-1.089E+17	-5.712E+46	1.097E+47	-1.299E+47	2.0011623E+74
48	1.050E+16	-1.347E+17	-7.023E+16	1.732E+46	-2.222E+47	-1.159E+47	2.7683199E+74
49	-4.595E+16	8.948E+15	1.450E+17	-4.111E+46	8.006E+45	1.297E+47	1.5008728E+74

		moment of Inertia for the START of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
50	1.368E+17	5.367E+16	-5.110E+16	8.160E+46	3.202E+46	-3.048E+46	1.0005634E+74
51	1.771E+16	2.708E+16	-1.522E+17	3.557E+46	5.439E+46	-3.057E+47	3.3686268E+74
52	-1.095E+17	9.683E+16	5.383E+16	-9.799E+46	8.664E+46	4.816E+46	1.5008734E+74
53	-4.723E+16	-1.168E+17	9.361E+16	-8.921E+46	-2.206E+47	1.768E+47	3.1685568E+74
54	9.791E+16	-9.246E+16	8.394E+16	4.984E+47	-4.706E+47	4.273E+47	8.5382730E+74
55	1.098E+17	9.705E+16	6.622E+16	4.367E+46	3.859E+46	2.633E+46	6.6703873E+73
56	-9.107E+16	-1.370E+17	-2.489E+16	-7.243E+46	-1.089E+47	-1.979E+46	1.3341432E+74
57	-7.004E+16	9.145E+16	1.217E+17	-7.660E+46	1.000E+47	1.331E+47	1.8343902E+74
58	-2.649E+16	4.323E+16	1.616E+17	-1.580E+46	2.578E+46	9.641E+46	1.0005756E+74
59	-3.167E+16	1.253E+17	1.107E+17	-4.723E+46	1.868E+47	1.650E+47	2.5014227E+74
60	4.740E+16	1.591E+15	1.634E+17	3.770E+46	1.265E+45	1.300E+47	1.3340959E+74
61	1.202E+17	-9.022E+16	8.744E+16	7.170E+46	-5.382E+46	5.216E+46	1.0005761E+74
62	-5.757E+16	-1.401E+17	8.885E+16	-5.151E+46	-1.253E+47	7.950E+46	1.5009009E+74
63	6.766E+16	-4.600E+16	-1.571E+17	5.381E+46	-3.659E+46	-1.249E+47	1.3341129E+74
64	-9.216E+16	-1.204E+17	9.306E+16	-1.961E+47	-2.562E+47	1.980E+47	3.5688143E+74
65	5.723E+15	1.766E+17	-2.279E+16	5.121E+45	1.580E+47	-2.039E+46	1.5008456E+74
66	-1.350E+17	-1.162E+17	-1.306E+16	-8.052E+46	-6.930E+46	-7.792E+45	1.0006096E+74
67	-1.195E+17	4.881E+16	-1.245E+17	-7.129E+46	2.911E+46	-7.423E+46	1.0005939E+74
68	7.873E+16	1.638E+16	-1.624E+17	7.827E+46	1.628E+46	-1.615E+47	1.6676284E+74
69	3.918E+16	1.473E+17	-9.985E+16	7.166E+46	2.695E+47	-1.826E+47	3.0684011E+74
70	1.673E+17	-1.185E+16	-7.328E+16	1.164E+47	-8.244E+45	-5.100E+46	1.1673290E+74
71	-1.391E+17	-9.109E+16	7.673E+16	-1.244E+47	-8.150E+46	6.865E+46	1.5009070E+74
72	5.242E+16	-1.594E+16	1.753E+17	1.459E+47	-4.436E+46	4.880E+47	4.6693401E+74
73	3.643E+15	2.913E+16	-1.818E+17	6.013E+45	4.808E+46	-3.000E+47	2.7682836E+74
74	-9.078E+16	1.016E+17	1.239E+17	-9.025E+46	1.010E+47	1.232E+47	1.6676293E+74
75	6.411E+15	1.797E+16	-1.837E+17	1.211E+46	3.394E+46	-3.470E+47	3.1685204E+74
76	-2.063E+15	-5.394E+15	1.866E+17	-3.897E+45	-1.019E+46	3.526E+47	3.1684949E+74
77	1.097E+17	-3.319E+16	1.477E+17	2.400E+47	-7.260E+46	3.231E+47	3.6687543E+74
78	-1.542E+17	-1.013E+17	3.853E+16	-3.372E+47	-2.216E+47	8.426E+46	3.6688980E+74
79	4.302E+16	-1.835E+17	8.559E+15	2.566E+46	-1.095E+47	5.105E+45	1.0005968E+74
80	-1.306E+17	6.845E+16	-1.209E+17	-1.299E+47	6.805E+46	-1.202E+47	1.6676549E+74
81	-1.313E+17	6.753E+16	-1.208E+17	-1.436E+47	7.384E+46	-1.321E+47	1.8344207E+74
82	-1.339E+17	-5.210E+16	1.258E+17	-1.597E+47	-6.215E+46	1.501E+47	2.0011969E+74
83	-2.191E+16	6.931E+16	-1.771E+17	-2.396E+46	7.580E+46	-1.937E+47	1.8344018E+74
84	4.000E+16	8.009E+16	1.707E+17	5.965E+46	1.194E+47	2.546E+47	2.5014106E+74
85	-2.198E+16	-1.283E+16	-1.917E+17	-1.529E+46	-8.930E+45	-1.334E+47	1.1673573E+74
86	-1.352E+17	-5.387E+16	1.274E+17	-1.479E+47	-5.891E+46	1.394E+47	1.8344310E+74
87	-2.074E+16	-9.290E+15	1.938E+17	-1.856E+46	-8.312E+45	1.734E+47	1.5008693E+74
88	1.014E+17	8.455E+16	1.452E+17	6.050E+46	5.043E+46	8.659E+46	1.0005579E+74
89	7.377E+16	-5.177E+16	-1.790E+17	4.400E+46	-3.088E+46	-1.068E+47	1.0005853E+74
90	-1.507E+17	6.467E+16	1.168E+17	-2.757E+47	1.183E+47	2.137E+47	3.0684705E+74
91	-3.308E+16	-1.223E+17	-1.588E+17	-2.302E+46	-8.508E+46	-1.105E+47	1.1673710E+74
92	-1.169E+21	-1.042E+21	9.315E+19	-1.410E+58	-1.257E+58	1.123E+57	2.5254483E+81
93	-1.794E+20	-3.618E+20	-1.423E+19	-1.334E+57	-2.689E+57	-1.057E+56	1.3205005E+81
94	1.487E+19	2.777E+19	-7.917E+19	1.426E+56	2.662E+56	-7.591E+56	1.6050401E+81
95	6.944E+19	-4.444E+18	7.944E+17	4.899E+56	-3.135E+55	5.605E+54	1.1751934E+81
96	9.113E+19	-4.393E+19	1.890E+20	5.892E+56	-2.840E+56	1.222E+57	1.0729861E+81
97	1.053E+20	2.065E+19	8.977E+19	7.618E+56	1.494E+56	6.494E+56	1.1937338E+81
98	1.257E+20	6.155E+19	3.770E+19	8.547E+56	4.185E+56	2.563E+56	1.1164095E+81
99	1.529E+20	2.408E+19	-1.583E+19	1.234E+57	1.944E+56	-1.278E+56	1.3290997E+81

		moment of Inertia for the START of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
100	1.749E+20	1.357E+19	-3.139E+19	1.675E+57	1.300E+56	-3.007E+56	1.5758249E+81
101	1.856E+20	5.871E+19	1.510E+19	1.540E+57	4.872E+56	1.253E+56	1.3550148E+81
102	2.008E+20	1.024E+20	7.893E+19	2.086E+57	1.064E+57	8.202E+56	1.6825323E+81
103	2.212E+20	1.032E+19	-1.157E+20	1.990E+57	9.283E+55	-1.041E+57	1.4771714E+81
104	2.409E+20	2.387E+19	8.081E+18	2.062E+57	2.043E+56	6.915E+55	1.3944870E+81
105	2.525E+20	-1.042E+19	-1.910E+18	2.479E+57	-1.023E+56	-1.875E+55	1.6043804E+81
106	2.637E+20	1.586E+19	2.362E+19	2.601E+57	1.564E+56	2.330E+56	1.6035980E+81
107	2.802E+20	4.574E+18	-5.622E+18	2.503E+57	4.085E+55	-5.021E+55	1.4530334E+81
108	2.936E+20	-2.524E+19	6.361E+18	2.964E+57	-2.548E+56	6.422E+55	1.6448167E+81
109	3.138E+20	-1.181E+18	1.466E+19	4.304E+57	-1.619E+55	2.011E+56	2.2226266E+81
110	3.353E+20	-1.681E+20	-3.478E+19	3.402E+57	-1.705E+57	-3.529E+56	1.6736921E+81
111	3.724E+20	1.374E+19	-1.256E+20	4.167E+57	1.537E+56	-1.406E+57	1.8078481E+81
112	4.873E+20	1.744E+20	8.661E+19	4.981E+57	1.783E+57	8.853E+56	1.5907843E+81
113	6.492E+20	1.826E+18	9.067E+19	6.042E+57	1.700E+55	8.439E+56	1.4506677E+81
114	1.023E+21	1.531E+20	4.804E+20	1.013E+58	1.515E+57	4.755E+57	1.4375796E+81
115	4.792E+19	1.675E+20	1.570E+20	3.433E+56	1.200E+57	1.125E+57	1.1688060E+81
116	-1.636E+20	1.478E+20	-7.974E+19	-6.296E+60	5.688E+60	-3.068E+60	6.4853629E+84
117	1.545E+20	8.226E+19	1.560E+20	7.431E+60	3.956E+60	7.505E+60	7.8257721E+84
118	-1.147E+19	4.682E+19	2.295E+20	-6.618E+59	2.702E+60	1.324E+61	9.5793160E+84
119	-8.866E+19	-1.061E+19	2.168E+20	-5.969E+60	-7.144E+59	1.460E+61	1.1343238E+85
120	5.625E+19	-1.613E+20	-1.607E+20	4.328E+60	-1.241E+61	-1.236E+61	1.3116831E+85
121	-1.157E+20	2.039E+20	6.682E+18	-1.001E+61	1.765E+61	5.784E+59	1.4391861E+85
122	-3.634E+19	1.123E+19	-2.314E+20	-3.495E+60	1.081E+60	-2.226E+61	1.6299145E+85
123	-1.722E+20	-7.679E+19	1.394E+20	-1.822E+61	-8.124E+60	1.475E+61	1.8152266E+85
124	-2.051E+19	-2.196E+20	7.974E+19	-2.170E+60	-2.323E+61	8.437E+60	1.8160794E+85
125	-1.584E+20	7.456E+19	-1.560E+20	-1.523E+61	7.172E+60	-1.501E+61	1.6367047E+85
126	-3.064E+19	-3.720E+19	-2.295E+20	-2.653E+60	-3.221E+60	-1.987E+61	1.4733697E+85
127	6.156E+19	-6.468E+19	-2.168E+20	4.737E+60	-4.977E+60	-1.669E+61	1.3000077E+85
128	9.556E+19	1.416E+20	1.607E+20	6.434E+60	9.533E+60	1.082E+61	1.0955848E+85
129	2.326E+20	-2.937E+19	-6.682E+18	1.342E+61	-1.695E+60	-3.856E+59	9.4718053E+84
130	3.075E+19	2.239E+19	2.314E+20	1.479E+60	1.077E+60	1.113E+61	7.9661970E+84
131	4.156E+19	1.839E+20	-1.394E+20	1.599E+60	7.077E+60	-5.363E+60	6.3291467E+84
132	1.743E+22	1.505E+22	6.793E+21	2.462E+64	2.126E+64	9.597E+63	1.7737554E+86
133	1.285E+20	1.931E+22	-1.820E+22	1.816E+61	2.728E+63	-2.572E+63	8.7849357E+85
		sum m*r		9.088E+21	8.858E+21	2.589E+21	4.5943978E+86
		Mass Centre		9.386E+19	-8.348E+19	1.163E+19	
						Polar MI tot	4.5943978E+86

Table 10 This table describes Polar Moment of Inertia for iteration END

		moment of Inertia for the END of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
1	1.314E+11	-2.109E+12	6.012E+10	6.283E+13	-1.008E+15	2.874E+13	8.0182445E+46
2	-1.086E+11	-6.259E+10	4.860E+09	-3.585E+34	-2.065E+34	1.604E+33	5.5356081E+67
3	1.271E+11	9.429E+09	-7.205E+09	6.190E+35	4.592E+34	-3.509E+34	8.1692156E+68
4	1.070E+11	-1.228E+11	3.984E+06	6.389E+35	-7.331E+35	2.378E+31	1.0014418E+69

		moment of Inertia for the END of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
5	1.613E+11	1.517E+11	-7.820E+08	1.036E+35	9.740E+34	-5.021E+32	1.0769274E+68
6	5.904E+11	-4.694E+11	-1.126E+10	1.122E+39	-8.919E+38	-2.140E+37	3.1871683E+71
7	-1.401E+12	1.587E+11	5.299E+10	-7.958E+38	9.013E+37	3.010E+37	9.5279558E+70
8	2.990E+12	-3.099E+11	-3.988E+10	2.596E+38	-2.690E+37	-3.462E+36	1.4560327E+70
9	3.675E+12	-2.584E+12	-3.147E+10	3.748E+38	-2.636E+38	-3.210E+36	1.7110061E+70
10	1.750E+11	-4.715E+12	4.542E+11	2.222E+33	-5.988E+34	5.768E+33	2.1303704E+66
11	1.042E+11	-1.303E+11	-1.357E+08	7.656E+33	-9.579E+33	-9.975E+30	1.2329309E+67
12	1.790E+07	-2.836E+07	-2.059E+05	3.562E+37	-5.644E+37	-4.098E+35	3.3381394E+74
13	-3.074E+16	-2.481E+16	5.990E+15	-1.222E+46	-9.865E+45	2.382E+45	6.6705871E+73
14	-1.701E+16	-4.496E+13	3.794E+16	-3.214E+46	-8.493E+43	7.166E+46	3.1685128E+74
15	-1.718E+16	-1.533E+14	3.786E+16	-3.757E+46	-3.353E+44	8.281E+46	3.6688044E+74
16	-1.858E+15	1.639E+15	-5.615E+16	-1.478E+45	1.304E+45	-4.466E+46	1.3341121E+74
17	9.029E+15	-7.132E+15	-7.779E+16	8.079E+45	-6.381E+45	-6.960E+46	1.5008767E+74
18	-3.168E+16	-2.997E+16	6.870E+16	-5.512E+47	-5.213E+47	1.195E+48	2.9183781E+75
19	2.377E+16	-7.076E+15	8.829E+16	2.126E+46	-6.331E+45	7.899E+46	1.5008666E+74
20	9.778E+16	-1.698E+16	3.329E+15	1.847E+47	-3.208E+46	6.287E+45	3.1684824E+74
21	-1.756E+16	-2.087E+16	9.780E+16	-1.571E+46	-1.868E+46	8.751E+46	1.5008751E+74
22	3.821E+16	6.008E+16	7.442E+16	1.519E+46	2.389E+46	2.960E+46	6.6704634E+73
23	-4.505E+16	3.010E+16	9.281E+16	-8.240E+46	5.506E+46	1.698E+47	3.0684488E+74
24	-8.423E+15	5.249E+16	-9.391E+16	-2.763E+46	1.722E+47	-3.081E+47	5.5031931E+74
25	-4.604E+16	3.039E+16	9.297E+16	-5.492E+46	3.625E+46	1.109E+47	2.0011624E+74
26	4.905E+16	9.646E+16	7.359E+15	3.901E+46	7.672E+46	5.853E+45	1.3340888E+74
27	4.992E+16	9.787E+16	7.068E+15	4.466E+46	8.757E+46	6.324E+45	1.5008495E+74
28	-1.391E+16	-1.091E+17	4.365E+15	-1.106E+46	-8.679E+46	3.472E+45	1.3341269E+74
29	-6.287E+16	-8.894E+16	-2.563E+16	-1.150E+47	-1.627E+47	-4.689E+46	3.0685045E+74
30	-6.906E+16	-8.502E+16	2.583E+16	-1.510E+47	-1.860E+47	5.650E+46	3.6688592E+74
31	-2.358E+16	2.089E+16	1.103E+17	-9.376E+45	8.306E+45	4.385E+46	6.6705283E+73
32	1.863E+16	-5.543E+16	-1.016E+17	1.481E+46	-4.409E+46	-8.079E+46	1.3341190E+74
33	-5.045E+16	3.780E+16	-1.031E+17	-4.514E+46	3.382E+46	-9.228E+46	1.5008804E+74
34	2.098E+16	-4.320E+16	-1.119E+17	2.503E+46	-5.153E+46	-1.335E+47	2.0011761E+74
35	-3.341E+16	-3.813E+16	1.128E+17	-1.993E+46	-2.275E+46	6.728E+46	1.0005865E+74
36	1.201E+17	-5.235E+15	-4.106E+16	7.164E+46	-3.123E+45	-2.449E+46	1.0005711E+74
37	-5.814E+16	4.544E+16	-1.084E+17	-5.202E+46	4.066E+46	-9.703E+46	1.5008807E+74
38	-1.074E+17	7.508E+16	-1.226E+16	-7.471E+46	5.225E+46	-8.535E+45	1.1673508E+74
39	2.961E+16	1.230E+17	4.581E+16	2.944E+46	1.223E+47	4.554E+46	1.6676078E+74
40	8.249E+16	-2.355E+16	-1.055E+17	2.395E+47	-6.837E+46	-3.062E+47	4.8694850E+74
41	-6.103E+16	4.804E+16	-1.154E+17	-5.461E+46	4.299E+46	-1.033E+47	1.5008811E+74
42	9.770E+16	2.146E+16	-9.754E+16	8.741E+46	1.920E+46	-8.727E+46	1.5008587E+74
43	2.152E+16	1.346E+17	-3.203E+16	1.711E+46	1.070E+47	-2.547E+46	1.3340890E+74
44	-5.352E+16	-2.816E+16	-1.291E+17	-3.022E+47	-1.590E+47	-7.291E+47	9.4723000E+74
45	1.146E+16	1.397E+16	-1.439E+17	7.977E+45	9.723E+45	-1.002E+47	1.1673480E+74
46	-1.328E+17	1.609E+16	-6.590E+16	-1.188E+47	1.439E+46	-5.897E+46	1.5008955E+74
47	-4.788E+16	9.195E+16	-1.089E+17	-5.712E+46	1.097E+47	-1.299E+47	2.0011623E+74
48	1.050E+16	-1.347E+17	-7.023E+16	1.732E+46	-2.222E+47	-1.159E+47	2.7683199E+74
49	-4.595E+16	8.948E+15	1.450E+17	-4.111E+46	8.006E+45	1.297E+47	1.5008728E+74
50	1.368E+17	5.367E+16	-5.110E+16	8.160E+46	3.202E+46	-3.048E+46	1.0005634E+74
51	1.771E+16	2.708E+16	-1.522E+17	3.557E+46	5.439E+46	-3.057E+47	3.3686268E+74
52	-1.095E+17	9.683E+16	5.383E+16	-9.799E+46	8.664E+46	4.816E+46	1.5008734E+74
53	-4.723E+16	-1.168E+17	9.361E+16	-8.921E+46	-2.206E+47	1.768E+47	3.1685568E+74
54	9.791E+16	-9.246E+16	8.394E+16	4.984E+47	-4.706E+47	4.273E+47	8.5382730E+74

		moment of Inertia for the END of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
55	1.098E+17	9.705E+16	6.622E+16	4.367E+46	3.859E+46	2.633E+46	6.6703873E+73
56	-9.107E+16	-1.370E+17	-2.489E+16	-7.243E+46	-1.089E+47	-1.979E+46	1.3341432E+74
57	-7.004E+16	9.145E+16	1.217E+17	-7.660E+46	1.000E+47	1.331E+47	1.8343902E+74
58	-2.649E+16	4.323E+16	1.616E+17	-1.580E+46	2.578E+46	9.641E+46	1.0005756E+74
59	-3.167E+16	1.253E+17	1.107E+17	-4.723E+46	1.868E+47	1.650E+47	2.5014227E+74
60	4.740E+16	1.591E+15	1.634E+17	3.770E+46	1.265E+45	1.300E+47	1.3340959E+74
61	1.202E+17	-9.022E+16	8.744E+16	7.170E+46	-5.382E+46	5.216E+46	1.0005761E+74
62	-5.757E+16	-1.401E+17	8.885E+16	-5.151E+46	-1.253E+47	7.950E+46	1.5009009E+74
63	6.766E+16	-4.600E+16	-1.571E+17	5.381E+46	-3.659E+46	-1.249E+47	1.3341129E+74
64	-9.216E+16	-1.204E+17	9.306E+16	-1.961E+47	-2.562E+47	1.980E+47	3.5688143E+74
65	5.723E+15	1.766E+17	-2.279E+16	5.121E+45	1.580E+47	-2.039E+46	1.5008456E+74
66	-1.350E+17	-1.162E+17	-1.306E+16	-8.052E+46	-6.930E+46	-7.792E+45	1.0006096E+74
67	-1.195E+17	4.881E+16	-1.245E+17	-7.129E+46	2.911E+46	-7.423E+46	1.0005939E+74
68	7.873E+16	1.638E+16	-1.624E+17	7.827E+46	1.628E+46	-1.615E+47	1.6676284E+74
69	3.918E+16	1.473E+17	-9.985E+16	7.166E+46	2.695E+47	-1.826E+47	3.0684011E+74
70	1.673E+17	-1.185E+16	-7.328E+16	1.164E+47	-8.244E+45	-5.100E+46	1.1673290E+74
71	-1.391E+17	-9.109E+16	7.673E+16	-1.244E+47	-8.150E+46	6.865E+46	1.5009070E+74
72	5.242E+16	-1.594E+16	1.753E+17	1.459E+47	-4.436E+46	4.880E+47	4.6693401E+74
73	3.643E+15	2.913E+16	-1.818E+17	6.013E+45	4.808E+46	-3.000E+47	2.7682836E+74
74	-9.078E+16	1.016E+17	1.239E+17	-9.025E+46	1.010E+47	1.232E+47	1.6676293E+74
75	6.411E+15	1.797E+16	-1.837E+17	1.211E+46	3.394E+46	-3.470E+47	3.1685204E+74
76	-2.063E+15	-5.394E+15	1.866E+17	-3.897E+45	-1.019E+46	3.526E+47	3.1684949E+74
77	1.097E+17	-3.319E+16	1.477E+17	2.400E+47	-7.260E+46	3.231E+47	3.6687543E+74
78	-1.542E+17	-1.013E+17	3.853E+16	-3.372E+47	-2.216E+47	8.426E+46	3.6688980E+74
79	4.302E+16	-1.835E+17	8.559E+15	2.566E+46	-1.095E+47	5.105E+45	1.0005968E+74
80	-1.306E+17	6.845E+16	-1.209E+17	-1.299E+47	6.805E+46	-1.202E+47	1.6676549E+74
81	-1.313E+17	6.753E+16	-1.208E+17	-1.436E+47	7.384E+46	-1.321E+47	1.8344207E+74
82	-1.339E+17	-5.210E+16	1.258E+17	-1.597E+47	-6.215E+46	1.501E+47	2.0011969E+74
83	-2.191E+16	6.931E+16	-1.771E+17	-2.396E+46	7.580E+46	-1.937E+47	1.8344018E+74
84	4.000E+16	8.009E+16	1.707E+17	5.965E+46	1.194E+47	2.546E+47	2.5014106E+74
85	-2.198E+16	-1.283E+16	-1.917E+17	-1.529E+46	-8.930E+45	-1.334E+47	1.1673573E+74
86	-1.352E+17	-5.387E+16	1.274E+17	-1.479E+47	-5.891E+46	1.394E+47	1.8344310E+74
87	-2.074E+16	-9.290E+15	1.938E+17	-1.856E+46	-8.312E+45	1.734E+47	1.5008693E+74
88	1.014E+17	8.455E+16	1.452E+17	6.050E+46	5.043E+46	8.659E+46	1.0005579E+74
89	7.377E+16	-5.177E+16	-1.790E+17	4.400E+46	-3.088E+46	-1.068E+47	1.0005853E+74
90	-1.507E+17	6.467E+16	1.168E+17	-2.757E+47	1.183E+47	2.137E+47	3.0684705E+74
91	-3.308E+16	-1.223E+17	-1.588E+17	-2.302E+46	-8.508E+46	-1.105E+47	1.1673710E+74
92	-1.169E+21	-1.042E+21	9.315E+19	-1.410E+58	-1.257E+58	1.123E+57	2.5254483E+81
93	-1.794E+20	-3.618E+20	-1.423E+19	-1.334E+57	-2.689E+57	-1.057E+56	1.3205005E+81
94	1.487E+19	2.777E+19	-7.917E+19	1.426E+56	2.662E+56	-7.591E+56	1.6050401E+81
95	6.944E+19	-4.444E+18	7.944E+17	4.899E+56	-3.135E+55	5.605E+54	1.1751934E+81
96	9.113E+19	-4.393E+19	1.890E+20	5.892E+56	-2.840E+56	1.222E+57	1.0729861E+81
97	1.053E+20	2.065E+19	8.977E+19	7.618E+56	1.494E+56	6.494E+56	1.1937338E+81
98	1.257E+20	6.155E+19	3.770E+19	8.547E+56	4.185E+56	2.563E+56	1.1164095E+81
99	1.529E+20	2.408E+19	-1.583E+19	1.234E+57	1.944E+56	-1.278E+56	1.3290997E+81
100	1.749E+20	1.357E+19	-3.139E+19	1.675E+57	1.300E+56	-3.007E+56	1.5758249E+81
101	1.856E+20	5.871E+19	1.510E+19	1.540E+57	4.872E+56	1.253E+56	1.3550148E+81
102	2.008E+20	1.024E+20	7.893E+19	2.086E+57	1.064E+57	8.202E+56	1.6825323E+81
103	2.212E+20	1.032E+19	-1.157E+20	1.990E+57	9.283E+55	-1.041E+57	1.4771714E+81
104	2.409E+20	2.387E+19	8.081E+18	2.062E+57	2.043E+56	6.915E+55	1.3944870E+81

		moment of Inertia for the END of iteration					Polar MI
Mass	s x	sy	sz	mass * x	mass * y	mass * z	=m*r^2
105	2.525E+20	-1.042E+19	-1.910E+18	2.479E+57	-1.023E+56	-1.875E+55	1.6043804E+81
106	2.637E+20	1.586E+19	2.362E+19	2.601E+57	1.564E+56	2.330E+56	1.6035980E+81
107	2.802E+20	4.574E+18	-5.622E+18	2.503E+57	4.085E+55	-5.021E+55	1.4530334E+81
108	2.936E+20	-2.524E+19	6.361E+18	2.964E+57	-2.548E+56	6.422E+55	1.6448167E+81
109	3.138E+20	-1.181E+18	1.466E+19	4.304E+57	-1.619E+55	2.011E+56	2.2226266E+81
110	3.353E+20	-1.681E+20	-3.478E+19	3.402E+57	-1.705E+57	-3.529E+56	1.6736921E+81
111	3.724E+20	1.374E+19	-1.256E+20	4.167E+57	1.537E+56	-1.406E+57	1.8078481E+81
112	4.873E+20	1.744E+20	8.661E+19	4.981E+57	1.783E+57	8.853E+56	1.5907843E+81
113	6.492E+20	1.826E+18	9.067E+19	6.042E+57	1.700E+55	8.439E+56	1.4506677E+81
114	1.023E+21	1.531E+20	4.804E+20	1.013E+58	1.515E+57	4.755E+57	1.4375796E+81
115	4.792E+19	1.675E+20	1.570E+20	3.433E+56	1.200E+57	1.125E+57	1.1688060E+81
116	-1.636E+20	1.478E+20	-7.974E+19	-6.296E+60	5.688E+60	-3.068E+60	6.4853629E+84
117	1.545E+20	8.226E+19	1.560E+20	7.431E+60	3.956E+60	7.505E+60	7.8257721E+84
118	-1.147E+19	4.682E+19	2.295E+20	-6.618E+59	2.702E+60	1.324E+61	9.5793160E+84
119	-8.866E+19	-1.061E+19	2.168E+20	-5.969E+60	-7.144E+59	1.460E+61	1.1343238E+85
120	5.625E+19	-1.613E+20	-1.607E+20	4.328E+60	-1.241E+61	-1.236E+61	1.3116831E+85
121	-1.157E+20	2.039E+20	6.682E+18	-1.001E+61	1.765E+61	5.784E+59	1.4391861E+85
122	-3.634E+19	1.123E+19	-2.314E+20	-3.495E+60	1.081E+60	-2.226E+61	1.6299145E+85
123	-1.722E+20	-7.679E+19	1.394E+20	-1.822E+61	-8.124E+60	1.475E+61	1.8152266E+85
124	-2.051E+19	-2.196E+20	7.974E+19	-2.170E+60	-2.323E+61	8.437E+60	1.8160794E+85
125	-1.584E+20	7.456E+19	-1.560E+20	-1.523E+61	7.172E+60	-1.501E+61	1.6367047E+85
126	-3.064E+19	-3.720E+19	-2.295E+20	-2.653E+60	-3.221E+60	-1.987E+61	1.4733697E+85
127	6.156E+19	-6.468E+19	-2.168E+20	4.737E+60	-4.977E+60	-1.669E+61	1.3000077E+85
128	9.556E+19	1.416E+20	1.607E+20	6.434E+60	9.533E+60	1.082E+61	1.0955848E+85
129	2.326E+20	-2.937E+19	-6.682E+18	1.342E+61	-1.695E+60	-3.856E+59	9.4718053E+84
130	3.075E+19	2.239E+19	2.314E+20	1.479E+60	1.077E+60	1.113E+61	7.9661970E+84
131	4.156E+19	1.839E+20	-1.394E+20	1.599E+60	7.077E+60	-5.363E+60	6.3291467E+84
132	1.743E+22	1.505E+22	6.793E+21	2.462E+64	2.126E+64	9.597E+63	1.7737554E+86
133	1.285E+20	1.931E+22	-1.820E+22	1.816E+61	2.728E+63	-2.572E+63	8.7849357E+85
		sum m*r		9.088E+21	8.858E+21	2.589E+21	4.5943978E+86
		Mass Centre		9.386E+19	-8.348E+19	1.163E+19	
						Polar MI tot	4.5943978E+86

Stable Model : Total energy h = T –V is negative

Theory and requirement

We now turn to the general *n-body problem* dealing with *n* material points (m_1, $\mathbf{r}_1$)… (m_n, $\mathbf{r}_n$) attracted to each other according to the Newton's law of universal gravitation. The kinetic energy is

$$T = \frac{1}{2}\sum m_i \dot{r}_i^2$$

and the force function (potential energy)

$$V = \sum_{j<k} \frac{m_j m_k}{r_{jk}}, \quad r_{jk} = |r_j - r_k|$$

is always positive. We introduce an inertial frame of reference with origin at the centre of mass, and let the $\mathbf{r}_i$ be the position vectors of the points in the new frame. The equations of the *n*-body problem have the form of Lagrange's equations with the Lagrangian $L = T + V$ *(A Lagrangian is energy difference between the Kinetic energy T and the Potential energy V, here V is shown as positive due to convention used)* .

Theorem (Jacobi)**.** *If a motion is stable, then the total energy h = T –V is negative.(Here also V is shown minus).* We have calculated the total energy h for all masses using the above equation, according to Vladimir Igorevich Amold, Kozolov, Neishtadt in section 2.3 [See ref].

Results conclusions and Inferences

Table 11 and Table 12 give the Gist and calculated values for showing the total Energy in the system h = T-V is negative. In Table 12 the Kinetic energy T of the each mass is shown in second column which is calculated according to the formula given in 'theory and requirement' portion of this section above. Later four columns in the table 12 give the calculated values of V corresponding to above formula involving masses # 133, 132, 131 and 130. Here V is calculated only for masses involving # 133, 132, 131 and 130 as the total of V containing mass 133 in the third column (1.26525 E +61) and itself is sufficiently larger than the calculated total of T(1.16843E+40) in the second column. If we add the force function for all the masses, it will be much higher. The other values of V involving the masses 132, 131, and130 (which are shown in the fourth fifth and sixth columns of table 12); are given only for comparison sake. Here the total of V is coming to 4.5479 x 10^{62}. Whereas T= 1.16843E+40. Hence V is larger by 4.5479 x 10^{62} joules. All the totals are shown as essence in the table 11.

Hence all the motions are stable in this Dynamic Universe model.

Table 11 : This table describes the gist and totals for "Table 12" Dynamic Universe Model is stable:" Total Energy = h=T-V" is NEGATIVE

	T= Kinetic energy	V= potential Energy grand total = .54794E+62			
Mass		133	132	131	130
totals	1.16843E+40	1.26525E+61	6.78911E+61	1.44655E+62	2.29595E+62

Table 12 : This table shows how Dynamic Universe Model is stable:" Total Energy = h=T-V" is NEGATIVE

Mass	T=Kinetic Energy	V for mass 133	V for mass 132	V for mass 131	V for mass 130
1	8.03639E+06	2.54507E+21	2.81332E+22	7.84206E+22	9.80258E+22
2	1.03793E+28	1.75706E+42	1.94225E+43	5.41398E+43	6.76747E+43
3	1.54861E+29	2.59299E+43	2.86629E+44	7.98972E+44	9.98715E+44
4	1.68395E+29	3.17868E+43	3.5137E+44	9.79438E+44	1.2243E+45
5	1.61487E+28	3.41827E+42	3.77856E+43	1.05326E+44	1.31658E+44
6	2.56043E+31	1.01164E+46	1.11826E+47	3.11714E+47	3.89642E+47
7	5.53700E+30	3.02427E+45	3.34302E+46	9.3186E+46	1.16483E+47
8	5.63786E+29	4.62159E+44	5.1087E+45	1.42404E+46	1.78005E+46
9	5.56305E+29	5.4309E+44	6.00331E+45	1.67341E+46	2.09176E+46
10	7.38599E+25	6.76201E+40	7.47471E+41	2.08356E+42	2.60445E+42
11	2.05088E+27	3.91345E+41	4.32592E+42	1.20584E+43	1.5073E+43
12	7.59304E+30	1.05956E+49	1.17123E+50	3.26479E+50	4.08099E+50
13	1.12065E+27	2.1173E+48	2.34046E+49	6.52319E+49	8.15496E+49
14	1.23373E+29	1.00572E+49	1.11172E+50	3.09855E+50	3.8742E+50
15	1.13903E+29	1.16451E+49	1.28725E+50	3.5878E+50	4.48591E+50
16	2.24806E+27	4.2346E+48	4.68091E+49	1.30499E+50	1.63061E+50
17	2.53062E+27	4.76393E+48	5.26603E+49	1.46816E+50	1.83427E+50
18	4.90720E+28	9.26316E+49	1.02395E+51	2.85339E+51	3.56873E+51
19	2.53202E+27	4.76391E+48	5.26604E+49	1.46756E+50	1.83557E+50
20	5.34572E+27	1.00572E+49	1.11172E+50	3.09892E+50	3.87385E+50
21	2.53826E+27	4.76391E+48	5.26603E+49	1.46741E+50	1.83559E+50
22	1.12388E+27	2.1173E+48	2.34047E+49	6.52425E+49	8.1579E+49
23	7.27064E+27	9.73956E+48	1.07661E+50	3.00053E+50	3.75271E+50
24	9.27928E+27	1.74678E+49	1.93088E+50	5.38448E+50	6.72531E+50
25	2.16377E+27	6.35189E+48	7.02138E+49	1.95686E+50	2.44742E+50
26	2.16715E+27	4.23461E+48	4.68094E+49	1.30524E+50	1.63115E+50
27	2.65022E+27	4.76393E+48	5.26605E+49	1.46841E+50	1.83505E+50
28	2.24633E+27	4.23458E+48	4.6809E+49	1.30429E+50	1.63094E+50

Mass	T=Kinetic Energy	V for mass 133	V for mass 132	V for mass 131	V for mass 130
29	5.15970E+27	9.73956E+48	1.07661E+50	3.00019E+50	3.75062E+50
30	6.16399E+27	1.16451E+49	1.28725E+50	3.58675E+50	4.4854E+50
31	1.12393E+27	2.11729E+48	2.34046E+49	6.5225E+49	8.15872E+49
32	2.25079E+27	4.2346E+48	4.68091E+49	1.30491E+50	1.63028E+50
33	2.53388E+27	4.76394E+48	5.26602E+49	1.46841E+50	1.83405E+50
34	3.37415E+27	6.35191E+48	7.02136E+49	1.9575E+50	2.44533E+50
35	1.68498E+27	3.17594E+48	3.51069E+49	9.78168E+49	1.22379E+50
36	1.68939E+27	3.17595E+48	3.5107E+49	9.78771E+49	1.22311E+50
37	2.53265E+27	4.76394E+48	5.26602E+49	1.46846E+50	1.83401E+50
38	1.96215E+27	3.70528E+48	4.0958E+49	1.14193E+50	1.427E+50
39	2.80895E+27	5.29326E+48	5.85117E+49	1.63151E+50	2.03927E+50
40	8.22295E+27	1.54563E+49	1.70854E+50	4.7637E+50	5.95071E+50
41	2.51214E+27	4.76394E+48	5.26602E+49	1.46849E+50	1.83395E+50
42	2.53501E+27	4.76394E+48	5.26604E+49	1.46847E+50	1.83423E+50
43	2.24838E+27	4.23462E+48	4.68094E+49	1.30551E+50	1.63088E+50
44	1.59488E+28	3.00657E+49	3.32344E+50	9.26584E+50	1.15733E+51
45	1.96978E+27	3.70529E+48	4.0958E+49	1.14218E+50	1.42627E+50
46	2.52292E+27	4.76393E+48	5.26601E+49	1.46807E+50	1.83424E+50
47	3.37022E+27	6.35193E+48	7.02137E+49	1.95827E+50	2.4454E+50
48	4.66520E+27	8.78677E+48	9.71286E+49	2.70674E+50	3.38315E+50
49	2.52218E+27	4.76391E+48	5.26604E+49	1.46735E+50	1.83595E+50
50	1.68977E+27	3.17596E+48	3.51071E+49	9.79001E+49	1.2231E+50
51	5.68905E+27	1.06924E+49	1.18193E+50	3.29622E+50	4.11571E+50
52	2.52098E+27	4.76393E+48	5.26603E+49	1.46805E+50	1.83524E+50
53	5.33045E+27	1.00571E+49	1.11171E+50	3.09684E+50	3.87485E+50
54	1.43832E+28	2.71013E+49	2.99579E+50	8.34695E+50	1.04422E+51
55	1.12477E+27	2.1173E+48	2.34047E+49	6.52554E+49	8.15807E+49
56	2.24286E+27	4.23458E+48	4.68089E+49	1.30419E+50	1.63065E+50
57	3.08357E+27	5.82257E+48	6.43627E+49	1.79399E+50	2.24376E+50
58	1.68210E+27	3.17594E+48	3.5107E+49	9.78318E+49	1.22408E+50
59	4.20675E+27	7.93987E+48	8.77675E+49	2.44677E+50	3.05964E+50
60	2.24316E+27	4.23458E+48	4.68093E+49	1.30431E+50	1.63216E+50
61	1.69351E+27	3.17593E+48	3.5107E+49	9.78174E+49	1.22373E+50
62	2.52271E+27	4.76389E+48	5.26601E+49	1.46681E+50	1.83539E+50
63	2.25267E+27	4.23461E+48	4.68091E+49	1.30518E+50	1.62995E+50
64	5.99197E+27	1.13275E+49	1.25214E+50	3.48786E+50	4.36418E+50
65	2.52850E+27	4.76395E+48	5.26606E+49	1.46885E+50	1.83483E+50
66	1.68044E+27	3.17594E+48	3.51066E+49	9.78149E+49	1.22303E+50
67	1.68425E+27	3.17596E+48	3.51067E+49	9.78977E+49	1.22255E+50
68	2.81729E+27	5.29327E+48	5.85115E+49	1.63185E+50	2.03745E+50
69	5.17656E+27	9.73964E+48	1.07662E+50	3.00336E+50	3.75002E+50
70	1.97252E+27	3.70528E+48	4.09582E+49	1.14201E+50	1.42681E+50
71	2.51881E+27	4.7639E+48	5.266E+49	1.46701E+50	1.83525E+50
72	7.86306E+27	1.4821E+49	1.63833E+50	4.56469E+50	5.71283E+50
73	4.66162E+27	8.78684E+48	9.71289E+49	2.70897E+50	3.38178E+50
74	2.79892E+27	5.29324E+48	5.85115E+49	1.63092E+50	2.03979E+50
75	5.34776E+27	1.00572E+49	1.11172E+50	3.10054E+50	3.87066E+50
76	5.32984E+27	1.00571E+49	1.11172E+50	3.09736E+50	3.87665E+50
77	6.18232E+27	1.16451E+49	1.28726E+50	3.58674E+50	4.48824E+50
78	6.15631E+27	1.16451E+49	1.28724E+50	3.58621E+50	4.48539E+50
79	1.68559E+27	3.17593E+48	3.51068E+49	9.78007E+49	1.22323E+50

