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Preface

In this monograph, equations of SITA software are explained for the singularity free solution to N-body problem – Dynamic Universe Model; which is, inter body collision free and dynamically stable are presented. SITA 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.

This is the second book, after the earlier book, “Dynamic Universe Model- a singularity free N-body problem solution” (ISBN 978-3-639-29436-1). Here SITA (Simulation of Inter-intra-Galaxy Tautness and Attraction forces) computer implementation Excel program software and its methodology and all the 21000 equations used there are explained in detail. One COPY OF SITA COPYRIGHTED SOFTWARE WILL SENT FREE OF COST BY CONTACTING THE AUTHOR AT ‘snpgupta@INDIATIMES.COM’ Provision for a lot of modifications exists in the program to tune to individual needs. This book is prepared in such a way it can be read independently of the first book.

Prelude

Summary

In this monograph, equations of SITA software are explained for the singularity free solution to N-body problem – Dynamic Universe Model; which is, inter body collision free and dynamically stable are presented. A COPY OF SITA COPYRIGHTED SOFTWARE WILL BE SENT FREE OF COST BY CONTACTING THE AUTHOR AT 'snpgupta@INDIATIMES.COM'. SITA 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 chapters in this book cover a little bit of history, mathematical background and an implementation of Dynamic universe model as SITA simulations, SITA explanations, and SITA results.

Basic structure of this monograph

Following is the basic structure of the monograph. In chapter 1, we discuss the History of N-body problem from the Newton's laws in 1687 and Kepler's orbit to period of Poincare in 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 : SITA software was explained. All the equations like Generic Equations, Non-Generic Non-repeating equations, Generic but not for 133 masses were discussed. Names of Ranges used in equations and sheets, Graphs and processes (macros) used in SITA were given. All the macro listings were given.

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

Chapter 8 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 9. 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. Tables of figures and tables at the end give the page numbers of all figures and tables in the book.

1.History of N-body problem till year 1900

1.1. Newton: Two-body problem

1.1.1. 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.

1.1.2. 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.

1.1.3. 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.

1.1.4. 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 $r = |\mathbf{r_1} - \mathbf{r_2}|$ is the distance between the bodies; U ($|\mathbf{r}_1 - \mathbf{r}_2|$) is the potential energy and

$$\hat{\mathbf{r}} = \frac{\mathbf{r_1} - \mathbf{r_2}}{r}$$

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

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

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* $\hat{\mathbf{r}}$*, the specific relative angular momentum* $\mathbf{H} = \mathbf{r} \times \dot{\mathbf{r}}$ *stays constant:*

$$\dot{\mathbf{H}} = \dot{\overline{\mathbf{r} \times \dot{\mathbf{r}}}} = \dot{\mathbf{r}} \times \dot{\mathbf{r}} + \mathbf{r} \times \ddot{\mathbf{r}} = \mathbf{0} + \mathbf{0} = \mathbf{0}$$

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.

1.2. N-body & 3-body problem

1.2.1. 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]

1.2.2. 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) mass-less 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!

1.2.3. 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.

1.3. 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.

2.1. 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 (S*imulation* of I*nter-intra-Galaxy* T*autness and* A*ttraction_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/ point mass in the **mathematical formulation** section in this book. Then we calculate the resultant UGF vector for each body/ point mass 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].

2.2. Initial conditions for Dynamic Universe Model

2.2.1. 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.

2.2.2. 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.

2.2.3. 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	-2869446
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

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
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
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

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 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
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

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 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
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

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 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 113020	343.3173	-14.26205842	1.45075E+17	45	near star	6.95902E+29	1.14625E+16	1.39712E+16	-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

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 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	-16.13230661	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
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

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 29295	92.64459	-21.86290752	1.78163E+17	65	near star	8.94731E+29	5.72296E+15	1.76608E+17	-2.3E+16
HIP 26857	85.53364	12.493155	1.78586E+17	66	near star	5.96488E+29	-1.34996E+17	-1.16182E+17	-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

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 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
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

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 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
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

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
	-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+19	-4.39257E+19	1.89032E+20	96	Glob Clus Group	6.46631E+36	9.11252E+19	-4.39257E+19	1.89E+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

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
	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
	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

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
	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 center	255.7611	-29.00780556	2.34506E+20	115	Galaxy center	7.164E+36	4.79211E+19	1.67483E+20	1.57E+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

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
	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+20
	258.75	0	2.34506E+20	127	Milkyway part	7.69462E+40	6.156E+19	-6.46792E+19	-2.2E+20

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
	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

3.1. 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 additional systems with a different number of point masses in these different additional 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} point mass 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 point mass α. 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 point masses.