Mass	T=Kinetic Energy	V for mass 133	V for mass 132	V for mass 131	V for mass 130
80	3.35691E+27	5.29327E+48	5.85113E+49	1.63171E+50	2.03761E+50
81	2.86431E+27	5.8226E+48	6.43624E+49	1.79487E+50	2.24138E+50
82	3.38459E+27	6.35187E+48	7.02135E+49	1.95603E+50	2.44755E+50
83	3.09182E+27	5.82261E+48	6.43626E+49	1.79529E+50	2.24098E+50
84	4.20903E+27	7.93985E+48	8.77677E+49	2.44616E+50	3.06048E+50
85	1.96715E+27	3.70529E+48	4.09579E+49	1.14218E+50	1.42595E+50
86	3.06464E+27	5.82254E+48	6.43624E+49	1.79301E+50	2.2436E+50
87	2.51921E+27	4.7639E+48	5.26604E+49	1.46711E+50	1.83634E+50
88	1.68551E+27	3.17594E+48	3.51071E+49	9.78588E+49	1.22411E+50
89	1.68962E+27	3.17596E+48	3.51068E+49	9.78926E+49	1.22235E+50
90	5.14809E+27	9.73956E+48	1.07661E+50	3.00045E+50	3.75292E+50
91	1.96743E+27	3.70528E+48	4.09578E+49	1.14166E+50	1.42607E+50
92	7.21463E+33	6.21843E+55	6.68424E+56	2.6676E+56	3.60108E+56
93	5.89622E+34	3.91982E+55	4.30985E+56	4.75098E+56	7.11961E+56
94	8.26639E+34	5.11944E+55	5.64445E+56	2.17629E+57	1.48253E+57
95	3.00929E+34	3.75617E+55	4.1609E+56	1.1479E+57	1.44164E+57
96	1.01299E+35	3.4221E+55	3.82034E+56	6.17628E+56	3.13519E+57
97	5.63559E+34	3.84488E+55	4.27799E+56	9.6459E+56	2.17337E+57
98	4.79123E+34	3.62281E+55	4.02531E+56	1.13177E+57	1.49139E+57
99	4.44598E+34	4.30275E+55	4.77526E+56	1.34628E+57	1.4078E+57
100	8.26862E+34	5.10596E+55	5.66719E+56	1.52402E+57	1.53618E+57
101	7.57160E+34	4.42368E+55	4.91993E+56	1.30011E+57	1.48634E+57
102	1.57267E+35	5.5365E+55	6.17509E+56	1.41627E+57	2.06514E+57
103	1.02392E+35	4.80558E+55	5.32427E+56	1.37902E+57	1.09222E+57
104	2.20946E+35	4.55825E+55	5.07697E+56	1.1154E+57	1.34191E+57
105	9.73166E+35	5.22621E+55	5.82097E+56	1.18745E+57	1.45924E+57
106	2.31520E+35	5.2495E+55	5.85442E+56	1.17538E+57	1.51883E+57
107	2.50512E+35	4.75699E+55	5.30201E+56	1.05034E+57	1.24654E+57
108	2.63280E+35	5.37114E+55	5.99183E+56	1.08347E+57	1.39008E+57
109	2.22220E+35	7.29811E+55	8.14891E+56	1.45133E+57	1.84565E+57
110	8.46397E+34	5.38234E+55	6.00329E+56	8.3011E+56	1.09143E+57
111	8.68164E+34	5.98021E+55	6.65369E+56	1.15657E+57	1.08899E+57
112	4.69281E+34	5.45584E+55	6.14068E+56	7.8674E+56	9.78244E+56
113	2.82541E+34	4.94299E+55	5.59264E+56	5.30646E+56	7.05316E+56
114	1.05234E+34	5.22313E+55	6.06965E+56	3.27872E+56	4.61423E+56
115	2.37745E+35	3.81633E+55	4.24897E+56	9.28298E+56	2.10128E+57
116	5.08470E+38	2.06097E+59	2.25969E+60	6.82981E+60	4.77194E+60
117	8.36077E+38	2.55602E+59	2.85516E+60	5.56886E+60	1.47517E+61
118	1.49924E+39	3.05839E+59	3.40862E+60	5.59103E+60	5.68593E+61
119	8.29389E+38	3.56367E+59	3.96087E+60	6.0766E+60	2.59574E+61
120	1.23063E+39	4.09571E+59	4.50872E+60	8.55086E+60	8.53202E+60
121	9.47957E+38	4.63395E+59	5.10433E+60	1.54525E+61	1.2855E+61
122	4.76792E+39	5.15345E+59	5.64077E+60	1.75691E+61	9.88849E+60
123	1.16221E+39	5.60101E+59	6.19233E+60	9.30381E+60	2.08582E+61
124	9.42878E+38	5.58807E+59	6.19329E+60	8.78475E+60	1.75372E+61
125	1.10911E+39	5.15223E+59	5.63435E+60	1.61943E+61	1.06509E+61
126	4.27483E+39	4.63165E+59	5.07131E+60	1.33495E+61	8.8806E+60
127	1.62876E+39	4.11261E+59	4.51778E+60	1.13348E+61	8.0856E+60
128	9.32892E+38	3.58377E+59	3.9965E+60	8.41535E+60	2.11612E+61
129	5.05386E+38	3.07077E+59	3.41761E+60	7.03524E+60	8.77236E+60
130	1.74494E+39	2.54687E+59	2.84241E+60	4.57292E+60	

Mass	T=Kinetic Energy	V for mass 133	V for mass 132	V for mass 131	V for mass 130
131	4.40091E+38	2.06635E+59	2.27433E+60		
132	3.72309E+36	6.50377E+60			
133	5.09959E+35				

NONE of the masses are moving towards Center of mass (The summation of Velocity Unit Vector differences Test)

Theory and requirement

In their book Vladimir Igorevich Amold, Kozolov, Neishtadt in section 2.2.2 said '*If the position vectors* $r_i(t)$ *of all the points have one and the same limit* r_o *as* $t \rightarrow t_o$ *then we say a simultaneous collision takes place at time* t_o. *The point* r_o *clearly must coincide with the centre of mass, that is* $r_o = \mathbf{0}$**.** When all the bodies fall into centre of mass of system then vector sum of all the velocity differences between present velocity UNIT vector of every mass and the UNIT vector directed toward centre of mass for the same mass in the in the system will be ZERO

Consider the general *n-body problem* dealing with *n* material points (m_1, $\mathbf{r}_1$)…(m_n, $\mathbf{r}_n$). Let the centre of mass Cm and it is at $\mathbf{r_c}$ with respect to present reference frame. $\dot{r}_1 \dots \dot{r}_n$ are the present actual velocities. $\dot{r}_{c1} \dots \dot{r}_{cn}$ are the supposed velocities toward centre of mass for the system when all the masses fall in to the centre of mass.

How to get these velocity UNIT vectors? These velocities are not possible in Dynamic Universe model. But, Direction UNIT vectors of velocities toward centre of mass will be in the same as direction of centre of mass for every point mass. Hence direction Unit vectors for every mass towards centre of mass can be calculated.

Vectors $\hat{r}_1 \dots \hat{r}_n$, $\hat{r}_{c1} \dots \hat{r}_{cn}$ are the corresponding Unit vectors for these velocities. Then

$$\Sigma_1^n(\hat{r}_{ci} - \hat{r}_i) = 0$$

Results conclusions and Inferences

If there is an all body simultaneous collision in nearby times to the present moment, all the masses will move towards center of mass. Hence velocities will be directed towards CENTER OF MASS. What we have to find is whether any of the present velocity unit vectors are directed towards center of mass or not. In that case if any velocity Unit vector is aligned with the unit vector towards center of mass then the difference between the x y z unit vectors will be zero or tends to zero. Table 14 gives the 'Present Velocity UNIT vectors', in the first three columns; next three columns gives 'Present Position UNIT vectors towards Centre of mass' and the Differences between these two UNIT vectors are given in the last three columns. It can be seen that there is no zero in the differences. That means that NONE of the masses is moving towards center of mass. If all the masses are falling towards the center of mass, then the totals of differences are will be ZERO. Table 13 gives the coordinates of Center of mass for this configuration (xyz)= 9.1E+21 9E+21 2.6E+21 for this iteration and the x y z non zero sums of 'difference between unit vectors' were also given in this table 13. If there is nonalignment then there is NO simultaneous collision which is self-evident: [see table 12]

This 'Non alignment of present velocity UNIT vectors with UNIT vectors towards Center of Mass of all point masses' shows that NONE of the masses are moving towards Center of mass and that Dynamic Universe Model is non-collapsing.

Table 13: This table describes gist and Center of mass and totals for "Table 14: Non- alignment of present velocity UNIT vectors with singularity velocity UNIT vectors towards Center of Mass"

	X	Y	Z	Non zero sums of difference between unit vectors		
Centre of mass for this configuration (xyz)=	9.1E+21	9E+21	2.6E+21	**13.657**	**88.679**	**-11.477**

Table 14: This table shows how the 'non- alignment of present velocity UNIT vectors' with 'singularity velocity UNIT vectors towards Center of Mass' and show their differences.

Present Velocity UNIT vectors			Present Position UNIT vectors towards Centre of mass			Differences between UNIT vectors		
u x	u y	u z	s x	sy	sz	x	y	z
0.3516	-0.9355	0.0358	-0.7017	-0.6839	-0.1999	1.0532	-0.2516	0.2357
0.0482	-0.9952	-0.0857	-0.7017	-0.6839	-0.1999	0.7498	-0.3113	0.1141
-0.0575	0.9982	0.0170	-0.7017	-0.6839	-0.1999	0.6442	1.6821	0.2169
0.7788	0.6273	0.0000	-0.7017	-0.6839	-0.1999	1.4804	1.3112	0.1998
-0.6019	0.7979	0.0315	-0.7017	-0.6839	-0.1999	0.0997	1.4818	0.2314
0.5934	0.8047	-0.0166	-0.7017	-0.6839	-0.1999	1.2951	1.4886	0.1832
-0.1644	-0.9861	0.0237	-0.7017	-0.6839	-0.1999	0.5372	-0.3022	0.2235
0.1019	0.9948	0.0024	-0.7017	-0.6839	-0.1999	0.8036	1.6787	0.2022
0.5686	0.8221	-0.0300	-0.7017	-0.6839	-0.1999	1.2703	1.5060	0.1698
0.9554	-0.1409	-0.2596	-0.7017	-0.6839	-0.1999	1.6571	0.5430	-0.0597
0.8129	0.5824	0.0007	-0.7017	-0.6839	-0.1999	1.5145	1.2663	0.2005
0.5791	-0.8152	-0.0087	-0.7017	-0.6839	-0.1999	1.2808	-0.1313	0.1911
-0.8744	0.0564	-0.4818	-0.7017	-0.6839	-0.1999	-0.1728	0.7403	-0.2820
-0.7894	-0.4965	-0.3611	-0.7017	-0.6839	-0.1999	-0.0877	0.1874	-0.1612
0.7666	0.5431	0.3426	-0.7017	-0.6839	-0.1999	1.4683	1.2270	0.5424
-0.8731	0.0549	-0.4844	-0.7017	-0.6839	-0.1999	-0.1715	0.7388	-0.2845
-0.8733	0.0553	-0.4840	-0.7017	-0.6839	-0.1999	-0.1717	0.7392	-0.2841
-0.8738	0.0567	-0.4829	-0.7017	-0.6839	-0.1999	-0.1722	0.7406	-0.2831
-0.8748	0.0546	-0.4814	-0.7017	-0.6839	-0.1999	-0.1731	0.7385	-0.2816
-0.8743	0.0550	-0.4822	-0.7017	-0.6839	-0.1999	-0.1727	0.7389	-0.2823
-0.8726	0.0540	-0.4855	-0.7017	-0.6839	-0.1999	-0.1709	0.7379	-0.2857
-0.8748	0.0536	-0.4816	-0.7017	-0.6839	-0.1999	-0.1731	0.7375	-0.2817
-0.9487	0.1329	-0.2870	-0.7017	-0.6839	-0.1999	-0.2470	0.8168	-0.0871
-0.8731	0.0536	-0.4846	-0.7017	-0.6839	-0.1999	-0.1714	0.7375	-0.2847
-0.2530	-0.2373	-0.9379	-0.7017	-0.6839	-0.1999	0.4487	0.4466	-0.7381
-0.8315	0.1787	-0.5260	-0.7017	-0.6839	-0.1999	-0.1298	0.8626	-0.3261
-0.8968	-0.0500	-0.4396	-0.7017	-0.6839	-0.1999	-0.1952	0.6339	-0.2397

Present Velocity UNIT vectors			Present Position UNIT vectors towards Centre of mass			Differences between UNIT vectors		
u x	u y	u z	s x	sy	sz	x	y	z
-0.8737	0.0577	-0.4830	-0.7017	-0.6839	-0.1999	-0.1721	0.7416	-0.2831
-0.8733	0.0571	-0.4838	-0.7017	-0.6839	-0.1999	-0.1717	0.7410	-0.2839
-0.8734	0.0577	-0.4835	-0.7017	-0.6839	-0.1999	-0.1718	0.7416	-0.2836
-0.8740	0.0538	-0.4829	-0.7017	-0.6839	-0.1999	-0.1723	0.7377	-0.2831
-0.8723	0.0578	-0.4855	-0.7017	-0.6839	-0.1999	-0.1706	0.7418	-0.2857
-0.8722	0.0566	-0.4859	-0.7017	-0.6839	-0.1999	-0.1705	0.7405	-0.2860
-0.8734	0.0552	-0.4839	-0.7017	-0.6839	-0.1999	-0.1717	0.7391	-0.2840
-0.8723	0.0574	-0.4855	-0.7017	-0.6839	-0.1999	-0.1707	0.7413	-0.2857
-0.8741	0.0546	-0.4826	-0.7017	-0.6839	-0.1999	-0.1725	0.7385	-0.2828
-0.8709	0.0545	-0.4885	-0.7017	-0.6839	-0.1999	-0.1692	0.7384	-0.2886
-0.8732	0.0542	-0.4843	-0.7017	-0.6839	-0.1999	-0.1716	0.7381	-0.2844
-0.8745	0.0529	-0.4822	-0.7017	-0.6839	-0.1999	-0.1728	0.7368	-0.2823
-0.8734	0.0552	-0.4839	-0.7017	-0.6839	-0.1999	-0.1717	0.7391	-0.2840
-0.8746	0.0519	-0.4820	-0.7017	-0.6839	-0.1999	-0.1729	0.7358	-0.2822
-0.8736	0.0536	-0.4836	-0.7017	-0.6839	-0.1999	-0.1720	0.7375	-0.2837
-0.8739	0.0529	-0.4832	-0.7017	-0.6839	-0.1999	-0.1722	0.7368	-0.2833
-0.8724	0.0560	-0.4856	-0.7017	-0.6839	-0.1999	-0.1707	0.7399	-0.2857
-0.8717	0.0571	-0.4868	-0.7017	-0.6839	-0.1999	-0.1700	0.7410	-0.2869
-0.8724	0.0554	-0.4856	-0.7017	-0.6839	-0.1999	-0.1708	0.7393	-0.2857
-0.8729	0.0527	-0.4851	-0.7017	-0.6839	-0.1999	-0.1712	0.7366	-0.2853
-0.8730	0.0572	-0.4843	-0.7017	-0.6839	-0.1999	-0.1714	0.7411	-0.2844
-0.8739	0.0552	-0.4829	-0.7017	-0.6839	-0.1999	-0.1723	0.7391	-0.2831
-0.8742	0.0535	-0.4827	-0.7017	-0.6839	-0.1999	-0.1725	0.7374	-0.2828
-0.8730	0.0531	-0.4848	-0.7017	-0.6839	-0.1999	-0.1714	0.7370	-0.2849
-0.8739	0.0540	-0.4832	-0.7017	-0.6839	-0.1999	-0.1722	0.7379	-0.2833
-0.8738	0.0578	-0.4828	-0.7017	-0.6839	-0.1999	-0.1722	0.7417	-0.2829
-0.8747	0.0566	-0.4814	-0.7017	-0.6839	-0.1999	-0.1730	0.7405	-0.2816
-0.8751	0.0534	-0.4811	-0.7017	-0.6839	-0.1999	-0.1734	0.7373	-0.2812
-0.8729	0.0580	-0.4845	-0.7017	-0.6839	-0.1999	-0.1712	0.7420	-0.2846
-0.8745	0.0542	-0.4819	-0.7017	-0.6839	-0.1999	-0.1729	0.7381	-0.2821
-0.8746	0.0542	-0.4818	-0.7017	-0.6839	-0.1999	-0.1729	0.7381	-0.2819
-0.8748	0.0532	-0.4816	-0.7017	-0.6839	-0.1999	-0.1731	0.7371	-0.2818
-0.8757	0.0531	-0.4799	-0.7017	-0.6839	-0.1999	-0.1741	0.7370	-0.2800
-0.8756	0.0557	-0.4798	-0.7017	-0.6839	-0.1999	-0.1740	0.7396	-0.2799
-0.8737	0.0597	-0.4827	-0.7017	-0.6839	-0.1999	-0.1721	0.7436	-0.2829
-0.8728	0.0556	-0.4849	-0.7017	-0.6839	-0.1999	-0.1712	0.7395	-0.2850
-0.8734	0.0581	-0.4836	-0.7017	-0.6839	-0.1999	-0.1717	0.7420	-0.2837
-0.8739	0.0524	-0.4832	-0.7017	-0.6839	-0.1999	-0.1723	0.7363	-0.2834
-0.8728	0.0576	-0.4846	-0.7017	-0.6839	-0.1999	-0.1712	0.7415	-0.2848
-0.8725	0.0560	-0.4854	-0.7017	-0.6839	-0.1999	-0.1708	0.7399	-0.2856
-0.8732	0.0540	-0.4843	-0.7017	-0.6839	-0.1999	-0.1716	0.7379	-0.2844
-0.8735	0.0526	-0.4839	-0.7017	-0.6839	-0.1999	-0.1719	0.7365	-0.2841
-0.8740	0.0545	-0.4829	-0.7017	-0.6839	-0.1999	-0.1723	0.7384	-0.2830
-0.8731	0.0573	-0.4841	-0.7017	-0.6839	-0.1999	-0.1715	0.7412	-0.2842
-0.8750	0.0562	-0.4808	-0.7017	-0.6839	-0.1998	-0.1734	0.7401	-0.2810
-0.8725	0.0483	-0.4863	-0.7017	-0.6839	-0.1999	-0.1708	0.7322	-0.2864
-0.8741	0.0536	-0.4827	-0.7017	-0.6839	-0.1999	-0.1725	0.7375	-0.2828
-0.8734	0.0597	-0.4834	-0.7017	-0.6839	-0.1999	-0.1717	0.7436	-0.2835
-0.8750	0.0555	-0.4808	-0.7017	-0.6839	-0.1998	-0.1734	0.7394	-0.2810
-0.8754	0.0555	-0.4802	-0.7017	-0.6839	-0.1999	-0.1737	0.7394	-0.2804

Present Velocity UNIT vectors			Present Position UNIT vectors towards Centre of mass			Differences between UNIT vectors		
u x	u y	u z	s x	sy	sz	x	y	z
-0.8730	0.0575	-0.4843	-0.7017	-0.6839	-0.1999	-0.1714	0.7414	-0.2844
-0.8737	0.0577	-0.4831	-0.7017	-0.6839	-0.1999	-0.1720	0.7416	-0.2833
-0.9077	-0.2166	-0.3595	-0.7017	-0.6839	-0.1999	-0.2060	0.4673	-0.1596
-0.7296	0.3647	-0.5785	-0.7017	-0.6839	-0.1999	-0.0279	1.0486	-0.3786
-0.8970	0.0161	-0.4417	-0.7017	-0.6839	-0.1999	-0.1954	0.7000	-0.2418
-0.8726	0.0530	-0.4856	-0.7017	-0.6839	-0.1999	-0.1709	0.7369	-0.2857
-0.8754	0.0539	-0.4804	-0.7017	-0.6839	-0.1999	-0.1737	0.7378	-0.2806
-0.8724	0.0558	-0.4857	-0.7017	-0.6839	-0.1999	-0.1707	0.7397	-0.2858
-0.8437	0.1014	-0.5271	-0.7017	-0.6839	-0.1999	-0.1421	0.7853	-0.3273
-0.8739	0.0563	-0.4828	-0.7017	-0.6839	-0.1998	-0.1723	0.7403	-0.2829
-0.8756	0.0538	-0.4800	-0.7017	-0.6839	-0.1999	-0.1739	0.7377	-0.2802
-0.8730	0.0557	-0.4844	-0.7017	-0.6839	-0.1999	-0.1714	0.7396	-0.2846
-0.8739	0.0551	-0.4829	-0.7017	-0.6839	-0.1999	-0.1723	0.7390	-0.2831
-0.8721	0.0569	-0.4860	-0.7017	-0.6839	-0.1999	-0.1704	0.7408	-0.2861
0.7393	0.6703	-0.0641	-0.7087	-0.6841	-0.1724	1.4481	1.3544	0.1083
0.4795	0.8716	0.1016	-0.6953	-0.6917	-0.1953	1.1748	1.5633	0.2969
-0.5965	-0.3266	-0.7332	-0.7012	-0.6825	-0.2062	0.1048	0.3558	-0.5270
-0.9796	0.0010	-0.2011	-0.6988	-0.6867	-0.2005	-0.2808	0.6877	-0.0006
-0.7069	0.6779	-0.2018	-0.6984	-0.6910	-0.1863	-0.0085	1.3689	-0.0155
-0.5927	0.6106	0.5253	-0.6992	-0.6879	-0.1945	0.1065	1.2985	0.7198
-0.7647	-0.2800	0.5804	-0.6994	-0.6865	-0.1991	-0.0653	0.4065	0.7795
-0.4542	-0.8570	0.2436	-0.6963	-0.6884	-0.2030	0.2421	-0.1685	0.4466
0.0262	-0.8709	0.4908	-0.6949	-0.6895	-0.2043	0.7210	-0.1814	0.6951
-0.6723	-0.7272	0.1386	-0.6966	-0.6886	-0.2014	0.0243	-0.0386	0.3400
-0.8656	-0.3450	0.3630	-0.6984	-0.6880	-0.1972	-0.1672	0.3430	0.5602
-0.8305	-0.2755	0.4840	-0.6919	-0.6904	-0.2110	-0.1386	0.4149	0.6951
-0.4772	-0.8556	-0.2006	-0.6930	-0.6920	-0.2021	0.2158	-0.1636	0.0015
-0.7586	-0.6322	-0.1577	-0.6911	-0.6937	-0.2026	-0.0675	0.0615	0.0450
-0.7573	-0.5493	-0.3532	-0.6920	-0.6934	-0.2011	-0.0653	0.1440	-0.1520
-0.9026	-0.4305	0.0019	-0.6905	-0.6941	-0.2034	-0.2121	0.2636	0.2053
-0.9892	-0.0137	-0.1461	-0.6890	-0.6960	-0.2023	-0.3002	0.6823	0.0562
-0.9793	-0.1564	-0.1285	-0.6892	-0.6958	-0.2022	-0.2901	0.5394	0.0736
-0.8694	0.4931	0.0324	-0.6815	-0.7028	-0.2043	-0.1879	1.1958	0.2366
-0.9494	-0.1010	0.2973	-0.6857	-0.6958	-0.2136	-0.2637	0.5948	0.5109
-0.9367	-0.3276	-0.1235	-0.6894	-0.6961	-0.2006	-0.2473	0.3684	0.0771
-0.9912	-0.0001	-0.1325	-0.6759	-0.7093	-0.2001	-0.3153	0.7092	0.0675
-0.9033	-0.1276	-0.4095	-0.6691	-0.7223	-0.1749	-0.2342	0.5946	-0.2346
0.6729	-0.7395	-0.0185	-0.7077	-0.6804	-0.1904	1.3806	-0.0591	0.1719
0.7414	-0.6679	-0.0649	-0.7126	-0.6708	-0.2055	1.4539	0.0029	0.1406
-0.9609	0.2519	-0.1152	-0.7003	-0.6879	-0.1907	-0.2606	0.9398	0.0755
0.6320	-0.6984	-0.3360	-0.7063	-0.6839	-0.1831	1.3382	-0.0145	-0.1529
0.6464	0.1944	-0.7378	-0.7070	-0.6832	-0.1827	1.3533	0.8777	-0.5551
-0.2954	0.9512	-0.0895	-0.6917	-0.6908	-0.2106	0.3963	1.6419	0.1211
0.1757	-0.8978	-0.4039	-0.7138	-0.6711	-0.2002	0.8895	-0.2266	-0.2037
0.1532	-0.9628	0.2226	-0.7009	-0.6796	-0.2166	0.8541	-0.2832	0.4392
0.9013	0.4190	-0.1099	-0.7069	-0.6821	-0.1870	1.6083	1.1011	0.0771
-0.1257	0.9685	-0.2151	-0.6952	-0.6928	-0.1915	0.5695	1.6613	-0.0236
0.9035	-0.1541	0.4000	-0.7088	-0.6733	-0.2104	1.6123	0.5192	0.6104
0.0681	0.9870	0.1459	-0.6989	-0.6818	-0.2160	0.7670	1.6688	0.3619
-0.9318	0.1787	0.3160	-0.6944	-0.6864	-0.2158	-0.2374	0.8651	0.5318

Present Velocity UNIT vectors			Present Position UNIT vectors towards Centre of mass			Differences between UNIT vectors		
u x	u y	u z	s x	sy	sz	x	y	z
-0.0803	-0.9790	-0.1873	-0.7049	-0.6833	-0.1903	0.6246	-0.2957	0.0030
-0.9923	0.1239	0.0031	-0.6912	-0.6937	-0.2026	-0.3011	0.8176	0.2056
-0.8507	0.4349	-0.2952	-0.7037	-0.6865	-0.1831	-0.1470	1.1214	-0.1120
-0.5207	-0.8130	0.2606	-0.7053	-0.6763	-0.2127	0.1845	-0.1367	0.4733
-0.7366	-0.5903	-0.3300	0.7443	0.5526	0.3752	-1.4809	-1.1429	-0.7052
0.2924	-0.4906	0.8209	-0.3593	0.4191	-0.8338	0.6517	-0.9097	1.6547

Non-zero Internal Distances between all pairs of point masses

Theory and requirement

In any collision free system the internal distance between point masses should not be zero. This is to be checked for every iteration of calculations. Hence a table of internal distances was formulated for every iteration and was checked for zeros every time.

As it is very difficult for anybody to reproduce all the tables for all iterations a particular instance of 220th iteration of 24 hr timestep was shown. This Table of internal distances gives the distances between all 133 point masses in this instance. This gives a 133 x 133 matrix of total 17689 internal distances; of which 133 in the diagonal are zero as they are representing same particle. Formula used for calculation of internal distance is D_{ij} from point mass I to point mass j, and when i=j, the distance is zero.

$$D_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2}$$

These result of calculations were shown below from table 13 to table 26

Results conclusions and Inferences

This one is about internal distances of point masses i.e., about binary collisions. The non-zero internal distance between all the pairs of point masses given are in table 13 to 26. The first column gives the mass number 'i' from which the distance to be calculated will start. The top row gives the mass number 'j' to which the distance to calculate will end. Because it is possible to accommodate all the 133 x 133 entries in one place that big table was divided14 small tables each having 6 10 columns. All these data was given in table 13 to table 26. All the zeros in these tables show the distance, when starting point and ending point are same (i=j). These distances are shown for the present iteration END positions and prove that there are no Binary collisions. These values are checked for iterations and are binary collision free.

Hence we can say this Dynamic Universe model is Binary collision free.

Table 15 This table gives internal distances of masses 133--128

Distances between pairs of masses						
M No.	133	132	131	130	129	128
1	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
2	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
3	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
4	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
5	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
6	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
7	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20

Distances between pairs of masses

M No.	133	132	131	130	129	128
8	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
9	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
10	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
11	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
12	2.65362E+22	2.4006E+22	2.34506E+20	2.34506E+20	2.34506E+20	2.34506E+20
13	2.65363E+22	2.40061E+22	2.34535E+20	2.34507E+20	2.34534E+20	2.3453E+20
14	2.65363E+22	2.4006E+22	2.34532E+20	2.34471E+20	2.34524E+20	2.34487E+20
15	2.65363E+22	2.4006E+22	2.34532E+20	2.34471E+20	2.34524E+20	2.34487E+20
16	2.65362E+22	2.40061E+22	2.34472E+20	2.34562E+20	2.34507E+20	2.34545E+20
17	2.65362E+22	2.40061E+22	2.34464E+20	2.34583E+20	2.34494E+20	2.3456E+20
18	2.65363E+22	2.40061E+22	2.34576E+20	2.34446E+20	2.34536E+20	2.3449E+20
19	2.65363E+22	2.4006E+22	2.3456E+20	2.34417E+20	2.34484E+20	2.3444E+20
20	2.65363E+22	2.4006E+22	2.34504E+20	2.34492E+20	2.34407E+20	2.34474E+20
21	2.65363E+22	2.4006E+22	2.34584E+20	2.34414E+20	2.34524E+20	2.34459E+20
22	2.65363E+22	2.4006E+22	2.34497E+20	2.34422E+20	2.34478E+20	2.34404E+20
23	2.65363E+22	2.4006E+22	2.34546E+20	2.34418E+20	2.34557E+20	2.34443E+20
24	2.65361E+22	2.4006E+22	2.34411E+20	2.34595E+20	2.34519E+20	2.34542E+20
25	2.65363E+22	2.4006E+22	2.34546E+20	2.34418E+20	2.34558E+20	2.34443E+20
26	2.65362E+22	2.40059E+22	2.34426E+20	2.34483E+20	2.3447E+20	2.34423E+20
27	2.65362E+22	2.40059E+22	2.34425E+20	2.34484E+20	2.34469E+20	2.34422E+20
28	2.65363E+22	2.40061E+22	2.34597E+20	2.34514E+20	2.34507E+20	2.34575E+20
29	2.65363E+22	2.40062E+22	2.34572E+20	2.34548E+20	2.34557E+20	2.34603E+20
30	2.65363E+22	2.40061E+22	2.34601E+20	2.34498E+20	2.34565E+20	2.34568E+20

Distances between pairs of masses						
M No.	133	132	131	130	129	128
31	2.65363E+22	2.4006E+22	2.3456E+20	2.34399E+20	2.34536E+20	2.34428E+20
32	2.65362E+22	2.40061E+22	2.34486E+20	2.34609E+20	2.34478E+20	2.34602E+20
33	2.65361E+22	2.40061E+22	2.34424E+20	2.34611E+20	2.34558E+20	2.34575E+20
34	2.65362E+22	2.40061E+22	2.3447E+20	2.34618E+20	2.34477E+20	2.34601E+20
35	2.65363E+22	2.40061E+22	2.34609E+20	2.34403E+20	2.34538E+20	2.34466E+20
36	2.65362E+22	2.4006E+22	2.34465E+20	2.34532E+20	2.34385E+20	2.34489E+20
37	2.65361E+22	2.40061E+22	2.34417E+20	2.34617E+20	2.34567E+20	2.34577E+20
38	2.65362E+22	2.40061E+22	2.34459E+20	2.34525E+20	2.34622E+20	2.34513E+20
39	2.65362E+22	2.40059E+22	2.34432E+20	2.34446E+20	2.34494E+20	2.34389E+20
40	2.65362E+22	2.4006E+22	2.34448E+20	2.34602E+20	2.34419E+20	2.34559E+20
41	2.65361E+22	2.40061E+22	2.34411E+20	2.34624E+20	2.3457E+20	2.34581E+20
42	2.65362E+22	2.4006E+22	2.34414E+20	2.34588E+20	2.34409E+20	2.3452E+20
43	2.65361E+22	2.4006E+22	2.34378E+20	2.34522E+20	2.34501E+20	2.34438E+20
44	2.65362E+22	2.40061E+22	2.34461E+20	2.34643E+20	2.34552E+20	2.34634E+20
45	2.65361E+22	2.40061E+22	2.34408E+20	2.34646E+20	2.34493E+20	2.34592E+20
46	2.65362E+22	2.40061E+22	2.34478E+20	2.34587E+20	2.34638E+20	2.34596E+20
47	2.65361E+22	2.40061E+22	2.34378E+20	2.34611E+20	2.34562E+20	2.34545E+20
48	2.65363E+22	2.40061E+22	2.34568E+20	2.34587E+20	2.34477E+20	2.34632E+20
49	2.65363E+22	2.4006E+22	2.34594E+20	2.34368E+20	2.34557E+20	2.3442E+20
50	2.65362E+22	2.40059E+22	2.3441E+20	2.34534E+20	2.34376E+20	2.34453E+20
51	2.65361E+22	2.40061E+22	2.34391E+20	2.34652E+20	2.34488E+20	2.34587E+20
52	2.65362E+22	2.4006E+22	2.34482E+20	2.34458E+20	2.34629E+20	2.34456E+20
53	2.65364E+22	2.40061E+22	2.34662E+20	2.34431E+20	2.34541E+20	2.34532E+20

Distances between pairs of masses

M No.	133	132	131	130	129	128
54	2.65364E+22	2.4006E+22	2.34611E+20	2.3442E+20	2.344E+20	2.34465E+20
55	2.65362E+22	2.40059E+22	2.3445E+20	2.34417E+20	2.34412E+20	2.34358E+20
56	2.65363E+22	2.40062E+22	2.34615E+20	2.34556E+20	2.34579E+20	2.34643E+20
57	2.65363E+22	2.4006E+22	2.34519E+20	2.34387E+20	2.34591E+20	2.34396E+20
58	2.65363E+22	2.4006E+22	2.34573E+20	2.34346E+20	2.34543E+20	2.3438E+20
59	2.65362E+22	2.4006E+22	2.3448E+20	2.34389E+20	2.34557E+20	2.34368E+20
60	2.65364E+22	2.4006E+22	2.34594E+20	2.34339E+20	2.34464E+20	2.34374E+20
61	2.65364E+22	2.4006E+22	2.34608E+20	2.34413E+20	2.34378E+20	2.34452E+20
62	2.65364E+22	2.40061E+22	2.34679E+20	2.3444E+20	2.34548E+20	2.34554E+20
63	2.65362E+22	2.40061E+22	2.34437E+20	2.34657E+20	2.34429E+20	2.34614E+20
64	2.65364E+22	2.40062E+22	2.34672E+20	2.34438E+20	2.34585E+20	2.34553E+20
65	2.65361E+22	2.40059E+22	2.34353E+20	2.34511E+20	2.34522E+20	2.34413E+20
66	2.65363E+22	2.40062E+22	2.34614E+20	2.34548E+20	2.34625E+20	2.3464E+20
67	2.65361E+22	2.40061E+22	2.34415E+20	2.3464E+20	2.34627E+20	2.34611E+20
68	2.65361E+22	2.4006E+22	2.34383E+20	2.34655E+20	2.34426E+20	2.34576E+20
69	2.65361E+22	2.4006E+22	2.34324E+20	2.34586E+20	2.34483E+20	2.3447E+20
70	2.65362E+22	2.4006E+22	2.34442E+20	2.34558E+20	2.34337E+20	2.34496E+20
71	2.65364E+22	2.40062E+22	2.34648E+20	2.34458E+20	2.34635E+20	2.34566E+20
72	2.65364E+22	2.4006E+22	2.34614E+20	2.34328E+20	2.34457E+20	2.34375E+20
73	2.65361E+22	2.40061E+22	2.34375E+20	2.34682E+20	2.34501E+20	2.34612E+20
74	2.65363E+22	2.4006E+22	2.34516E+20	2.34386E+20	2.34613E+20	2.34397E+20
75	2.65361E+22	2.40061E+22	2.34382E+20	2.34685E+20	2.34497E+20	2.34619E+20
76	2.65364E+22	2.4006E+22	2.34622E+20	2.34323E+20	2.34513E+20	2.34383E+20

Distances between pairs of masses						
M No.	133	132	131	130	129	128
77	2.65364E+22	2.40059E+22	2.34601E+20	2.34349E+20	2.34398E+20	2.34381E+20
78	2.65363E+22	2.40062E+22	2.34636E+20	2.34498E+20	2.34648E+20	2.34604E+20
79	2.65364E+22	2.40061E+22	2.34648E+20	2.3451E+20	2.34441E+20	2.34594E+20
80	2.65361E+22	2.40061E+22	2.34404E+20	2.34636E+20	2.34641E+20	2.34601E+20
81	2.65361E+22	2.40061E+22	2.34405E+20	2.34636E+20	2.34642E+20	2.34602E+20
82	2.65364E+22	2.40061E+22	2.34646E+20	2.34405E+20	2.34636E+20	2.34506E+20
83	2.65361E+22	2.40061E+22	2.34351E+20	2.34677E+20	2.34532E+20	2.34595E+20
84	2.65363E+22	2.40059E+22	2.34538E+20	2.34325E+20	2.34482E+20	2.34325E+20
85	2.65361E+22	2.40061E+22	2.34406E+20	2.347E+20	2.34521E+20	2.34654E+20
86	2.65364E+22	2.40061E+22	2.34648E+20	2.34404E+20	2.34637E+20	2.34507E+20
87	2.65364E+22	2.4006E+22	2.34633E+20	2.34319E+20	2.34531E+20	2.34388E+20
88	2.65363E+22	2.40059E+22	2.34508E+20	2.34342E+20	2.34421E+20	2.34315E+20
89	2.65362E+22	2.40061E+22	2.34428E+20	2.34678E+20	2.34422E+20	2.3463E+20
90	2.65363E+22	2.40061E+22	2.34552E+20	2.34405E+20	2.34667E+20	2.34449E+20
91	2.65362E+22	2.40062E+22	2.34514E+20	2.34679E+20	2.34519E+20	2.34702E+20
92	2.73968E+22	2.54875E+22	1.73902E+21	1.61028E+21	1.73245E+21	1.73386E+21
93	2.67924E+22	2.43678E+22	6.01923E+20	5.02086E+20	5.29414E+20	5.99651E+20
94	2.64617E+22	2.40004E+22	1.695E+20	3.11023E+20	2.36448E+20	2.77466E+20
95	2.65398E+22	2.39583E+22	2.36474E+20	2.35364E+20	1.65189E+20	2.18099E+20
96	2.66978E+22	2.39147E+22	4.02797E+20	9.91881E+19	2.41911E+20	1.87725E+20
97	2.65826E+22	2.38914E+22	2.88525E+20	1.60067E+20	1.67326E+20	1.40526E+20
98	2.65171E+22	2.38656E+22	2.31131E+20	2.19248E+20	1.47161E+20	1.49783E+20
99	2.65076E+22	2.38846E+22	2.30688E+20	2.7576E+20	9.63846E+19	2.19651E+20

Distances between pairs of masses

M No.	133	132	131	130	129	128
100	2.65046E+22	2.38798E+22	2.41799E+20	2.99855E+20	7.6036E+19	2.44063E+20
101	2.65037E+22	2.38304E+22	2.45558E+20	2.68489E+20	1.02168E+20	1.90175E+20
102	2.6516E+22	2.37739E+22	2.82256E+20	2.41963E+20	1.60302E+20	1.38872E+20
103	2.64493E+22	2.38726E+22	2.50978E+20	3.96102E+20	1.16556E+20	3.30748E+20
104	2.65244E+22	2.38144E+22	2.9516E+20	3.06672E+20	5.58816E+19	2.41392E+20
105	2.65425E+22	2.38305E+22	3.18096E+20	3.23563E+20	2.79307E+19	2.7235E+20
106	2.6541E+22	2.37985E+22	3.22775E+20	3.12234E+20	6.27336E+19	2.50731E+20
107	2.65292E+22	2.38021E+22	3.27169E+20	3.44593E+20	5.85383E+19	2.83783E+20
108	2.65592E+22	2.38079E+22	3.58517E+20	3.49299E+20	6.25657E+19	3.01442E+20
109	2.65475E+22	2.37758E+22	3.63508E+20	3.57306E+20	8.86283E+19	2.98904E+20
110	2.66355E+22	2.38805E+22	4.70265E+20	4.47086E+20	1.74885E+20	4.37688E+20
111	2.6441E+22	2.37647E+22	3.7228E+20	4.94225E+20	1.8856E+20	4.1826E+20
112	2.64715E+22	2.35193E+22	4.99867E+20	5.02515E+20	3.39294E+20	4.0004E+20
113	2.6602E+22	2.35119E+22	6.74753E+20	6.34565E+20	4.28967E+20	5.75254E+20
114	2.67729E+22	2.3039E+22	1.16136E+21	1.03153E+21	9.46409E+20	9.81274E+20
115	2.65229E+22	2.38223E+22	2.9691E+20	1.63961E+20	3.15647E+20	5.43461E+19
116	2.63753E+22	2.40558E+22	2.16723E+20	3.8773E+20	4.40135E+20	3.53582E+20
117	2.65837E+22	2.37984E+22	3.32245E+20	1.5678E+20	2.12211E+20	8.37707E+19
118	2.66604E+22	2.39211E+22	3.97112E+20	4.88105E+19	3.48048E+20	1.58668E+20
119	2.66937E+22	2.40168E+22	4.26277E+20	1.24739E+20	3.91789E+20	2.45476E+20
120	2.65442E+22	2.41127E+22	3.46206E+20	4.33713E+20	2.68706E+20	4.43327E+20
121	2.63937E+22	2.39614E+22	2.15525E+20	3.23844E+20	4.19339E+20	2.68706E+20
122	2.637E+22	2.40919E+22	2.10623E+20	4.67772E+20	3.52786E+20	4.33713E+20