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

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

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

Moment of inertia tensor

Consider a system of N point masses 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 point mass 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}

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

OR =>

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

And =>

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

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

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

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

(9)

Lets denote Potential energy tensor = Wjk =

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

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

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

$$= \left\{ \ddot{x}^{\alpha}(\text{int}) - \nabla_{\alpha}\Phi_{ext}(\alpha) \right\} m_{\alpha} \tag{15}$$

$$\ddot{x}(\alpha) = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_{\beta}\left(x^{\beta} - x^{\alpha}\right)}{\left|x^{\beta} - x^{\alpha}\right|^{3}} - \nabla\Phi_{ext} \tag{16}$$

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

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

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

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

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

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

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 point mass 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 $\phi_{ext.}$ Now let's consider an ENSEMBLE of system consisting of N_1, N_2 … Nj point masses in each. These systems are moving in the ensemble due to mutual gravitation between them. For example, each system is a Galaxy, and then ensemble represents a local group. Suppose number of Galaxies is j, Galaxies are systems with point masss 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)

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

Here $^{\gamma}$ denotes Ensemble.

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

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

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.

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

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

And $\Phi^{\gamma}_{jk} = \sum_{\alpha=1}^{N^{\gamma}} \nabla\Phi^{\delta}_{ext}\, m_{\alpha} x^{\delta\alpha}_{j} + \sum_{\alpha=1}^{N} \nabla\Phi^{\delta}_{ext}\, m_{\alpha} x^{\delta\alpha}_{k}$ (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. $$\frac{d^2 I^{\gamma}_{jk}}{dt^2} = 0 \tag{29}$$

$$W^{\gamma}_{jk} + 2K^{\gamma}_{jk} = 2\Phi^{\gamma}_{jk} \tag{30}$$

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

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

$$W_{jk} + 2K_{jk} = 2\Phi^{\gamma}_{jk} \tag{31}$$

4. Dynamic Universe model: SITA Equations

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

4.0.1. Method of Calculations

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

4.0.2. MKS Units

The fundamental units of measurement used in SITA are MKS i.e., length is denoted in meters, mass in kilograms, time in seconds. All the other consequent units like velocity, acceleration, center of mass etc., are derived from the basic MKS units. Likewise velocity of light ‘c’ is constant not taken as unity (1) as in theoretical literature on astrophysics and cosmology but as 300000000 meters per second approximately or 299792459.291176 meters per second exactly.

4.0.3. Computers and Accuracies

The values of SITA 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 the resulting values are meaningless for smaller and nearer point masses. 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.

4.0.4.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.

4.1. Dynamic Universe Model: Processes and Equations used in SITA

SITA is an implementation of Dynamic Universe model. At present there are more than 21000 (twenty one thousand) different equations. All these equations are individually tested and tested in groups and in totality. They are giving good results. There are Generic equations and non generic / single equations and processes and graphs. In this attempt all these equations / processes / graphs were presented as it is and explanations were given to all of them. SITA is very simple and straightforward. It was earlier developed in Lotus 123, and later ported to Excel.

Basically SITA can be thought over as consisting of four parts or divisions' viz., equations, procedures, visual graphs and data (output as well as input) records. Let's see each of them separately below…..