Distances between pairs of masses						
M No.	133	132	131	130	129	128
123	2.66892E+22	2.41405E+22	4.37508E+20	2.43939E+20	4.32957E+20	3.46206E+20
124	2.6751E+22	2.41368E+22	4.63359E+20	2.90132E+20	3.28166E+20	3.87895E+20
125	2.63763E+22	2.41193E+22	2.28504E+20	4.34289E+20	4.31213E+20	4.11441E+20
126	2.64068E+22	2.41174E+22	2.49477E+20	4.68775E+20	3.44946E+20	4.47352E+20
127	2.64351E+22	2.40643E+22	2.61173E+20	4.57659E+20	2.73232E+20	4.31526E+20
128	2.6544E+22	2.38027E+22	3.07808E+20	1.53011E+20	2.75686E+20	0
129	2.65529E+22	2.38582E+22	3.15593E+20	3.16373E+20	0	2.75686E+20
130	2.66792E+22	2.39051E+22	4.04604E+20	0	3.16373E+20	1.53011E+20
131	2.63066E+22	2.39009E+22	0	4.04604E+20	3.15593E+20	3.07808E+20
132	3.06943E+22	0	2.39009E+22	2.39051E+22	2.38582E+22	2.38027E+22
133	0	3.06943E+22	2.63066E+22	2.66792E+22	2.65529E+22	2.6544E+22

Table 16 This table gives Internal distances between masses 127--119

M No.	127	126	125	124	123	122	121	120	119
1	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
3	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
4	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
5	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
6	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
7	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
8	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
9	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
10	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
11	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
12	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
13	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
14	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
15	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
16	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
17	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20

M No.	127	126	125	124	123	122	121	120	119
18	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
19	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20
21	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
22	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
23	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
24	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
25	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
26	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
27	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
28	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
29	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
30	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
31	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
32	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
33	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
34	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
35	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
36	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
37	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
38	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20
39	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
40	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
41	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
42	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
43	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
44	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
45	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
46	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
47	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
48	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
49	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
50	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
51	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
52	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
53	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
54	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
55	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
56	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
57	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
58	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
59	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
60	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
61	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
62	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
63	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
64	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
65	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
66	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
67	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
68	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20

M No.	127	126	125	124	123	122	121	120	119
69	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
70	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
71	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
72	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
73	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
74	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
75	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
76	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
77	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
78	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
79	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20
80	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
81	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
82	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
83	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
84	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
85	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
86	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
87	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
88	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
89	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
90	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
91	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
92	1.6E+21	1.55E+21	1.53E+21	1.41E+21	1.39E+21	1.58E+21	1.63E+21	1.53E+21	1.5E+21
93	4.33E+20	4.17E+20	4.59E+20	2.33E+20	3.24E+20	4.55E+20	5.7E+20	3.42E+20	4.3E+20
94	1.72E+20	1.7E+20	1.95E+20	2.96E+20	3.06E+20	1.61E+20	2.35E+20	2.1E+20	3.16E+20
95	2.26E+20	2.53E+20	2.88E+20	2.46E+20	2.88E+20	2.56E+20	2.79E+20	2.25E+20	2.68E+20
96	4.07E+20	4.36E+20	4.42E+20	2.35E+20	2.7E+20	4.43E+20	3.71E+20	3.71E+20	1.85E+20
97	3.21E+20	3.52E+20	3.65E+20	2.71E+20	2.98E+20	3.51E+20	2.99E+20	3.13E+20	2.34E+20
98	2.91E+20	3.25E+20	3.44E+20	3.2E+20	3.44E+20	3.18E+20	2.82E+20	3.06E+20	2.89E+20
99	2.38E+20	2.88E+20	3.45E+20	3.14E+20	3.74E+20	2.87E+20	3.24E+20	2.54E+20	3.37E+20
100	2.31E+20	2.9E+20	3.61E+20	3.24E+20	3.97E+20	2.91E+20	3.49E+20	2.48E+20	3.63E+20
101	2.91E+20	3.4E+20	3.85E+20	3.52E+20	4.02E+20	3.35E+20	3.35E+20	3.1E+20	3.47E+20
102	3.67E+20	4.1E+20	4.3E+20	3.91E+20	4.18E+20	4.01E+20	3.4E+20	3.84E+20	3.4E+20
103	2.03E+20	2.8E+20	3.87E+20	3.87E+20	4.77E+20	2.82E+20	4.07E+20	2.42E+20	4.55E+20
104	3.01E+20	3.66E+20	4.35E+20	3.64E+20	4.45E+20	3.67E+20	3.99E+20	3.11E+20	3.92E+20
105	2.93E+20	3.64E+20	4.47E+20	3.53E+20	4.53E+20	3.7E+20	4.26E+20	2.94E+20	4.05E+20
106	3.24E+20	3.92E+20	4.62E+20	3.73E+20	4.6E+20	3.94E+20	4.24E+20	3.29E+20	4.03E+20
107	3.12E+20	3.85E+20	4.69E+20	3.85E+20	4.82E+20	3.89E+20	4.43E+20	3.19E+20	4.31E+20
108	3.24E+20	4.01E+20	4.91E+20	3.77E+20	4.87E+20	4.08E+20	4.69E+20	3.21E+20	4.37E+20
109	3.48E+20	4.24E+20	5.08E+20	4.05E+20	5.07E+20	4.28E+20	4.76E+20	3.5E+20	4.51E+20
110	3.45E+20	4.35E+20	5.63E+20	3.77E+20	5.44E+20	4.57E+20	5.86E+20	3.06E+20	5.18E+20
111	3.33E+20	4.19E+20	5.35E+20	5.01E+20	6.12E+20	4.22E+20	5.4E+20	3.63E+20	5.75E+20
112	5.75E+20	6.43E+20	6.97E+20	6.43E+20	7.08E+20	6.34E+20	6.09E+20	6E+20	6.19E+20
113	6.67E+20	7.52E+20	8.48E+20	7.05E+20	8.27E+20	7.57E+20	7.96E+20	6.64E+20	7.49E+20
114	1.21E+21	1.28E+21	1.34E+21	1.18E+21	1.26E+21	1.28E+21	1.23E+21	1.2E+21	1.15E+21
115	4.4E+20	4.44E+20	3.86E+20	4.01E+20	3.29E+20	4.27E+20	2.25E+20	4.57E+20	2.32E+20
116	3.39E+20	2.73E+20	1.06E+20	4.25E+20	3.14E+20	2.41E+20	1.14E+20	3.88E+20	3.45E+20
117	4.11E+20	4.44E+20	4.42E+20	3.57E+20	3.64E+20	4.38E+20	3.32E+20	4.11E+20	2.67E+20
118	4.66E+20	4.67E+20	4.14E+20	3.06E+20	2.22E+20	4.63E+20	2.92E+20	4.47E+20	9.7E+19
119	4.62E+20	4.51E+20	3.89E+20	2.59E+20	1.32E+20	4.52E+20	3.02E+20	4.32E+20	0

M No.	127	126	125	124	123	122	121	120	119
120	1.12E+20	1.66E+20	3.19E+20	2.59E+20	3.86E+20	2.08E+20	4.37E+20	0	4.32E+20
121	3.92E+20	3.48E+20	2.12E+20	4.4E+20	3.16E+20	3.16E+20	0	4.37E+20	3.02E+20
122	1.25E+20	4.88E+19	1.57E+20	3.88E+20	4.05E+20	0	3.16E+20	2.08E+20	4.52E+20
123	4.26E+20	3.97E+20	3.32E+20	2.17E+20	0	4.05E+20	3.16E+20	3.86E+20	1.32E+20
124	3.45E+20	3.59E+20	4.01E+20	0	2.17E+20	3.88E+20	4.4E+20	2.59E+20	2.59E+20
125	2.67E+20	1.85E+20	0	4.01E+20	3.32E+20	1.57E+20	2.12E+20	3.19E+20	3.89E+20
126	9.7E+19	0	1.85E+20	3.59E+20	3.97E+20	4.88E+19	3.48E+20	1.66E+20	4.51E+20
127	0	9.7E+19	2.67E+20	3.45E+20	4.26E+20	1.25E+20	3.92E+20	1.12E+20	4.62E+20
128	4.32E+20	4.47E+20	4.11E+20	3.88E+20	3.46E+20	4.34E+20	2.69E+20	4.43E+20	2.45E+20
129	2.73E+20	3.45E+20	4.31E+20	3.28E+20	4.33E+20	3.53E+20	4.19E+20	2.69E+20	3.92E+20
130	4.58E+20	4.69E+20	4.34E+20	2.9E+20	2.44E+20	4.68E+20	3.24E+20	4.34E+20	1.25E+20
131	2.61E+20	2.49E+20	2.29E+20	4.63E+20	4.38E+20	2.11E+20	2.16E+20	3.46E+20	4.26E+20
132	2.41E+22	2.41E+22	2.41E+22	2.41E+22	2.41E+22	2.41E+22	2.4E+22	2.41E+22	2.4E+22
133	2.64E+22	2.64E+22	2.64E+22	2.68E+22	2.67E+22	2.64E+22	2.64E+22	2.65E+22	2.67E+22

Table 17: This table gives internal distances between masses 118--110

M No.	118	117	116	115	114	113	112	111	110
1	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
2	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
3	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
4	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
5	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
6	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
7	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
8	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
9	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
10	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
11	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
12	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
13	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20

M No.	118	117	116	115	114	113	112	111	110
14	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
15	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
16	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
17	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
18	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
19	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
21	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
22	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
23	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
24	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
25	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
26	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
27	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
28	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
29	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
30	2.34E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
31	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
32	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
33	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
34	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
35	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
36	2.35E+20	2.34E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
37	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20

M No.	118	117	116	115	114	113	112	111	110
38	2.34E+20	2.35E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
39	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
40	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
41	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
42	2.35E+20	2.34E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
43	2.35E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
44	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
45	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
46	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
47	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
48	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
49	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
50	2.35E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
51	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
52	2.34E+20	2.35E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
53	2.34E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
54	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
55	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
56	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
57	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
58	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
59	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
60	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
61	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20

M No.	118	117	116	115	114	113	112	111	110
62	2.34E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
63	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
64	2.34E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
65	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
66	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
67	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
68	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
69	2.35E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
70	2.35E+20	2.34E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
71	2.34E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
72	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
73	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
74	2.34E+20	2.34E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
75	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
76	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
77	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
78	2.34E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
79	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
80	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
81	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
82	2.34E+20	2.35E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
83	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
84	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
85	2.35E+20	2.35E+20	2.34E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20

M No.	118	117	116	115	114	113	112	111	110
86	2.34E+20	2.35E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
87	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
88	2.34E+20	2.34E+20	2.35E+20	2.34E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
89	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.55E+20	5.25E+20	3.93E+20	3.77E+20
90	2.34E+20	2.35E+20	2.34E+20	2.34E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
91	2.35E+20	2.35E+20	2.35E+20	2.35E+20	1.14E+21	6.56E+20	5.25E+20	3.93E+20	3.77E+20
92	1.6E+21	1.74E+21	1.57E+21	1.72E+21	2.53E+21	2.1E+21	2.06E+21	1.88E+21	1.74E+21
93	5.05E+20	5.81E+20	5.14E+20	6.01E+20	1.4E+21	9.11E+20	8.61E+20	6.77E+20	5.5E+20
94	3.1E+20	2.79E+20	2.15E+20	2.76E+20	1.16E+21	6.57E+20	5.22E+20	3.61E+20	3.78E+20
95	2.48E+20	1.97E+20	2.9E+20	2.33E+20	1.08E+21	5.87E+20	4.63E+20	3.29E+20	3.14E+20
96	1.43E+20	1.45E+20	4.17E+20	2.18E+20	9.96E+20	5.68E+20	4.64E+20	4.26E+20	3.54E+20
97	1.84E+20	1.03E+20	3.42E+20	1.71E+20	1.01E+21	5.44E+20	4.12E+20	3.43E+20	3.23E+20
98	2.36E+20	1.24E+20	3.24E+20	1.77E+20	1E+21	5.3E+20	3.82E+20	3E+20	3.19E+20
99	2.96E+20	1.81E+20	3.46E+20	2.48E+20	1.01E+21	5.08E+20	3.81E+20	2.46E+20	2.66E+20
100	3.22E+20	2.01E+20	3.67E+20	2.74E+20	1E+21	4.9E+20	3.71E+20	2.19E+20	2.42E+20
101	2.91E+20	1.46E+20	3.73E+20	2.26E+20	9.63E+20	4.73E+20	3.31E+20	2.38E+20	2.76E+20
102	2.66E+20	9.21E+19	4E+20	1.84E+20	9.17E+20	4.6E+20	2.96E+20	2.81E+20	3.23E+20
103	4.18E+20	2.89E+20	4.1E+20	3.59E+20	1.01E+21	4.75E+20	3.72E+20	1.51E+20	2.27E+20
104	3.37E+20	1.81E+20	4.32E+20	2.83E+20	9.23E+20	4.17E+20	2.99E+20	1.88E+20	2.18E+20
105	3.56E+20	2.08E+20	4.52E+20	3.14E+20	9.24E+20	4.07E+20	3.12E+20	1.74E+20	1.81E+20
106	3.45E+20	1.84E+20	4.59E+20	2.96E+20	8.97E+20	3.91E+20	2.81E+20	1.85E+20	2.06E+20
107	3.77E+20	2.19E+20	4.72E+20	3.27E+20	9E+20	3.81E+20	2.83E+20	1.52E+20	1.84E+20
108	3.85E+20	2.31E+20	4.96E+20	3.47E+20	8.88E+20	3.66E+20	2.9E+20	1.59E+20	1.54E+20
109	3.93E+20	2.29E+20	5.09E+20	3.46E+20	8.63E+20	3.44E+20	2.57E+20	1.53E+20	1.75E+20

M No.	118	117	116	115	114	113	112	111	110
110	4.86E+20	3.63E+20	5.92E+20	4.82E+20	9.18E+20	3.78E+20	3.94E+20	2.07E+20	0
111	5.24E+20	3.63E+20	5.54E+20	4.57E+20	9E+20	3.52E+20	2.9E+20	0	2.07E+20
112	5.34E+20	3.52E+20	6.72E+20	4.45E+20	6.65E+20	2.37E+20	0	2.9E+20	3.94E+20
113	6.77E+20	5.05E+20	8.43E+20	6.27E+20	5.61E+20	0	2.37E+20	3.52E+20	3.78E+20
114	1.07E+21	9.3E+20	1.31E+21	1.03E+21	0	5.61E+20	6.65E+20	9E+20	9.18E+20
115	1.53E+20	1.36E+20	3.18E+20	0	1.03E+21	6.27E+20	4.45E+20	4.57E+20	4.82E+20
116	3.59E+20	4.01E+20	0	3.18E+20	1.31E+21	8.43E+20	6.72E+20	5.54E+20	5.92E+20
117	1.85E+20	0	4.01E+20	1.36E+20	9.3E+20	5.05E+20	3.52E+20	3.63E+20	3.63E+20
118	0	1.85E+20	3.59E+20	1.53E+20	1.07E+21	6.77E+20	5.34E+20	5.24E+20	4.86E+20
119	9.7E+19	2.67E+20	3.45E+20	2.32E+20	1.15E+21	7.49E+20	6.19E+20	5.75E+20	5.18E+20
120	4.47E+20	4.11E+20	3.88E+20	4.57E+20	1.2E+21	6.64E+20	6E+20	3.63E+20	3.06E+20
121	2.92E+20	3.32E+20	1.14E+20	2.25E+20	1.23E+21	7.96E+20	6.09E+20	5.4E+20	5.86E+20
122	4.63E+20	4.38E+20	2.41E+20	4.27E+20	1.28E+21	7.57E+20	6.34E+20	4.22E+20	4.57E+20
123	2.22E+20	3.64E+20	3.14E+20	3.29E+20	1.26E+21	8.27E+20	7.08E+20	6.12E+20	5.44E+20
124	3.06E+20	3.57E+20	4.25E+20	4.01E+20	1.18E+21	7.05E+20	6.43E+20	5.01E+20	3.77E+20
125	4.14E+20	4.42E+20	1.06E+20	3.86E+20	1.34E+21	8.48E+20	6.97E+20	5.35E+20	5.63E+20
126	4.67E+20	4.44E+20	2.73E+20	4.44E+20	1.28E+21	7.52E+20	6.43E+20	4.19E+20	4.35E+20
127	4.66E+20	4.11E+20	3.39E+20	4.4E+20	1.21E+21	6.67E+20	5.75E+20	3.33E+20	3.45E+20
128	1.59E+20	8.38E+19	3.54E+20	5.43E+19	9.81E+20	5.75E+20	4E+20	4.18E+20	4.38E+20
129	3.48E+20	2.12E+20	4.4E+20	3.16E+20	9.46E+20	4.29E+20	3.39E+20	1.89E+20	1.75E+20
130	4.88E+19	1.57E+20	3.88E+20	1.64E+20	1.03E+21	6.35E+20	5.03E+20	4.94E+20	4.47E+20
131	3.97E+20	3.32E+20	2.17E+20	2.97E+20	1.16E+21	6.75E+20	5E+20	3.72E+20	4.7E+20
132	2.39E+22	2.38E+22	2.41E+22	2.38E+22	2.3E+22	2.35E+22	2.35E+22	2.38E+22	2.39E+22
133	2.67E+22	2.66E+22	2.64E+22	2.65E+22	2.68E+22	2.66E+22	2.65E+22	2.64E+22	2.66E+22

Table 18: This table gives internal distance for point masses 109-100

109	108	107	106	105	104	103	102	101	100
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20

109	108	107	106	105	104	103	102	101	100
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
3.14E+20	2.95E+20	2.8E+20	2.65E+20	2.53E+20	2.42E+20	2.5E+20	2.39E+20	1.95E+20	1.78E+20
1.81E+21	1.78E+21	1.79E+21	1.78E+21	1.76E+21	1.77E+21	1.76E+21	1.79E+21	1.75E+21	1.71E+21
6.12E+20	5.81E+20	5.88E+20	5.83E+20	5.57E+20	5.71E+20	5.56E+20	6.07E+20	5.58E+20	5.16E+20
3.15E+20	2.96E+20	2.76E+20	2.7E+20	2.53E+20	2.42E+20	2.1E+20	2.55E+20	1.97E+20	1.68E+20
2.45E+20	2.25E+20	2.11E+20	1.97E+20	1.83E+20	1.74E+20	1.92E+20	1.86E+20	1.33E+20	1.12E+20
2.86E+20	2.73E+20	2.76E+20	2.46E+20	2.52E+20	2.45E+20	3.36E+20	2.13E+20	2.23E+20	2.43E+20
2.23E+20	2.11E+20	2E+20	1.72E+20	1.76E+20	1.58E+20	2.36E+20	1.26E+20	1.16E+20	1.4E+20
2E+20	1.92E+20	1.7E+20	1.46E+20	1.51E+20	1.25E+20	1.88E+20	9.49E+19	6.41E+19	9.74E+19

109	108	107	106	105	104	103	102	101	100
1.66E+20	1.51E+20	1.29E+20	1.18E+20	1.06E+20	9.12E+19	1.22E+20	1.32E+20	5.68E+19	2.89E+19
1.47E+20	1.3E+20	1.09E+20	1.05E+20	8.64E+19	7.76E+19	9.62E+19	1.44E+20	6.57E+19	0
1.42E+20	1.37E+20	1.11E+20	8.95E+19	9.77E+19	6.58E+19	1.44E+20	7.88E+19	0	6.57E+19
1.66E+20	1.74E+20	1.52E+20	1.2E+20	1.48E+20	1.13E+20	2.16E+20	0	7.88E+19	1.44E+20
1.6E+20	1.46E+20	1.25E+20	1.46E+20	1.2E+20	1.26E+20	0	2.16E+20	1.44E+20	9.62E+19
7.74E+19	7.2E+19	4.59E+19	2.87E+19	3.76E+19	0	1.26E+20	1.13E+20	6.58E+19	7.76E+19
6.42E+19	4.45E+19	3.17E+19	3.83E+19	0	3.76E+19	1.2E+20	1.48E+20	9.77E+19	8.64E+19
5.37E+19	5.37E+19	3.54E+19	0	3.83E+19	2.87E+19	1.46E+20	1.2E+20	8.95E+19	1.05E+20
3.97E+19	3.48E+19	0	3.54E+19	3.17E+19	4.59E+19	1.25E+20	1.52E+20	1.11E+20	1.09E+20
3.25E+19	0	3.48E+19	5.37E+19	4.45E+19	7.2E+19	1.46E+20	1.74E+20	1.37E+20	1.3E+20
0	3.25E+19	3.97E+19	5.37E+19	6.42E+19	7.74E+19	1.6E+20	1.66E+20	1.42E+20	1.47E+20
1.75E+20	1.54E+20	1.84E+20	2.06E+20	1.81E+20	2.18E+20	2.27E+20	3.23E+20	2.76E+20	2.42E+20
1.53E+20	1.59E+20	1.52E+20	1.85E+20	1.74E+20	1.88E+20	1.51E+20	2.81E+20	2.38E+20	2.19E+20
2.57E+20	2.9E+20	2.83E+20	2.81E+20	3.12E+20	2.99E+20	3.72E+20	2.96E+20	3.31E+20	3.71E+20
3.44E+20	3.66E+20	3.81E+20	3.91E+20	4.07E+20	4.17E+20	4.75E+20	4.6E+20	4.73E+20	4.9E+20
8.63E+20	8.88E+20	9E+20	8.97E+20	9.24E+20	9.23E+20	1.01E+21	9.17E+20	9.63E+20	1E+21
3.46E+20	3.47E+20	3.27E+20	2.96E+20	3.14E+20	2.83E+20	3.59E+20	1.84E+20	2.26E+20	2.74E+20
5.09E+20	4.96E+20	4.72E+20	4.59E+20	4.52E+20	4.32E+20	4.1E+20	4E+20	3.73E+20	3.67E+20
2.29E+20	2.31E+20	2.19E+20	1.84E+20	2.08E+20	1.81E+20	2.89E+20	9.21E+19	1.46E+20	2.01E+20
3.93E+20	3.85E+20	3.77E+20	3.45E+20	3.56E+20	3.37E+20	4.18E+20	2.66E+20	2.91E+20	3.22E+20
4.51E+20	4.37E+20	4.31E+20	4.03E+20	4.05E+20	3.92E+20	4.55E+20	3.4E+20	3.47E+20	3.63E+20
3.5E+20	3.21E+20	3.19E+20	3.29E+20	2.94E+20	3.11E+20	2.42E+20	3.84E+20	3.1E+20	2.48E+20
4.76E+20	4.69E+20	4.43E+20	4.24E+20	4.26E+20	3.99E+20	4.07E+20	3.4E+20	3.35E+20	3.49E+20
4.28E+20	4.08E+20	3.89E+20	3.94E+20	3.7E+20	3.67E+20	2.82E+20	4.01E+20	3.35E+20	2.91E+20
5.07E+20	4.87E+20	4.82E+20	4.6E+20	4.53E+20	4.45E+20	4.77E+20	4.18E+20	4.02E+20	3.97E+20
4.05E+20	3.77E+20	3.85E+20	3.73E+20	3.53E+20	3.64E+20	3.87E+20	3.91E+20	3.52E+20	3.24E+20
5.08E+20	4.91E+20	4.69E+20	4.62E+20	4.47E+20	4.35E+20	3.87E+20	4.3E+20	3.85E+20	3.61E+20
4.24E+20	4.01E+20	3.85E+20	3.92E+20	3.64E+20	3.66E+20	2.8E+20	4.1E+20	3.4E+20	2.9E+20
3.48E+20	3.24E+20	3.12E+20	3.24E+20	2.93E+20	3.01E+20	2.03E+20	3.67E+20	2.91E+20	2.31E+20
2.99E+20	3.01E+20	2.84E+20	2.51E+20	2.72E+20	2.41E+20	3.31E+20	1.39E+20	1.9E+20	2.44E+20
8.86E+19	6.26E+19	5.85E+19	6.27E+19	2.79E+19	5.59E+19	1.17E+20	1.6E+20	1.02E+20	7.6E+19
3.57E+20	3.49E+20	3.45E+20	3.12E+20	3.24E+20	3.07E+20	3.96E+20	2.42E+20	2.68E+20	3E+20
3.64E+20	3.59E+20	3.27E+20	3.23E+20	3.18E+20	2.95E+20	2.51E+20	2.82E+20	2.46E+20	2.42E+20
2.38E+22	2.38E+22	2.38E+22	2.38E+22	2.38E+22	2.38E+22	2.39E+22	2.38E+22	2.38E+22	2.39E+22
2.65E+22	2.66E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.64E+22	2.65E+22	2.65E+22	2.65E+22

Table 19: This table gives internal distances for masses 99-90

99	98	97	96	95	94	93	92	91	90
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17

99	98	97	96	95	94	93	92	91	90
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.03E+17	2.01E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	1.91E+17	1.86E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.32E+17	1.68E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	2.32E+17	1.68E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	1.64E+17	2.37E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.47E+17	2.62E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.45E+17	1.6E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.78E+17	1.91E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.52E+19	4.04E+20	1.57E+21	2.33E+17	2.85E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.76E+17	1.59E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.52E+19	4.04E+20	1.57E+21	3.04E+17	1.94E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.94E+17	1.14E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.88E+17	2.55E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.95E+17	1.13E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.52E+19	4.04E+20	1.57E+21	2.87E+17	2.3E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.52E+19	4.04E+20	1.57E+21	2.88E+17	2.31E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	1.65E+17	2.48E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	1.4E+17	2.27E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	1.92E+17	1.93E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	3.05E+17	1.35E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.02E+17	3.01E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.7E+17	2.43E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.07E+17	3.06E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.84E+17	1.56E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.51E+19	4.04E+20	1.57E+21	2.26E+17	3.21E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.77E+17	2.44E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.52E+19	4.04E+20	1.57E+21	2.57E+17	1.37E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	3.25E+17	2.02E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.51E+19	4.04E+20	1.57E+21	1.61E+17	3.34E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.78E+17	2.5E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.51E+19	4.04E+20	1.57E+21	2.04E+17	3.31E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	2.92E+17	2.38E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.01E+17	2.8E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.44E+17	3.11E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.97E+19	8.52E+19	4.04E+20	1.57E+21	1.94E+17	1.9E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	2.2E+17	2.5E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.52E+19	4.04E+20	1.57E+21	9.95E+16	3.17E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	3.31E+17	1.22E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.51E+19	4.04E+20	1.57E+21	2.67E+17	3.33E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	1.58E+17	3.2E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.52E+19	4.04E+20	1.57E+21	3.15E+17	8.19E+16
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.53E+17	2.1E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	2.77E+17	2.96E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.52E+19	4.04E+20	1.57E+21	3.45E+17	2.67E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.52E+19	4.04E+20	1.57E+21	1.47E+17	2.54E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	3.55E+17	8.51E+16
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	3.61E+17	1.34E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	3.66E+17	1.34E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	3.54E+17	2.13E+17

99	98	97	96	95	94	93	92	91	90
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	2.92E+17	3.13E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.53E+19	4.04E+20	1.57E+21	2.49E+17	2.27E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.51E+19	4.04E+20	1.57E+21	1.26E+17	3.67E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	2.59E+17	1.96E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	3.31E+17	2.38E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	1.78E+17	2.23E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.97E+19	8.51E+19	4.04E+20	1.57E+21	1.95E+17	2.44E+17
1.55E+20	1.45E+20	1.4E+20	2.15E+20	6.95E+19	8.5E+19	4.04E+20	1.57E+21	1.78E+17	3.65E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	2.85E+17	3E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.94E+19	8.51E+19	4.04E+20	1.57E+21	2.44E+17	3.78E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	2.6E+17	1.61E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.54E+19	4.04E+20	1.57E+21	3.61E+17	2.26E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.5E+19	4.04E+20	1.57E+21	1.57E+17	3.38E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	3.65E+17	7.08E+16
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.5E+19	4.04E+20	1.57E+21	1.48E+17	3.42E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.54E+19	4.04E+20	1.57E+21	3.66E+17	1.79E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	3.5E+17	2.8E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	2.32E+17	1.84E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	1.94E+17	3.33E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.97E+19	8.51E+19	4.04E+20	1.57E+21	2.18E+17	2.39E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.97E+19	8.51E+19	4.04E+20	1.57E+21	2.17E+17	2.38E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.54E+19	4.04E+20	1.57E+21	3.1E+17	1.18E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.5E+19	4.04E+20	1.57E+21	1.93E+17	3.21E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	3.94E+17	1.99E+17
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.5E+19	4.04E+20	1.57E+21	1.15E+17	3.43E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.54E+19	4.04E+20	1.57E+21	3.11E+17	1.2E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.96E+19	8.54E+19	4.04E+20	1.57E+21	3.7E+17	1.68E+17
1.55E+20	1.45E+20	1.4E+20	2.14E+20	6.95E+19	8.53E+19	4.04E+20	1.57E+21	3.91E+17	2.55E+17
1.55E+20	1.45E+20	1.4E+20	2.15E+20	6.95E+19	8.5E+19	4.04E+20	1.57E+21	1.3E+17	3.89E+17
1.56E+20	1.45E+20	1.4E+20	2.14E+20	6.97E+19	8.53E+19	4.04E+20	1.57E+21	3.53E+17	0
1.56E+20	1.45E+20	1.4E+20	2.15E+20	6.96E+19	8.51E+19	4.04E+20	1.57E+21	0	3.53E+17
1.7E+21	1.7E+21	1.66E+21	1.61E+21	1.62E+21	1.61E+21	1.21E+21	0	1.57E+21	1.57E+21
5.09E+20	5.24E+20	4.88E+20	4.64E+20	4.36E+20	4.4E+20	0	1.21E+21	4.04E+20	4.04E+20
1.52E+20	1.65E+20	1.92E+20	2.88E+20	1.02E+20	0	4.4E+20	1.61E+21	8.51E+19	8.53E+19
8.97E+19	9.43E+19	9.92E+19	1.94E+20	0	1.02E+20	4.36E+20	1.62E+21	6.96E+19	6.97E+19
2.25E+20	1.88E+20	1.19E+20	0	1.94E+20	2.88E+20	4.64E+20	1.61E+21	2.15E+20	2.14E+20
1.16E+20	6.93E+19	0	1.19E+20	9.92E+19	1.92E+20	4.88E+20	1.66E+21	1.4E+20	1.4E+20
7.08E+19	0	6.93E+19	1.88E+20	9.43E+19	1.65E+20	5.24E+20	1.7E+21	1.45E+20	1.45E+20
0	7.08E+19	1.16E+20	2.25E+20	8.97E+19	1.52E+20	5.09E+20	1.7E+21	1.56E+20	1.56E+20
2.89E+19	9.74E+19	1.4E+20	2.43E+20	1.12E+20	1.68E+20	5.16E+20	1.71E+21	1.78E+20	1.78E+20
5.68E+19	6.41E+19	1.16E+20	2.23E+20	1.33E+20	1.97E+20	5.58E+20	1.75E+21	1.95E+20	1.95E+20
1.32E+20	9.49E+19	1.26E+20	2.13E+20	1.86E+20	2.55E+20	6.07E+20	1.79E+21	2.39E+20	2.39E+20
1.22E+20	1.88E+20	2.36E+20	3.36E+20	1.92E+20	2.1E+20	5.56E+20	1.76E+21	2.5E+20	2.5E+20
9.12E+19	1.25E+20	1.58E+20	2.45E+20	1.74E+20	2.42E+20	5.71E+20	1.77E+21	2.42E+20	2.42E+20
1.06E+20	1.51E+20	1.76E+20	2.52E+20	1.83E+20	2.53E+20	5.57E+20	1.76E+21	2.53E+20	2.53E+20
1.18E+20	1.46E+20	1.72E+20	2.46E+20	1.97E+20	2.7E+20	5.83E+20	1.78E+21	2.65E+20	2.65E+20
1.29E+20	1.7E+20	2E+20	2.76E+20	2.11E+20	2.76E+20	5.88E+20	1.79E+21	2.8E+20	2.8E+20
1.51E+20	1.92E+20	2.11E+20	2.73E+20	2.25E+20	2.96E+20	5.81E+20	1.78E+21	2.95E+20	2.95E+20
1.66E+20	2E+20	2.23E+20	2.86E+20	2.45E+20	3.15E+20	6.12E+20	1.81E+21	3.14E+20	3.14E+20
2.66E+20	3.19E+20	3.23E+20	3.54E+20	3.14E+20	3.78E+20	5.5E+20	1.74E+21	3.77E+20	3.77E+20
2.46E+20	3E+20	3.43E+20	4.26E+20	3.29E+20	3.61E+20	6.77E+20	1.88E+21	3.93E+20	3.93E+20

99	98	97	96	95	94	93	92	91	90
3.81E+20	3.82E+20	4.12E+20	4.64E+20	4.63E+20	5.22E+20	8.61E+20	2.06E+21	5.25E+20	5.25E+20
5.08E+20	5.3E+20	5.44E+20	5.68E+20	5.87E+20	6.57E+20	9.11E+20	2.1E+21	6.56E+20	6.56E+20
1.01E+21	1E+21	1.01E+21	9.96E+20	1.08E+21	1.16E+21	1.4E+21	2.53E+21	1.14E+21	1.14E+21
2.48E+20	1.77E+20	1.71E+20	2.18E+20	2.33E+20	2.76E+20	6.01E+20	1.72E+21	2.35E+20	2.34E+20
3.46E+20	3.24E+20	3.42E+20	4.17E+20	2.9E+20	2.15E+20	5.14E+20	1.57E+21	2.35E+20	2.34E+20
1.81E+20	1.24E+20	1.03E+20	1.45E+20	1.97E+20	2.79E+20	5.81E+20	1.74E+21	2.35E+20	2.35E+20
2.96E+20	2.36E+20	1.84E+20	1.43E+20	2.48E+20	3.1E+20	5.05E+20	1.6E+21	2.35E+20	2.34E+20
3.37E+20	2.89E+20	2.34E+20	1.85E+20	2.68E+20	3.16E+20	4.3E+20	1.5E+21	2.35E+20	2.34E+20
2.54E+20	3.06E+20	3.13E+20	3.71E+20	2.25E+20	2.1E+20	3.42E+20	1.53E+21	2.34E+20	2.35E+20
3.24E+20	2.82E+20	2.99E+20	3.71E+20	2.79E+20	2.35E+20	5.7E+20	1.63E+21	2.35E+20	2.34E+20
2.87E+20	3.18E+20	3.51E+20	4.43E+20	2.56E+20	1.61E+20	4.55E+20	1.58E+21	2.34E+20	2.35E+20
3.74E+20	3.44E+20	2.98E+20	2.7E+20	2.88E+20	3.06E+20	3.24E+20	1.39E+21	2.35E+20	2.34E+20
3.14E+20	3.2E+20	2.71E+20	2.35E+20	2.46E+20	2.96E+20	2.33E+20	1.41E+21	2.34E+20	2.35E+20
3.45E+20	3.44E+20	3.65E+20	4.42E+20	2.88E+20	1.95E+20	4.59E+20	1.53E+21	2.34E+20	2.34E+20
2.88E+20	3.25E+20	3.52E+20	4.36E+20	2.53E+20	1.7E+20	4.17E+20	1.55E+21	2.34E+20	2.35E+20
2.38E+20	2.91E+20	3.21E+20	4.07E+20	2.26E+20	1.72E+20	4.33E+20	1.6E+21	2.34E+20	2.35E+20
2.2E+20	1.5E+20	1.41E+20	1.88E+20	2.18E+20	2.77E+20	6E+20	1.73E+21	2.35E+20	2.34E+20
9.64E+19	1.47E+20	1.67E+20	2.42E+20	1.65E+20	2.36E+20	5.29E+20	1.73E+21	2.35E+20	2.35E+20
2.76E+20	2.19E+20	1.6E+20	9.92E+19	2.35E+20	3.11E+20	5.02E+20	1.61E+21	2.35E+20	2.34E+20
2.31E+20	2.31E+20	2.89E+20	4.03E+20	2.36E+20	1.7E+20	6.02E+20	1.74E+21	2.35E+20	2.35E+20
2.39E+22	2.39E+22	2.39E+22	2.39E+22	2.4E+22	2.4E+22	2.44E+22	2.55E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.66E+22	2.67E+22	2.65E+22	2.65E+22	2.68E+22	2.74E+22	2.65E+22	2.65E+22

Table 20: This table gives internal distances for masses 89-80

89	88	87	86	85	84	83	82	81	80
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2E+17	1.96E+17	1.95E+17	1.93E+17	1.93E+17	1.93E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
2.14E+17	2.21E+17	1.89E+17	1.63E+17	1.98E+17	2.08E+17	2.06E+17	1.6E+17	1.86E+17	1.87E+17
2.41E+17	1.81E+17	1.56E+17	1.58E+17	2.3E+17	1.65E+17	2.26E+17	1.55E+17	2.07E+17	2.07E+17
2.41E+17	1.81E+17	1.56E+17	1.58E+17	2.3E+17	1.65E+17	2.26E+17	1.55E+17	2.07E+17	2.07E+17
1.54E+17	2.41E+17	2.51E+17	2.34E+17	1.38E+17	2.44E+17	1.4E+17	2.31E+17	1.59E+17	1.59E+17
1.28E+17	2.58E+17	2.73E+17	2.55E+17	1.18E+17	2.65E+17	1.29E+17	2.53E+17	1.65E+17	1.65E+17
2.7E+17	1.92E+17	1.27E+17	1.21E+17	2.61E+17	1.66E+17	2.65E+17	1.19E+17	2.35E+17	2.35E+17
2.76E+17	1.33E+17	1.14E+17	1.7E+17	2.84E+17	1.21E+17	2.8E+17	1.68E+17	2.71E+17	2.71E+17
1.87E+17	1.74E+17	2.24E+17	2.67E+17	2.29E+17	2.02E+17	2.33E+17	2.64E+17	2.74E+17	2.74E+17
2.93E+17	1.66E+17	9.67E+16	1.26E+17	2.9E+17	1.37E+17	2.89E+17	1.24E+17	2.62E+17	2.62E+17
2.79E+17	9.8E+16	1.5E+17	2.14E+17	2.82E+17	9.84E+16	2.59E+17	2.12E+17	2.59E+17	2.58E+17
3.08E+17	1.65E+17	1.11E+17	1.28E+17	2.89E+17	1.26E+17	2.74E+17	1.25E+17	2.33E+17	2.33E+17
1.58E+17	2.65E+17	2.94E+17	2.76E+17	1.18E+17	2.7E+17	8.59E+16	2.74E+17	1.27E+17	1.26E+17