1. SITA Equations: Many types of equations are used. Some of them are Generic and some are individual equations. The Generic equations are common for all 133 masses, where the main change between them is the mass number. There are many cases where the number of equations is not based on masses, but on different criteria. Non generic are individual equations for calculating the various outcomes. E.g. sum of all masses.
2. SITA Procedures: (macros) used in calculation process.
3. SITA Numerical outputs:
4. SITA Graphs to display Numerical outputs:

4.1.1. SITA equations: Description of worksheet:

The TENSOR equation 25 is subdivided into many small equations as given in SITA software (COPY OF SITA COPYRIGHTED SOFTWARE WILL BE SENT FREE OF COST BY CONTACTING THE AUTHOR AT 'snpgupta@INDIATIMES.COM') In this work sheet serial number of point mass is given in column starting from '1' at address 'E8' to '133' at address 'E140'. Name of the point mass is given in the next column starting at F8. They are New-horizons satellite, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Moon, SUN, near stars, Milkyway parts, Andromeda Galaxy, and Triangulum Galaxy. The values of masses in Kilograms are given in the next column starting at address 'G8' to address 'G140'.

The HELIO CENTRIC ECLIPTIC (X, Y, Z) coordinate values in meters are given in next three columns starting from (H8, I8, J8) to (H140, I140, J140) with SUN as center. The starting point was taken as on 01.01.2000@00.00:00 hours. The headings of these columns are given the names (xecliptic, yecliptic, zecliptic).

Now the input masses and coordinates are defined. With this structure of point masses, the Universal Gravitational Force (UGF) acting on each mass is calculated using Newtonian Gravitation force formulae. Let’s see the various equations used in this calculation.

4.1.2. Basic Excel conventions:

I am denoting cell addresses in Excel work sheet as ‘A1’ or ‘M9’ or ‘AH340’ etc., consists of two portions. First one is alphabet portion and second one is numeric portion. In general alphabet portion denotes the column address and numeric portion denotes row address. These are the standard conventions used in Excel. All the formulae in any particular the worksheet address is given as it is in the following explanations. Its physical meaning is explained. Some of the formulae may not have physical meaning sometimes.

4.2. Types of Equations used in SITA:

Many types of equations are used in this sheet. They are:

4.2.1. Generic Equations:

These equations are similar for all the 133 masses. In a Generic equation the variation in between equation to equation is point mass number. Say first in the set of equations is ‘m1*y1’ for mass m1 multiplied by its y1 distance, then the second equation is ‘m2*y2’, i.e., mass m2 is multiplied by distance y2. And so, the last equation in this Generic set will be ‘m133*y133’. Henceforth I will explain only one equation of each generic equations set, later equations are similar.

4.2.2. Non-Generic Non-repeating equations

There are many situations in which each equation is used only once. This set indicates such equations.

4.2.3. Generic but not for 133 masses:

There are situations when we need to repeat the equation not for 133 masses, but for different number of another variable for diverse uses. This class indicates such set. This set was also shown in the generic equations set, and in the explanation it was mentioned, that some particular equation is not for 133 point masses.

4.2.4. Names of Ranges used in equations and sheets

All the names of Ranges used in the software are explained in sec 4.5.

4.3. Generic Equations used in SITA:

General format of explanation of equations is given here. All Generic equations will have a header line starting with equation serial number for example [4.3.1] for the first equation in the explanation sheets. A simple technical name of the equation is given after the number [Mass*x]. It may be equation as it is as used in the sheet or with some common terms. Name of the excel sheet was given in the Beginning of all these generic equations. Next in the heading line comes equation address [(Address ‘B8’):]. A general description of the equation is given in the paragraph followed by the equation. This paragraph contains the starting address of the Generic equations. Whether the equation is generic or non-generic, and how many such equations are used in the sheet. A small explanation of the equation is given. Additional information was also given such as the result of the equation is an intermediate result and that particular result is used somewhere else OR the result is final result. Later there is a sentence explaining where the equation is situated, such as excel sheet ‘main’.

This format is used for all the explanations of equations so that page length will reduce. Unnecessary repeated explanations are not given.

All these following equations are from sheet “main”:

4.3.1. Mass*x (Address ‘B8’):

The start Address is ‘B8’. The equation is ‘G8*H8’. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘B8’ to ‘B140’. This means mass in row 8 is multiplied by distance x, its value can be found here after multiplication. This is an intermediate result used two three places later.

One purpose is for finding the center of mass of the system of point masses used here. This equation is in sheet “Main”.

4.3.2. Mass*y (Address ‘C8’):

The equation is ‘G8*I8’. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘C8’ to ‘C140’. This means mass in row 8 is multiplied by distance y, its value can be found here after multiplication. This is an intermediate result used two three places later. One purpose is for finding the center of mass of the system of point masses used here. This equation is in sheet “Main”.

4.3.3. Mass* z (Address ‘D8’):

The equation is ‘G8*J8’. This is a Generic equation; there will be such 133 similar equations. This equation is Generic from cell addresses ‘D8’ to ‘D140’. This means mass in row 8 is multiplied by distance x, its value can be found here after multiplication. This is an intermediate result used two three places later. One of the purposes is for finding the center of mass of the system of point masses used here. This equation is in sheet “Main”.

4.3.4. Acceleration (Address ‘K8’)

The equation is ‘$J$1*G8/((($H$140-H8)^2+($I$140-I8)^2+($J$140-J8)^2))^1.5 ’. This acceleration is an intermediate result, which will be used later on. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘K8’ to ‘K140’. This equation calculates acceleration of point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.5. Acceleration x (Address ‘L8’)

The equation is ‘K8*(H8-$H$140)’. This acceleration x is an intermediate result, which will be used later on. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘K8’ to ‘K140’. This equation calculates x coordinate of acceleration of point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.6. Acceleration y (Address ‘M8’)

The equation is ‘K8*(I8-$I$140)’. This acceleration y is an intermediate result, which will be used later on. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘M8’ to ‘M140’. This equation calculates y coordinate of acceleration of point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.7. Acceleration z (Address ‘N8’)

The equation is ‘K8*(J8-$J$140)’. This acceleration z is an intermediate result, which will be used later on. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘N8’ to ‘N140’. This equation calculates z coordinate of acceleration of point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.8. Final velocity vx (Address ‘S8’)

The equation is ‘P8*$O$1+V8’. This Final velocity vx is a final result for this iteration, which will be used later on in the next iteration. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘S8’ to ‘S140’. This equation calculates x coordinate of Final velocity vx of point mass after the timestep whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.9. Final velocity vy (Address ‘T8’)

The equation is ‘Q8*$O$1+W8’. This Final velocity vy is a final result for this iteration, which will be used later on in the next iteration. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘T8’ to ‘T140’. This equation calculates y coordinate of final velocity vy of point mass after the timestep whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.10. Final velocity vz (Address ‘U8’)

The equation is ‘R8*$O$1+X8’. This Final velocity vz is a final result for this iteration, which will be used later on in the next iteration. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘U8’ to ‘U140’. This equation calculates z coordinate of final velocity vz of point mass after the timestep whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.11. Next positions SX (Address ‘Y8’)

The equation is ‘V8*time+0.5*P8*time*time+H8’, where ‘time’ is address ‘O8’. This ‘Next positions SX’ is a final result for this iteration, which will be used later on in the next iteration. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘Y8’ to ‘Y140’. This equation calculates x coordinate of final position sx of point mass after the timestep whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.12. Next positions SY (Address ‘Z8’)

The equation is ‘W8*time+0.5*Q8*time*time+I8’, where ‘time’ is address ‘O8’. This ‘Next positions SY’ is a final result for this iteration, which will be used later on in the next iteration. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘Z8’ to ‘Z140’. This equation calculates x coordinate of final position SY of point mass after the timestep whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.13. Next positions SZ (Address ‘AA8’)

The equation is ‘V8*time+0.5*P8*time*time+H8’, where ‘time’ is address ‘O8’. This ‘Next positions SZ’ is a final result for this iteration, which will be used later on in the next iteration. This is a Generic equation; there will be 133 such similar equations. This equation is Generic from cell addresses ‘AA8’ to ‘AA140’. This equation calculates x coordinate of final position sx of point mass after the timestep whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J). This equation is in sheet “Main”.