89	88	87	86	85	84	83	82	81	80
3.08E+17	1.66E+17	1.11E+17	1.27E+17	2.89E+17	1.26E+17	2.74E+17	1.25E+17	2.33E+17	2.33E+17
2.39E+17	1.48E+17	2.25E+17	2.66E+17	2.38E+17	1.64E+17	2E+17	2.64E+17	2.23E+17	2.23E+17
2.4E+17	1.48E+17	2.27E+17	2.68E+17	2.39E+17	1.65E+17	2E+17	2.65E+17	2.24E+17	2.23E+17
2.11E+17	2.66E+17	2.14E+17	1.81E+17	2.19E+17	2.58E+17	2.55E+17	1.8E+17	2.46E+17	2.47E+17
2.09E+17	2.94E+17	2.37E+17	1.73E+17	1.87E+17	2.79E+17	2.23E+17	1.71E+17	1.95E+17	1.96E+17
2.52E+17	2.68E+17	1.9E+17	1.25E+17	2.34E+17	2.45E+17	2.59E+17	1.24E+17	2.21E+17	2.21E+17
3.14E+17	1.45E+17	8.88E+16	1.35E+17	3.04E+17	1.06E+17	2.91E+17	1.33E+17	2.59E+17	2.59E+17
9.51E+16	2.96E+17	3.01E+17	2.76E+17	1.08E+17	3.05E+17	1.51E+17	2.74E+17	1.95E+17	1.95E+17
1.71E+17	2.95E+17	3.02E+17	2.62E+17	1.06E+17	2.92E+17	8.53E+16	2.6E+17	8.79E+16	8.77E+16
8.58E+16	2.98E+17	3.1E+17	2.86E+17	9.56E+16	3.09E+17	1.37E+17	2.84E+17	1.88E+17	1.89E+17
3.11E+17	1.85E+17	8.69E+16	1.04E+17	3.06E+17	1.51E+17	3.09E+17	1.02E+17	2.74E+17	2.75E+17
1.53E+17	2.08E+17	2.74E+17	3.1E+17	2.07E+17	2.42E+17	2.1E+17	3.07E+17	2.74E+17	2.73E+17
1.78E+17	3.02E+17	3.09E+17	2.67E+17	1.08E+17	2.98E+17	8.12E+16	2.65E+17	7.74E+16	7.71E+16
2.77E+17	2.62E+17	2.39E+17	1.92E+17	2.17E+17	2.35E+17	1.86E+17	1.9E+17	1.11E+17	1.11E+17
2.88E+17	1.28E+17	2.05E+17	2.55E+17	2.78E+17	1.32E+17	2.35E+17	2.53E+17	2.38E+17	2.38E+17
7.92E+16	2.74E+17	3.17E+17	3.2E+17	1.36E+17	2.98E+17	1.57E+17	3.18E+17	2.33E+17	2.33E+17
1.79E+17	3.09E+17	3.17E+17	2.74E+17	1.05E+17	3.05E+17	7.61E+16	2.71E+17	7.31E+16	7.28E+16
1.12E+17	2.51E+17	3.16E+17	3.32E+17	1.56E+17	2.81E+17	1.51E+17	3.3E+17	2.35E+17	2.34E+17
2.43E+17	2.01E+17	2.71E+17	2.92E+17	2.22E+17	2.11E+17	1.65E+17	2.9E+17	1.89E+17	1.88E+17
1.39E+17	3.35E+17	3.25E+17	2.7E+17	7.18E+16	3.32E+17	1.13E+17	2.68E+17	1.24E+17	1.24E+17
9.71E+16	3.11E+17	3.4E+17	3.16E+17	6.42E+16	3.23E+17	7.26E+16	3.13E+17	1.54E+17	1.54E+17
2.45E+17	3.23E+17	2.84E+17	2.06E+17	1.7E+17	3E+17	1.66E+17	2.03E+17	7.52E+16	7.6E+16
2.01E+17	2.95E+17	3.2E+17	2.91E+17	1.36E+17	2.93E+17	7.64E+16	2.88E+17	8.77E+16	8.69E+16
1.51E+17	3.2E+17	2.94E+17	2.59E+17	1.75E+17	3.24E+17	2.33E+17	2.57E+17	2.52E+17	2.52E+17
3.51E+17	1.66E+17	5.79E+16	1.11E+17	3.38E+17	1.15E+17	3.29E+17	1.09E+17	2.85E+17	2.85E+17
1.77E+17	2.02E+17	2.98E+17	3.43E+17	2.22E+17	2.43E+17	2.03E+17	3.4E+17	2.77E+17	2.77E+17
1E+17	3.14E+17	3.5E+17	3.29E+17	6.88E+16	3.28E+17	6.3E+16	3.26E+17	1.58E+17	1.57E+17
3.31E+17	2.3E+17	1.97E+17	1.7E+17	2.83E+17	1.91E+17	2.49E+17	1.67E+17	1.78E+17	1.78E+17
3.05E+17	2.56E+17	1.49E+17	1.13E+17	3.05E+17	2.29E+17	3.29E+17	1.13E+17	2.95E+17	2.95E+17
2.67E+17	1.87E+17	1.82E+17	2.4E+17	3.11E+17	2.02E+17	3.3E+17	2.39E+17	3.46E+17	3.47E+17
2.89E+17	8.04E+16	2.11E+17	2.94E+17	3.1E+17	1.27E+17	2.78E+17	2.92E+17	3.07E+17	3.06E+17
2.41E+17	3.39E+17	2.63E+17	1.79E+17	2.19E+17	3.2E+17	2.66E+17	1.78E+17	2.29E+17	2.3E+17
3.63E+17	1.73E+17	1.33E+17	1.59E+17	3.34E+17	1.21E+17	3.03E+17	1.57E+17	2.51E+17	2.51E+17
3.68E+17	1.35E+17	6.18E+16	1.5E+17	3.58E+17	7.66E+16	3.4E+17	1.48E+17	3.02E+17	3.02E+17
3.55E+17	1.43E+17	1.59E+17	2.08E+17	3.33E+17	1.04E+17	2.93E+17	2.05E+17	2.59E+17	2.58E+17
3.48E+17	1.01E+17	7.54E+16	1.94E+17	3.62E+17	7.92E+16	3.54E+17	1.93E+17	3.42E+17	3.42E+17
2.73E+17	1.85E+17	1.94E+17	2.61E+17	3.23E+17	2.06E+17	3.4E+17	2.6E+17	3.63E+17	3.63E+17
3.11E+17	2.81E+17	1.72E+17	1.22E+17	3.1E+17	2.54E+17	3.4E+17	1.22E+17	3.04E+17	3.05E+17
2.35E+16	3.31E+17	3.64E+17	3.5E+17	1.02E+17	3.52E+17	1.47E+17	3.47E+17	2.32E+17	2.32E+17
3.26E+17	2.87E+17	1.66E+17	8.64E+16	3.12E+17	2.52E+17	3.38E+17	8.65E+16	2.87E+17	2.88E+17
2.85E+17	2.14E+17	2.87E+17	3.09E+17	2.55E+17	2.19E+17	1.9E+17	3.06E+17	2.01E+17	2E+17
2.74E+17	3.48E+17	2.59E+17	1.54E+17	2.35E+17	3.21E+17	2.72E+17	1.53E+17	2.13E+17	2.14E+17
2.25E+17	3.5E+17	3.38E+17	2.72E+17	1.34E+17	3.37E+17	1.13E+17	2.7E+17	2.24E+16	2.28E+16
7.03E+16	3.16E+17	3.71E+17	3.67E+17	1.09E+17	3.41E+17	1.15E+17	3.65E+17	2.2E+17	2.2E+17
2.17E+17	2.6E+17	3.38E+17	3.5E+17	1.95E+17	2.79E+17	1.26E+17	3.47E+17	1.89E+17	1.88E+17
1.47E+17	2.48E+17	3.27E+17	3.65E+17	2.23E+17	2.9E+17	2.31E+17	3.63E+17	3.13E+17	3.12E+17
3.35E+17	3.06E+17	1.85E+17	6.3E+16	3.03E+17	2.65E+17	3.22E+17	6.29E+16	2.53E+17	2.54E+17
3.57E+17	1.16E+17	7.57E+16	1.97E+17	3.75E+17	9.69E+16	3.7E+17	1.96E+17	3.58E+17	3.58E+17
1.07E+17	3.46E+17	3.78E+17	3.49E+17	5.02E+16	3.58E+17	4.78E+16	3.47E+17	1.53E+17	1.53E+17
3.77E+17	1.94E+17	1.49E+17	1.62E+17	3.43E+17	1.41E+17	3.11E+17	1.6E+17	2.5E+17	2.5E+17
9.71E+16	3.49E+17	3.79E+17	3.49E+17	4.27E+16	3.61E+17	5.9E+16	3.47E+17	1.59E+17	1.59E+17

89	88	87	86	85	84	83	82	81	80
3.76E+17	1.43E+17	2.04E+16	1.54E+17	3.79E+17	9.66E+16	3.72E+17	1.53E+17	3.41E+17	3.41E+17
3.29E+17	1.18E+17	1.4E+17	2.47E+17	3.65E+17	1.35E+17	3.65E+17	2.45E+17	3.75E+17	3.75E+17
3.19E+17	3.34E+17	2.24E+17	1.03E+17	2.8E+17	2.97E+17	3.05E+17	1.02E+17	2.33E+17	2.34E+17
2.31E+17	3.07E+17	2.62E+17	2.5E+17	2.71E+17	3.1E+17	3.2E+17	2.5E+17	3.32E+17	3.32E+17
2.44E+17	3.53E+17	3.42E+17	2.77E+17	1.53E+17	3.38E+17	1.22E+17	2.75E+17	1.13E+15	0
2.44E+17	3.54E+17	3.42E+17	2.76E+17	1.53E+17	3.38E+17	1.23E+17	2.74E+17	0	1.13E+15
3.69E+17	2.73E+17	1.39E+17	2.78E+15	3.39E+17	2.23E+17	3.45E+17	0	2.74E+17	2.75E+17
1.54E+17	3.45E+17	3.79E+17	3.48E+17	8.34E+16	3.53E+17	0	3.45E+17	1.23E+17	1.22E+17
3.75E+17	6.67E+16	1.1E+17	2.25E+17	3.79E+17	0	3.53E+17	2.23E+17	3.38E+17	3.38E+17
1.04E+17	3.72E+17	3.86E+17	3.41E+17	0	3.79E+17	8.34E+16	3.39E+17	1.53E+17	1.53E+17
3.71E+17	2.75E+17	1.4E+17	0	3.41E+17	2.25E+17	3.48E+17	2.78E+15	2.76E+17	2.77E+17
3.87E+17	1.62E+17	0	1.4E+17	3.86E+17	1.1E+17	3.79E+17	1.39E+17	3.42E+17	3.42E+17
3.53E+17	0	1.62E+17	2.75E+17	3.72E+17	6.67E+16	3.45E+17	2.73E+17	3.54E+17	3.53E+17
0	3.53E+17	3.87E+17	3.71E+17	1.04E+17	3.75E+17	1.54E+17	3.69E+17	2.44E+17	2.44E+17
3.89E+17	2.55E+17	1.68E+17	1.2E+17	3.43E+17	1.99E+17	3.21E+17	1.18E+17	2.38E+17	2.39E+17
1.3E+17	3.91E+17	3.7E+17	3.11E+17	1.15E+17	3.94E+17	1.93E+17	3.1E+17	2.17E+17	2.18E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.5E+19	8.53E+19	8.54E+19	8.54E+19	8.5E+19	8.53E+19	8.5E+19	8.54E+19	8.51E+19	8.51E+19
6.95E+19	6.95E+19	6.96E+19	6.97E+19	6.96E+19	6.95E+19	6.96E+19	6.97E+19	6.97E+19	6.97E+19
2.15E+20	2.14E+20	2.14E+20	2.14E+20	2.15E+20	2.14E+20	2.15E+20	2.14E+20	2.15E+20	2.15E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.55E+20	1.55E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.55E+20	6.55E+20	6.56E+20	6.56E+20	6.55E+20	6.56E+20	6.56E+20	6.56E+20	6.56E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20

89	88	87	86	85	84	83	82	81	80
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 21: This table gives internal distances for masses 79-70

79	78	77	76	75	74	73	72	71	70
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.89E+17	1.88E+17	1.87E+17	1.87E+17	1.85E+17	1.84E+17	1.84E+17	1.84E+17	1.83E+17	1.83E+17
1.75E+17	1.49E+17	2E+17	1.84E+17	1.98E+17	1.83E+17	1.98E+17	1.89E+17	1.45E+17	2.14E+17
1.95E+17	1.7E+17	1.71E+17	1.5E+17	2.24E+17	1.52E+17	2.23E+17	1.55E+17	1.57E+17	2.16E+17
1.95E+17	1.7E+17	1.71E+17	1.5E+17	2.24E+17	1.52E+17	2.23E+17	1.55E+17	1.57E+17	2.16E+17
2.01E+17	2.07E+17	2.35E+17	2.43E+17	1.29E+17	2.24E+17	1.29E+17	2.38E+17	2.12E+17	1.71E+17
1.99E+17	2.21E+17	2.48E+17	2.65E+17	1.09E+17	2.5E+17	1.1E+17	2.57E+17	2.3E+17	1.58E+17
1.81E+17	1.45E+17	1.62E+17	1.24E+17	2.6E+17	1.54E+17	2.6E+17	1.37E+17	1.24E+17	2.45E+17
1.95E+17	2.07E+17	1.08E+17	1.02E+17	2.74E+17	1.62E+17	2.73E+17	9.21E+16	1.84E+17	2.16E+17
1.75E+17	2.68E+17	1.46E+17	2.09E+17	2.11E+17	2.53E+17	2.13E+17	1.78E+17	2.59E+17	1.04E+17
1.95E+17	1.69E+17	1.37E+17	9.15E+16	2.85E+17	1.45E+17	2.85E+17	1.05E+17	1.42E+17	2.52E+17
2.52E+17	2.54E+17	1.39E+17	1.36E+17	2.63E+17	1.44E+17	2.6E+17	1.27E+17	2.33E+17	2.09E+17
2.46E+17	1.79E+17	1.76E+17	1.09E+17	2.82E+17	9.04E+16	2.79E+17	1.36E+17	1.54E+17	2.73E+17
2.62E+17	2.5E+17	2.82E+17	2.87E+17	9.73E+16	2.38E+17	9.17E+16	2.84E+17	2.58E+17	1.88E+17
2.47E+17	1.79E+17	1.77E+17	1.09E+17	2.82E+17	8.96E+16	2.79E+17	1.36E+17	1.54E+17	2.74E+17
2.8E+17	2.85E+17	2E+17	2.12E+17	2.11E+17	1.82E+17	2.06E+17	2.02E+17	2.75E+17	1.79E+17
2.81E+17	2.87E+17	2.01E+17	2.14E+17	2.11E+17	1.83E+17	2.06E+17	2.03E+17	2.76E+17	1.8E+17
9.38E+16	1.45E+17	2.04E+17	2.1E+17	2.28E+17	2.54E+17	2.33E+17	2.06E+17	1.46E+17	2.2E+17
1.46E+17	1.12E+17	2.51E+17	2.36E+17	2.03E+17	2.44E+17	2.07E+17	2.43E+17	1.28E+17	2.47E+17
1.5E+17	8.76E+16	2.23E+17	1.92E+17	2.45E+17	2.12E+17	2.48E+17	2.05E+17	8.68E+16	2.67E+17
2.38E+17	1.93E+17	1.49E+17	8.36E+16	2.96E+17	1.06E+17	2.93E+17	1.07E+17	1.64E+17	2.67E+17
1.71E+17	2.27E+17	2.66E+17	2.93E+17	1.11E+17	2.96E+17	1.18E+17	2.82E+17	2.41E+17	1.57E+17
2.65E+17	2.24E+17	3.06E+17	2.97E+17	1.01E+17	2.39E+17	9.58E+16	3.02E+17	2.38E+17	2.25E+17
1.86E+17	2.38E+17	2.75E+17	3.02E+17	9.54E+16	2.98E+17	1.02E+17	2.9E+17	2.52E+17	1.55E+17
1.95E+17	1.55E+17	1.47E+17	8.67E+16	3.04E+17	1.51E+17	3.04E+17	1.08E+17	1.24E+17	2.75E+17
2E+17	3.01E+17	1.91E+17	2.58E+17	1.84E+17	2.88E+17	1.86E+17	2.27E+17	2.97E+17	5.75E+16
2.76E+17	2.29E+17	3.16E+17	3.05E+17	1.03E+17	2.41E+17	9.73E+16	3.11E+17	2.44E+17	2.35E+17
3E+17	1.89E+17	2.91E+17	2.39E+17	2.14E+17	1.4E+17	2.08E+17	2.63E+17	1.91E+17	2.94E+17
3.09E+17	2.9E+17	2.03E+17	1.93E+17	2.53E+17	1.45E+17	2.48E+17	1.91E+17	2.74E+17	2.27E+17

79	78	77	76	75	74	73	72	71	70
2E+17	2.88E+17	2.55E+17	3.05E+17	1.17E+17	3.14E+17	1.22E+17	2.83E+17	2.95E+17	9.15E+16
2.83E+17	2.34E+17	3.24E+17	3.12E+17	1.01E+17	2.47E+17	9.46E+16	3.19E+17	2.5E+17	2.4E+17
2.37E+17	3.11E+17	2.52E+17	3.02E+17	1.26E+17	3.02E+17	1.27E+17	2.79E+17	3.15E+17	8.09E+16
3.21E+17	3.02E+17	2.61E+17	2.61E+17	1.92E+17	1.95E+17	1.84E+17	2.58E+17	2.98E+17	2.11E+17
2.29E+17	2.09E+17	3.21E+17	3.21E+17	9.33E+16	2.87E+17	9.66E+16	3.23E+17	2.32E+17	2.28E+17
2.52E+17	2.72E+17	3.11E+17	3.31E+17	4.03E+16	3E+17	4.15E+16	3.23E+17	2.87E+17	1.73E+17
2.76E+17	1.59E+17	3.27E+17	2.85E+17	1.82E+17	2.12E+17	1.79E+17	3.06E+17	1.79E+17	3.01E+17
3.13E+17	2.65E+17	3.26E+17	3.15E+17	1.18E+17	2.37E+17	1.09E+17	3.2E+17	2.76E+17	2.42E+17
9.83E+16	2E+17	2.6E+17	2.88E+17	1.9E+17	3.22E+17	1.98E+17	2.76E+17	2.14E+17	1.99E+17
2.52E+17	1.88E+17	1.61E+17	6.22E+16	3.33E+17	1.05E+17	3.31E+17	1.06E+17	1.53E+17	3.06E+17
2.62E+17	3.42E+17	2.19E+17	2.82E+17	1.89E+17	2.91E+17	1.88E+17	2.51E+17	3.37E+17	7.56E+16
2.66E+17	2.87E+17	3.19E+17	3.41E+17	3.46E+16	3.06E+17	3.28E+16	3.32E+17	3.02E+17	1.74E+17
3.22E+17	2.04E+17	2.72E+17	1.99E+17	2.76E+17	7.27E+16	2.7E+17	2.32E+17	1.92E+17	3.23E+17
1.41E+17	1.21E+17	1.86E+17	1.52E+17	3.13E+17	2.25E+17	3.16E+17	1.64E+17	9.69E+16	2.91E+17
1.3E+17	2.56E+17	8.79E+16	1.68E+17	3.04E+17	2.74E+17	3.07E+17	1.28E+17	2.37E+17	1.9E+17
2.94E+17	3.31E+17	1.54E+17	1.94E+17	2.82E+17	2.09E+17	2.78E+17	1.67E+17	3.12E+17	1.86E+17
1.46E+17	9.63E+16	2.84E+17	2.65E+17	2.42E+17	2.81E+17	2.47E+17	2.74E+17	1.21E+17	2.91E+17
3.18E+17	2.26E+17	2.2E+17	1.35E+17	3.23E+17	2.32E+16	3.18E+17	1.71E+17	2E+17	3.24E+17
2.82E+17	2.29E+17	1.57E+17	5.99E+16	3.48E+17	9.47E+16	3.45E+17	9.96E+16	1.95E+17	3.09E+17
3.34E+17	2.68E+17	2.16E+17	1.54E+17	3.16E+17	6.5E+16	3.1E+17	1.77E+17	2.44E+17	3.04E+17
2.41E+17	2.58E+17	7.31E+16	5.51E+16	3.5E+17	1.75E+17	3.49E+17	2.18E+16	2.26E+17	2.66E+17
1.45E+17	2.79E+17	8.36E+16	1.79E+17	3.13E+17	2.87E+17	3.17E+17	1.34E+17	2.59E+17	1.85E+17
1.36E+17	1.16E+17	2.07E+17	1.75E+17	3.21E+17	2.47E+17	3.25E+17	1.87E+17	9.59E+16	3.05E+17
2.17E+17	3.01E+17	3.08E+17	3.53E+17	9.25E+16	3.55E+17	1.02E+17	3.34E+17	3.15E+17	1.35E+17
1.71E+17	8.47E+16	2.27E+17	1.74E+17	3.25E+17	2.24E+17	3.27E+17	1.96E+17	5.77E+16	3.27E+17
3.63E+17	3.26E+17	2.9E+17	2.78E+17	2.26E+17	1.91E+17	2.17E+17	2.8E+17	3.2E+17	2.53E+17
1.92E+17	5.7E+16	3.04E+17	2.64E+17	2.59E+17	2.61E+17	2.62E+17	2.84E+17	9.33E+16	3.25E+17
3.13E+17	2.24E+17	3.65E+17	3.37E+17	1.43E+17	2.56E+17	1.37E+17	3.52E+17	2.46E+17	2.98E+17
2.65E+17	3.29E+17	3.16E+17	3.59E+17	7.54E+16	3.44E+17	7.86E+16	3.4E+17	3.41E+17	1.29E+17
3.48E+17	3.44E+17	3.14E+17	3.27E+17	1.58E+17	2.63E+17	1.48E+17	3.2E+17	3.46E+17	2.06E+17
2.27E+17	3.52E+17	2.29E+17	3.1E+17	1.97E+17	3.44E+17	2.01E+17	2.74E+17	3.5E+17	0
2.15E+17	4.23E+16	2.65E+17	1.95E+17	3.18E+17	2.04E+17	3.19E+17	2.28E+17	0	3.5E+17
2.37E+17	2.62E+17	6.59E+16	5.66E+16	3.64E+17	1.92E+17	3.63E+17	0	2.28E+17	2.74E+17
2.88E+17	3.01E+17	3.52E+17	3.7E+17	1.17E+16	3.28E+17	0	3.63E+17	3.19E+17	2.01E+17
3.35E+17	2.29E+17	2.43E+17	1.53E+17	3.33E+17	0	3.28E+17	1.92E+17	2.04E+17	3.44E+17
2.81E+17	2.99E+17	3.51E+17	3.71E+17	0	3.33E+17	1.17E+16	3.64E+17	3.18E+17	1.97E+17
2.56E+17	2.33E+17	1.22E+17	0	3.71E+17	1.53E+17	3.7E+17	5.66E+16	1.95E+17	3.1E+17
2.15E+17	2.94E+17	0	1.22E+17	3.51E+17	2.43E+17	3.52E+17	6.59E+16	2.65E+17	2.29E+17
2.16E+17	0	2.94E+17	2.33E+17	2.99E+17	2.29E+17	3.01E+17	2.62E+17	4.23E+16	3.52E+17
0	2.16E+17	2.15E+17	2.56E+17	2.81E+17	3.35E+17	2.88E+17	2.37E+17	2.15E+17	2.27E+17
3.32E+17	2.34E+17	3.75E+17	3.41E+17	1.59E+17	2.5E+17	1.53E+17	3.58E+17	2.54E+17	3.12E+17
3.32E+17	2.33E+17	3.75E+17	3.41E+17	1.59E+17	2.5E+17	1.53E+17	3.58E+17	2.53E+17	3.13E+17
2.5E+17	1.02E+17	2.45E+17	1.53E+17	3.47E+17	1.6E+17	3.47E+17	1.96E+17	6.29E+16	3.63E+17
3.2E+17	3.05E+17	3.65E+17	3.72E+17	5.9E+16	3.11E+17	4.78E+16	3.7E+17	3.22E+17	2.31E+17
3.1E+17	2.97E+17	1.35E+17	9.66E+16	3.61E+17	1.41E+17	3.58E+17	9.69E+16	2.65E+17	2.9E+17
2.71E+17	2.8E+17	3.65E+17	3.79E+17	4.27E+16	3.43E+17	5.02E+16	3.75E+17	3.03E+17	2.23E+17
2.5E+17	1.03E+17	2.47E+17	1.54E+17	3.49E+17	1.62E+17	3.49E+17	1.97E+17	6.3E+16	3.65E+17
2.62E+17	2.24E+17	1.4E+17	2.04E+16	3.79E+17	1.49E+17	3.78E+17	7.57E+16	1.85E+17	3.27E+17
3.07E+17	3.34E+17	1.18E+17	1.43E+17	3.49E+17	1.94E+17	3.46E+17	1.16E+17	3.06E+17	2.48E+17
2.31E+17	3.19E+17	3.29E+17	3.76E+17	9.71E+16	3.77E+17	1.07E+17	3.57E+17	3.35E+17	1.47E+17
3.33E+17	1.84E+17	2.8E+17	1.79E+17	3.42E+17	7.08E+16	3.38E+17	2.26E+17	1.61E+17	3.78E+17

79	78	77	76	75	74	73	72	71	70
1.94E+17	2.32E+17	3.5E+17	3.66E+17	1.48E+17	3.65E+17	1.57E+17	3.61E+17	2.6E+17	2.44E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.53E+19	8.53E+19	8.53E+19	8.54E+19	8.5E+19	8.53E+19	8.5E+19	8.54E+19	8.53E+19	8.51E+19
6.95E+19	6.97E+19	6.95E+19	6.96E+19	6.96E+19	6.97E+19	6.96E+19	6.95E+19	6.97E+19	6.94E+19
2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.15E+20	2.14E+20	2.15E+20	2.14E+20	2.14E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.55E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.55E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.56E+20	6.55E+20	6.55E+20	6.55E+20	6.56E+20	6.55E+20	6.55E+20	6.56E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 22 : This table gives internal distances table

69	68	67	66	65	64	63	62	61	60
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17

69	68	67	66	65	64	63	62	61	60
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
1.82E+17	1.81E+17	1.79E+17	1.79E+17	1.78E+17	1.78E+17	1.77E+17	1.76E+17	1.74E+17	1.7E+17
2.14E+17	2.05E+17	1.74E+17	1.4E+17	2.07E+17	1.43E+17	1.92E+17	1.44E+17	1.84E+17	1.78E+17
2.09E+17	2.23E+17	1.98E+17	1.73E+17	1.88E+17	1.52E+17	2.18E+17	1.54E+17	1.71E+17	1.41E+17
2.1E+17	2.23E+17	1.98E+17	1.73E+17	1.88E+17	1.52E+17	2.17E+17	1.54E+17	1.72E+17	1.41E+17
1.58E+17	1.34E+17	1.44E+17	1.83E+17	1.78E+17	2.13E+17	1.31E+17	2.1E+17	2.1E+17	2.25E+17
1.59E+17	1.12E+17	1.48E+17	1.92E+17	1.92E+17	2.29E+17	1.06E+17	2.23E+17	2.16E+17	2.44E+17
2.55E+17	2.6E+17	2.26E+17	1.57E+17	2.29E+17	1.12E+17	2.47E+17	1.15E+17	1.64E+17	1.27E+17
2.44E+17	2.58E+17	2.63E+17	2.18E+17	2.15E+17	1.62E+17	2.52E+17	1.56E+17	1.27E+17	7.93E+16
2.03E+17	1.7E+17	2.61E+17	2.54E+17	2.16E+17	2.34E+17	1.66E+17	2.16E+17	1.14E+17	1.69E+17
2.66E+17	2.8E+17	2.54E+17	1.88E+17	2.33E+17	1.25E+17	2.7E+17	1.26E+17	1.55E+17	9.5E+16
1.95E+17	2.44E+17	2.54E+17	2.62E+17	1.55E+17	2.23E+17	2.56E+17	2.22E+17	1.72E+17	1.07E+17
2.41E+17	2.84E+17	2.3E+17	2.02E+17	1.93E+17	1.58E+17	2.84E+17	1.71E+17	2.04E+17	1.2E+17
1.06E+17	1.17E+17	1.15E+17	2.26E+17	1.44E+17	2.68E+17	1.4E+17	2.7E+17	2.64E+17	2.68E+17
2.41E+17	2.85E+17	2.3E+17	2.02E+17	1.94E+17	1.58E+17	2.85E+17	1.71E+17	2.05E+17	1.21E+17
1.19E+17	1.9E+17	2.19E+17	2.82E+17	9.6E+16	2.73E+17	2.18E+17	2.72E+17	2.15E+17	1.83E+17
1.18E+17	1.9E+17	2.2E+17	2.84E+17	9.51E+16	2.74E+17	2.19E+17	2.74E+17	2.16E+17	1.84E+17
2.82E+17	2.28E+17	2.3E+17	1.23E+17	2.88E+17	1.19E+17	1.92E+17	1E+17	1.59E+17	2.03E+17
2.68E+17	2.23E+17	1.79E+17	7.81E+16	2.74E+17	1.26E+17	1.9E+17	1.26E+17	2.15E+17	2.37E+17
2.85E+17	2.6E+17	2.07E+17	8.26E+16	2.76E+17	7.94E+16	2.32E+17	8.45E+16	1.99E+17	2E+17
2.53E+17	2.91E+17	2.55E+17	2.15E+17	2.07E+17	1.58E+17	2.9E+17	1.66E+17	1.83E+17	9.07E+16
2.04E+17	1.12E+17	1.75E+17	1.87E+17	2.45E+17	2.33E+17	7.46E+16	2.22E+17	2.17E+17	2.73E+17
1.42E+17	1.44E+17	7.31E+16	1.97E+17	1.7E+17	2.55E+17	1.55E+17	2.62E+17	2.86E+17	2.86E+17
1.92E+17	9.71E+16	1.68E+17	1.99E+17	2.38E+17	2.47E+17	6.5E+16	2.36E+17	2.28E+17	2.8E+17
2.91E+17	3.02E+17	2.67E+17	1.8E+17	2.57E+17	1.03E+17	2.88E+17	1.07E+17	1.64E+17	1.03E+17
1.82E+17	1.3E+17	2.59E+17	2.8E+17	2.16E+17	2.76E+17	1.34E+17	2.58E+17	1.54E+17	2.17E+17
1.41E+17	1.5E+17	6.35E+16	2.03E+17	1.69E+17	2.63E+17	1.63E+17	2.71E+17	2.98E+17	2.95E+17
1.85E+17	2.46E+17	1.16E+17	1.93E+17	1.52E+17	2.23E+17	2.57E+17	2.43E+17	2.98E+17	2.45E+17
1.48E+17	2.39E+17	2.38E+17	2.96E+17	9.03E+16	2.76E+17	2.67E+17	2.8E+17	2.35E+17	1.7E+17
1.76E+17	6.96E+16	2.15E+17	2.54E+17	2.3E+17	2.82E+17	5.82E+16	2.66E+17	2.08E+17	2.72E+17
1.42E+17	1.51E+17	5.92E+16	2.07E+17	1.72E+17	2.7E+17	1.65E+17	2.78E+17	3.05E+17	3.03E+17
1.39E+17	6.78E+16	2.21E+17	2.83E+17	1.95E+17	3.04E+17	9.49E+16	2.91E+17	2.17E+17	2.67E+17
7.12E+16	1.85E+17	1.89E+17	2.96E+17	4.59E+16	3.06E+17	2.24E+17	3.1E+17	2.73E+17	2.38E+17
2.01E+17	1.43E+17	1.01E+17	1.67E+17	2.38E+17	2.44E+17	1.26E+17	2.45E+17	2.84E+17	3.11E+17
1.43E+17	6.98E+16	1.37E+17	2.36E+17	2.03E+17	2.92E+17	8.32E+16	2.88E+17	2.76E+17	3.1E+17
2.19E+17	2.32E+17	6.84E+16	1.42E+17	2.16E+17	2.13E+17	2.29E+17	2.32E+17	3.14E+17	2.92E+17
1.04E+17	1.57E+17	8.51E+16	2.45E+17	1.32E+17	2.96E+17	1.86E+17	3.05E+17	3.16E+17	3.02E+17
2.85E+17	1.9E+17	2.31E+17	1.57E+17	3.15E+17	1.93E+17	1.37E+17	1.73E+17	1.97E+17	2.73E+17
2.94E+17	3.32E+17	2.82E+17	2.2E+17	2.43E+17	1.47E+17	3.27E+17	1.6E+17	2.02E+17	9.54E+16
1.44E+17	1.31E+17	2.67E+17	3.23E+17	1.82E+17	3.22E+17	1.61E+17	3.08E+17	2E+17	2.38E+17
1.33E+17	6.28E+16	1.42E+17	2.51E+17	1.98E+17	3.07E+17	8.87E+16	3.03E+17	2.86E+17	3.18E+17
2.2E+17	2.98E+17	1.85E+17	2.25E+17	1.6E+17	2.21E+17	3.1E+17	2.45E+17	2.98E+17	2.14E+17

69	68	67	66	65	64	63	62	61	60
3.39E+17	3.15E+17	2.83E+17	1.38E+17	3.2E+17	4.51E+16	2.85E+17	2.6E+16	1.7E+17	1.67E+17
3.08E+17	2.7E+17	3.33E+17	2.53E+17	3.04E+17	1.92E+17	2.47E+17	1.63E+17	2.27E+16	1.33E+17
1.87E+17	2.44E+17	3.02E+17	3.34E+17	1.58E+17	2.98E+17	2.69E+17	2.91E+17	1.89E+17	1.5E+17
3.22E+17	2.67E+17	2.13E+17	5E+16	3.28E+17	1.19E+17	2.26E+17	1.19E+17	2.44E+17	2.72E+17
2.53E+17	3.29E+17	2.55E+17	2.56E+17	1.84E+17	2.15E+17	3.4E+17	2.34E+17	2.65E+17	1.54E+17
2.89E+17	3.42E+17	3.01E+17	2.6E+17	2.3E+17	1.89E+17	3.44E+17	2E+17	2.12E+17	8.48E+16
2.23E+17	3.14E+17	2.62E+17	2.9E+17	1.48E+17	2.54E+17	3.33E+17	2.68E+17	2.65E+17	1.56E+17
3.01E+17	3.28E+17	3.36E+17	2.8E+17	2.59E+17	1.98E+17	3.25E+17	1.91E+17	1.4E+17	0
3.13E+17	2.75E+17	3.49E+17	2.75E+17	3.11E+17	2.15E+17	2.54E+17	1.85E+17	0	1.4E+17
3.57E+17	3.26E+17	2.92E+17	1.3E+17	3.42E+17	4E+16	2.92E+17	0	1.85E+17	1.91E+17
2.04E+17	6.36E+16	2.12E+17	2.58E+17	2.67E+17	3.06E+17	0	2.92E+17	2.54E+17	3.25E+17
3.55E+17	3.36E+17	2.77E+17	1.15E+17	3.34E+17	0	3.06E+17	4E+16	2.15E+17	1.98E+17
8.9E+16	2.25E+17	2.06E+17	3.25E+17	0	3.34E+17	2.67E+17	3.42E+17	3.11E+17	2.59E+17
3.28E+17	2.93E+17	2E+17	0	3.25E+17	1.15E+17	2.58E+17	1.3E+17	2.75E+17	2.8E+17
1.88E+17	2.04E+17	0	2E+17	2.06E+17	2.77E+17	2.12E+17	2.92E+17	3.49E+17	3.36E+17
1.5E+17	0	2.04E+17	2.93E+17	2.25E+17	3.36E+17	6.36E+16	3.26E+17	2.75E+17	3.28E+17
0	1.5E+17	1.88E+17	3.28E+17	8.9E+16	3.55E+17	2.04E+17	3.57E+17	3.13E+17	3.01E+17
2.06E+17	1.29E+17	2.98E+17	3.25E+17	2.53E+17	3.27E+17	1.35E+17	3.05E+17	1.85E+17	2.66E+17
3.46E+17	3.41E+17	2.46E+17	9.33E+16	3.2E+17	5.77E+16	3.15E+17	9.59E+16	2.59E+17	2.26E+17
3.2E+17	3.4E+17	3.52E+17	2.84E+17	2.8E+17	1.96E+17	3.34E+17	1.87E+17	1.34E+17	2.18E+16
1.48E+17	7.86E+16	1.37E+17	2.62E+17	2.17E+17	3.27E+17	1.02E+17	3.25E+17	3.17E+17	3.49E+17
2.63E+17	3.44E+17	2.56E+17	2.61E+17	1.91E+17	2.24E+17	3.55E+17	2.47E+17	2.87E+17	1.75E+17
1.58E+17	7.54E+16	1.43E+17	2.59E+17	2.26E+17	3.25E+17	9.25E+16	3.21E+17	3.13E+17	3.5E+17
3.27E+17	3.59E+17	3.37E+17	2.64E+17	2.78E+17	1.74E+17	3.53E+17	1.75E+17	1.79E+17	5.51E+16
3.14E+17	3.16E+17	3.65E+17	3.04E+17	2.9E+17	2.27E+17	3.08E+17	2.07E+17	8.36E+16	7.31E+16
3.44E+17	3.29E+17	2.24E+17	5.7E+16	3.26E+17	8.47E+16	3.01E+17	1.16E+17	2.79E+17	2.58E+17
3.48E+17	2.65E+17	3.13E+17	1.92E+17	3.63E+17	1.71E+17	2.17E+17	1.36E+17	1.45E+17	2.41E+17
1.88E+17	2.2E+17	2.28E+16	2.14E+17	2E+17	2.88E+17	2.32E+17	3.05E+17	3.63E+17	3.42E+17
1.89E+17	2.2E+17	2.24E+16	2.13E+17	2.01E+17	2.87E+17	2.32E+17	3.04E+17	3.63E+17	3.42E+17
3.47E+17	3.65E+17	2.7E+17	1.53E+17	3.06E+17	8.65E+16	3.47E+17	1.22E+17	2.6E+17	1.93E+17
1.26E+17	1.15E+17	1.13E+17	2.72E+17	1.9E+17	3.38E+17	1.47E+17	3.4E+17	3.4E+17	3.54E+17
2.79E+17	3.41E+17	3.37E+17	3.21E+17	2.19E+17	2.52E+17	3.52E+17	2.54E+17	2.06E+17	7.92E+16
1.95E+17	1.09E+17	1.34E+17	2.35E+17	2.55E+17	3.12E+17	1.02E+17	3.1E+17	3.23E+17	3.62E+17
3.5E+17	3.67E+17	2.72E+17	1.54E+17	3.09E+17	8.64E+16	3.5E+17	1.22E+17	2.61E+17	1.94E+17
3.38E+17	3.71E+17	3.38E+17	2.59E+17	2.87E+17	1.66E+17	3.64E+17	1.72E+17	1.94E+17	7.54E+16
2.6E+17	3.16E+17	3.5E+17	3.48E+17	2.14E+17	2.87E+17	3.31E+17	2.81E+17	1.85E+17	1.01E+17
2.17E+17	7.03E+16	2.25E+17	2.74E+17	2.85E+17	3.26E+17	2.35E+16	3.11E+17	2.73E+17	3.48E+17
3E+17	3.65E+17	2.44E+17	2.23E+17	2.38E+17	1.96E+17	3.67E+17	2.27E+17	3.13E+17	2.13E+17
2.85E+17	1.78E+17	1.95E+17	1.78E+17	3.31E+17	2.59E+17	1.26E+17	2.49E+17	2.92E+17	3.54E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.51E+19	8.5E+19	8.51E+19	8.53E+19	8.51E+19	8.53E+19	8.51E+19	8.53E+19	8.53E+19	8.53E+19
6.96E+19	6.95E+19	6.97E+19	6.97E+19	6.96E+19	6.97E+19	6.95E+19	6.96E+19	6.95E+19	6.95E+19
2.14E+20	2.15E+20	2.15E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.55E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.55E+20	1.56E+20	1.55E+20	1.56E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20

69	68	67	66	65	64	63	62	61	60
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.55E+20	6.56E+20	6.56E+20	6.55E+20	6.56E+20	6.55E+20	6.56E+20	6.55E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 23: This table gives internal distances table

59	58	57	56	55	54	53	52	51	50
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.7E+17	1.69E+17	1.68E+17	1.66E+17	1.61E+17	1.59E+17	1.57E+17	1.56E+17	1.56E+17	1.56E+17
1.83E+17	1.7E+17	1.69E+17	1.31E+17	1.96E+17	1.65E+17	1.28E+17	1.53E+17	1.73E+17	1.94E+17
1.46E+17	1.31E+17	1.35E+17	1.68E+17	1.62E+17	1.54E+17	1.33E+17	1.35E+17	1.95E+17	1.86E+17