4.3.14. Distance from Mass Center (Address ‘AB8’)

The equation is ‘((Y8-$B$141)^2+(Z8-$C$141)^2+(AA8-$D$141)^2)^0.5’. This ‘Distance from Mass Center’ is a final result for the present iteration, which will be used for showing a graph. This equation is Generic from cell addresses ‘AB8’ to ‘AB140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.15. Velocity perpendicular to Center of mass projected on to central plane (Address ‘AC8’)

The equation is ‘ABS(S8*($H$175*(Z8-$C$141)-$I$175*(AA8-$D$141))+T8*(-$H$175*(Y8-$B$141)-(AA8-$D$141))+U8*((Z8-$C$141)+$I$175*(Y8-$B$141)))/((1+$H$175^2+$I$175^2)^0.5+((Z8-$C$141)^2+(AA8-$D$141)^2+(Y8-$B$141)^2)^0.5)’. This ‘Velocity perpendicular to Center of mass projected on to central plane’ is a final result for the present iteration, which will be used for showing a graph. This equation is Generic from cell addresses ‘AC8’ to ‘AC140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. These equations can be retuned for according to situation of point masses. This equation is in sheet “Main”.

4.3.16. Velocity perpendicular to Center of mass projected on to central plane (Address ‘AD8’)

The equation is ‘ABS(S8*($H$168*(Z8-$C$142)-$I$168*(AA8-$D$142))+T8*(-$H$168*(Y8-$B$142)-(AA8-$D$142))+U8*((Z8-$C$142)+$I$168*(Y8-$B$142)))/((1+$H$168^2+$I$168^2)^0.5+((Z8-$C$142)^2+(AA8-$D$142)^2+(Y8-$B$142)^2)^0.5)’. This ‘Velocity perpendicular to Center of mass projected on to central plane’ is a final result for the present iteration, which will be used for showing another graph. This equation is Generic from cell addresses ‘AD8’ to ‘AD117’; there will be 109 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. These equations can be retuned for according to situation of point masses. This equation is in sheet “Main”.

4.3.17. Distance from Mass Center (Address ‘AE8’)

The equation is ‘((Y8-$B$142)^2+(Z8-$C$142)^2+(AA8-$D$142)^2)^0.5’. This ‘Distance from Mass Center’ is a final result for the present iteration, which will be used for showing another graph. This equation is Generic from cell addresses ‘AE8’ to ‘AE117’; there will be 109 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.18. Vector cross product x (Address ‘BO8’)

The equation is ‘BJ8*BF8-BI8*BG8’. This ‘Vector cross product x’ gives the x component and is final result for the present iteration, which will be used for showing that no singularity exists in the present iteration. This equation is Generic from cell addresses ‘BO8’ to ‘BO140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.19. Vector cross product y (Address ‘BP8’)

The equation is ‘BJ8*BE8-BH8*BG8’. This ‘Vector cross product y’ gives the y component and is final result for the present iteration, which will be used for showing that no singularity exists in the present iteration. This equation is Generic from cell addresses ‘BP8’ to ‘BP140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.20. Vector cross product z (Address ‘BQ8’)

The equation is ‘BH8*BF8-BI8*BE8’. This ‘Vector cross product z’ gives the z component and is final result for the present iteration, which will be used for showing that no singularity exists in the present iteration. This equation is Generic from cell addresses ‘BQ8’ to ‘BQ140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.21. Polar moment of Inertia (Address ‘BS8’)

The equation is ‘G8*((BH8-$BR$3)^2+(BI8-$BS$3)^2+(BJ8-$BT$3)^2)’. This ‘Polar moment of Inertia’ gives the final result for the present iteration, which will be used for showing that no singularity exists in the present iteration. This equation is Generic from cell addresses ‘BS8’ to ‘BS140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.22. Polar moment of Inertia (angle) (Address ‘BT8’)

The equation is ‘ATAN2(BI8,BH8)’. This ‘Polar moment of Inertia (angle)’ gives the z component and is final result for the present iteration, which will be used for further analysis, showing that no singularity exists in the present iteration. This equation is Generic from cell addresses ‘BT8’ to ‘Bt140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘G’ and coordinates are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

4.3.23. Distances between all pairs (Starting Address ‘BW8’…)

The equations are ‘SQRT(($BH$140-BH8)^2+($BI$140-BI8)^2+($BJ$140-BJ8)^2)’ , SQRT(($BH$139-BH8)^2+($BI$139-BI8)^2+($BJ$139-BJ8)^2) … to… ‘SQRT (($BH$8-BH8)^2+($BI$8-BI8)^2+($BJ$8-BJ8)^2)’ for 133 masses. This ‘Distance between all pairs of point masses’ are final results for the present iteration, which show the non-zero Distance for any pair of masses. Thus show that no binary singularity exists in the present iteration. This equation is Generic from cell addresses ‘BW8’: ‘BW140’ to ‘GY8’ : ‘GY140’; there will be 133 x 133 i.e. 17689 total such similar equations. This equations set calculate distance between any pair, i.e., from every point mass to all other point masses. The point mass value is in column ‘G’ and coordinates of these masses are given in columns (H, I, J) to the mass center. This equation is in sheet “Main”.

The following equations are from sheet “Previous itr”

4.3.24. Vector cross product x (Address ‘N8’)

The equation is ‘I8*E8-H8*F8’. This ‘Vector cross product x’ gives the x component and is final result for the present iteration, which will be used for showing that no singularity exists in the *starting data* of present iteration. This equation is Generic from cell addresses ‘N8’ to ‘N140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘C’ and coordinates are given in columns (D, E, F) to the mass center. This equation is in sheet “Previous itr”.

4.3.25. Vector cross product y (Address ‘O8’)

The equation is ‘I8*D8-G8*F8’. This ‘Vector cross product y’ gives the y component and is final result for the present iteration, which will be used for showing that no singularity exists in the *starting data* present iteration. This equation is Generic from cell addresses ‘O8’ to ‘O140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘C’ and coordinates are given in columns (D, E, F) to the mass center. This equation is in sheet “Previous itr”.

4.3.26. Vector cross product z (Address ‘P8’)

The equation is ‘G8*E8-H8*D8’. This ‘Vector cross product z’ gives the z component and is final result for the present iteration, which will be used for showing that no singularity exists in the *starting data* of present iteration. This equation is Generic from cell addresses ‘P8’ to ‘P140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘C’ and coordinates are given in columns (D, E, F) to the mass center. This equation is in sheet “Previous itr”.

4.3.27. Angular momentum: Mass velocity position cross product X (Address ‘R8’)

The equation is ‘C8*N8’. This ‘Angular momentum: Mass velocity position cross product’ gives x value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation is Generic from cell addresses ‘R8’ to ‘R140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘C’ and coordinates are given in columns (D, E, F) to the mass center. This equation is in sheet “Previous itr”.

4.3.28. Angular momentum: Mass velocity position cross product Y (Address ‘S8’)

The equation is ‘C8*O8’. This ‘Angular momentum: Mass velocity position cross product’ gives Y value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation is Generic from cell addresses ‘S8’ to ‘S140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘C’ and coordinates are given in columns (D, E, F) to the mass center. This equation is in sheet “Previous itr”.

4.3.29. Angular momentum: Mass velocity position cross product Z (Address ‘R8’)

The equation is ‘C8*P8’. This ‘Angular momentum: Mass velocity position cross product’ gives Z value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation is Generic from cell addresses ‘T8’ to ‘T140’; there will be 133 such similar equations. This equation calculates distance from the point mass whose mass value is in column ‘C’ and coordinates are given in columns (D, E, F) to the mass center. This equation is in sheet “Previous itr”.

The following equations are from sheet “Stability”

4.3.30. Necessary Condition for Stability T (KE) (Address ‘K19’)

The equation is ‘C19*SQRT(D19^2+E19^2+F19^2)/2’. This ‘Necessary Condition for Stability T (the total energy h = T –V is negative)’ gives ‘T’ the Kinetic Energy value for the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘K19’ to ‘K151’; there will be 133 such similar equations. This equation calculates T whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “Stability”.