59	58	57	56	55	54	53	52	51	50
1.46E+17	1.31E+17	1.35E+17	1.68E+17	1.62E+17	1.55E+17	1.33E+17	1.35E+17	1.95E+17	1.86E+17
2.1E+17	2.23E+17	2.11E+17	1.68E+17	1.91E+17	1.96E+17	1.96E+17	1.81E+17	1.01E+17	1.48E+17
2.34E+17	2.47E+17	2.36E+17	1.72E+17	2.04E+17	2.03E+17	2.11E+17	2.05E+17	8.24E+16	1.44E+17
1.61E+17	1.18E+17	1.38E+17	1.54E+17	1.9E+17	1.45E+17	9.16E+16	1.5E+17	2.33E+17	2.23E+17
1.45E+17	1.02E+17	1.4E+17	2.07E+17	1.37E+17	1.13E+17	1.31E+17	1.72E+17	2.43E+17	1.89E+17
2.2E+17	2.1E+17	2.32E+17	2.26E+17	1.31E+17	1.1E+17	1.98E+17	2.42E+17	1.8E+17	9.74E+16
1.47E+17	9.09E+16	1.26E+17	1.84E+17	1.76E+17	1.37E+17	1E+17	1.56E+17	2.57E+17	2.27E+17
1.02E+17	1.1E+17	1.22E+17	2.56E+17	8.1E+16	1.64E+17	1.97E+17	1.54E+17	2.3E+17	1.6E+17
9.78E+16	7.25E+16	7.23E+16	2.09E+17	1.71E+17	1.89E+17	1.47E+17	1.01E+17	2.53E+17	2.33E+17
2.18E+17	2.56E+17	2.28E+17	2.18E+17	2.04E+17	2.53E+17	2.56E+17	1.84E+17	6.88E+16	1.51E+17
9.76E+16	7.25E+16	7.16E+16	2.1E+17	1.72E+17	1.89E+17	1.47E+17	9.99E+16	2.53E+17	2.34E+17
1.34E+17	1.8E+17	1.65E+17	2.74E+17	8.46E+16	2.1E+17	2.49E+17	1.65E+17	1.77E+17	1.14E+17
1.35E+17	1.81E+17	1.66E+17	2.76E+17	8.42E+16	2.11E+17	2.51E+17	1.66E+17	1.77E+17	1.14E+17
2.58E+17	2.19E+17	2.39E+17	8.71E+16	2.48E+17	1.38E+17	9.56E+16	2.32E+17	2.1E+17	2.29E+17
2.56E+17	2.32E+17	2.33E+17	5.57E+16	2.7E+17	1.95E+17	1.23E+17	2.07E+17	1.9E+17	2.47E+17
2.3E+17	1.92E+17	2.01E+17	7.59E+16	2.58E+17	1.77E+17	7.8E+16	1.88E+17	2.28E+17	2.6E+17
1.05E+17	5.61E+16	8.53E+16	2.19E+17	1.6E+17	1.68E+17	1.41E+17	1.28E+17	2.66E+17	2.3E+17
2.83E+17	2.85E+17	2.82E+17	1.57E+17	2.44E+17	2.05E+17	2.15E+17	2.53E+17	9.68E+16	1.69E+17
2.32E+17	2.66E+17	2.32E+17	1.96E+17	2.41E+17	2.72E+17	2.5E+17	1.78E+17	8.47E+16	1.95E+17
2.84E+17	2.91E+17	2.85E+17	1.7E+17	2.44E+17	2.16E+17	2.29E+17	2.53E+17	8.11E+16	1.63E+17
1.63E+17	9.51E+16	1.35E+17	1.79E+17	2.02E+17	1.45E+17	8.21E+16	1.66E+17	2.78E+17	2.53E+17
2.51E+17	2.55E+17	2.68E+17	2.49E+17	1.49E+17	1.54E+17	2.42E+17	2.69E+17	1.55E+17	6.2E+16
2.35E+17	2.72E+17	2.35E+17	2.03E+17	2.48E+17	2.84E+17	2.59E+17	1.78E+17	8.95E+16	2.03E+17
1.53E+17	1.94E+17	1.4E+17	2.13E+17	2.32E+17	2.82E+17	2.27E+17	6.96E+16	1.94E+17	2.48E+17
8.93E+16	1.51E+17	1.29E+17	2.95E+17	8.67E+16	2.29E+17	2.56E+17	1.42E+17	2.2E+17	1.6E+17
2.86E+17	2.96E+17	2.97E+17	2.22E+17	2.12E+17	2.02E+17	2.55E+17	2.77E+17	9.46E+16	1.09E+17
2.41E+17	2.79E+17	2.41E+17	2.08E+17	2.54E+17	2.91E+17	2.67E+17	1.83E+17	8.94E+16	2.08E+17
2.66E+17	2.88E+17	2.85E+17	2.57E+17	1.81E+17	2.14E+17	2.77E+17	2.67E+17	9.71E+16	6.87E+16
1.53E+17	2.19E+17	1.84E+17	2.94E+17	1.37E+17	2.66E+17	2.89E+17	1.61E+17	1.61E+17	1.42E+17
2.86E+17	3.01E+17	2.78E+17	1.55E+17	2.84E+17	2.69E+17	2.4E+17	2.29E+17	9.31E+16	2.21E+17
2.81E+17	3.09E+17	2.88E+17	2.18E+17	2.46E+17	2.66E+17	2.77E+17	2.46E+17	1.67E+16	1.61E+17
2.31E+17	2.53E+17	2.12E+17	1.64E+17	2.88E+17	2.96E+17	2.25E+17	1.46E+17	1.74E+17	2.73E+17
2.23E+17	2.76E+17	2.32E+17	2.48E+17	2.36E+17	3.04E+17	2.91E+17	1.74E+17	1.02E+17	1.97E+17
3.19E+17	2.95E+17	3.07E+17	1.11E+17	2.87E+17	1.82E+17	1.75E+17	2.89E+17	1.81E+17	2.28E+17
1.22E+17	4.28E+16	8.9E+16	2.28E+17	1.96E+17	1.86E+17	1.36E+17	1.42E+17	3.05E+17	2.72E+17
2.44E+17	2.68E+17	2.72E+17	2.98E+17	1.28E+17	2.03E+17	2.9E+17	2.71E+17	1.58E+17	0
2.85E+17	3.17E+17	2.95E+17	2.34E+17	2.47E+17	2.77E+17	2.92E+17	2.52E+17	0	1.58E+17
1.01E+17	1.46E+17	7.87E+16	2.47E+17	2.2E+17	2.82E+17	2.26E+17	0	2.52E+17	2.71E+17
2.43E+17	1.75E+17	2.11E+17	1.28E+17	2.67E+17	1.47E+17	0	2.26E+17	2.92E+17	2.9E+17
2.55E+17	2E+17	2.52E+17	2.23E+17	1.91E+17	0	1.47E+17	2.82E+17	2.77E+17	2.03E+17
1.51E+17	1.75E+17	1.88E+17	3.22E+17	0	1.91E+17	2.67E+17	2.2E+17	2.47E+17	1.28E+17
3.01E+17	2.67E+17	2.72E+17	0	3.22E+17	2.23E+17	1.28E+17	2.47E+17	2.34E+17	2.98E+17
5.23E+16	7.63E+16	0	2.72E+17	1.88E+17	2.52E+17	2.11E+17	7.87E+16	2.95E+17	2.72E+17
9.67E+16	0	7.63E+16	2.67E+17	1.75E+17	2E+17	1.75E+17	1.46E+17	3.17E+17	2.68E+17
0	9.67E+16	5.23E+16	3.01E+17	1.51E+17	2.55E+17	2.43E+17	1.01E+17	2.85E+17	2.44E+17
1.56E+17	8.48E+16	1.54E+17	2.72E+17	1.5E+17	1.33E+17	1.67E+17	2.14E+17	3.18E+17	2.38E+17
2.65E+17	2.12E+17	2.65E+17	2.44E+17	1.89E+17	2.27E+16	1.7E+17	2.98E+17	2.86E+17	2E+17
2.68E+17	2E+17	2.34E+17	1.19E+17	2.91E+17	1.63E+17	2.6E+16	2.45E+17	3.03E+17	3.08E+17
3.33E+17	3.44E+17	3.4E+17	2.26E+17	2.69E+17	2.47E+17	2.85E+17	3.1E+17	8.87E+16	1.61E+17
2.54E+17	1.89E+17	2.15E+17	1.19E+17	2.98E+17	1.92E+17	4.51E+16	2.21E+17	3.07E+17	3.22E+17
1.48E+17	2.3E+17	1.84E+17	3.28E+17	1.58E+17	3.04E+17	3.2E+17	1.6E+17	1.98E+17	1.82E+17

59	58	57	56	55	54	53	52	51	50
2.9E+17	2.6E+17	2.56E+17	5E+16	3.34E+17	2.53E+17	1.38E+17	2.25E+17	2.51E+17	3.23E+17
2.62E+17	3.01E+17	2.55E+17	2.13E+17	3.02E+17	3.33E+17	2.83E+17	1.85E+17	1.42E+17	2.67E+17
3.14E+17	3.42E+17	3.29E+17	2.67E+17	2.44E+17	2.7E+17	3.15E+17	2.98E+17	6.28E+16	1.31E+17
2.23E+17	2.89E+17	2.53E+17	3.22E+17	1.87E+17	3.08E+17	3.39E+17	2.2E+17	1.33E+17	1.44E+17
3.04E+17	3.09E+17	3.24E+17	2.91E+17	1.86E+17	1.9E+17	2.91E+17	3.23E+17	1.74E+17	7.56E+16
2.44E+17	1.95E+17	2E+17	1.21E+17	3.12E+17	2.37E+17	9.69E+16	1.92E+17	3.02E+17	3.37E+17
1.77E+17	9.96E+16	1.71E+17	2.74E+17	1.67E+17	1.28E+17	1.64E+17	2.32E+17	3.32E+17	2.51E+17
3.1E+17	3.45E+17	3.18E+17	2.47E+17	2.78E+17	3.07E+17	3.16E+17	2.7E+17	3.28E+16	1.88E+17
6.5E+16	9.47E+16	2.32E+16	2.81E+17	2.09E+17	2.74E+17	2.25E+17	7.27E+16	3.06E+17	2.91E+17
3.16E+17	3.48E+17	3.23E+17	2.42E+17	2.82E+17	3.04E+17	3.13E+17	2.76E+17	3.46E+16	1.89E+17
1.54E+17	5.99E+16	1.35E+17	2.65E+17	1.94E+17	1.68E+17	1.52E+17	1.99E+17	3.41E+17	2.82E+17
2.16E+17	1.57E+17	2.2E+17	2.84E+17	1.54E+17	8.79E+16	1.86E+17	2.72E+17	3.19E+17	2.19E+17
2.68E+17	2.29E+17	2.26E+17	9.63E+16	3.31E+17	2.56E+17	1.21E+17	2.04E+17	2.87E+17	3.42E+17
3.34E+17	2.82E+17	3.18E+17	1.46E+17	2.94E+17	1.3E+17	1.41E+17	3.22E+17	2.66E+17	2.62E+17
2.58E+17	3.02E+17	2.51E+17	2.3E+17	3.06E+17	3.47E+17	2.95E+17	1.78E+17	1.57E+17	2.77E+17
2.59E+17	3.02E+17	2.51E+17	2.29E+17	3.07E+17	3.46E+17	2.95E+17	1.78E+17	1.58E+17	2.77E+17
2.05E+17	1.48E+17	1.57E+17	1.78E+17	2.92E+17	2.39E+17	1.13E+17	1.67E+17	3.26E+17	3.4E+17
2.93E+17	3.4E+17	3.03E+17	2.66E+17	2.78E+17	3.3E+17	3.29E+17	2.49E+17	6.3E+16	2.03E+17
1.04E+17	7.66E+16	1.21E+17	3.2E+17	1.27E+17	2.02E+17	2.29E+17	1.91E+17	3.28E+17	2.43E+17
3.33E+17	3.58E+17	3.34E+17	2.19E+17	3.1E+17	3.11E+17	3.05E+17	2.83E+17	6.88E+16	2.22E+17
2.08E+17	1.5E+17	1.59E+17	1.79E+17	2.94E+17	2.4E+17	1.13E+17	1.7E+17	3.29E+17	3.43E+17
1.59E+17	6.18E+16	1.33E+17	2.63E+17	2.11E+17	1.82E+17	1.49E+17	1.97E+17	3.5E+17	2.98E+17
1.43E+17	1.35E+17	1.73E+17	3.39E+17	8.04E+16	1.87E+17	2.56E+17	2.3E+17	3.14E+17	2.02E+17
3.55E+17	3.68E+17	3.63E+17	2.41E+17	2.89E+17	2.67E+17	3.05E+17	3.31E+17	1E+17	1.77E+17
1.34E+17	1.34E+17	8.51E+16	2.54E+17	2.67E+17	2.96E+17	2.1E+17	8.19E+16	3.2E+17	3.33E+17
3.66E+17	3.61E+17	3.55E+17	1.47E+17	3.45E+17	2.77E+17	2.53E+17	3.15E+17	1.58E+17	2.67E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.53E+19	8.53E+19	8.53E+19	8.52E+19	8.52E+19	8.53E+19	8.53E+19	8.52E+19	8.51E+19	8.51E+19
6.96E+19	6.96E+19	6.97E+19	6.97E+19	6.95E+19	6.95E+19	6.96E+19	6.97E+19	6.96E+19	6.95E+19
2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.15E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.55E+20	1.55E+20	1.56E+20	1.56E+20	1.56E+20	1.55E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.55E+20	6.56E+20	6.56E+20	6.55E+20	6.55E+20	6.56E+20	6.56E+20	6.55E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20

59	58	57	56	55	54	53	52	51	50
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 24 : This table gives internal distances for masses 49--40

49	48	47	46	45	44	43	42	41	40
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.52E+17	1.52E+17	1.5E+17	1.49E+17	1.45E+17	1.43E+17	1.4E+17	1.4E+17	1.39E+17	1.36E+17
1.44E+17	1.4E+17	1.65E+17	1.31E+17	1.61E+17	1.37E+17	1.72E+17	1.71E+17	1.45E+17	1.59E+17
1.11E+17	1.75E+17	1.76E+17	1.56E+17	1.85E+17	1.73E+17	1.57E+17	1.79E+17	1.67E+17	1.76E+17
1.11E+17	1.75E+17	1.76E+17	1.56E+17	1.85E+17	1.73E+17	1.57E+17	1.79E+17	1.67E+17	1.76E+17
2.06E+17	1.38E+17	1.14E+17	1.32E+17	8.97E+16	9.43E+16	1.37E+17	1.1E+17	9.57E+16	1.01E+17
2.3E+17	1.28E+17	1.18E+17	1.44E+17	6.95E+16	8.36E+16	1.49E+17	9.52E+16	9.68E+16	8.02E+16
8.68E+16	1.79E+17	2.16E+17	1.75E+17	2.21E+17	1.99E+17	2E+17	2.17E+17	2.02E+17	2.08E+17
9.13E+16	2.04E+17	2.32E+17	2.21E+17	2.34E+17	2.32E+17	1.86E+17	2.02E+17	2.27E+17	2.03E+17
2.03E+17	1.64E+17	2.14E+17	2.43E+17	1.73E+17	2.01E+17	1.73E+17	1.08E+17	2.09E+17	1.1E+17
6.26E+16	2.05E+17	2.37E+17	2.04E+17	2.46E+17	2.3E+17	2.06E+17	2.31E+17	2.28E+17	2.27E+17
1.21E+17	2.44E+17	2.05E+17	2.26E+17	2.25E+17	2.4E+17	1.31E+17	1.86E+17	2.15E+17	2.03E+17

49	48	47	46	45	44	43	42	41	40
5.63E+16	2.38E+17	2.11E+17	1.82E+17	2.44E+17	2.3E+17	1.76E+17	2.38E+17	2.1E+17	2.42E+17
2.46E+17	1.9E+17	5.78E+16	1.33E+17	6.62E+16	9.89E+16	1.07E+17	1.11E+17	5.7E+16	1.19E+17
5.63E+16	2.39E+17	2.11E+17	1.82E+17	2.44E+17	2.3E+17	1.76E+17	2.39E+17	2.1E+17	2.43E+17
1.89E+17	2.47E+17	1.51E+17	2.12E+17	1.76E+17	2.11E+17	6.13E+16	1.38E+17	1.72E+17	1.68E+17
1.9E+17	2.48E+17	1.52E+17	2.13E+17	1.77E+17	2.12E+17	6.07E+16	1.38E+17	1.73E+17	1.69E+17
1.86E+17	8.25E+16	2.33E+17	1.86E+17	1.94E+17	1.61E+17	2.49E+17	2E+17	2.03E+17	1.69E+17
1.97E+17	9.73E+16	2E+17	1.32E+17	1.74E+17	1.2E+17	2.39E+17	2.08E+17	1.64E+17	1.78E+17
1.53E+17	1.34E+17	2.23E+17	1.51E+17	2.12E+17	1.66E+17	2.44E+17	2.33E+17	1.94E+17	2.1E+17
4.3E+16	2.41E+17	2.32E+17	2.07E+17	2.57E+17	2.46E+17	1.88E+17	2.41E+17	2.3E+17	2.44E+17
2.63E+17	8.56E+16	1.62E+17	1.71E+17	8.16E+16	8.19E+16	2.02E+17	1.1E+17	1.31E+17	7.15E+16
2.5E+17	1.86E+17	5.45E+16	9.29E+16	7.79E+16	7.1E+16	1.4E+17	1.49E+17	1.92E+16	1.46E+17
2.71E+17	1.01E+17	1.52E+17	1.71E+17	6.62E+16	7.79E+16	1.95E+17	1.01E+17	1.23E+17	6.49E+16
5.84E+16	2.12E+17	2.57E+17	2.12E+17	2.66E+17	2.43E+17	2.32E+17	2.55E+17	2.45E+17	2.48E+17
2.5E+17	1.72E+17	2.06E+17	2.55E+17	1.51E+17	1.96E+17	1.71E+17	6.64E+16	2.03E+17	7.68E+16
2.56E+17	1.96E+17	4.76E+16	9.08E+16	8.42E+16	7.66E+16	1.42E+17	1.58E+17	7.98E+15	1.57E+17
1.81E+17	2.47E+17	1.15E+17	8.37E+16	1.88E+17	1.65E+17	1.43E+17	2.28E+17	1.16E+17	2.33E+17
1.69E+17	2.83E+17	1.76E+17	2.24E+17	2.2E+17	2.46E+17	7.91E+16	1.88E+17	2E+17	2.17E+17
2.83E+17	1.37E+17	1.74E+17	2.22E+17	8.91E+16	1.38E+17	1.85E+17	4.82E+16	1.61E+17	0
2.64E+17	2.01E+17	4.63E+16	9.28E+16	8.5E+16	7.78E+16	1.46E+17	1.62E+17	0	1.61E+17
2.82E+17	1.81E+17	1.62E+17	2.33E+17	9.82E+16	1.62E+17	1.51E+17	0	1.62E+17	4.82E+16
2.27E+17	2.72E+17	1.12E+17	1.97E+17	1.65E+17	2.04E+17	0	1.51E+17	1.46E+17	1.85E+17
2.77E+17	1.38E+17	1.22E+17	1.11E+17	7.89E+16	0	2.04E+17	1.62E+17	7.78E+16	1.38E+17
2.95E+17	1.66E+17	1.04E+17	1.64E+17	0	7.89E+16	1.65E+17	9.82E+16	8.5E+16	8.91E+16
2.28E+17	2.08E+17	1.22E+17	0	1.64E+17	1.11E+17	1.97E+17	2.33E+17	9.28E+16	2.22E+17
2.67E+17	2.37E+17	0	1.22E+17	1.04E+17	1.22E+17	1.12E+17	1.62E+17	4.63E+16	1.74E+17
2.65E+17	0	2.37E+17	2.08E+17	1.66E+17	1.38E+17	2.72E+17	1.81E+17	2.01E+17	1.37E+17
0	2.65E+17	2.67E+17	2.28E+17	2.95E+17	2.77E+17	2.27E+17	2.82E+17	2.64E+17	2.83E+17
2.72E+17	2.28E+17	1.97E+17	2.73E+17	1.61E+17	2.21E+17	1.42E+17	6.87E+16	2.08E+17	1.09E+17
3.05E+17	1.81E+17	1.02E+17	1.74E+17	1.67E+16	9.31E+16	1.61E+17	9.71E+16	8.94E+16	9.46E+16
1.42E+17	2.89E+17	1.74E+17	1.46E+17	2.46E+17	2.29E+17	1.61E+17	2.67E+17	1.83E+17	2.77E+17
1.36E+17	1.75E+17	2.91E+17	2.25E+17	2.77E+17	2.4E+17	2.89E+17	2.77E+17	2.67E+17	2.55E+17
1.86E+17	1.82E+17	3.04E+17	2.96E+17	2.66E+17	2.69E+17	2.66E+17	2.14E+17	2.91E+17	2.02E+17
1.96E+17	2.87E+17	2.36E+17	2.88E+17	2.46E+17	2.84E+17	1.37E+17	1.81E+17	2.54E+17	2.12E+17
2.28E+17	1.11E+17	2.48E+17	1.64E+17	2.18E+17	1.55E+17	2.94E+17	2.57E+17	2.08E+17	2.22E+17
8.9E+16	3.07E+17	2.32E+17	2.12E+17	2.88E+17	2.78E+17	1.84E+17	2.85E+17	2.41E+17	2.97E+17
4.28E+16	2.95E+17	2.76E+17	2.53E+17	3.09E+17	3.01E+17	2.19E+17	2.88E+17	2.79E+17	2.96E+17
1.22E+17	3.19E+17	2.23E+17	2.31E+17	2.81E+17	2.86E+17	1.53E+17	2.66E+17	2.41E+17	2.86E+17
9.54E+16	2.73E+17	3.02E+17	2.92E+17	3.1E+17	3.11E+17	2.38E+17	2.67E+17	3.03E+17	2.72E+17
2.02E+17	1.97E+17	3.16E+17	3.14E+17	2.76E+17	2.84E+17	2.73E+17	2.17E+17	3.05E+17	2.08E+17
1.6E+17	1.73E+17	3.05E+17	2.32E+17	2.88E+17	2.45E+17	3.1E+17	2.91E+17	2.78E+17	2.66E+17
3.27E+17	1.37E+17	1.86E+17	2.29E+17	8.32E+16	1.26E+17	2.24E+17	9.49E+16	1.65E+17	5.82E+16
1.47E+17	1.93E+17	2.96E+17	2.13E+17	2.92E+17	2.44E+17	3.06E+17	3.04E+17	2.7E+17	2.82E+17
2.43E+17	3.15E+17	1.32E+17	2.16E+17	2.03E+17	2.38E+17	4.59E+16	1.95E+17	1.72E+17	2.3E+17
2.2E+17	1.57E+17	2.45E+17	1.42E+17	2.36E+17	1.67E+17	2.96E+17	2.83E+17	2.07E+17	2.54E+17
2.82E+17	2.31E+17	8.51E+16	6.84E+16	1.37E+17	1.01E+17	1.89E+17	2.21E+17	5.92E+16	2.15E+17
3.32E+17	1.9E+17	1.57E+17	2.32E+17	6.98E+16	1.43E+17	1.85E+17	6.78E+16	1.51E+17	6.96E+16
2.94E+17	2.85E+17	1.04E+17	2.19E+17	1.43E+17	2.01E+17	7.12E+16	1.39E+17	1.42E+17	1.76E+17
3.06E+17	1.99E+17	2.42E+17	3.01E+17	1.73E+17	2.28E+17	2.11E+17	8.09E+16	2.4E+17	9.15E+16
1.53E+17	2.14E+17	2.76E+17	1.79E+17	2.87E+17	2.32E+17	2.98E+17	3.15E+17	2.5E+17	2.95E+17
1.06E+17	2.76E+17	3.2E+17	3.06E+17	3.23E+17	3.23E+17	2.58E+17	2.79E+17	3.19E+17	2.83E+17
3.31E+17	1.98E+17	1.09E+17	1.79E+17	4.15E+16	9.66E+16	1.84E+17	1.27E+17	9.46E+16	1.22E+17

49	48	47	46	45	44	43	42	41	40
1.05E+17	3.22E+17	2.37E+17	2.12E+17	3E+17	2.87E+17	1.95E+17	3.02E+17	2.47E+17	3.14E+17
3.33E+17	1.9E+17	1.18E+17	1.82E+17	4.03E+16	9.33E+16	1.92E+17	1.26E+17	1.01E+17	1.17E+17
6.22E+16	2.88E+17	3.15E+17	2.85E+17	3.31E+17	3.21E+17	2.61E+17	3.02E+17	3.12E+17	3.05E+17
1.61E+17	2.6E+17	3.26E+17	3.27E+17	3.11E+17	3.21E+17	2.61E+17	2.52E+17	3.24E+17	2.55E+17
1.88E+17	2E+17	2.65E+17	1.59E+17	2.72E+17	2.09E+17	3.02E+17	3.11E+17	2.34E+17	2.88E+17
2.52E+17	9.83E+16	3.13E+17	2.76E+17	2.52E+17	2.29E+17	3.21E+17	2.37E+17	2.83E+17	2E+17
2.85E+17	2.52E+17	8.69E+16	7.6E+16	1.54E+17	1.24E+17	1.88E+17	2.34E+17	7.28E+16	2.33E+17
2.85E+17	2.52E+17	8.77E+16	7.52E+16	1.54E+17	1.24E+17	1.89E+17	2.35E+17	7.31E+16	2.33E+17
1.09E+17	2.57E+17	2.88E+17	2.03E+17	3.13E+17	2.68E+17	2.9E+17	3.3E+17	2.71E+17	3.18E+17
3.29E+17	2.33E+17	7.64E+16	1.66E+17	7.26E+16	1.13E+17	1.65E+17	1.51E+17	7.61E+16	1.57E+17
1.15E+17	3.24E+17	2.93E+17	3E+17	3.23E+17	3.32E+17	2.11E+17	2.81E+17	3.05E+17	2.98E+17
3.38E+17	1.75E+17	1.36E+17	1.7E+17	6.42E+16	7.18E+16	2.22E+17	1.56E+17	1.05E+17	1.36E+17
1.11E+17	2.59E+17	2.91E+17	2.06E+17	3.16E+17	2.7E+17	2.92E+17	3.32E+17	2.74E+17	3.2E+17
5.79E+16	2.94E+17	3.2E+17	2.84E+17	3.4E+17	3.25E+17	2.71E+17	3.16E+17	3.17E+17	3.17E+17
1.66E+17	3.2E+17	2.95E+17	3.23E+17	3.11E+17	3.35E+17	2.01E+17	2.51E+17	3.09E+17	2.74E+17
3.51E+17	1.51E+17	2.01E+17	2.45E+17	9.71E+16	1.39E+17	2.43E+17	1.12E+17	1.79E+17	7.92E+16
1.22E+17	3.17E+17	2.5E+17	1.9E+17	3.11E+17	2.8E+17	2.38E+17	3.31E+17	2.5E+17	3.34E+17
3.31E+17	9.95E+16	2.2E+17	1.94E+17	1.44E+17	1.01E+17	2.92E+17	2.04E+17	1.78E+17	1.61E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.53E+19	8.52E+19	8.51E+19	8.52E+19	8.51E+19	8.51E+19	8.51E+19	8.51E+19	8.51E+19	8.51E+19
6.96E+19	6.96E+19	6.96E+19	6.97E+19	6.96E+19	6.96E+19	6.96E+19	6.95E+19	6.96E+19	6.95E+19
2.14E+20	2.14E+20	2.15E+20	2.15E+20	2.15E+20	2.15E+20	2.14E+20	2.14E+20	2.15E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.55E+20	1.56E+20	1.55E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.56E+20	6.55E+20	6.56E+20	6.56E+20	6.55E+20	6.56E+20	6.55E+20	6.55E+20	6.56E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20

49	48	47	46	45	44	43	42	41	40
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 25: This table gives internal distances for masses 39--30

39	38	37	36	35	34	33	32	31	30
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.35E+17	1.32E+17	1.31E+17	1.27E+17	1.24E+17	1.22E+17	1.21E+17	1.17E+17	1.15E+17	1.13E+17
1.65E+17	1.27E+17	1.37E+17	1.59E+17	1.08E+17	1.3E+17	1.27E+17	1.22E+17	1.14E+17	7.41E+16
1.32E+17	1.28E+17	1.59E+17	1.58E+17	8.56E+16	1.61E+17	1.5E+17	1.54E+17	7.56E+16	1E+17
1.32E+17	1.28E+17	1.59E+17	1.58E+17	8.56E+16	1.6E+17	1.5E+17	1.54E+17	7.57E+16	1E+17
1.62E+17	1.36E+17	8.84E+16	1.23E+17	1.76E+17	7.51E+16	7.67E+16	7.58E+16	1.69E+17	1.37E+17
1.81E+17	1.57E+17	9.06E+16	1.17E+17	1.98E+17	5.11E+16	7.87E+16	5.47E+16	1.93E+17	1.51E+17
1.66E+17	1.53E+17	1.94E+17	1.89E+17	4.49E+16	1.89E+17	1.86E+17	1.79E+17	6.62E+16	7.92E+16
1.37E+17	1.85E+17	2.19E+17	1.61E+17	6.95E+16	2.03E+17	2.1E+17	1.96E+17	5.92E+16	1.36E+17
1.61E+17	2.25E+17	2.02E+17	5.11E+16	1.72E+17	1.41E+17	1.91E+17	1.37E+17	1.66E+17	1.82E+17
1.6E+17	1.71E+17	2.2E+17	1.96E+17	2.78E+16	2.14E+17	2.12E+17	2.06E+17	4.4E+16	1.09E+17
6.96E+16	1.7E+17	2.07E+17	1.56E+17	1.27E+17	2.14E+17	2E+17	2.11E+17	8.15E+16	1.87E+17
1.28E+17	1.3E+17	2.02E+17	2.16E+17	7.2E+16	2.27E+17	1.96E+17	2.22E+17	2.92E+16	1.35E+17
1.61E+17	1.3E+17	5.23E+16	1.5E+17	2.27E+17	1.02E+17	4.55E+16	1.12E+17	2.07E+17	1.92E+17
1.29E+17	1.3E+17	2.02E+17	2.16E+17	7.24E+16	2.28E+17	1.96E+17	2.22E+17	2.99E+16	1.35E+17
5.06E+16	1.59E+17	1.66E+17	1.33E+17	1.9E+17	1.86E+17	1.6E+17	1.89E+17	1.47E+17	2.17E+17
5.04E+16	1.6E+17	1.67E+17	1.34E+17	1.91E+17	1.87E+17	1.61E+17	1.9E+17	1.48E+17	2.19E+17
2.4E+17	2.07E+17	1.96E+17	1.76E+17	1.31E+17	1.38E+17	1.86E+17	1.23E+17	1.68E+17	6.39E+16
2.42E+17	1.7E+17	1.58E+17	2.02E+17	1.5E+17	1.29E+17	1.49E+17	1.16E+17	1.79E+17	5.2E+16
2.31E+17	1.69E+17	1.88E+17	2.16E+17	1.05E+17	1.7E+17	1.79E+17	1.57E+17	1.43E+17	0
1.32E+17	1.58E+17	2.23E+17	2.1E+17	5.99E+16	2.36E+17	2.16E+17	2.29E+17	0	1.43E+17
2.32E+17	2.02E+17	1.27E+17	1.28E+17	2.21E+17	1.62E+16	1.16E+17	0	2.29E+17	1.57E+17

39	38	37	36	35	34	33	32	31	30
1.89E+17	1.14E+17	1.21E+16	1.87E+17	2.3E+17	1.08E+17	0	1.16E+17	2.16E+17	1.79E+17
2.29E+17	2.01E+17	1.19E+17	1.28E+17	2.31E+17	0	1.08E+17	1.62E+16	2.36E+17	1.7E+17
1.86E+17	1.84E+17	2.38E+17	2.2E+17	0	2.31E+17	2.3E+17	2.21E+17	5.99E+16	1.05E+17
1.79E+17	2.43E+17	1.97E+17	0	2.2E+17	1.28E+17	1.87E+17	1.28E+17	2.1E+17	2.16E+17
1.94E+17	1.12E+17	0	1.97E+17	2.38E+17	1.19E+17	1.21E+16	1.27E+17	2.23E+17	1.88E+17
1.56E+17	0	1.12E+17	2.43E+17	1.84E+17	2.01E+17	1.14E+17	2.02E+17	1.58E+17	1.69E+17
0	1.56E+17	1.94E+17	1.79E+17	1.86E+17	2.29E+17	1.89E+17	2.32E+17	1.32E+17	2.31E+17
2.17E+17	2.33E+17	1.57E+17	7.68E+16	2.48E+17	6.49E+16	1.46E+17	7.15E+16	2.44E+17	2.1E+17
2E+17	1.16E+17	7.98E+15	2.03E+17	2.45E+17	1.23E+17	1.92E+16	1.31E+17	2.3E+17	1.94E+17
1.88E+17	2.28E+17	1.58E+17	6.64E+16	2.55E+17	1.01E+17	1.49E+17	1.1E+17	2.41E+17	2.33E+17
7.91E+16	1.43E+17	1.42E+17	1.71E+17	2.32E+17	1.95E+17	1.4E+17	2.02E+17	1.88E+17	2.44E+17
2.46E+17	1.65E+17	7.66E+16	1.96E+17	2.43E+17	7.79E+16	7.1E+16	8.19E+16	2.46E+17	1.66E+17
2.2E+17	1.88E+17	8.42E+16	1.51E+17	2.66E+17	6.62E+16	7.79E+16	8.16E+16	2.57E+17	2.12E+17
2.24E+17	8.37E+16	9.08E+16	2.55E+17	2.12E+17	1.71E+17	9.29E+16	1.71E+17	2.07E+17	1.51E+17
1.76E+17	1.15E+17	4.76E+16	2.06E+17	2.57E+17	1.52E+17	5.45E+16	1.62E+17	2.32E+17	2.23E+17
2.83E+17	2.47E+17	1.96E+17	1.72E+17	2.12E+17	1.01E+17	1.86E+17	8.56E+16	2.41E+17	1.34E+17
1.69E+17	1.81E+17	2.56E+17	2.5E+17	5.84E+16	2.71E+17	2.5E+17	2.63E+17	4.3E+16	1.53E+17
1.6E+17	2.48E+17	2.03E+17	6.2E+16	2.53E+17	1.63E+17	1.95E+17	1.69E+17	2.3E+17	2.6E+17
2.2E+17	1.94E+17	8.95E+16	1.55E+17	2.78E+17	8.11E+16	8.47E+16	9.68E+16	2.66E+17	2.28E+17
1.42E+17	6.96E+16	1.78E+17	2.69E+17	1.66E+17	2.53E+17	1.78E+17	2.53E+17	1.28E+17	1.88E+17
2.56E+17	2.27E+17	2.59E+17	2.42E+17	8.21E+16	2.29E+17	2.5E+17	2.15E+17	1.41E+17	7.8E+16
2.29E+17	2.82E+17	2.84E+17	1.54E+17	1.45E+17	2.16E+17	2.72E+17	2.05E+17	1.68E+17	1.77E+17
8.67E+16	2.32E+17	2.48E+17	1.49E+17	2.02E+17	2.44E+17	2.41E+17	2.44E+17	1.6E+17	2.58E+17
2.95E+17	2.13E+17	2.03E+17	2.49E+17	1.79E+17	1.7E+17	1.96E+17	1.57E+17	2.19E+17	7.59E+16
1.29E+17	1.4E+17	2.35E+17	2.68E+17	1.35E+17	2.85E+17	2.32E+17	2.82E+17	8.53E+16	2.01E+17
1.51E+17	1.94E+17	2.72E+17	2.55E+17	9.51E+16	2.91E+17	2.66E+17	2.85E+17	5.61E+16	1.92E+17
8.93E+16	1.53E+17	2.35E+17	2.51E+17	1.63E+17	2.84E+17	2.32E+17	2.83E+17	1.05E+17	2.3E+17
1.7E+17	2.45E+17	2.95E+17	2.17E+17	1.03E+17	2.8E+17	2.86E+17	2.73E+17	9.07E+16	2E+17
2.35E+17	2.98E+17	2.98E+17	1.54E+17	1.64E+17	2.28E+17	2.86E+17	2.17E+17	1.83E+17	1.99E+17
2.8E+17	2.43E+17	2.71E+17	2.58E+17	1.07E+17	2.36E+17	2.62E+17	2.22E+17	1.66E+17	8.45E+16
2.67E+17	2.57E+17	1.63E+17	1.34E+17	2.88E+17	6.5E+16	1.55E+17	7.46E+16	2.9E+17	2.32E+17
2.76E+17	2.23E+17	2.63E+17	2.76E+17	1.03E+17	2.47E+17	2.55E+17	2.33E+17	1.58E+17	7.94E+16
9.03E+16	1.52E+17	1.69E+17	2.16E+17	2.57E+17	2.38E+17	1.7E+17	2.45E+17	2.07E+17	2.76E+17
2.96E+17	1.93E+17	2.03E+17	2.8E+17	1.8E+17	1.99E+17	1.97E+17	1.87E+17	2.15E+17	8.26E+16
2.38E+17	1.16E+17	6.35E+16	2.59E+17	2.67E+17	1.68E+17	7.31E+16	1.75E+17	2.55E+17	2.07E+17
2.39E+17	2.46E+17	1.5E+17	1.3E+17	3.02E+17	9.71E+16	1.44E+17	1.12E+17	2.91E+17	2.6E+17
1.48E+17	1.85E+17	1.41E+17	1.82E+17	2.91E+17	1.92E+17	1.42E+17	2.04E+17	2.53E+17	2.85E+17
2.27E+17	2.94E+17	2.35E+17	5.75E+16	2.75E+17	1.55E+17	2.25E+17	1.57E+17	2.67E+17	2.67E+17
2.74E+17	1.91E+17	2.44E+17	2.97E+17	1.24E+17	2.52E+17	2.38E+17	2.41E+17	1.64E+17	8.68E+16
1.91E+17	2.63E+17	3.11E+17	2.27E+17	1.08E+17	2.9E+17	3.02E+17	2.82E+17	1.07E+17	2.05E+17
2.48E+17	2.08E+17	9.73E+16	1.86E+17	3.04E+17	1.02E+17	9.58E+16	1.18E+17	2.93E+17	2.48E+17
1.45E+17	1.4E+17	2.41E+17	2.88E+17	1.51E+17	2.98E+17	2.39E+17	2.96E+17	1.06E+17	2.12E+17
2.53E+17	2.14E+17	1.03E+17	1.84E+17	3.04E+17	9.54E+16	1.01E+17	1.11E+17	2.96E+17	2.45E+17
1.93E+17	2.39E+17	3.05E+17	2.58E+17	8.67E+16	3.02E+17	2.97E+17	2.93E+17	8.36E+16	1.92E+17
2.03E+17	2.91E+17	3.16E+17	1.91E+17	1.47E+17	2.75E+17	3.06E+17	2.66E+17	1.49E+17	2.23E+17
2.9E+17	1.89E+17	2.29E+17	3.01E+17	1.55E+17	2.38E+17	2.24E+17	2.27E+17	1.93E+17	8.76E+16
3.09E+17	3E+17	2.76E+17	2E+17	1.95E+17	1.86E+17	2.65E+17	1.71E+17	2.38E+17	1.5E+17
2.38E+17	1.11E+17	7.71E+16	2.73E+17	2.75E+17	1.89E+17	8.77E+16	1.95E+17	2.59E+17	2.21E+17
2.38E+17	1.11E+17	7.74E+16	2.74E+17	2.74E+17	1.88E+17	8.79E+16	1.95E+17	2.59E+17	2.21E+17
2.53E+17	1.9E+17	2.65E+17	3.07E+17	1.02E+17	2.84E+17	2.6E+17	2.74E+17	1.33E+17	1.24E+17
2.35E+17	1.86E+17	8.12E+16	2.1E+17	3.09E+17	1.37E+17	8.53E+16	1.51E+17	2.91E+17	2.59E+17

39	38	37	36	35	34	33	32	31	30
1.32E+17	2.35E+17	2.98E+17	2.42E+17	1.51E+17	3.09E+17	2.92E+17	3.05E+17	1.06E+17	2.45E+17
2.78E+17	2.17E+17	1.08E+17	2.07E+17	3.06E+17	9.56E+16	1.06E+17	1.08E+17	3.04E+17	2.34E+17
2.55E+17	1.92E+17	2.67E+17	3.1E+17	1.04E+17	2.86E+17	2.62E+17	2.76E+17	1.35E+17	1.25E+17
2.05E+17	2.39E+17	3.09E+17	2.74E+17	8.69E+16	3.1E+17	3.02E+17	3.01E+17	8.88E+16	1.9E+17
1.28E+17	2.62E+17	3.02E+17	2.08E+17	1.85E+17	2.98E+17	2.95E+17	2.96E+17	1.45E+17	2.68E+17
2.88E+17	2.77E+17	1.78E+17	1.53E+17	3.11E+17	8.58E+16	1.71E+17	9.51E+16	3.14E+17	2.52E+17
2.02E+17	1.37E+17	2.44E+17	3.21E+17	1.56E+17	3.06E+17	2.43E+17	3.01E+17	1.35E+17	1.93E+17
3.25E+17	2.57E+17	1.77E+17	2.26E+17	2.84E+17	1.07E+17	1.7E+17	1.02E+17	3.05E+17	1.92E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.52E+19	8.52E+19	8.51E+19	8.51E+19	8.53E+19	8.51E+19	8.51E+19	8.51E+19	8.53E+19	8.53E+19
6.96E+19	6.97E+19	6.96E+19	6.95E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19
2.14E+20	2.14E+20	2.15E+20	2.14E+20	2.14E+20	2.14E+20	2.15E+20	2.14E+20	2.14E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.56E+20	1.55E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.56E+20	6.56E+20	6.55E+20	6.55E+20	6.55E+20	6.56E+20	6.55E+20	6.55E+20	6.56E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 26 : This table gives internal distance for masses 29--20

29	28	27	26	25	24	23	22	21	20
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
1.12E+17	1.1E+17	1.1E+17	1.08E+17	1.08E+17	1.08E+17	1.07E+17	1.03E+17	1.02E+17	9.93E+16
7.84E+16	8.6E+16	1.47E+17	1.45E+17	1.04E+17	1.28E+17	1.04E+17	1.29E+17	9.28E+16	1.29E+17
1.19E+17	1.14E+17	1.23E+17	1.21E+17	6.93E+16	1.42E+17	6.86E+16	8.94E+16	6.34E+16	1.21E+17
1.18E+17	1.14E+17	1.23E+17	1.21E+17	6.93E+16	1.42E+17	6.86E+16	8.96E+16	6.34E+16	1.21E+17
1.13E+17	1.27E+17	1.26E+17	1.25E+17	1.58E+17	6.37E+16	1.58E+17	1.49E+17	1.56E+17	1.18E+17
1.21E+17	1.33E+17	1.41E+17	1.4E+17	1.83E+17	6.42E+16	1.83E+17	1.69E+17	1.78E+17	1.21E+17
1.16E+17	1.04E+17	1.64E+17	1.62E+17	6.66E+16	1.84E+17	6.61E+16	1.14E+17	3.36E+16	1.46E+17
1.65E+17	1.37E+17	1.35E+17	1.34E+17	7.94E+16	1.94E+17	7.83E+16	7.01E+16	4.46E+16	1.13E+17
1.78E+17	1.45E+17	1.24E+17	1.24E+17	1.76E+17	1.6E+17	1.75E+17	1.21E+17	1.49E+17	0
1.48E+17	1.29E+17	1.64E+17	1.62E+17	5.88E+16	2.05E+17	5.81E+16	1.01E+17	0	1.49E+17
2.06E+17	1.9E+17	7.81E+16	7.71E+16	9.12E+16	1.75E+17	9.04E+16	0	1.01E+17	1.21E+17
1.69E+17	1.68E+17	1.45E+17	1.43E+17	1.05E+15	1.92E+17	0	9.04E+16	5.81E+16	1.75E+17
1.66E+17	1.89E+17	1.25E+17	1.24E+17	1.92E+17	0	1.92E+17	1.75E+17	2.05E+17	1.6E+17
1.69E+17	1.68E+17	1.45E+17	1.44E+17	0	1.92E+17	1.05E+15	9.12E+16	5.88E+16	1.76E+17
2.19E+17	2.15E+17	1.68E+15	0	1.44E+17	1.24E+17	1.43E+17	7.71E+16	1.62E+17	1.24E+17
2.21E+17	2.17E+17	0	1.68E+15	1.45E+17	1.25E+17	1.45E+17	7.81E+16	1.64E+17	1.24E+17
6.09E+16	0	2.17E+17	2.15E+17	1.68E+17	1.89E+17	1.68E+17	1.9E+17	1.29E+17	1.45E+17
0	6.09E+16	2.21E+17	2.19E+17	1.69E+17	1.66E+17	1.69E+17	2.06E+17	1.48E+17	1.78E+17
5.2E+16	6.39E+16	2.19E+17	2.17E+17	1.35E+17	1.92E+17	1.35E+17	1.87E+17	1.09E+17	1.82E+17
1.79E+17	1.68E+17	1.48E+17	1.47E+17	2.99E+16	2.07E+17	2.92E+16	8.15E+16	4.4E+16	1.66E+17
1.16E+17	1.23E+17	1.9E+17	1.89E+17	2.22E+17	1.12E+17	2.22E+17	2.11E+17	2.06E+17	1.37E+17
1.49E+17	1.86E+17	1.61E+17	1.6E+17	1.96E+17	4.55E+16	1.96E+17	2E+17	2.12E+17	1.91E+17
1.29E+17	1.38E+17	1.87E+17	1.86E+17	2.28E+17	1.02E+17	2.27E+17	2.14E+17	2.14E+17	1.41E+17
1.5E+17	1.31E+17	1.91E+17	1.9E+17	7.24E+16	2.27E+17	7.2E+16	1.27E+17	2.78E+16	1.72E+17
2.02E+17	1.76E+17	1.34E+17	1.33E+17	2.16E+17	1.5E+17	2.16E+17	1.56E+17	1.96E+17	5.11E+16
1.58E+17	1.96E+17	1.67E+17	1.66E+17	2.02E+17	5.23E+16	2.02E+17	2.07E+17	2.2E+17	2.02E+17
1.7E+17	2.07E+17	1.6E+17	1.59E+17	1.3E+17	1.3E+17	1.3E+17	1.7E+17	1.71E+17	2.25E+17
2.42E+17	2.4E+17	5.04E+16	5.06E+16	1.29E+17	1.61E+17	1.28E+17	6.96E+16	1.6E+17	1.61E+17
1.78E+17	1.69E+17	1.69E+17	1.68E+17	2.43E+17	1.19E+17	2.42E+17	2.03E+17	2.27E+17	1.1E+17
1.64E+17	2.03E+17	1.73E+17	1.72E+17	2.1E+17	5.7E+16	2.1E+17	2.15E+17	2.28E+17	2.09E+17
2.08E+17	2E+17	1.38E+17	1.38E+17	2.39E+17	1.11E+17	2.38E+17	1.86E+17	2.31E+17	1.08E+17
2.39E+17	2.49E+17	6.07E+16	6.13E+16	1.76E+17	1.07E+17	1.76E+17	1.31E+17	2.06E+17	1.73E+17
1.2E+17	1.61E+17	2.12E+17	2.11E+17	2.3E+17	9.89E+16	2.3E+17	2.4E+17	2.3E+17	2.01E+17
1.74E+17	1.94E+17	1.77E+17	1.76E+17	2.44E+17	6.62E+16	2.44E+17	2.25E+17	2.46E+17	1.73E+17

29	28	27	26	25	24	23	22	21	20
1.32E+17	1.86E+17	2.13E+17	2.12E+17	1.82E+17	1.33E+17	1.82E+17	2.26E+17	2.04E+17	2.43E+17
2E+17	2.33E+17	1.52E+17	1.51E+17	2.11E+17	5.78E+16	2.11E+17	2.05E+17	2.37E+17	2.14E+17
9.73E+16	8.25E+16	2.48E+17	2.47E+17	2.39E+17	1.9E+17	2.38E+17	2.44E+17	2.05E+17	1.64E+17
1.97E+17	1.86E+17	1.9E+17	1.89E+17	5.63E+16	2.46E+17	5.63E+16	1.21E+17	6.26E+16	2.03E+17
2.47E+17	2.29E+17	1.14E+17	1.14E+17	2.34E+17	1.51E+17	2.33E+17	1.6E+17	2.27E+17	9.74E+16
1.9E+17	2.1E+17	1.77E+17	1.77E+17	2.53E+17	6.88E+16	2.53E+17	2.3E+17	2.57E+17	1.8E+17
2.07E+17	2.32E+17	1.66E+17	1.65E+17	9.99E+16	1.84E+17	1.01E+17	1.54E+17	1.56E+17	2.42E+17
1.23E+17	9.56E+16	2.51E+17	2.49E+17	1.47E+17	2.56E+17	1.47E+17	1.97E+17	1E+17	1.98E+17
1.95E+17	1.38E+17	2.11E+17	2.1E+17	1.89E+17	2.53E+17	1.89E+17	1.64E+17	1.37E+17	1.1E+17
2.7E+17	2.48E+17	8.42E+16	8.46E+16	1.72E+17	2.04E+17	1.71E+17	8.1E+16	1.76E+17	1.31E+17
5.57E+16	8.71E+16	2.76E+17	2.74E+17	2.1E+17	2.18E+17	2.09E+17	2.56E+17	1.84E+17	2.26E+17
2.33E+17	2.39E+17	1.66E+17	1.65E+17	7.16E+16	2.28E+17	7.23E+16	1.22E+17	1.26E+17	2.32E+17
2.32E+17	2.19E+17	1.81E+17	1.8E+17	7.25E+16	2.56E+17	7.25E+16	1.1E+17	9.09E+16	2.1E+17
2.56E+17	2.58E+17	1.35E+17	1.34E+17	9.76E+16	2.18E+17	9.78E+16	1.02E+17	1.47E+17	2.2E+17
2.37E+17	2.03E+17	1.84E+17	1.83E+17	1.21E+17	2.68E+17	1.2E+17	1.07E+17	9.5E+16	1.69E+17
2.15E+17	1.59E+17	2.16E+17	2.15E+17	2.05E+17	2.64E+17	2.04E+17	1.72E+17	1.55E+17	1.14E+17
1.26E+17	1E+17	2.74E+17	2.72E+17	1.71E+17	2.7E+17	1.71E+17	2.22E+17	1.26E+17	2.16E+17
1.9E+17	1.92E+17	2.19E+17	2.18E+17	2.85E+17	1.4E+17	2.84E+17	2.56E+17	2.7E+17	1.66E+17
1.26E+17	1.19E+17	2.74E+17	2.73E+17	1.58E+17	2.68E+17	1.58E+17	2.23E+17	1.25E+17	2.34E+17
2.74E+17	2.88E+17	9.51E+16	9.6E+16	1.94E+17	1.44E+17	1.93E+17	1.55E+17	2.33E+17	2.16E+17
7.81E+16	1.23E+17	2.84E+17	2.82E+17	2.02E+17	2.26E+17	2.02E+17	2.62E+17	1.88E+17	2.54E+17
1.79E+17	2.3E+17	2.2E+17	2.19E+17	2.3E+17	1.15E+17	2.3E+17	2.54E+17	2.54E+17	2.61E+17
2.23E+17	2.28E+17	1.9E+17	1.9E+17	2.85E+17	1.17E+17	2.84E+17	2.44E+17	2.8E+17	1.7E+17
2.68E+17	2.82E+17	1.18E+17	1.19E+17	2.41E+17	1.06E+17	2.41E+17	1.95E+17	2.66E+17	2.03E+17
2.47E+17	2.2E+17	1.8E+17	1.79E+17	2.74E+17	1.88E+17	2.73E+17	2.09E+17	2.52E+17	1.04E+17
1.28E+17	1.46E+17	2.76E+17	2.75E+17	1.54E+17	2.58E+17	1.54E+17	2.33E+17	1.42E+17	2.59E+17
2.43E+17	2.06E+17	2.03E+17	2.02E+17	1.36E+17	2.84E+17	1.36E+17	1.27E+17	1.05E+17	1.78E+17
2.07E+17	2.33E+17	2.06E+17	2.06E+17	2.79E+17	9.17E+16	2.79E+17	2.6E+17	2.85E+17	2.13E+17
2.44E+17	2.54E+17	1.83E+17	1.82E+17	8.96E+16	2.38E+17	9.04E+16	1.44E+17	1.45E+17	2.53E+17
2.03E+17	2.28E+17	2.11E+17	2.11E+17	2.82E+17	9.73E+16	2.82E+17	2.63E+17	2.85E+17	2.11E+17
2.36E+17	2.1E+17	2.14E+17	2.12E+17	1.09E+17	2.87E+17	1.09E+17	1.36E+17	9.15E+16	2.09E+17
2.51E+17	2.04E+17	2.01E+17	2E+17	1.77E+17	2.82E+17	1.76E+17	1.39E+17	1.37E+17	1.46E+17
1.12E+17	1.45E+17	2.87E+17	2.85E+17	1.79E+17	2.5E+17	1.79E+17	2.54E+17	1.69E+17	2.68E+17
1.46E+17	9.38E+16	2.81E+17	2.8E+17	2.47E+17	2.62E+17	2.46E+17	2.52E+17	1.95E+17	1.75E+17
1.96E+17	2.47E+17	2.23E+17	2.23E+17	2.33E+17	1.26E+17	2.33E+17	2.58E+17	2.62E+17	2.74E+17
1.95E+17	2.46E+17	2.24E+17	2.23E+17	2.33E+17	1.27E+17	2.33E+17	2.59E+17	2.62E+17	2.74E+17
1.71E+17	1.8E+17	2.65E+17	2.64E+17	1.25E+17	2.74E+17	1.25E+17	2.12E+17	1.24E+17	2.64E+17
2.23E+17	2.55E+17	2E+17	2E+17	2.74E+17	8.59E+16	2.74E+17	2.59E+17	2.89E+17	2.33E+17
2.79E+17	2.58E+17	1.65E+17	1.64E+17	1.26E+17	2.7E+17	1.26E+17	9.84E+16	1.37E+17	2.02E+17
1.87E+17	2.19E+17	2.39E+17	2.38E+17	2.89E+17	1.18E+17	2.89E+17	2.82E+17	2.9E+17	2.29E+17
1.73E+17	1.81E+17	2.68E+17	2.66E+17	1.27E+17	2.76E+17	1.28E+17	2.14E+17	1.26E+17	2.67E+17
2.37E+17	2.14E+17	2.27E+17	2.25E+17	1.11E+17	2.94E+17	1.11E+17	1.5E+17	9.67E+16	2.24E+17
2.94E+17	2.66E+17	1.48E+17	1.48E+17	1.66E+17	2.65E+17	1.65E+17	9.8E+16	1.66E+17	1.74E+17
2.09E+17	2.11E+17	2.4E+17	2.39E+17	3.08E+17	1.58E+17	3.08E+17	2.79E+17	2.93E+17	1.87E+17
2.27E+17	2.48E+17	2.31E+17	2.3E+17	1.13E+17	2.55E+17	1.14E+17	1.94E+17	1.59E+17	2.85E+17
1.4E+17	1.65E+17	2.88E+17	2.87E+17	2.95E+17	1.88E+17	2.94E+17	3.04E+17	2.76E+17	2.33E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.53E+19	8.51E+19	8.53E+19	8.52E+19	8.53E+19	8.52E+19
6.96E+19	6.96E+19	6.95E+19	6.95E+19	6.96E+19	6.96E+19	6.96E+19	6.95E+19	6.96E+19	6.95E+19
2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20

29	28	27	26	25	24	23	22	21	20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.55E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.56E+20	6.55E+20	6.55E+20	6.55E+20	6.56E+20	6.55E+20	6.56E+20	6.55E+20	6.55E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20
2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.34E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 27 : This table gives internal distances for masses 19--10

19	18	17	16	15	14	13	12	11	10
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	2.11E+12	1.98E+12	2.64E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	1.25E+11	2.23E+11	4.68E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	1.28E+11	1.42E+11	4.75E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	1.63E+11	8.06E+09	4.62E+12

19	18	17	16	15	14	13	12	11	10
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	2.21E+11	2.88E+11	4.89E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	7.54E+11	5.93E+11	4.29E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	1.41E+12	1.53E+12	5.14E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	3.01E+12	2.89E+12	5.25E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	4.49E+12	4.33E+12	4.13E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	3.99E+16	4.74E+12	4.61E+12	0
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	1.67E+11	0	4.61E+12
9.17E+16	8.14E+16	7.86E+16	5.62E+16	4.16E+16	4.16E+16	4E+16	0	1.67E+11	4.74E+12
1E+17	6.29E+16	9.44E+16	7.34E+16	4.25E+16	4.27E+16	0	4E+16	4E+16	3.99E+16
6.52E+16	4.53E+16	1.19E+17	9.53E+16	2.09E+14	0	4.27E+16	4.16E+16	4.16E+16	4.16E+16
6.53E+16	4.53E+16	1.19E+17	9.53E+16	0	2.09E+14	4.25E+16	4.16E+16	4.16E+16	4.16E+16
1.47E+17	1.32E+17	2.58E+16	0	9.53E+16	9.53E+16	7.34E+16	5.62E+16	5.62E+16	5.62E+16
1.67E+17	1.54E+17	0	2.58E+16	1.19E+17	1.19E+17	9.44E+16	7.86E+16	7.86E+16	7.86E+16
6.31E+16	0	1.54E+17	1.32E+17	4.53E+16	4.53E+16	6.29E+16	8.14E+16	8.14E+16	8.14E+16
0	6.31E+16	1.67E+17	1.47E+17	6.53E+16	6.52E+16	1E+17	9.17E+16	9.17E+16	9.17E+16
1.13E+17	1.46E+17	1.21E+17	1.18E+17	1.21E+17	1.21E+17	1.29E+17	9.93E+16	9.93E+16	9.93E+16
4.46E+16	3.36E+16	1.78E+17	1.56E+17	6.34E+16	6.34E+16	9.28E+16	1.02E+17	1.02E+17	1.02E+17
7.01E+16	1.14E+17	1.69E+17	1.49E+17	8.96E+16	8.94E+16	1.29E+17	1.03E+17	1.03E+17	1.03E+17
7.83E+16	6.61E+16	1.83E+17	1.58E+17	6.86E+16	6.86E+16	1.04E+17	1.07E+17	1.07E+17	1.07E+17
1.94E+17	1.84E+17	6.42E+16	6.37E+16	1.42E+17	1.42E+17	1.28E+17	1.08E+17	1.08E+17	1.08E+17
7.94E+16	6.66E+16	1.83E+17	1.58E+17	6.93E+16	6.93E+16	1.04E+17	1.08E+17	1.08E+17	1.08E+17
1.34E+17	1.62E+17	1.4E+17	1.25E+17	1.21E+17	1.21E+17	1.45E+17	1.08E+17	1.08E+17	1.08E+17
1.35E+17	1.64E+17	1.41E+17	1.26E+17	1.23E+17	1.23E+17	1.47E+17	1.1E+17	1.1E+17	1.1E+17
1.37E+17	1.04E+17	1.33E+17	1.27E+17	1.14E+17	1.14E+17	8.6E+16	1.1E+17	1.1E+17	1.1E+17
1.65E+17	1.16E+17	1.21E+17	1.13E+17	1.18E+17	1.19E+17	7.84E+16	1.12E+17	1.12E+17	1.12E+17
1.36E+17	7.92E+16	1.51E+17	1.37E+17	1E+17	1E+17	7.41E+16	1.13E+17	1.13E+17	1.13E+17
5.92E+16	6.62E+16	1.93E+17	1.69E+17	7.57E+16	7.56E+16	1.14E+17	1.15E+17	1.15E+17	1.15E+17
1.96E+17	1.79E+17	5.47E+16	7.58E+16	1.54E+17	1.54E+17	1.22E+17	1.17E+17	1.17E+17	1.17E+17
2.1E+17	1.86E+17	7.87E+16	7.67E+16	1.5E+17	1.5E+17	1.27E+17	1.21E+17	1.21E+17	1.21E+17
2.03E+17	1.89E+17	5.11E+16	7.51E+16	1.6E+17	1.61E+17	1.3E+17	1.22E+17	1.22E+17	1.22E+17
6.95E+16	4.49E+16	1.98E+17	1.76E+17	8.56E+16	8.56E+16	1.08E+17	1.24E+17	1.24E+17	1.24E+17
1.61E+17	1.89E+17	1.17E+17	1.23E+17	1.58E+17	1.58E+17	1.59E+17	1.27E+17	1.27E+17	1.27E+17
2.19E+17	1.94E+17	9.06E+16	8.84E+16	1.59E+17	1.59E+17	1.37E+17	1.31E+17	1.31E+17	1.31E+17
1.85E+17	1.53E+17	1.57E+17	1.36E+17	1.28E+17	1.28E+17	1.27E+17	1.32E+17	1.32E+17	1.32E+17
1.37E+17	1.66E+17	1.81E+17	1.62E+17	1.32E+17	1.32E+17	1.65E+17	1.35E+17	1.35E+17	1.35E+17
2.03E+17	2.08E+17	8.02E+16	1.01E+17	1.76E+17	1.76E+17	1.59E+17	1.36E+17	1.36E+17	1.36E+17
2.27E+17	2.02E+17	9.68E+16	9.57E+16	1.67E+17	1.67E+17	1.45E+17	1.39E+17	1.39E+17	1.39E+17
2.02E+17	2.17E+17	9.52E+16	1.1E+17	1.79E+17	1.79E+17	1.71E+17	1.4E+17	1.4E+17	1.4E+17
1.86E+17	2E+17	1.49E+17	1.37E+17	1.57E+17	1.57E+17	1.72E+17	1.4E+17	1.4E+17	1.4E+17
2.32E+17	1.99E+17	8.36E+16	9.43E+16	1.73E+17	1.73E+17	1.37E+17	1.43E+17	1.43E+17	1.43E+17
2.34E+17	2.21E+17	6.95E+16	8.97E+16	1.85E+17	1.85E+17	1.61E+17	1.45E+17	1.45E+17	1.45E+17
2.21E+17	1.75E+17	1.44E+17	1.32E+17	1.56E+17	1.56E+17	1.31E+17	1.49E+17	1.49E+17	1.49E+17
2.32E+17	2.16E+17	1.18E+17	1.14E+17	1.76E+17	1.76E+17	1.65E+17	1.5E+17	1.5E+17	1.5E+17
2.04E+17	1.79E+17	1.28E+17	1.38E+17	1.75E+17	1.75E+17	1.4E+17	1.52E+17	1.52E+17	1.52E+17
9.13E+16	8.68E+16	2.3E+17	2.06E+17	1.11E+17	1.11E+17	1.44E+17	1.52E+17	1.52E+17	1.52E+17
1.89E+17	2.23E+17	1.44E+17	1.48E+17	1.86E+17	1.86E+17	1.94E+17	1.56E+17	1.56E+17	1.56E+17
2.43E+17	2.33E+17	8.24E+16	1.01E+17	1.95E+17	1.95E+17	1.73E+17	1.56E+17	1.56E+17	1.56E+17
1.72E+17	1.5E+17	2.05E+17	1.81E+17	1.35E+17	1.35E+17	1.53E+17	1.56E+17	1.56E+17	1.56E+17
1.31E+17	9.16E+16	2.11E+17	1.96E+17	1.33E+17	1.33E+17	1.28E+17	1.57E+17	1.57E+17	1.57E+17
1.13E+17	1.45E+17	2.03E+17	1.96E+17	1.55E+17	1.54E+17	1.65E+17	1.59E+17	1.59E+17	1.59E+17
1.37E+17	1.9E+17	2.04E+17	1.91E+17	1.62E+17	1.62E+17	1.96E+17	1.61E+17	1.61E+17	1.61E+17

19	18	17	16	15	14	13	12	11	10
2.07E+17	1.54E+17	1.72E+17	1.68E+17	1.68E+17	1.68E+17	1.31E+17	1.66E+17	1.66E+17	1.66E+17
1.4E+17	1.38E+17	2.36E+17	2.11E+17	1.35E+17	1.35E+17	1.69E+17	1.68E+17	1.68E+17	1.68E+17
1.02E+17	1.18E+17	2.47E+17	2.23E+17	1.31E+17	1.31E+17	1.7E+17	1.69E+17	1.69E+17	1.69E+17
1.45E+17	1.61E+17	2.34E+17	2.1E+17	1.46E+17	1.46E+17	1.83E+17	1.7E+17	1.7E+17	1.7E+17
7.93E+16	1.27E+17	2.44E+17	2.25E+17	1.41E+17	1.41E+17	1.78E+17	1.7E+17	1.7E+17	1.7E+17
1.27E+17	1.64E+17	2.16E+17	2.1E+17	1.72E+17	1.71E+17	1.84E+17	1.74E+17	1.74E+17	1.74E+17
1.56E+17	1.15E+17	2.23E+17	2.1E+17	1.54E+17	1.54E+17	1.44E+17	1.76E+17	1.76E+17	1.76E+17
2.52E+17	2.47E+17	1.06E+17	1.31E+17	2.17E+17	2.18E+17	1.92E+17	1.77E+17	1.77E+17	1.77E+17
1.62E+17	1.12E+17	2.29E+17	2.13E+17	1.52E+17	1.52E+17	1.43E+17	1.78E+17	1.78E+17	1.78E+17
2.15E+17	2.29E+17	1.92E+17	1.78E+17	1.88E+17	1.88E+17	2.07E+17	1.78E+17	1.78E+17	1.78E+17
2.18E+17	1.57E+17	1.92E+17	1.83E+17	1.73E+17	1.73E+17	1.4E+17	1.79E+17	1.79E+17	1.79E+17
2.63E+17	2.26E+17	1.48E+17	1.44E+17	1.98E+17	1.98E+17	1.74E+17	1.79E+17	1.79E+17	1.79E+17
2.58E+17	2.6E+17	1.12E+17	1.34E+17	2.23E+17	2.23E+17	2.05E+17	1.81E+17	1.81E+17	1.81E+17
2.44E+17	2.55E+17	1.59E+17	1.58E+17	2.1E+17	2.09E+17	2.14E+17	1.82E+17	1.82E+17	1.82E+17
2.16E+17	2.45E+17	1.58E+17	1.71E+17	2.16E+17	2.16E+17	2.14E+17	1.83E+17	1.83E+17	1.83E+17
1.84E+17	1.24E+17	2.3E+17	2.12E+17	1.57E+17	1.57E+17	1.45E+17	1.83E+17	1.83E+17	1.83E+17
9.21E+16	1.37E+17	2.57E+17	2.38E+17	1.55E+17	1.55E+17	1.89E+17	1.84E+17	1.84E+17	1.84E+17
2.73E+17	2.6E+17	1.1E+17	1.29E+17	2.23E+17	2.23E+17	1.98E+17	1.84E+17	1.84E+17	1.84E+17
1.62E+17	1.54E+17	2.5E+17	2.24E+17	1.52E+17	1.52E+17	1.83E+17	1.84E+17	1.84E+17	1.84E+17
2.74E+17	2.6E+17	1.09E+17	1.29E+17	2.24E+17	2.24E+17	1.98E+17	1.85E+17	1.85E+17	1.85E+17
1.02E+17	1.24E+17	2.65E+17	2.43E+17	1.5E+17	1.5E+17	1.84E+17	1.87E+17	1.87E+17	1.87E+17
1.08E+17	1.62E+17	2.48E+17	2.35E+17	1.71E+17	1.71E+17	2E+17	1.87E+17	1.87E+17	1.87E+17
2.07E+17	1.45E+17	2.21E+17	2.07E+17	1.7E+17	1.7E+17	1.49E+17	1.88E+17	1.88E+17	1.88E+17
1.95E+17	1.81E+17	1.99E+17	2.01E+17	1.95E+17	1.95E+17	1.75E+17	1.89E+17	1.89E+17	1.89E+17
2.71E+17	2.35E+17	1.65E+17	1.59E+17	2.07E+17	2.07E+17	1.87E+17	1.91E+17	1.91E+17	1.91E+17
2.71E+17	2.35E+17	1.65E+17	1.59E+17	2.07E+17	2.07E+17	1.86E+17	1.91E+17	1.91E+17	1.91E+17
1.68E+17	1.19E+17	2.53E+17	2.31E+17	1.55E+17	1.55E+17	1.6E+17	1.91E+17	1.91E+17	1.91E+17
2.8E+17	2.65E+17	1.29E+17	1.4E+17	2.26E+17	2.26E+17	2.06E+17	1.91E+17	1.91E+17	1.91E+17
1.21E+17	1.66E+17	2.65E+17	2.44E+17	1.65E+17	1.65E+17	2.08E+17	1.93E+17	1.93E+17	1.93E+17
2.84E+17	2.61E+17	1.18E+17	1.38E+17	2.3E+17	2.3E+17	1.98E+17	1.93E+17	1.93E+17	1.93E+17
1.7E+17	1.21E+17	2.55E+17	2.34E+17	1.58E+17	1.58E+17	1.63E+17	1.93E+17	1.93E+17	1.93E+17
1.14E+17	1.27E+17	2.73E+17	2.51E+17	1.56E+17	1.56E+17	1.89E+17	1.95E+17	1.95E+17	1.95E+17
1.33E+17	1.92E+17	2.58E+17	2.41E+17	1.81E+17	1.81E+17	2.21E+17	1.96E+17	1.96E+17	1.96E+17
2.76E+17	2.7E+17	1.28E+17	1.54E+17	2.41E+17	2.41E+17	2.14E+17	2E+17	2E+17	2E+17
1.91E+17	1.6E+17	2.62E+17	2.37E+17	1.68E+17	1.68E+17	1.86E+17	2.01E+17	2.01E+17	2.01E+17
2.78E+17	2.45E+17	1.47E+17	1.64E+17	2.32E+17	2.32E+17	1.91E+17	2.03E+17	2.03E+17	2.03E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.53E+19	8.53E+19	8.51E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19
6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19
2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20

19	18	17	16	15	14	13	12	11	10
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.56E+20	6.55E+20	6.55E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.35E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.34E+20	2.34E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

Table 28 : This table gives internal distances for masses 9--1

9	8	7	6	5	4	3	2	1
3.58E+12	3.38E+12	2.74E+12	1.7E+12	2.26E+12	1.99E+12	2.12E+12	2.06E+12	0
4.55E+12	3.11E+12	1.31E+12	8.09E+11	3.45E+11	2.24E+11	2.47E+11	0	2.06E+12
4.39E+12	2.88E+12	1.54E+12	6.66E+11	1.46E+11	1.34E+11	0	2.47E+11	2.12E+12
4.33E+12	2.89E+12	1.54E+12	5.95E+11	2.8E+11	0	1.34E+11	2.24E+11	1.99E+12
4.45E+12	2.87E+12	1.56E+12	7.55E+11	0	2.8E+11	1.46E+11	3.45E+11	2.26E+12
3.74E+12	2.41E+12	2.09E+12	0	7.55E+11	5.95E+11	6.66E+11	8.09E+11	1.7E+12
5.77E+12	4.42E+12	0	2.09E+12	1.56E+12	1.54E+12	1.54E+12	1.31E+12	2.74E+12
2.37E+12	0	4.42E+12	2.41E+12	2.87E+12	2.89E+12	2.88E+12	3.11E+12	3.38E+12
0	2.37E+12	5.77E+12	3.74E+12	4.45E+12	4.33E+12	4.39E+12	4.55E+12	3.58E+12
4.13E+12	5.25E+12	5.14E+12	4.29E+12	4.89E+12	4.62E+12	4.75E+12	4.68E+12	2.64E+12
4.33E+12	2.89E+12	1.53E+12	5.93E+11	2.88E+11	8.06E+09	1.42E+11	2.23E+11	1.98E+12
4.49E+12	3.01E+12	1.41E+12	7.54E+11	2.21E+11	1.63E+11	1.28E+11	1.25E+11	2.11E+12
4E+16	4E+16	4E+16	4E+16	4E+16	4E+16	4E+16	4E+16	4E+16
4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16
4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16	4.16E+16
5.62E+16	5.62E+16	5.62E+16	5.62E+16	5.62E+16	5.62E+16	5.62E+16	5.62E+16	5.62E+16
7.86E+16	7.86E+16	7.86E+16	7.86E+16	7.86E+16	7.86E+16	7.86E+16	7.86E+16	7.86E+16

9	8	7	6	5	4	3	2	1
8.14E+16	8.14E+16	8.14E+16	8.14E+16	8.14E+16	8.14E+16	8.14E+16	8.14E+16	8.14E+16
9.17E+16	9.17E+16	9.17E+16	9.17E+16	9.17E+16	9.17E+16	9.17E+16	9.17E+16	9.17E+16
9.93E+16	9.93E+16	9.93E+16	9.93E+16	9.93E+16	9.93E+16	9.93E+16	9.93E+16	9.93E+16
1.02E+17	1.02E+17	1.02E+17	1.02E+17	1.02E+17	1.02E+17	1.02E+17	1.02E+17	1.02E+17
1.03E+17	1.03E+17	1.03E+17	1.03E+17	1.03E+17	1.03E+17	1.03E+17	1.03E+17	1.03E+17
1.07E+17	1.07E+17	1.07E+17	1.07E+17	1.07E+17	1.07E+17	1.07E+17	1.07E+17	1.07E+17
1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17
1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17
1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17	1.08E+17
1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17
1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17	1.1E+17
1.12E+17	1.12E+17	1.12E+17	1.12E+17	1.12E+17	1.12E+17	1.12E+17	1.12E+17	1.12E+17
1.13E+17	1.13E+17	1.13E+17	1.13E+17	1.13E+17	1.13E+17	1.13E+17	1.13E+17	1.13E+17
1.15E+17	1.15E+17	1.15E+17	1.15E+17	1.15E+17	1.15E+17	1.15E+17	1.15E+17	1.15E+17
1.17E+17	1.17E+17	1.17E+17	1.17E+17	1.17E+17	1.17E+17	1.17E+17	1.17E+17	1.17E+17
1.21E+17	1.21E+17	1.21E+17	1.21E+17	1.21E+17	1.21E+17	1.21E+17	1.21E+17	1.21E+17
1.22E+17	1.22E+17	1.22E+17	1.22E+17	1.22E+17	1.22E+17	1.22E+17	1.22E+17	1.22E+17
1.24E+17	1.24E+17	1.24E+17	1.24E+17	1.24E+17	1.24E+17	1.24E+17	1.24E+17	1.24E+17
1.27E+17	1.27E+17	1.27E+17	1.27E+17	1.27E+17	1.27E+17	1.27E+17	1.27E+17	1.27E+17
1.31E+17	1.31E+17	1.31E+17	1.31E+17	1.31E+17	1.31E+17	1.31E+17	1.31E+17	1.31E+17
1.32E+17	1.32E+17	1.32E+17	1.32E+17	1.32E+17	1.32E+17	1.32E+17	1.32E+17	1.32E+17
1.35E+17	1.35E+17	1.35E+17	1.35E+17	1.35E+17	1.35E+17	1.35E+17	1.35E+17	1.35E+17
1.36E+17	1.36E+17	1.36E+17	1.36E+17	1.36E+17	1.36E+17	1.36E+17	1.36E+17	1.36E+17
1.39E+17	1.39E+17	1.39E+17	1.39E+17	1.39E+17	1.39E+17	1.39E+17	1.39E+17	1.39E+17
1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17
1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17	1.4E+17
1.43E+17	1.43E+17	1.43E+17	1.43E+17	1.43E+17	1.43E+17	1.43E+17	1.43E+17	1.43E+17
1.45E+17	1.45E+17	1.45E+17	1.45E+17	1.45E+17	1.45E+17	1.45E+17	1.45E+17	1.45E+17
1.49E+17	1.49E+17	1.49E+17	1.49E+17	1.49E+17	1.49E+17	1.49E+17	1.49E+17	1.49E+17
1.5E+17	1.5E+17	1.5E+17	1.5E+17	1.5E+17	1.5E+17	1.5E+17	1.5E+17	1.5E+17
1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17
1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17	1.52E+17
1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17
1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17
1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17	1.56E+17
1.57E+17	1.57E+17	1.57E+17	1.57E+17	1.57E+17	1.57E+17	1.57E+17	1.57E+17	1.57E+17
1.59E+17	1.59E+17	1.59E+17	1.59E+17	1.59E+17	1.59E+17	1.59E+17	1.59E+17	1.59E+17
1.61E+17	1.61E+17	1.61E+17	1.61E+17	1.61E+17	1.61E+17	1.61E+17	1.61E+17	1.61E+17
1.66E+17	1.66E+17	1.66E+17	1.66E+17	1.66E+17	1.66E+17	1.66E+17	1.66E+17	1.66E+17
1.68E+17	1.68E+17	1.68E+17	1.68E+17	1.68E+17	1.68E+17	1.68E+17	1.68E+17	1.68E+17
1.69E+17	1.69E+17	1.69E+17	1.69E+17	1.69E+17	1.69E+17	1.69E+17	1.69E+17	1.69E+17
1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17
1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17	1.7E+17
1.74E+17	1.74E+17	1.74E+17	1.74E+17	1.74E+17	1.74E+17	1.74E+17	1.74E+17	1.74E+17
1.76E+17	1.76E+17	1.76E+17	1.76E+17	1.76E+17	1.76E+17	1.76E+17	1.76E+17	1.76E+17
1.77E+17	1.77E+17	1.77E+17	1.77E+17	1.77E+17	1.77E+17	1.77E+17	1.77E+17	1.77E+17
1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17
1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17	1.78E+17
1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17
1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17	1.79E+17
1.81E+17	1.81E+17	1.81E+17	1.81E+17	1.81E+17	1.81E+17	1.81E+17	1.81E+17	1.81E+17

9	8	7	6	5	4	3	2	1
1.82E+17	1.82E+17	1.82E+17	1.82E+17	1.82E+17	1.82E+17	1.82E+17	1.82E+17	1.82E+17
1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17
1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17	1.83E+17
1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17
1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17
1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17	1.84E+17
1.85E+17	1.85E+17	1.85E+17	1.85E+17	1.85E+17	1.85E+17	1.85E+17	1.85E+17	1.85E+17
1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17
1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17	1.87E+17
1.88E+17	1.88E+17	1.88E+17	1.88E+17	1.88E+17	1.88E+17	1.88E+17	1.88E+17	1.88E+17
1.89E+17	1.89E+17	1.89E+17	1.89E+17	1.89E+17	1.89E+17	1.89E+17	1.89E+17	1.89E+17
1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17	1.91E+17
1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17
1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17
1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17	1.93E+17
1.95E+17	1.95E+17	1.95E+17	1.95E+17	1.95E+17	1.95E+17	1.95E+17	1.95E+17	1.95E+17
1.96E+17	1.96E+17	1.96E+17	1.96E+17	1.96E+17	1.96E+17	1.96E+17	1.96E+17	1.96E+17
2E+17	2E+17	2E+17	2E+17	2E+17	2E+17	2E+17	2E+17	2E+17
2.01E+17	2.01E+17	2.01E+17	2.01E+17	2.01E+17	2.01E+17	2.01E+17	2.01E+17	2.01E+17
2.03E+17	2.03E+17	2.03E+17	2.03E+17	2.03E+17	2.03E+17	2.03E+17	2.03E+17	2.03E+17
1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21	1.57E+21
4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20	4.04E+20
8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19	8.52E+19
6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19	6.96E+19
2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20	2.14E+20
1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20	1.4E+20
1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20	1.45E+20
1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20	1.56E+20
1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20	1.78E+20
1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20	1.95E+20
2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20	2.39E+20
2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20	2.5E+20
2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20	2.42E+20
2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20	2.53E+20
2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20	2.65E+20
2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20	2.8E+20
2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20	2.95E+20
3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20	3.14E+20
3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20	3.77E+20
3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20	3.93E+20
5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20	5.25E+20
6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20	6.55E+20
1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21	1.14E+21
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20

9	8	7	6	5	4	3	2	1
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20	2.35E+20
2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22	2.4E+22
2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22	2.65E+22

All the other data can also be supplied on request. I stopped here as this increases the page count.

6. Comparison of Dynamic Universe model with other N-body models

Dynamic Universe model: N-body problem- solution

In Dynamic Universe Model, there are no singularities and no collisions if we use heterogeneous mass distributions. When homogeneous mass distributions are used, there are collisions but no singularities. Resultant Universal Gravitational Force is calculated for each body for every time step in all the three dimensions. Conservation of energy, moment etc, were taken into consideration as shown in the Mathematical formulation. Using exactly same setup of mathematics and SITA algorithm and same number of 133 masses, all the results are derived, in the last 18 years.

Dynamic Universe Model is a mathematical framework of cosmology of N-body simulations, based on classical Physics. Here in Dynamic Universe Model all bodies move and keep themselves in dynamic equilibrium with all other bodies depending on their present positions, velocities and masses. This Dynamic Universe Model is a finite and closed universe model. Here we first theoretically find the Universal gravitational force (here after let us call this as UGF) on each body/ particle in the **mathematical formulation** section in this paper. Then we calculate the resultant UGF vector for each body/ particle on that body at that instant at that position using computer based *Simulation of Inter-intra-Galaxy Tautness and Attraction_forces* (here after let us call this as SITA simulations) which simulate Dynamic universe model. In SITA simulations, real calculations are done on the computer, no imaginary numbers are used and nothing abnormal is assumed anywhere. There are no singularities while forming the theory or while doing the calculations. Basically SITA is a calculation method where we can use a computer or calculator, real observational data based theoretical simulation system. In addition, just day-to-day physical equations are sufficient for all these results. Initially 133 masses were used in SITA about 17 years back, after theoretical formulation of Dynamic universe model. Using higher number of masses is difficult to handle, which was a limitation of 386 and 486 PCs available at time in the market. I did not change the number of masses until now due to two reasons. Firstly getting higher order computers is difficult for my purse as well as additional programming will also be required. Secondly, I want to see and obtain the different results from the same SITA and math framework. There are many references by the author presenting papers in many parts of the world [20, 23].

Comparison with other N-body simulations

In both N- body simulations and SITA simulations; Newtonian gravitation law is used, without any change. The other N-body simulation techniques mainly failed to calculate the resulting UGF on the particular body which is both time and position dependent. This is the reason that they resulted into singularities and /or two or multiple body collisions. Some N-body simulations use some modifications in Newton's Gravitational law, which is not correct. Sometimes, they use some software to detect and avoid collisions, singularities etc. No such modifications were done in Dynamic Universe model. Here we calculate the resultant UGF on the body using classical physics only. In N-body simulations, there are 6N variables and 10 algebraic integral equations, three for center of mass, three for linear momentum, three for angular momentum and finally one for energy. By solving these differential and integral equations for variables, people used to get singularities and collisions of two bodies or multiple bodies. Here no additional equations are used except as shown in the mathematical formulation section.

Chaotic Systems with the Earlier Large Astrophysical N-body Problem

The following paragraphs and sections were taken from the thesis of Wayne Hayes , 1995 [0] given in italics. This is not necessarily his personal opinion; it represents the prevailing thought on the subject that time. A comparison with Dynamic Universe Model concepts with those expressed by different authors are discussed below in NORMAL print. This is a comparison study only; so that the concepts of Dynamic Universe Model can be understood well and visualized, how different it is from earlier concepts. In General it is opined by Wayne Hayes *that:*

> *N-body systems are chaotic. This means that numerical errors in their solution are magnified exponentially with time, perhaps making the solutions useless... Astrophysical N-body systems are chaotic. In other words, they have sensitive dependence on initial conditions. This means that the phase-space distance between two solutions whose initial conditions differ by an arbitrarily small amount will increase exponentially with time. Since computers constantly make small errors in the computation of such solutions, it is guaranteed (with probability 1) that a computed solution will diverge exponentially from the true solution with the same initial conditions. … Later Wayne Hayes attribute many these errors are due to computer calculation errors accumulated later after some iterations.*

In Dynamic Universe Model (SITA), solution and calculation outputs are not chaotic. The calculation and chaotic errors are not true with present day computers and sufficient accuracies can be achieved...

> *Numerical simulation is a standard tool in the repertoire of the modern physical scientist's study of complex systems. The astronomical literature is brimming with results of large N-body simulations. The proliferation of titles such as ``Simulations of Sinking Galaxies'' [33], ``Dissipationless Collapse of Galaxies and Initial Conditions'' [23], ``A*

> *Numerical Study of the Stability of Spherical Galaxies'' [24], ``The Global Stability of Our Galaxy'' [30], and ``Dynamical Instabilities in Spherical Stellar Systems'' [4] shows that much trust is placed in the results of these simulations.*
>
> *Can these simulation results really be trusted? What conditions must a simulation meet for its accuracy to be assured? Is there a limit on the length of simulated time a system can be followed accurately? What measures can be used to ascertain the accuracy of a simulation? More fundamentally, what do we mean by ``accuracy'' and ``error'' in these simulations?*

Recalculation of these simulations may need to be done with Dynamic Universe Model; trust may not be placed….

> *All these questions have been addressed in the past with varying degrees of success. There is still some controversy about whether simulations of N-body systems can be trusted. The main reason for this concern is that N-body systems are chaotic -- small perturbations in the phase-space co-ordinates at any point result in a vastly different phase-space solution a short time later.*

Dynamic universe model is stable on small perturbation it will go back to its original state. It withstands 10^5 times the Normal Jeans swindle test. In case the large perturbation is of the order 10^5 percent Dynamic Universe model will go in to another stable state. It will not collapse or diverge or go chaotic.

> *Given that numerical computations are constantly introducing small errors to the computed solution, we must naturally ask what effect these errors have on computed solutions.*

For better accuracies sixteen digits are being used here. The error due to computer calculations is limited. These calculations errors will not lead to chaotic situations.

Exponential divergence

> *Miller [26] was the first to show that small changes in the initial conditions of an N-body system result in exponentially diverging solutions.*

Again here in Dynamic universe model, small changes or big changes in initial conditions does not cause any diverging solution

> *Lecar [22] co-ordinated a study between many researchers, each of whom independently computed the solution to an N-body problem with identical initial conditions. They found that different algorithms and computers gave results in which some measures differed by as much as 100%.*

Different algorithms use different formulae and they don't use Newton's law as it is, which is the main source of error.

> *More recent work on the growth of errors includes Kandrup and Smith [19], who showed that under a large range of parameters, the time scale over which small perturbations grow by a factor of e (Euler's constant, 2.7182...), called the e-folding time, is comparable to the crossing time (the average time it takes a particle to cross the system once).*

Perturbations are not a problem in Dynamic universe model. There is no crossing time problem in Dynamic Universe Model

> *Goodman, Heggie, and Hut [10] developed a detailed theory of the growth of small perturbations, and verified it with simulation to show that the exponential growth of small errors results mostly from close encounters, which occur infrequently. This is an interesting result because it says that, even though the full phase-space solutions may*

> *experience exponential error growth, this growth is due mainly to a few particles that undergo close encounters.*

There are no close encounters of particles here.

> *Perhaps the results of collisionless systems can be trusted for longer than collisional ones, since close encounters have a much smaller effect in the former.*

Dynamic Universe Model is a collisionless system

> *Kandrup and Smith [21] showed that as softening is increased (i.e., the collisionality is decreased), the e-folding time grows slightly faster than linearly. (i.e., the Lyapunov exponent decreases, so errors are magnified more slowly.)*

No softening is used as Newton's law is used as it is.

> *They agree with Goodman et al. that the error magnification is more due to the rare individual particles whose errors grow much more quickly than the average, although they claim the global potential also plays a role.*

In Dynamic Universe model the Resultant **Universal Gravitational force** is calculated on every point mass for that instant. This UGF is different at different places and at different times.

> *Presumably the particles whose errors grow more quickly than average are ones that have suffered close encounters.*

There are no close encounters between the particles. When uniform mass density or distribution is used, close encounters are seen. This problem will not occur in heterogeneous mass distributions.

> *Since the time-scale for the growth of errors is so short (the errors can be magnified by a factor of* ~ 10 *each crossing time), the results of all N-body simulations may be suspect. If the relative error per crossing time for a simulation is* 10^{-p}*, then after about p crossing times, a particle's position will have an error comparable to the size of the system -- in other words, all information will have been lost about the particle's position. Typical simulations today have a p between 4 and 8.*

This problem of particles crossings never occurred in Dynamic universe model.

> *I am not aware of any convincing justification for the belief that statistical measures taken from these simulations are valid, although I tend to share the same ``warm fuzzy'' feelings that most astronomers have -- namely that, in some sense, large N-body simulations give valid statistical results. The problem is, in what sense are they valid, if any; how valid are they; and finally, how badly are we allowed to integrate before validity is lost?*

All the earlier simulations suffered these problems. This is not present in Dynamic universe model.

The kinds of errors made in N-body simulations: Input and output Errors

> I first distinguish between two general types of errors.
>
> ***Input errors*** *are errors that can be controlled directly while devising and implementing models of N-body systems. Input errors in N-body systems may also be called approximations, and may be divided into modelling approximations and implementation approximations.*

Modelling approximations simplify the system being simulated, and include:

- *finite-N sampling, also called discreteness noise, because the N used is generally several orders of magnitude less than the N of the real system being modelled. The general consensus seems to be that this is the limiting source of error in current large N-body simulations. For example, Hernquist, Hut and Makino [15], Barnes and Hut [5], and Sellwood [31] explicitly say this; Singh, Hennessy and Gupta [32] have a ``master error equation'' in which clearly discreteness noise is dominant; and Pfenniger and Friedl [27], Jernigan and Porter [17], and Barnes and Hut [3] all imply that using the largest possible N is a desirable characteristic.*

In Dynamic Universe Model this remains same. Higher N will have better accuracies. N=2 or N=3 bodies will suffer accuracy loss and be subjected to huge errors when compared with the real movement of single bodies in large systems; for e.g. movement of earth, moon in solar system.

- *force softening, i.e., replacing* r^2 *with* $(r^2 + \varepsilon_{soft}^2)$ *in the denominator of the gravitational force computation for some small constant* ε_{soft}*, usually chosen to approximate the average inter-particle separation. This is done because it allows a smaller N to approximate a larger N, and also to eliminate the singularity at r=0 [6].*

No forced softening is used in Dynamic Universe Model. Newton’s gravitation law is used as it is

- *reducing the dimensionality of the problem from 3 to 2, if applicable. This is not done as often as in the past.*

In the Dynamic Universe Model we do not need to reduce the dimensionality of the problem from 3 to 2.

> *Implementation approximations measure how well the implementation simulates the model, and include such things as*
>
> - *numerical integration truncation error.*

No *numerical integration is done* in Dynamic Universe Model. No differential equations are used here.

> - *machine roundoff error.*

Machine round-off errors are less in Dynamic Universe Model as it uses Excel instead of Fortran

> - *Using approximate force computation algorithms like the Barnes-Hut tree code [3] or the Fast Multipole Method [12]. Hernquist, Hut, and Makino [15] try to show that the effect of this error is negligible, by showing that the energy of each individual particle is conserved to a high degree regardless of whether the Barnes-Hut or the direct* ***$O(N^2)$*** *algorithm is used. However, they used the leapfrog integrator with a constant timestep which guarantees that the energy error for the entire system is bounded. I'm not sure if this integrator guarantees that the energy of individual particles is conserved; if it does, the results may not be as conclusive as they appear. Furthermore, as discussed below, energy conservation may not be a stringent enough error criterion.*

No *leapfrog integrator with a constant timestep* in Dynamic Universe Model. Timestep need not be constant. No differential equations and integrators are used.

> *Output error measures the difference between the output and a real system, and results from the cumulative effect of all the input errors. A simulation with small output errors is said to have high accuracy. Given*

> *that N-body systems are chaotic, and that their simulation introduces the above input errors, we must now ask precisely what we mean by the ``accuracy'' of a simulation. Amazing as it may seem, there is currently no clear definition of simulation accuracy [29]. Obviously, attempting to follow the individual paths of all N particles is infeasible; Goodman, Heggie and Hut [10] show that this would require O(N) digits of precision. On the other hand, most astronomical publications quote energy conservation as their only measure of output error, even though there are infinitely many solutions with equal energy but vastly different phase-space trajectories. Some of these simulations even use an energy-conserving integrator like leapfrog, in which case quoting energy conservation is of dubious merit, because the integrator conserves energy no matter how big other errors become!*

No ***leapfrog integrator is used*** in Dynamic Universe Model. Output error depends on accuracy of input data like values of masses and their positions.

The kinds of errors made in N-body simulations: Macroscopic statistics *vs.* microscopic details

> *In large N-body simulations, one is not usually concerned with the precise evolution of individual particles, but instead with the evolution of the distribution of particles. Most practitioners know that the exponential magnification of errors means they cannot possibly trust the microscopic details, but they believe that the statistical results are independent of the microscopic errors, although little work has been done to test this belief [10]. Barnes and Hut [5] claim that astrophysical N-body simulations require only ``modest'' accuracy levels, but also concede that quoting energy conservation isn't enough, and that more stringent tests are needed.*

In Dynamic Universe Model individual small particles can be traced. For e.g. New Horizons satellite can be traced in a system of many huge masses like Earth and Sun and stars.

> *An example of conservation of macroscopic properties is given by Kandrup and Smith [19]. They show that a histogram of the e-folding times of individual particles stays constant within statistical uncertainties, even though the phase-space distribution of those particles is vastly different for different initial conditions.*
>
> *However, until more stringent tests are applied to N-body simulations, we'll never know, for example, if our simulations of spiral galaxies produce spirals for the same reason that real spiral galaxies do.*

Galaxy disk formation was tested in Dynamic Universe Model. Further models can also be tested…………

The kinds of errors made in N-body simulations: Suggestions for measures of output error

> *We now must distinguish between the desired properties of simulations, and deviations that simulations make from those properties, i.e., the output errors they make.*
>
> ***0.***
>
> > *We could demand that a simulation precisely follow the exact evolution of the true solution.*
> >
> > *This would be possible in principle for chaotic maps, but not for ODEs. For maps, an arbitrary precision arithmetic package could be employed, but this is infeasible because it requires keeping all*

> *the digits of every operation, and each multiplication operation typically doubles the number of digits.*
>
> *For problems in which the map is really an ODE integration, like N-body systems, this is not possible even in principle, because no numerical integration routine is known that can give exact solutions to arbitrary nonlinear ODEs.*

No *integrators* in Dynamic Universe Model. Timestep need not be constant. No differential equations and integrators are used. No ODEs.

1.

> *Next, we could demand that a simulation have the property that the phase-space distance between the computed solution and the true solution with the same initial conditions be bounded by a small constant.*
>
> *If this property could be realized, all our troubles would be over, for it is a sufficient condition under any reasonable definition of simulation validity. Unfortunately, ODE integrations have truncation errors, so the magnitude of these errors will be magnified exponentially on a short time scale. Goodman, Heggie and Hut [10] offer some solace in that the exact evolution could be closely followed for a long time if O(N) digits are kept, but this is currently infeasible. There seems little hope of obtaining valid simulations by this criterion.*

No ODE integrators and truncation errors are present in Dynamic Universe Model. No differential equations and integrators are used.

2.

At the least stringent extreme we can demand that such physically conserved quantities as energy, and linear and angular momentum, are conserved to some small error.

Certainly global conservation of these quantities is necessary for any reasonable definition of simulation validity, but it is unclear what other properties are implied by such conservations.

There are several possibilities between these extremes.

In Dynamic Universe Model global conservation of energy and linear momentum were done. Individual point mass energy conservation is not done.

3.

A little less stringent than (1), we can demand that a simulation follow, with some small error, the exact phase-space evolution of a set of initial conditions that is close to the actual set of initial conditions used in the simulation.

In Dynamic Universe Model error is less.

Since, with large simulations, we are only interested in the evolution of the distribution of particles, and since the initial conditions are usually generated from some random distribution anyway, this is almost as good as option (1). The study of shadowing relates precisely to this property.

Large simulations are possible with Dynamic Universe Model. Extensive studies were done with 133 mass models only due to limitations of available resources

What if shadowing turns out also to be an unattainable goal? We will need to demand less stringent properties of simulations, such as:

4.

> *Even if a shadow solution cannot be found for a particular simulation, it is still possible that the global distribution of particles is close to the exact global distribution of a true solution with similar initial conditions. In other words, a low-resolution, ``smoothed'' animation of the real system and the computed solution would be indistinguishable to the unaided eye.*

No shadow solution is required and such shadow solution does not exist.. Only one solution exists that is exact solution in Dynamic Universe Model. Many cases were seen with this exact solution, it follows close to real paths. Error depends on accuracies of input data.

> *This would be almost as good as shadowing, at least for collisionless systems, but it is unclear how one would go about proving the existence of this property for a simulation.*

Dynamic Universe Model is collisionless solution. It is stable. Collisions are there when there is uniform density distribution is used. Collisions are not dependent on Dynamic Universe Model or its basic ideology.

5.

> *If the global distribution cannot be followed closely, then perhaps at least some statistical properties of the distribution could be reproduced by a simulation. A reasonable statistical property may be something like the time-evolution of the Fourier spectrum of the density distribution in spherical or cylindrical co-ordinates, so that the wavelengths of the distribution (i.e., the relative abundance of*

> *``clumpiness" of various sizes) are similar to those of the real system.*

Dynamic Universe Model is collisionless solution. It is stable. Collisions are there when there is uniform density distribution is used. Collisions are not dependent on Dynamic Universe Model or its basic ideology. It says clumpiness is a natural property of universe. Sun, moon, galaxy etc all are having different masses. No uniform density is seen any where.

> *This is the least stringent property, that I can think of, that a large N-body simulation would need to be considered valid; i.e., it is the weakest necessary condition I can think of. Note it is more stringent than energy conservation. However, it is again unclear how one would go about proving this property exists for a simulation.*

In Dynamic Universe Model global energy is conserved.

> *It should be clear that the ordering in stringency of the above properties, from most to least stringent, allows the following logical deductions:* $0 \Rightarrow 1 \Rightarrow 3 \Rightarrow 4 \Rightarrow 5 \Rightarrow 2$.

In Dynamic Universe Model the *above properties, from most to least stringent* are followed……..

7. SITA & CUDA comparison

Comparison of SITA with NVIDIA's CUDA implementation: Present CUDA implementation is not singularity free.

Let's make a comparison study with CUDA here. SITA does not implement any portion of CUDA in its algorithm or in theory or development. Only differences are brought out here, so that SITA can be better understood.

Comparison Table SITA & CUDA

One of the contemporary N-body simulations 'the CUDA implementation' done by Lars Nyland, & Mark Harris, of NVIDIA Corporation Jan Prins of University of North Carolina at Chapel Hill [ref] was taken for studying the differences in implementations of SITA &CUDA. The following table gives the comparison. The column on the left side data from Chapter 31 of NVIDIA Corporation describing CUDA, while right side is SITA implementation of Dynamic Universe Model. This CUDA is given for comparison only, SITA is not using any portion of CUDA. Basic idea why this table is given is for better understanding of SITA. SITA also can be implemented on NVIDIA hardware.

Table 29 : In this table SITA & CUDA methods are compared

CUDA	SITA
1 Introduction An N-body simulation numerically approximates the evolution of a system of bodies in which each body continuously interacts with every other body. A familiar example is an astrophysical simulation in which each body represents a galaxy or an individual star, and the bodies attract each other through the gravitational force, as in Figure 31-1.	In Dynamic Universe model also it is the same; each body represents a planet, star or Galaxy. All these bodies attract each other under Newton's Gravitation laws without any modification.
N-body simulation arises in many other computational science problems as well. For example, protein folding is studied using N-body simulation to calculate electrostatic and van der Waals forces. Turbulent fluid flow simulation and global illumination computation in computer graphics are other examples of problems that use N-body simulation.	This Dynamic Universe model was used by me in astrophysical context and in some few cases used sub-atomical particles were used successfully for testing purposes.

CUDA	SITA
The *all-pairs* approach to N-body simulation is a brute-force technique that evaluates all pair-wise interactions among the *N* bodies. It is a relatively simple method, but one that is not generally used on its own in the simulation of large systems because of its $O(N^2)$ computational complexity. Instead, the all-pairs approach is typically used as a kernel to determine the forces in close-range interactions. The all-pairs method is combined with a faster method based on a far-field approximation of longer-range forces, which is valid only between parts of the system that are well separated. Fast N-body algorithms of this form include the Barnes-Hut method (BH) (Barnes and Hut 1986), the fast multipole method (FMM) (Greengard 1987), and the particle-mesh methods (Hockney and Eastwood 1981, Darden et al. 1993). The all-pairs component of the algorithms just mentioned requires substantial time to compute and is therefore an interesting target for acceleration. Improving the performance of the all-pairs component will also improve the performance of the far-	*Al- pairs* method is used in Dynamic Universe model. I did not try any other method except SITA simulations till now. Probably far field approximations for long-range forces is to be checked, developed and used separately after completing the 10000 body model on SITA-CUDA-O(N^2) algorithm finalization. I have thought about this .but I have not developed… .

CUDA	SITA
field component as well, because the balance between far-field and near-field (all-pairs) can be shifted to assign more work to a faster all-pairs component. Accelerating one component will offload work from the other components, so the entire application benefits from accelerating one kernel.	
All-Pairs N-Body Simulation We use the gravitational potential to illustrate the basic form of computation in an allpairs N-body simulation. In the following computation, we use bold font to signify vectors (typically in 3D). Given *N* bodies with an initial position x*i* and velocity v*i* for 1 ≤ *i* ≤ *N*, the force vector f*ij* on body *i* caused by its gravitational attraction to body *j* is given by the following: $\boldsymbol{f}_{ij} = \mathbf{G}\frac{\mathbf{m_i m_j}}{\lVert\mathbf{r_{ij}}\rVert^2}\cdot\frac{\mathbf{r_{ij}}}{\lVert\mathbf{r_{ij}}\rVert}$ where *mi* and *mj* are the masses of bodies *i* and *j*, respectively; r*ij* = x*j* – x*i* is the vector from body *i* to body *j*; and *G* is the	All is ok up to now….SITA & CUDA are same

CUDA	SITA
gravitational constant. The left factor, the *magnitude* of the force, is proportional to the product of the masses and diminishes with the square of the distance between bodies *i* and *j*. The right factor is the *direction* of the force, a unit vector from body *i* in the direction of body *j* (because gravitation is an attractive force).The total force F*i* on body *i*, due to its interactions with the other *N* – 1 bodies, is obtained by summing all interactions: $\mathbf{F}_i = \sum_{\substack{1\le j\le N \\ j\ne i}} \mathbf{f}_{ij} = Gm_i \cdot \sum_{\substack{1\le j\le N \\ j\ne i}} \frac{m_j \mathbf{r}_{ij}}{\left\lVert \mathbf{r}_{ij} \right\rVert^3}.$	
As bodies approach each other, the force between them grows without bound, which is an undesirable situation for numerical integration. In astrophysical simulations, collisions between bodies are generally precluded; this is reasonable if the bodies represent galaxies that may pass right through each other. Therefore, a *softening factor* $\varepsilon^2 > 0$ is added, and the denominator is rewritten as follows:	….SITA & CUDA ……are different now….Newton’s Laws are not changed in SITA. $\varepsilon^2= 0$ in SITA…

CUDA	SITA
$F_i \approx Gm_i \cdot \sum_{1\le j\le N} \frac{m_j \mathbf{r}_{ij}}{\left(\lVert\mathbf{r}_{ij}\rVert^2 + \varepsilon^2\right)^{3/2}}.$	….SITA & CUDA ……are different now… Newton’s equation changed in CUDA, where as in SITA WE USE IT WITHOUT ANY CHANGE
Note the condition $j \neq i$ is no longer needed in the sum, because $fii = 0$ when $\varepsilon2 > 0$.	….SITA & CUDA ……are different now….Newton’s Laws are not changed in SITA. Condition *j ≠ I can not be removed* $\mathbf{F}_i$ is the force acting on i th particle and is exact value not an approximation. The force will be :. $\mathbf{F}_i == \mathrm{Gm_i} \sum_{\substack{1\le i\le N \\ j\neq i}} \frac{\mathrm{m_j}\,\mathbf{r}_{\mathrm{ij}}}{\lVert\mathbf{r}_{\mathrm{ij}}\rVert^3}$ In SITA…‘Vak1’ macro is used for calculating the UGF (Universal Gravitational Force) on each particle /mass. Now we will calculate the acceleration using formula ‘$ai = Fi/m$’ No additional error e was introduced.

CUDA	SITA
The softening factor models the interaction between two Plummer point masses: masses that behave as if they were spherical galaxies (Aarseth 2003, Dyer and Ip 1993). In effect, the softening factor limits the magnitude of the force between the bodies, which is desirable for numerical integration of the system state.	….SITA & CUDA ……are different now….No softening factor is introduced as said by Aarseth 2003, Dyer and Ip 1993. They claim that the softening factor models the interaction between two Plummer point masses: masses that behave as if they were spherical galaxies, but that introduces the error and wrong behavior of masses on higher time-steps and longer iterations...
To integrate over time, we need the acceleration a*i* = F*i*/*mi* to update the position and velocity of body *i*, and so we simplify the computation to this: $\mathbf{a}_i \approx G \cdot \sum_{1 \le j \le N} \frac{m_j \mathbf{r}_{ij}}{\left(\left\Vert \mathbf{r}_{ij} \right\Vert^2 + \varepsilon^2 \right)^{3/2}}.$	….SITA & CUDA ……are different now…In CUDA acceleration is calculated now, which was done earlier in SITA.

CUDA	SITA
The integrator used to update the positions and velocities is a leapfrog-Verlet integrator (Verlet 1967)	The leapfrog-Verlet integrator IS NOT USED for finding distances IN SITA.. In general any integrator WILL give computational errors…
…because it is applicable to this problem and is computationally efficient (it has a high ratio of accuracy to computational cost). The choice of integration method in N-body problems usually depends on the nature of the system being studied. The integrator is included in our timings, but discussion of its implementation is omitted because its complexity is *O*(*N*) and its cost becomes insignificant as *N* grows.	….SITA & CUDA ……are different now…In CUDA this acceleration is integrated over time. In SITA the resultant Universal Gravitational Force is calculated on each mass and resultant vectorial accelerations are calculated using SITA algorithm programs. Simple formulae are later used like ‘v-u = a t’ and, that is, final velocity is acceleration multiplied by time step plus initial velocity etc... And thus in SITA we don’t use any integrators, but we use UGF calculator and simple linear equations which approximate that portion of trajectory. And at present cost factor and O(N) are omitted in SITA

CUDA	SITA
A CUDA Implementation of the All-Pairs N-Body Algorithm We may think of the all-pairs algorithm as calculating each entry f*ij* in an *N*×*N* grid of all pair-wise forces.(*. The relation between reciprocal forces fji=−fij can be used to reduce the number of force evaluations by a factor of two, but this optimization has an adverse effect on parallel evaluation strategies (especially with small N), so it is not employed in our implementation*)	….SITA & CUDA ……are different now…This relation *reciprocal forces fji=−fij* is not used. Remember that we already stated that j=I condition was not removed from Dynamic universe model.
Then the total force F*i* (or acceleration a*i*) on body *i* is obtained from the sum of all entries in row *i*. Each entry can be computed independently, so there is O(N^2) available parallelism.	Total force F*i* is calculated on body *i* from the sum of all entries in the Row *i* in CUDA In SITA UGF is calculated.
However, this approach requires O(N^2) memory and would be substantially limited by memory bandwidth.	In CUDA everything is kept in memory. In SITA additional “Display refreshing cycles” and hard disk transfers are present which are inbuilt in the commercial compiler used,

CUDA	SITA
Instead, we serialize some of the computations to achieve the data reuse needed to reach peak performance of the arithmetic units and to reduce the memory bandwidth required. Consequently, we introduce the notion of a computational *tile*, a square region of the grid of pair-wise forces consisting of *p* rows and *p* columns. Only 2*p* body descriptions are required to evaluate all *p*2 interactions in the tile (*p* of which can be reused later). These body descriptions can be stored in shared memory or in registers. The total effect of the interactions in the tile on the *p* bodies is captured as an update to *p* acceleration vectors.	In CUDA, they are going to update acceleration vectors? why? In SITA this computation tile notion will be required for faster processing of higher number of masses…
To achieve optimal reuse of data, we arrange the computation of a tile so that the interactions in each row are evaluated in sequential order, updating the acceleration vector, while the separate rows are evaluated in parallel.	In CUDA this is GOOD, separate rows are evaluated in parallel… To be implemented in SITA….

CUDA	SITA
Body-Body Force Calculation The interaction between a pair of bodies as described in Section 31.2 is implemented as an entirely serial computation. The code in Listing 31-1 computes the force on body *i* from its interaction with body *j* and updates acceleration a*i* of body *i* as a result of this interaction. Then the total force F*i* (or acceleration a*i*) on body *i* is obtained from the sum of all entries in row *i*. Each entry can be computed independently, so there is O(N^2) available parallelism.	In CUDA-total force F*i* is calculated on body *i* from the sum of all entries in the Row *i.* In SITA UGF is calculated.
Listing 31-1. Updating Acceleration of One Body as a Result of Its Interaction with Another Body __device__ float3 bodyBodyInteraction(float4 bi, float4 bj, float3 ai)	Listing 31-1. The comments on this listing below, this programming is not yet been done. These are hypothetical comments only. // name of the program with INPUTS 4 vector bi, bj and OUTPUT ai,

CUDA	SITA

// name of the program with INPUTS 4 vector bi, bj and OUTPUT ai,
{
float3 r;
// ??float3= 3 data sets x,y,z floating point ? float4= 4 data sets w, x,y,z floating point ?
// r_ij [3 FLOPS]
r.x = bj.x - bi.x;
r.y = bj.y - bi.y;
r.z = bj.z - bi.z;
// DISTANCE= r = bj - bi
// distSqr = dot(r_ij, r_ij) + EPS^2 [6 FLOPS]
float distSqr = r.x * r.x + r.y * r.y + r.z * r.z + EPS^2;
	// ??float3= 3 data sets x,y,z floating point ? float4= 4 data sets w, x,y,z floating point ?
	// DISTANCE= r = bj - bi
	// IMP!!!! dist^2= x^2+y^2+z^2+EPS^2 ===WRONG !!!! EPS=0 should be in SITA

CUDA	SITA

// IMP!!!! dist^2= $x^2+y^2+z^2+EPS^2$ ===WRONG !!!! EPS=0 should be in SITA
// invDistCube =1/distSqr^(3/2) [4 FLOPS (2 mul, 1 sqrt, 1 inv)]
float distSixth = distSqr * distSqr * distSqr;
float invDistCube = 1.0f/sqrtf(distSixth);
// dist Sixth = $r^2.r^2.r^2$
// Inv distCube = $1/(r^2.r^2.r^2)^{0.5}$ = $1 / r^3$
// s = m_j * invDistCube [1 FLOP]
float s = bj.w * invDistCube;
// s = mass / r^3
// a_i = a_i + s * r_ij [6 FLOPS]
ai.x += r.x * s;
ai.y += r.y * s;
ai.z += r.z * s;
	// dist Sixth = $r^2.r^2.r^2$
	// Inv distCube = $1/(r^2.r^2.r^2)^{0.5}$ = $1 / r^3$
	// s = mass / r^3\\
	// IMP !!! UGF (vak1) or total force in x,y,z directions are tobe calculated first in SITA… x,y,z accelerations are
	// calculated here directly…????
	// Return x,y,z accelerations to caller program…
	}

CUDA	SITA

// IMP !!! UGF (vak1) or total force in x,y,z directions are tobe calculated first in SITA… x,y,z accelerations are
// calculated here directly…????
return ai;
// Return x,y,z accelerations to caller program…
}	

We use CUDA's float4 data type for body descriptions and accelerations stored in GPU device memory. We store each body's mass in the *w* field of the body's float4 position. Using float4 (instead of float3) data allows *coalesced* memory	*coalesced* memory :efficient float 4 memory handling.
access to the arrays of data in device memory, resulting in efficient memory requests and transfers. (See the *CUDA Programming Guide* (NVIDIA 2007) for	For efficient memory requests: See the *CUDA Programming Guide* (NVIDIA 2007

CUDA	SITA
details on coalescing memory requests.)	
Three-dimensional vectors stored in local variables are stored as float3 variables, because register space is an issue and coalesced access is not.	
Tile Calculation A tile is evaluated by *p* threads performing the same sequence of operations on different data. Each thread updates the acceleration of one body as a result of its interaction with *p* other bodies.	….SITA & CUDA ……are different now…In CUDA direct accelerations are calculated.
We load *p* body descriptions from the GPU device memory into the shared memory provided to each *thread block* in the CUDA model. Each thread in the block evaluates *p* successive interactions. The result of the tile calculation is *p* updated accelerations.	CUDA steps are here…

CUDA	SITA
The code for the tile calculation is shown in Listing 31-2. The input parameter myPosition holds the position of the body for the executing thread, and the array shPosition is an array of body descriptions in shared memory. Recall that *p* threads execute the function body in parallel, and each thread iterates over the same *p* bodies, computing the acceleration of its individual body as a result of interaction with *p* other bodies.	CUDA Tile P x P calculations………
Listing 31-2. Evaluating Interactions in a *p*×*p* Tile __device__ float3 tile_calculation(float4 myPosition, float3 accel) // Input myPosition w,x,y,z ; Acceleration x,y,z output	Listing 31-2. Comments are in red // Input myPosition w,x,y,z ; Acceleration x,y,z output

CUDA	SITA

{
int i;
extern __shared__ float4[] shPosition;
for (i = 0; i < blockDim.x; i++) {
// blockDim .x is the P in P x P matrix probably….??
// shPosition is array i variable probably….
accel = bodyBodyInteraction(myPosition, shPosition[i], accel);
// calling the sub bodyBodyInteraction(myPosition, shPosition[i], accel);
}
// for loop ended…..
return accel;
	// blockDim .x is the P in P x P matrix probably….??
	// shPosition is array i variable probably….
	// calling the sub bodyBodyInteraction(myPosition, shPosition[i], accel);
	// for loop ended…..
	// what is this acceleration????????????
	}

CUDA	SITA
// what is this acceleration???????????? }	
The G80 GPU architecture supports concurrent reads from multiple threads to a single shared memory address, so there are no shared-memory-bank conflicts in the evaluation of interactions. (Refer to the *CUDA Programming Guide* (NVIDIA 2007) for details on the shared memory broadcast mechanism used here.)	IMP!!! CUDA Shared memory broadcast: see the *CUDA Programming Guide* (NVIDIA 2007)
Clustering Tiles into Thread Blocks We define a thread block as having *p* threads that execute some number of tiles in sequence.	Note: CUDA Tiles are to be executed in sequence…………..!
Further work not done as it requires practical programming and hands on testing….	Further work has not been done as it requires practical programming and hands on testing….
Previous Methods Using GPUs (Graphics Processing Units) for N-Body Simulation	(Graphics Processing Units)

CUDA	SITA
The N-body problem has been studied throughout the history of computing. In the 1980s several hierarchical and mesh-style algorithms were introduced, successfully reducing the $O(N^2)$ complexity. The parallelism of the N-body problem has also been studied as long as there have been parallel computers. We limit our review to previous work that pertains to achieving high performance using GPU hardware.	CUDA: Discussion limited to achieving high performance using GPU hardware
In 2004 we built an N-body application for GPUs by using Cg and OpenGL (Nyland, Harris, and Prins 2004). Although Cg presented a more powerful GPU programming language than had previously been available, we faced several drawbacks to building the application in a graphics environment. All data were either read-only or write-only, so a double-buffering scheme had to be used. All computations were initiated by drawing a rectangle whose pixel values were computed by a shader program, requiring $O(N^2)$ memory.	All data were either read-only or write-only,

CUDA	SITA
Hierarchical N-Body Methods Many practical N-body applications use a hierarchical approach, recursively dividing the space into subregions until some criterion is met (for example, that the space contains fewer than *k* bodies). For interactions within a leaf cell, the all-pairs method is used, usually along with one or more layers of neighboring leaf cells. For interactions with subspaces farther away, far-field approximations are used. Popular hierarchical methods are Barnes-Hut (Barnes and Hut 1986) and Greengard's fast multipole method (Greengard 1987, Greengard and Huang 2002). Both algorithms must choose how to interact with remote leaf cells. The general result is that many body-cell or cell-cell interactions require an all-pairs solution to calculate the forces. The savings in the algorithm comes from the use of a multipole expansion of the potential due to bodies at a distance, rather than from	We believe that the savings of moving from the CPU to the GPU will come not only from the increased computational horsepower, but also from the increased size of the leaf cells, making the hierarchical decomposition shallower, saving time in the far-field evaluation as well. In future work we hope to implement the BH or FMM algorithms, to evaluate the savings of more-efficient algorithms.

CUDA	SITA
interactions with the individual bodies at a distance. As an example in 3D, consider a simulation of 2^{18} bodies (256 K), decomposed into a depth-3 octree containing 512 leaf cells with 512 bodies each. The minimum neighborhood of cells one layer deep will contain 27 leaf cells, but probably many more will be used. For each leaf cell, there are at least 27 × 512 × 512 pair-wise force interactions to compute. That yields more than 7 million interactions per leaf cell, which in our implementation would require less than 1 millisecond of computation to solve. The total time required for all 512 leaf cells would be less than a half-second. Contrast this with our all-pairs implementation3 on an Intel Core 2 Duo (4. Intel Core 2 Duo 6300 CPU at 1.87 GHz with 2.00 GB of RAM) that achieves about 20 million interactions per second. The estimated time for the same calculation is about 90 seconds (don’t forget that the	

CUDA	SITA
CPU calculates only half as many pair-wise interactions). Even the high-performance implementations that compute 100 million interactions per second require 18 seconds. One way to alleviate the load is to deepen the hierarchical decomposition and rely more on the far-field approximations, so that the leaf cells would be populated with fewer particles. Of course, the deeper tree means more work in the far-field segment.	
Conclusion (CUDA) It is difficult to imagine a real-world algorithm that is better suited to execution on the G80 architecture than the all-pairs N-body algorithm. In this chapter we have demonstrated three features of the algorithm that help it achieve such high efficiency: ● Straightforward parallelism with sequential memory access patterns ● Data reuse that keeps the arithmetic units busy ● Fully pipelined arithmetic, including complex operations such as inverse square root,that are much faster clock-for-	**Conclusion (SITA)** CUDA is a practically developed programming technique. On the other hand SITA is Singularity free and Collision free programming with O (N^2) computational complexity…

CUDA	SITA
clock on a GeForce 8800 GTX GPU than on a CPU The result is an algorithm that runs more than 50 times as fast as a highly tuned serial implementation (Elsen et al. 2006) or 250 times faster than our portable C implementation. At this performance level, 3D simulations with large numbers of particles can be run interactively, providing 3D visualizations of gravitational, electrostatic, or other mutual-force systems. 3. Our implementation is single-threaded, does not use any SSE instructions, and is compiled with gcc. Other specialized N-body implementations on Intel processors achieve 100 million interactions a second (Elsen et al. 2006).	

8. General questions and discussions:

Some general questions on N-body are discussed in this chapter. I have been asked these questions in the summits, conferences and forums where this topic was presented.

Q: The disagreement here seems to be over what constitutes a "solution" for the N-body Problem..

The original prize announced by King Oscar II of Sweden for the N body problem was for an **analytical** solution. My understanding is that this means that you have a set of equations where you put in the initial values for various parameters (mass, velocity, etc) at t_0 and then you can then calculate the positions, velocities, etc at any given value of t, say t_n. That is, a single step to calculate the result at t_n

What **you are** presenting appears to be a **simulation** or **numerical** solution where you put in the initial values at time t and then to get to the value at t_n you have to run through a ***series of steps from*** $t=t_0, t_1, t_2, t_3, \ldots. t_n$.

A: The *original prize* announcement by King Oscar II of Sweden:

…. is for a solution of N-body problem with advice given by Gösta Mittag-Leffler in 1887. He announced:

> ‘*Given a system of arbitrarily many mass points that attract each according to Newton's law, under the assumption that no two points ever collide, try to find a representation of the coordinates of each point as a series in a variable that is some known function of time and for all of whose values the series* ***converges uniformly.’*** *See Ref [1]*

Here we have taken a ‘*a system of arbitrarily many mass points that attract each according to Newton's law’* in Dynamic Universe model. **We have not changed the NEWTON’s law anywhere.**

And *the assumption ‘**that no two points ever collide**’* is a valid assumption in Dynamic universe model. Due to this model’s fundamental ideology and mathematic formulation the collisions will not happen. But they may happen if uniform density of matter is used. For heterogeneous distributions the point masses will not colloid with each other. They start moving about each other for any formation of point masses as observed physically.

The announcement further says we have to find the ‘*coordinates of each point as a series in a variable’,* the words **‘analytical solution’** is not mentioned in the announcement. Here in Dynamic universe Model we find the representation of each point exactly from an **‘analytical solution’** derived here in Mathematical Background section (#3) and its Resulting Equation 25 of this monograph. The value of the variables ***converges uniformly*** for each point and gives only single value.

So, the original announcement as stated above says about a series, that should converge uniformly, and it should not give chaotic results. In Dynamic Universe model case, the series converges uniformly, gives a unique value. He did not mention that it should not run through a ***series of steps from*** $t=t_0, t_1, t_2, t_3, \ldots. t_n$. *Of course we can calculate the* ***result directly*** ‘t_n’ with limited accuracy on single time step. In the literature of science, there are many simulation methods for the last 120 years and **almost all have changed the Newton’s laws**. Some of the recent approaches were using iterative methods with high speed computers. None of them claim that they are singularity free and collision free.

My solution is Equation 25; it is **analytical** and is derived analytically. Just by saying that Equation 25, is the solution is not sufficient. People may not understand its complexity and depth. To make it understandable, SITA was developed. I want to stress that point again, that SITA is one of the many solutions possible for Equation 25. Many other solutions are possible for this Tensor. Then question comes how to prove and check SITA validity?

The tensor at the equation 25 is subdivided into many equations and calculations are done. Tensor is the basic equation. I am using basic methodology of calculations. It may be called a simulation, but should it be called Calculation? I don't know. If you don't want testing of Equation 25, then SITA is not required. I could not find any other method of testing Equation 25.

This equation 25 can be tested **by any person who has pencil and a paper.** Depending on the budget available with him, he can use logarithmic tables, Simple calculators, scientific calculators, PC, Laptop, Main Frame computers or Super computers.

This Dynamic Universe Model (SITA) is NOT **a** '**simulation** or **numerical** solution' when we are calculating the positions / velocities / accelerations of point masses using actual data. It is simply another calculation method. When we use factitious data which is not real or some data used for testing purposes then the results can be called as '**simulation** or **numerical** solution'.

Q: Please form the differential equation that describes the motion and solve it.

A: No differential equation is formed here in Dynamic Universe Model. Only simple and tested engineering equations are used in SITA. These are all outcomes after solving equation 25, which I referred in Dynamic universe model.

This approach is slightly different from forming differential equations and solving. We cannot get solutions with that approach. People have tried in vain and have not been able to arrive at a solution and we already know that. That’s why there was no singularity free solution earlier.

Q: When carrying out these kinds of solutions is it normal to have a variable time step in order to maintain accuracy in those regions of the particle trajectories where things are changing very quickly.

A: It is possible to have a variable time step.

Q: Your equations are Newtonian, i.e. there is e.g. no time derivative of the mass

A: There is no time derivative of the mass, etc.

Q: What is a tensor?

A: A tensor is a relationship between some vectors that is the general definition.

9. Comparison with other cosmologies

Our universe is not having a uniform mass distribution. Isotropy & homogeneity in mass distribution is not observable at any scale. We can see present day observations in '2dFGRS survey' publications for detailed surveys and technical papers [1]. The universe is lumpy as you can see in the picture given here in wikipedia [2]. There are Great voids, of the order of 1 billion light years where nothing is seen and then there is the Sloan Great Wall, the largest known structure, a giant wall of galaxies. These two observations indicate that our Universe is lumpy. After seeing all these we can say that uniform density as prevalent in Bigbang based cosmologies is not a valid assumption.

This universe is now in the present state, as existed earlier and will continue to exist in the same way. This is something like Hoyle's Steady state model philosophy [7] but without creation of matter. PCP (Perfect Cosmological Principle) was not considered true here as in steady state universe. We need not assume any homogeneity and isotropy here at any point of time. Matter need not be created to keep the density constant. Here Bigbang like creation of matter is also not required. Blue shifted galaxies also exist along with red shifted ones. No dark energy and dark matter is required to explain physical phenomena here. Here in this model the present measured CMB is from stars, galaxies and other astronomical bodies. This Dynamic Universe Model is a closed universe model.

Our Universe is not empty. For example De Sitter's universe model explains everything but his Universe has no matter in it [8]. It may not hold a sink to hold all the energy that is escaped from the universe at infinity.[ref Einstein] It is a finite and closed universe. Absolute Rest frame of reference is not necessary. The time and space coordinates can be chosen as required. Dynamic Universe Model is different from Fritz Zwicky's tired light theory as light does not loose energy here [9]. Gravitational red shift is present here.

Dynamic Universe Model gives a daring new approach. It is different from Newtonian static model and Olber's paradox [10]. Here masses don't collapse due to self-gravitation and even though the masses are finite in number, they balance with each other dynamically and expanding. There is no space-time continuum. Hawking and Penrose [11,12] (1969, 1996) in their singularity theorem said that 'In an Isotropic and homogeneous expanding universe, there must be a Big bang singularity some time in the past according to General theory of relativity '. Since Isotropy and Homogeneity is not an assumption in Dynamic Universe Model, singularity theorem is not applicable here and Hawking's Imaginary time axis perpendicular to time axis is not required. No baby universes, Blackhole or wormhole singularity [13] is built in. No Bigbang singularity [14] as in Friedmann-Robertson-Walker models. JV Narlikars' many mini Bigbangs are also not present here [15]. Also this Dynamic Universe Model is poles apart from, M-theory & String theories or any of the Unified field theories. The basic problem in all these models, including String theory [16] and M-theory [17] is that the matter density is significantly low and they push Bigbang singularity into some other dimensions.

There is a fundamental difference between galaxies / systems of galaxies and systems that normally use statistical mechanics, such as molecules in a box. The molecules repel each other but in gravitation we have not yet experienced any repulsive forces. Only attraction forces were seen in Newtonian and Bigbang based cosmologies. (See for ref: Binny and Tremaine 1987 [18]). But here in Dynamic Universe Model masses when distributed heterogeneously experience repulsive forces as well as attractive forces due to the total resulting universal force acting on the particular mass. Einstein's cosmological constant λ[19] to introduce repulsive forces at large scales like inter galactic distances (as also in MOND), is not required here.

Comparison between Dynamic Universe and Bigbang model:

Now I feel it is high time to consider the other possible cosmological models also. People have seen both positive and negative sides of Bigbang based cosmologies. However, it is not that the Dynamic Universe Model explains every aspect of cosmology. Nevertheless, it tries to explain many aspects. Now let us compare the Dynamic Universe Model as an Alternative Cosmological model with Bigbang based cosmologies. I am requesting you to see the Comparison Table 30. Here we can see the Bigbang based cosmological models and their problems with achievements of Dynamic Universe Model.

Table 30 : This is a Comparison Table: Here Bigbang vs. Dynamic Universe Model comparison done. The general questions and cosmological conditions which are supposed to be answered by any Cosmology model are given and comparison of various respective answers given by Bigbang based cosmological models with Dynamic Universe Model is shown.

	General question answered by any theory (Cosmology condition) ………	**Bigbang based cosmology**	**Dynamic Universe Model**
1	It should say something about the creation of Universe / matter.	Required, In the form of Bigbang Singularity.	Not required, NO Bigbang Singularity, No SINGULARITY
2	It should explain about the expansion of Universe.	Says Universe is expanding, But keeps mum about explaining the force behind expansion.	Says Universe is expanding, But explains the force behind expansion.

	General question answered by any theory (Cosmology condition) ………	Bigbang based cosmology	Dynamic Universe Model
3	It should say about the universe closed-ness,	Due to Space-time continuum and curvature.	Due to Classical Physics
4	It should explain Large scale structures etc.	Explained Using General relativity	Explained Using Total Universal Gravitational Force on Bodies
5	Dark matter	Cannot explain missing mass, Concept of UNKNOWN dark matter required to explain many things	Explains missing mass, dark matter NOT required
6	Dark energy	Concept of UNKNOWN dark energy required to explain many things	NOT required
7	It should tell about existence of Blue shifted Galaxies	Keeps mum No answer	Blue and red-shifted Galaxies can co-exist

	General question answered by any theory (Cosmology condition) ………	**Bigbang based cosmology**	**Dynamic Universe Model**
8	It should explain about universe starting assumptions like uniform density of matter	Uniform density of matter required	Can explain large VOIDs, Based on NON uniform mass densities……..
9	It should deal correctly with celestial mechanics Like pioneer anomaly	Predicts away from SUN Observed is TOWARDS SUN	Predicts towards SUN as Observed (Important)
10	It should calculate correctly the Trajectory of New horizons satellite to Pluto.	At present trajectory predictions done using thumb-rules not from any model	Theoretically Calculates Trajectory accurately

10. Dynamic Universe model results

Other results of Dynamic universe model

Dynamic Universe Model is a mathematical model of cosmology based on classical Physics. Real calculations are done on the computer, No imaginary numbers are used. Nothing abnormal is assumed anywhere. Basically it is a calculation based system and real observational data based theoretical system. Here in Dynamic Universe Model all bodies move and keep themselves in dynamic equilibrium with all other bodies depending on their present positions, velocities and masses. The mathematical portion is exactly same with133 point mass structure for all these derived results given below…

1. Galaxy Disk formation using Dynamic Universe Model (Densemass) Equations [See ref for chapter]

2. Solution to Missing mass in Galaxies: It proves that there is no missing mass in Galaxy due to circular velocity curves [ref]

3. Explains gravity disturbances like Pioneer anomaly, etc [ref].

4. Non-collapsing Large scale mass structures formed when non-uniform density distributions of masses were used [ref]

5. Offers Singularity free solutions.
6. Non- collapsing Galaxy structures
7. Solving Missing mass in Galaxies, and it finds reason for Galaxy circular

velocity curves….

8. Blue shifted and red shifted Galaxies co-existence…
9. Explains the force behind expansion of universe.
10. Explains the large voids and non-uniform matter densities.
11. Predicts the trajectory of New Horizons satellite.

12 Withstands 10^5 times the Normal Jeans swindle test

13. Explaining the Existence of large number of blue shifted Galaxies etc…..

Only differences used between the various simulations are in the initial values & the time steps. The structure of masses is different. In the first 2 cases, I have used approximate values of masses and distances. In the third and fourth case, I have used real values of masses and distances for a close approximation.

Discussion:

This Dynamic Universe Model gives a different approach for modeling Universe. This methodology is dissimilar to the existing all the present day known models. This work is based on results of 18 years of testing of Dynamic Universe Model equations. It produced results for large-scale structures without any singularities. To summarize some of the important advantages of Dynamic Universe Model as an Alternative Cosmological model. Here for comparison sake, we can see the Bigbang based cosmological models and their problems with achievements of Dynamic Universe Model. The masses are allowed on Newtonian gravitation here. Mass distribution is at the actual, as close to the present day measurements as possible. It is found that they do not collapse due to Newtonian gravitation, but they expand. Their internal distances increase. Otherwise, when the mass distribution is uniform as taken in other models, the masses show a collapsing tendency. This does not use General Relativity. Penrose and Stephen Hawking's Singularity theorem is not applicable. Thence there is no Bigbang singularity theoretically. On the other hand, with the same math model and simulation setup, it finds solutions to problems like missing mass in Galaxies, Pioneer anomaly, Galaxy disk formation etc,. All the results which were achieved by this Dynamic Universe Model are by using simple Newtonian day-to-day engineering Physics in Euclidian geometry. Bigbang based cosmologies require dark energy, dark matter etc, resulting into singularities. No Bigbang, Blackhole or warm-hole are present here. NO additional singularities introduced because of its model SITA simulation calculations. Due to its finite number of masses, Newton's Static Model and Olber's paradox is not applicable. Light does not loose energy here; hence, tired Light models are not applicable. This is different from Steady state model also. No creation of matter is required as in Hoyle's Steady state or Bigbang models. And Dynamic Universe Model is poles apart from MOND, M-theory & String theories or any of the Unified field theories. The time and space coordinates are not merged. There is no space-time continuum. The present measured CMB is from stars Galaxies and other astronomical bodies. This Dynamic Universe Model gives a finite, closed universe. *The universe is in the present state as today; will remain same tomorrow also.*

Safe conclusions on singularities of Dynamic Universe Model:

In Dynamic Universe model, *a system of arbitrarily many mass points that attract each according to Newton's law* were taken and the NEWTON's law was not changed anywhere. The basic assumption is '*that no two points ever collide*' in Dynamic Universe model. Due to this model's fundamental ideology and mathematic formulation, the collisions will not happen. But they may happen if uniform density of matter is used in the input data. For heterogeneous distributions the point masses will not colloid with each other. They start moving about each other for heterogeneous formation of point masses as observed physically.

Here in, the Dynamic universe Model we find the representation of each point i.e., '*the coordinates of each point as a series in a variable*' are calculated using a computer (the calculations are done in the computer as a series) exactly (in a non-diverging way) from *an analytical solution* as derived here in Mathematical Background section (Chapter 3) and its Resulting Equation 25 of this monograph. The value of the variables converges uniformly for each point and gives only a single value.

How to test the Dynamic Universe model for singularities? Simple answer is to browse the web for existing methods and theorems for 'singularities in N-body' solutions available in the scientific world from earlier Newtonian time to present day. Whatever the scientific theories obtainable were collected. Although so much literature was available for 3 body problem singularities, it quickly vanishes after 4-body problem. What we need is such literature, which proves conclusively for any arbitrary N that singularities exist or not in a particular N-body system and discuss about its stability. All these available literature were presented at the beginning of the relevant tables on singularities in chapter 5, in the table 3 to table 26.

Six cases were considered for checking the singularities in dynamic Universe model in Chapter 5:

1. Non-zero velocity position vector cross product,
2. Non-zero Angular Momentum: MASS Velocity Position Vector cross product,
3. Dynamic Universe Model is stable: showing 'Total Energy = h=T-V" is NEGATIVE',
4. Non-zero polar moment of inertia
5. The non-zero Internal Distance between all pairs of point masses.
6. The summation of Velocity unit vector differences Test

All these results were checked many times while doing the calculations. It is difficult to give all the resulting data. Some example outputs are given Chapter 5 for the 220th iteration.. Now let's discuss each case separately.

This first one sum of the constant specific relative angular momentum (velocity position vector cross product) is almost from the Newtonian times. One example was given here. The Sum of the velocity position vector cross product or the specific relative angular momentum, for START positions and velocities of present iteration is given in Table 4. Table 5 gives the same for positions & velocities of the END of the present iteration. First column in table 4 and 5 gives lists the point mass number and later x, y & z values for each point mass. It can be observed the x, y & z values and their totals are non-zero and not changing much in value. We can cross check from table to table. Further grand totals and essence can be seen in see table 3. Their vector sum is also same. Hence this test implies the Dynamic universe model is stable and Newtonian.

The second one is "The zero sum of angular momentum or mass velocity position vector cross product at the time of singularity" This was first affirmed by Sundman 1912 *that angular momentum c = 0 at collision and tends to zero before* *and after collision*, Weierstrass also mentioned this result in his works and References were available in the book by Igorevich Amold, Kozolov, and Neishtadt. Referring the above three citations, *angular momentum* are to be checked for possible singularities. Position and velocity data from Iteration END (Table 8) & START (table 7) were taken calculating the non-zero "Angular Momentum". Calculations show that no singularities exist in Dynamic Universe model.

The third one is the non-zero Polar moment of inertia. In their book Vladimir Igorevich Amold, Kozolov, Neishtadt in section 2.2.2 said '*If the position vectors* $r_i(t)$ *of all the points have one and the same limit* r_o *as* $t \rightarrow t_o$ *then we say a simultaneous collision takes place at time* t_o*. The point* r_o *clearly must coincide with the centre of mass, that is* $r_o =$ ***0.*** *A simultaneous collision occurs if and only if the polar moment of inertia* $I(t) \rightarrow 0$ *as* $t \rightarrow t_o$ *.'* Referring the above citation; ***polar moment of inertia*** was checked for zero for possible singularities. So, sum of *polar moment of inertia* was calculated many times, it was never zero or it tends to zero. The vector sum is also similar. One example was shown for Iteration END (Table 9) & START (table 10). Hence results of this test imply the Dynamic universe model is singularity and collision free.

The fourth one shows the Dynamic Universe Model is stable [see Table 11]. "Total Energy = h=T-V" is NEGATIVE as discussed in their book by Vladimir Igorevich Amold, Kozolov, Neishtadt. (2003). Here V is calculated only for masses involving # 133, 132, 131 and 130. If we add the force function for all the masses, it will be much higher. Here itself the total of V is 4.5479×10^{62}. Whereas T= 1.16843E+40. Hence V is larger by 4.5479×10^{62} joules. Hence all the motions are stable in this model.

The fifth one is 'The velocity unit vectors for all masses will be directed towards the center of mass at and before the time of collision'. In their book Vladimir Igorevich Amold, Kozolov, Neishtadt in section 2.2.2 said '*If the position vectors* $r_i(t)$ *of all the points have one and the same limit* r_o *as* $t \rightarrow t_o$ *then we say a simultaneous collision takes place at time* t_o*. The point* r_o *clearly must coincide with the center of mass, that is* $r_o =$ ***0.*** If there is a non-alignment then there is NO collision which is self-evident: [see table 12] This Non alignment of present velocity UNIT vectors with UNIT vectors towards Center of Mass of all point masses, shows that Dynamic Universe Model is stable and non-collapsing. This velocity unit vector alignment is devised in Dynamic universe model.

The sixth one is about internal distances of point masses. The non-zero internal distance between all pairs of point masses [see table 13 to 26]. The zeros in these tables show the distance, when starting point and ending point are same. These distances are shown for the iteration END positions and prove that there are no Binary collisions.

I performed these tests and calculated the resulting values no chaotic situations and no singularities in Dynamic Universe Model. All these six sets of theory and tables provide necessary and sufficient proof for saying that Dynamic Universe Model is singularity free from the point of view of angular momentum, moment of inertia, polar moment of inertia, total energy, binary collisions and total collapse of the system.

The chaotic situations encountered in the earlier large scale N-body problem solutions as discussed by Wayne Hayes can be seen in Chapter 6. There are other problems like system stability failure on small perturbation, Numerical error accumulation (see page 147), diverging solutions, different algorithms give different solutions, close encounters of particles (see page 148), softening factors, Universal Gravitational force, Error accumulation (see page 149), validity large N-body simulations, forced softening methods(see page 150), problems of numerical integration and its truncation errors, round-off errors (see page 151) etc., were discussed and compared with Dynamic universe model.

All these problems are not apparent in Dynamic Universe Model.

That is how we can say this model is Singularity and collision free and stable.

11. Acknowledgements

Bringing all this mathematical work is solitary work under the guidance given by Goddess VAK, but publishing a book is not. There are many people to whom I want to give my individual aloha! for their help. Special thanks to Vibha, Shantala Ramesh, Bujji, Kiron and Savitri who are my editors, from the time we had discussions for this book to the final edits before the launching of this book, their guidance and contributions are invaluable.

12. References

References: Chapter 1 History <1900

1. Newton

http://www.google.co.in/search?hl=en&lr=&as_qdr=all&tbs=tl:1,tl_num:100&q=isaac%20newton&sa=X&ei=nKpgTPzOD4uavgOf86WyCQ&ved=0CC4Q0AEoADAB

… Terrorism: Eliciting the dynamic of two-body, three-body and **n-body** … - Related web pages www.laetusinpraesens.org/musings/threebod.php

http://en.wikipedia.org/wiki/Isaac_Newton

2. History

http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/Orbits.html

http://www.google.co.in/search?hl=en&tbs=tl%3A1%2Ctl_num%3A100&as_q=history+of++problem&as_epq=n+body+&as_oq=&as_eq=&num=10&lr=&as_filetype=&ft=i&as_sitesearch=&as_qdr=all&as_rights=&as_occt=any&cr=&as_nlo=&as_nhi=&safe=images

http://en.wikipedia.org/wiki/Collinear

3. Cotes

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Cotes.html

4. Euler

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Euler.html http://en.wikipedia.org/wiki/Leonhard_Euler

5. Clairaut

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Clairaut.html

6. Lagrange

http://en.wikipedia.org/wiki/Joseph_Louis_Lagrange

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Lagrange.html

7. D'Alembert

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/D'Alembert.html

http://www-groups.dcs.st-and.ac.uk/~history/Societies/Paris.html

7.A. JacobiIntegral

http://scienceworld.wolfram.com/physics/JacobiIntegral.html

8. Herschel

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Herschel.html

9. Lapalce

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Laplace.html

10. Adams

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Adams.html

11. Delaunay

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Delaunay.html

http://en.wikipedia.org/wiki/Charles-Eug%C3%A8ne_Delaunay

12. Gauss

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Gauss.html

13. Airy

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Airy.html

14. Bessel.

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Bessel.html

15. Arago

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Arago.html

16. Le_Verrier

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Le_Verrier.html

17. Liouville

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Liouville.html

18. Hamilton

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Hamilton.html

19. Jacobi

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Jacobi.html

20. Bertrand

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Bertrand.html

21. Newcomb

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Newcomb.html

22. Saturn rings

JK's Applets for Teaching Astrophysics

http://astro.u-strasbg.fr/~koppen/apindex.html

23. Three body

http://ebooks.cambridge.org/aaa/chapter.jsf?bid=CBO9780511526367&cid=CBO9780511526367A008&pageTab=ce

http://www-groups.dcs.st-and.ac.uk/~history/Societies/Paris.html

http://en.wikipedia.org/wiki/Euler%27s_three-body_problem

http://en.wikipedia.org/wiki/Lagrangian_point

24. Hill_sphere

http://en.wikipedia.org/wiki/Hill_sphere

25. Roche_lobe

http://en.wikipedia.org/wiki/Roche_lobe

26. Henri_Poincare

http://en.wikipedia.org/wiki/Henri_Poincar%C3%A9

27. Chaos_theory

http://en.wikipedia.org/wiki/Chaos_theory

http://ebooks.cambridge.org/aaa/chapter.jsf?bid=CBO9780511526367&cid=CBO9780511526367A008&pageTab=ce

http://en.wikipedia.org/wiki/Lagrangian_point

http://www-groups.dcs.st-and.ac.uk/~history/Societies/Paris.html

http://en.wikipedia.org/wiki/Perturbation_theory

28. Birkhoff

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Birkhoff.html

29. Levi-Civita

http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Levi-Civita.html

30. King Oscar prize http://en.wikipedia.org/wiki/N-body_problem

31. Principia by Sir Isaac Newton:

see Book I, Prop.65, 66 and its corollaries, Newton, 1687 and 1999 [transl.], see Tisserand, 1894

References: Chapter 2 Universe model

2**6.** Gott et al., 2005, ApJ, 624, 463 http://www.journals.uchicago.edu/ApJ/journal/issues/ApJ/v624n2/59364/59364.html
http://www.astro.princeton.edu/universe/ms.pdf

See for various maps of Universe and Fig 8 at:

http://www.astro.princeton.edu/universe/

27 Cruz, Martínez-González, Vielva & Cayón (2005), "Detection of a non-Gaussian Spot in WMAP", MNRAS 356 29-40 [astro-ph/0405341]

28 Colless M.M., Dalton G.B., Maddox S.J., Sutherland W.J., Norberg P., Cole S.M., Bland-Hawthorn J., Bridges T.J., Cannon R.D., Collins C.A., Couch W.J., Cross N., Deeley K., De Propris R., Driver S.P., Efstathiou G., Ellis R.S., Frenk C.S., Glazebrook K., Jackson C.A., Lahav O., Lewis I.J., Lumsden S., Madgwick D.S., Peacock J.A., Peterson B.A., Price I.A., Seaborne M., Taylor K., 2001, MNRAS, 328, 1039 [ADS | astro-ph/0106498] See 2dFGRS publications http://www.mso.anu.edu.au/2dFGRS/

29 Fairall, A. P., Palumbo, G. G. C., Vettolani, G., Kauffman, G., Jones, A., & Baiesi- 1990MNRAS.247P..21F. See in Wikipedia “The Large scale structure of cosmos” http://en.wikipedia.org/wiki/Large-scale_structure_of_the_cosmos H.P. Robertson, Kinematics and world Structure III , The Astrophysical Journal, May 1936, vol 83 pp 257.

30 Lawrence Rudnick, Shea Brown, Liliya R. Williams, Extragalactic Radio Sources and the WMAP Cold Spot, Astrophysics journal and arXiv:0704.0908v2 [astro-ph],

31. S.Samurovic et al; 0811.0698v1 Arxiv, ‘*Mond vs Newtonian dynamics GC*’, A&A accpted Nov 5, 2008. (for mass calculations)

32.

References: Chapter 3 Math background

http://members.wap.org/kevin.parker/Densemass/VakPioneerAnom.doc

References: Chapter 4 SITA

http://members.wap.org/kevin.parker/Densemass/VakPioneerAnom.doc

References: Chapter 5 No singularity

Book: **Mathematical Aspects of Classical and celestial mechanics,** Vladimir Igorevich Amold, Kozolov, Neishtadt in page 73, section 2.2.2.

Barrow-Green, J. *Poincaré and the Three Body Problem.* Amer. Math. Soc., 1996. http://www.amazon.com/exec/obidos/ASIN/0821803670/ref=nosim/weisstein-20

Hénon, M. "Numerical Exploration of Hamiltonian Systems." Course 2 in *Les Houches, Session XXXVI, 1981--Compartment Chaotique des Systémes Déterministes/Chaotic Behavior of Deterministic Systems.* Amsterdam, Netherlands: North-Holland, p. 93, 1983.

Poincaré, H. *New Methods of Celestial Mechanics.* AIP, 1992.

http://www.amazon.com/exec/obidos/ASIN/1563961156/ref=nosim/weisstein-20

Sundman, K. F. "Mémoire sur le problème des trois corps." *Acta Math.* **36**, 105, 1912.

Szebehely, V. G. *Theory of Orbits: The Restricted Problem of Three Bodies.* New York: Academic Press, 1967. http://www.amazon.com/exec/obidos/ASIN/0126806500/ref=nosim/weisstein-20

References: Chapter 6 Other N-body

0

http://www.cs.utoronto.ca/~wayne/research/thesis/msc/msc.html

1

Sverre J. Aarseth. Direct Methods for *N*-Body Simulations. In ***Multiple Time Scales***, pages 377-418. Academic Press, Inc., 1985.

2

D. V. Anosov. Geodesic Flows and Closed Riemannian Manifolds with Negative Curvature. ***Proc. Steklov Inst. Math***, 90:1, 1967.

3

Josh Barnes and Piet Hut. A hierarchical $O(N \log N)$ force-calculation algorithm. ***Nature***, 324:446-449, 4 December 1986.

4

Joshua Barnes, Jeremy Goodman, and Piet Hut. Dynamical instabilities in spherical stellar systems. ***The Astrophysical Journal***, 300:112-131, 1986.

5

Joshua E. Barnes and Piet Hut. Error analysis of a tree code. ***Astrophysical Journal Supplement Series***, 70:389-417, 1989.

6

James Binney and Scott Tremaine. ***Galactic Dynamics***. Princeton Series in Astrophysics. Princeton University Press, 1987.

7

R. Bowen. $O(N\log N)$-Limit Sets for Axiom *A* Diffeomorphisms. ***Journal of Differential Equations***, 18:333, 1975.

8

Silvina Dawson, Celso Grebogi, Tim Sauer, and James A. Yorke. Obstructions to Shadowing When a Lyapunov Exponent Fluctuates about Zero. ***Physical Review Letters***, 73(14):1927-1930, 3 Oct 1994.

9

Al Geist, Adam Beguelin, Jack Dongarra, Weicheng Jiang, Robert Manchek, and Vaidy Sunderam. PVM: Parallel Virtual Machine:A Users' Guide and Tutorial for Network Parallel Computing. Available via anonymous ftp from netlib2.cs.utk.edu:/pvm3/book/pvm-book.ps.

10

Jeremy Goodman, Douglas C. Heggie, and Piet Hut. On the exponential instability of *N*-body systems. ***The Astrophysical Journal***, 415:715-733, 1993.

11

Celso Grebogi, Stephen M. Hammel, James A. Yorke, and Tim Sauer. Shadowing of Physical Trajectories in Chaotic Dynamics: Containment and Refinement. ***Physical Review Letters***, 65(13):1527-1530, 24 September 1990.

12

Leslie Greengard and Vladimir Rokhlin. A fast algorithm for particle simulation. ***Journal of Computational Physics***, 73:325, 1987.

13

Ernst Hairer, Syvert Paul Nørsett, and Gerhard Wanner. ***Solving Ordinary Differential Equations I - Nonstiff Problems***. Springer-Verlag, 1980.

14

D. C. Heggie and R. D. Mathieu. Standardized units and time scales. In Piet Hut and S. L. W. McMillan, editors, ***Standardized Units and Time Scales***, pages 233-235. Springer-Verlag, 1986.

15

Lars Hernquist, Piet Hut, and Jun Makino. Discreteness noise versus force errors in *N*-body simulations. ***Astrophysical Journal Letters***, 402:L85-L88, 1993.

16

Alan C. Hindmarsh. LSODE and LSODI, two new initial value ordinary differential equation solvers. ***ACM-SIGNUM Newsletter***, 15(4):10-11, 1980.

17

J. Garrett Jernigan and David H. Porter. A tree code with logarithmic reduction of force terms, hierarchical regularization of all variables, and explicit accuracy controls. ***Astrophysical Journal Supplement Series***, 71:871-893, 1989.

18

David Kahaner, Cleve Moler, and Stephen Nash. ***Numerical Methods and Software***. Prentice-Hall series in Computational Mathematics. Prentice-Hall, 1989.

19

Henry E. Kandrup and Haywood Smith. On the sensitivity of the *N*-body problem to small changes in initial conditions. ***The Astrophysical Journal***, 374:255-265, 1991.

20

Henry E. Kandrup and Haywood Smith. On the sensitivity of the *N*-body problem to small changes in initial conditions. II. ***The Astrophysical Journal***, 386:635-645, 1992.

21

Henry E. Kandrup, Haywood Smith, and David Willmes. On the sensitivity of the *N*-body problem to small changes in initial conditions. III. ***The Astrophysical Journal***, 399:627-633, 1992.

22

M. Lecar. A comparison of eleven numerical integrations of the same gravitational 25-body problem. ***Bull. Astron.***, 3:91, 1968.

23

Thomas A. McGlynn. Dissipational collapse of galaxies and initial conditions. ***The Astrophysical Journal***, 281:13-30, 1984.

24

David Merritt and Luis A. Aguilar. A numerical study of the stability of spherical galaxies. ***Monthly Notices of the Royal Astronomical Society***, 217:787-804, 1985.

25

Dimitri Mihalas and James Binney. ***Galactic Astronomy -- Structure and Kinematics***. Princeton Series in Astrophysics. Freeman, 1981.

26

R. H. Miller. Irreversibility in small stellar dynamical systems. ***The Astrophysical Journal***, 140:250, 1964.

27

D. Pfenniger and D. Friedli. Computational issues connected with 3D N-body simulations. ***Astronomy and Astrophysics***, 270:561-572, 1993.

28

William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery. ***Numerical Recipes in C***. Cambridge University Press, second edition, 1992.

29

Gerald D. Quinlan and Scott Tremaine. On the reliability of gravitational *N*-body integrations. ***Monthly Notices of the Royal Astronomical Society***, 259:505-518, 1992.

30

J. A. Sellwood. The global stability of our Galaxy. ***Monthly Notices of the Royal Astronomical Society***, 217:127-148, 1985.

31

J. A. Sellwood. The art of *N*-body building. ***Annual Review of Astronomy and Astrophysics***, 25:151-86, 1987.

32

Jaswinder Pal Singh, John L. Hennessy, and Anoop Gupta. Implications of Hierarchical *N*-body Methods for Multiprocessor Architecture. Technical Report CSL-TR-92-506, Computer Systems Lab, Stanford University, Stanford, CA 94305, 1992.

33

Simon D. White. Simulations of sinking galaxies. ***The Astrophysical Journal***, 274:53-61, 1983.

34

SNP.Gupta (The following results were publicized by me in the earlier seminars / conferences.) ‘Absolute Rest frame of reference is not necessary’, presented in Symposium on Early Universe SEU, Dec 20-22; 1994, IIT, Madras, India, Proceedings Page 54. MULTIPLE BENDING OF LIGHT RAY IN OUR DYNAMIC UNIVERSE; A COMPUTER SIMULATION. Gr15: 15th international conference on gravitational conference on gravitation and relativity, pune, India. 16-21 DEC 1995\7. P116; a6.32 (1997),,; SNP. GUPTA, and ’ presented in SIGRAV, 18-22 September 2000 , Italy; Edited by R. Cianci, R. Collina, M. Francaviglia, and P. Fré (Eds) in Book “Recent Developments in General relativity Genoa 2000” published by Springer- Verlag Italia, Milano 2002, Page 389. On DYNAMIC UNIVERSE MODEL of cosmology and SITA (*Simulation* of *Inter-intra-Galaxy Tautness and Attraction_forces* with variable time step). The simulations in above paper were changed to small time steps and were accepted in British Gravity Meeting, in UK. 15-18 Sept 2004 the international conference on gravitation. SNP.GUPTA, DYNAMIC UNIVERSE MODEL of cosmology and SITA (*Simulation* of *Inter-intra-Galaxy Tautness and Attraction_forces* with higher time step). This

paper was formally presented in GR17; The 17th international conference on gravitation and relativity, in Dublin, Ireland, 18-24 July 2004. And on DYNAMIC UNIVERSE MODEL of cosmology and SITA again Presented in ICR 2005 (International Conference on Relativity) , at Amravati University , India, Jan 11-14, 2005 . On Missing mass , “DYNAMIC UNIVERSE MODEL of cosmology: *Missing mass* in Galaxy” Presented at OMEG05 Origin of Matter and Evolution of Galaxies, November 8-11, 2005 at Koshiba Hall, University of Tokyo, Tokyo . also in “*Missing mass* in Galaxy using regression analysis in DYNAMIC UNIVERSE MODEL of cosmology” Presented at PHYSTAT05 Conference on 'Statistical Problems in Particle Physics, Astrophysics and Cosmology'' held in Oxford, UK on Sept 12th to 15th, 2005. And “DYNAMIC UNIVERSE MODEL of cosmology: *Missing mass* in Galaxy” Presented in 7th Astronomical conf by HEL.A.S,. Kefallinia, Greece 8-11,Sept, 2005. Copies of my earlier papers were kept here on the links below… http://members.wap.org/kevin.parker/Densemass/VakPioneerAnom.doc and http://members.wap.org/kevin.parker/Densemass/VDUMOC%20kp%20.doc

References: Chapter 7 SITA & CUDA

These references were taken from CUDA as they are. I did not change anything. Only concepts are compared with SITA, for ref see:

http://http.developer.nvidia.com/GPUGems3/gpugems3_ch31.html

Aarseth, S. 2003. *Gravitational N-Body Simulations*. Cambridge University Press.

Barnes, J., and P. Hut. 1986. “A Hierarchical O(n log n) Force Calculation Algorithm.” *Nature* 324.

Buck, I., T. Foley, D. Horn, J. Sugerman, K. Fatahalian, M. Houston, and P. Hanrahan.2004. “Brook for GPUs: Stream Computing on Graphics Hardware.”

In *ACM Transactions on Graphics (Proceedings of SIGGRAPH 2004)* 23(3).

Darden, T., D. York, and L. Pederson. 1993. “Particle Mesh Ewald: An N log(N) Method for Ewald Sums in Large Systems.” *Journal of Chemical Physics* 98(12), p. 10089.

Dehnen, Walter. 2001. “Towards Optimal Softening in 3D N-body Codes: I. Minimizing the Force Error.” *Monthly Notices of the Royal Astronomical Society* 324, p. 273.

Dyer, Charles, and Peter Ip. 1993. “Softening in N-Body Simulations of Collisionless Systems.” *The Astrophysical Journal* 409, pp. 60–67.

Elsen, Erich, Mike Houston, V. Vishal, Eric Darve, Pat Hanrahan, and Vijay Pande. 2006. “N-Body Simulation on GPUs.” Poster presentation. Supercomputing 06 Conference.

Greengard, L. 1987. *The Rapid Evaluation of Potential Fields in Particle Systems*. ACM Press.

Greengard, Leslie F., and Jingfang Huang. 2002. “A New Version of the Fast Multipole Method for Screened Coulomb Interactions in Three Dimensions.” *Journal of Computational Physics* 180(2), pp. 642–658.

Hamada, T., and T. Iitaka. 2007. "The Chamomile Scheme: An Optimized Algorithm for N-body Simulations on Programmable Graphics Processing Units." *ArXiv Astrophysics e-prints*, astro-ph/0703100, March 2007.

Hockney, R., and J. Eastwood. 1981. *Computer Simulation Using Particles*. McGraw-Hill. Intel Corporation. 1999. "Increasing the Accuracy of the Results from the Reciprocal and Reciprocal Square Root Instructions Using the Newton-Raphson Method."

Version 2.1. Order Number: 243637-002. Available online at

http://cache-www.intel.com/cd/00/00/04/10/41007_nrmethod.pdf.

Intel Corporation. 2003. *Intel Pentium 4 and Intel Xeon Processor Optimization Reference Manual.* Order Number: 248966-007.

Johnson, Vicki, and Alper Ates. 2005. "NBodyLab Simulation Experiments with GRAPE-6a and MD-GRAPE2 Acceleration." *Astronomical Data Analysis Software and Systems XIV P3-1-6*, ASP Conference Series, Vol. XXX, P. L. Shopbell, M. C.

Britton, and R. Ebert, eds. Available online at http://nbodylab.interconnect.com/docs/P3.1.6_revised.pdf.

Makino, J., T. Fukushige, and M. Koga. 2000. "A 1.349 Tflops Simulation of Black Holes in a Galactic Center on GRAPE-6." In *Proceedings of the 2000 ACM/IEEE Conference on Supercomputing*.

NVIDIA Corporation. 2007. *NVIDIA CUDA Compute Unified Device Architecture Programming Guide.* Version 0.8.1.

Nyland, Lars, Mark Harris, and Jan Prins. 2004. “The Rapid Evaluation of Potential Fields Using Programmable Graphics Hardware.” Poster presentation at GP2, the ACM Workshop on General Purpose Computing on Graphics Hardware.

Portegies Zwart, S., R. Belleman, and P. Geldof. 2007. “High Performance Direct Gravitational N-body Simulations on Graphics Processing Unit.” *ArXiv Astrophysics e-prints*, astro-ph/0702058, Feb. 2007

.

Verlet, J. 1967. “Computer Experiments on Classical Fluids.” *Physical Review* 159(1), pp. 98–103.

http://http.developer.nvidia.com/GPUGems3/gpugems3_ch31.html

References: Chapter 8 Discussion

http://www.bautforum.com/showthread.php/95912-A-singularity-free-N-Body-problem-%E2%80%93-solution?p=1613549#post1613549

1.

http://en.wikipedia.org/wiki/N-body_problem

2.

http://www.bautforum.com/showthread....49#post1613549

http://www.bautforum.com/showthread.php/95912-A-singularity-free-N-Body-problem-%E2%80%93-solution?p=1613549#post1613549

References: Chapter9 Comparison

1. See 2dFGRS publications http://www.mso.anu.edu.au/2dFGRS/

2. See in Wikipedia “The Large scale structure of cosmos” http://en.wikipedia.org/wiki/Large-scale_structure_of_the_cosmos

   Biggest void in space is 1 billion light years across see http://www.newscientist.com/article/dn12546

   The Sloan Great Wall is a giant wall of galaxies, (a galactic filament). See http://en.wikipedia.org/wiki/Sloan_Great_Wall

3. SNP.GUPTA, DYNAMIC UNIVERSE MODEL of cosmology and SITA (*Simulation* of *Inter-intra-Galaxy Tautness and Attraction_forces* with variable time step). The simulations in above paper were changed to small time steps and were accepted in British Gravity Meeting, in UK. 15-18 Sept 2004 the international conference on gravitation.

4. SNP.GUPTA, “DYNAMIC UNIVERSE MODEL of cosmology: *Missing mass* in Galaxy” Presented at OMEG05 Origin of Matter and Evolution of Galaxies, November 8-11, 2005 at Koshiba Hall, University of Tokyo, Tokyo

5. A copy of my earlier paper was kept here on the link below…

   http://members.wap.org/kevin.parker/Densemass/VakPioneerAnom.doc

   Some questions raised by Baut forum can be seen here in this link…

   http://www.bautforum.com/against-mainstream/82024-pioneer-anomaly-dynamic-universe-model-cosmology.html

6. SNP.GUPTA, “DYNAMIC UNIVERSE MODEL of cosmology: *Missing mass* in Galaxy” Presented in 7th Astronomical conf by HEL.A.S,. Kefallinia, Greece 8-11,Sept, 2005.

   Some questions raised by the Baut forum can be seen in this link…

http://www.bautforum.com/against-mainstream/85940-unanswered-questions-about-dynamic-universe-model.html

7. Hoyle, F, On the Cosmological Problem, 1949MNRAS.109..365H.

8. W. de Sitter, On Einstein's theory of gravitation and its astronomical consequences, 1916MNRAS..77..155D

9. Zwicky, F. 1929. *On the Red Shift of Spectral Lines through Interstellar Space.* PNAS **15**:773-779. Abstract (ADS) Full article (PDF).

10. http://en.wikipedia.org/wiki/Olbers'_paradox

11. S.W. Hawking, Singularities in collapsing stars and Expanding Universes with Dennis William Sciama, Comments on Astrophysics and space Physics Vol 1#1, 1969, MNRAS **142**, 129, (1969).

12. Stephen Hawking and Roger Penrose, 'The Nature of space and time', Princeton University press, 1996.

13. -Einstein, A. 1916, "The foundation of General theory of relativity ", Methuen and company, 1923, Reprinted, Dover publications, 1952, New York, USA.

-Einstein, A. 1911, "On the influence of Gravitation on the propagation of light", Methuen and company, 1923, Reprinted, Dover publications, 1952, New York, USA.

14. A. G. Walker, On Milines theory of World Structure, 1937, Volume s2-42, Number 1, pp 90-127

H.P. Robertson, Kinematics and world Structure III , The Astrophysical Journal, May 1936, vol 83 pp 257.

15. JVNarlikar, Mini-bangs in Cosmology and astrophysics, Pramana (Springer India), Vol 2, No.3, 1974, pp-158-170

16. String theory M. J. Duff, James T. Liu, and R Minasian , Eleven dimensional origin of STRING / string duality.: arXiv:hep-th/9506126v2

17. A. Miemiec, I. Schnakenburg : Basics of M-theory; Fortsch.Phys. 54(2006) Page 5-72 and preprints at arXiv:hep-th/0509137v2, Sept 2005

18. James Binny and Scott Tremaine : Text book 'Galactic Dynamics' 1987

19. Einstein, A. 1917, "Cosmological considerations of General theory of relativity ", Methuen and company, 1923, Reprinted, Dover publications, 1952, New York, USA.

20. S.N.P. Gupta, 'Absolute Rest frame of reference is not necessary', presented in Symposium on Early Universe SEU, Dec 20-22; 1994, IIT, Madras, India, Proceedings Page 54.

28 Pioneer Anomaly :John D. Anderson, Philip A. Laing, Eunice L. Lau, Anthony S. Liu, Michael Martin Nieto, Slava G. Turyshev (1998). "Indication, from Pioneer 10/11, Galileo, and Ulysses Data, of an Apparent Anomalous, Weak, Long-Range Acceleration". Phys. Rev. Lett. **81**: 2858–2861. doi:10.1103/PhysRevLett.81.2858. http://prola.aps.org/abstract/PRL/v81/i14/p2858_1. (preprint) arXiv:gr-qc/9808081

29 For new Horizons satellite details please see: http://pluto.jhuapl.edu/index.php. Ephemeris from Jet propulsion lab http://ssd.jpl.nasa.gov/horizons.cgi#top. Starting data given at http://ssd.jpl.nasa.gov/horizons.cgi#top . The website [http://ssd.jpl.nasa.gov/horizons.cgi#results gives output as in Table 4.

30 SNP.Gupta (The following results were publicized by me in the earlier seminars / conferences.) ‘Absolute Rest frame of reference is not necessary’, presented in Symposium on Early Universe SEU, Dec 20-22; 1994, IIT, Madras, India, Proceedings Page 54. MULTIPLE BENDING OF LIGHT RAY IN OUR DYNAMIC UNIVERSE; A COMPUTER SIMULATION. Gr15: 15th international conference on gravitational conference on gravitation and relativity, pune, India. 16-21 DEC 1995\7. P116; a6.32 (1997),; SNP. GUPTA, and ’ presented in SIGRAV, 18-22 September 2000 , Italy; Edited by R. Cianci, R. Collina, M. Francaviglia, and P. Fré (Eds) in Book “Recent Developments in General relativity Genoa 2000” published by Springer- Verlag Italia, Milano 2002, Page 389. On DYNAMIC UNIVERSE MODEL of cosmology and SITA (S*imulation* of I*nter-intra-Galaxy* T*autness and* A*ttraction forces* with variable time step). The simulations in above paper were changed to small time steps and were accepted in British Gravity Meeting, in UK. 15-18 Sept 2004 the international conference on gravitation. SNP.GUPTA, DYNAMIC UNIVERSE MODEL of cosmology and SITA (S*imulation* of I*nter-intra-Galaxy* T*autness and* A*ttraction forces* with higher time step). This paper was formally presented in GR17; The 17th international conference on gravitation and relativity, in Dublin, Ireland, 18-24 July 2004. And on DYNAMIC UNIVERSE MODEL of cosmology and SITA again Presented in ICR 2005 (International Conference on Relativity) , at Amravati University , India, Jan 11- 14, 2005 . On Missing mass , “DYNAMIC UNIVERSE MODEL of cosmology: *Missing mass* in Galaxy” Presented at OMEG05 Origin of Matter and Evolution of Galaxies, November 8-11, 2005 at Koshiba Hall, University of Tokyo, Tokyo . also in “*Missing mass* in Galaxy using regression analysis in DYNAMIC UNIVERSE MODEL of cosmology” Presented at PHYSTAT05 Conference on 'Statistical Problems in Particle Physics, Astrophysics and Cosmology” held in Oxford, UK on Sept 12th to 15th, 2005. And “DYNAMIC UNIVERSE MODEL of cosmology: *Missing mass* in Galaxy” Presented in 7th Astronomical conf by HEL.A.S,. Kefallinia, Greece 8-11,Sept, 2005. Copies of my earlier papers were kept here on the links below…

http://members.wap.org/kevin.parker/Densemass/VakPioneerAnom.doc and http://members.wap.org/kevin.parker/Densemass/VDUMOC%20kp%20.doc

31 http://en.wikipedia.org/wiki/N-body_problem

32 Ref Book ‘Celestial mechanics: the waltz of the planets’ By Alessandra Celletti, Ettore Perozzi, page 27.

References: Chapter 10 Results

See reference No. 30 for chapter 9

Table of Tables