4.3.31. Necessary Condition for Stability V (PE) for mass 133 (Address ‘L19’)

The equation is ‘C19*$C$151/SQRT((G19-$G$151)^2+(H19-$H$151)^2+(I19-$I$151)^2)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives ‘V’ the Potential Energy value for the mass 133 for the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘L19’ to ‘L151’; there will be 133 such similar equations. This equation calculates V for mass 133 and with another mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “Stability”.

4.3.32. Necessary Condition for Stability V (PE) for mass 132 (Address ‘M19’)

The equation is ‘C19*$C$150/SQRT((G19-$G$150)^2+(H19-$H$150)^2+(I19-$I$150)^2)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives ‘V’ the Potential Energy value for the mass 132 for the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘M19’ to ‘M151’; there will be 133 such similar equations. This equation calculates V for mass 132 and with another mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “Stability”.

4.3.33. Necessary Condition for Stability V (PE) for mass 131 (Address ‘N19’)

The equation is ‘C19*$C$149/SQRT((G19-$G$149)^2+(H19-$H$149)^2+(I19-$I$149)^2)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives ‘V’ the Potential Energy value for the mass 131 for the *Resulting data* in the present iteration.

This equation is Generic from cell addresses ‘N19’ to ‘N151’; there will be 133 such similar equations. This equation calculates V for mass 131 and with another mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “Stability”.

4.3.34. Necessary Condition for Stability V (PE) for mass 130 (Address ‘O19’)

The equation is ‘C19*$C$148/SQRT((G19-$G$148)^2+(H19-$H$148)^2+(I19-$I$148)^2)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives ‘V’ the Potential Energy value for the mass 130 for the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘O19’ to ‘O151’; there will be 133 such similar equations. This equation calculates V for mass 130 and with another mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “Stability”.

The following equations are from sheet “vel unit vector”

4.3.35. Velocity Unit Vectors UX Test (Address ‘K8’)

The equation is ‘D19/SQRT(D19^2+E19^2+F19^2)’. This ‘velocity Unit vector UX’ gives the X portion of Unit vector for the final velocities achieved in the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘K19’ to ‘K151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.36. Velocity Unit Vectors UY Test (Address ‘L8’)

The equation is ‘E19/SQRT(D19^2+E19^2+F19^2)’. This ‘velocity Unit vector UY’ gives the Y portion of Unit vector for the final velocities achieved in the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘L19’ to ‘L151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.37. Velocity Unit Vectors UZ Test (Address ‘M8’)

The equation is ‘F19/SQRT(D19^2+E19^2+F19^2)’. This ‘velocity Unit vector UZ’ gives the Z portion of Unit vector for the final velocities achieved in the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘M19’ to ‘M151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.38. Velocity Unit Vectors SX Test (Address ‘N8’)

The equation is ‘(G19-$N$16)/SQRT((G19-$N$16)^2+(H19-$O$16)^2+(I19-$P$16)^2)’. This ‘velocity Unit vector SX’ gives the X portion of Unit vector for the final positions achieved in the *Resulting data* in the present iteration. The values in row 16 here indicate center of mass for all the 133 masses. This equation is Generic from cell addresses ‘N19’ to ‘N151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.39. Velocity Unit Vectors SY Test (Address 'O8')

The equation is '(H19-$N$16)/SQRT((G19-$N$16)^2+(H19-$O$16)^2+(I19-$P$16)^2)'. This 'velocity Unit vector SY' gives the Y portion of Unit vector for the final positions achieved in the *Resulting data* in the present iteration. The values in row 16 here indicate center of mass for all the 133 masses. This equation is Generic from cell addresses 'O19' to 'O151'; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column 'C' and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet "vel unit vector".

4.3.40. Velocity Unit Vectors SZ Test (Address 'P8')

The equation is '(I19-$N$16)/SQRT((G19-$N$16)^2+(H19-$O$16)^2+(I19-$P$16)^2)'. This 'velocity Unit vector SZ' gives the Z portion of Unit vector for the final positions achieved in the *Resulting data* in the present iteration. The values in row 16 here indicate center of mass for all the 133 masses. This equation is Generic from cell addresses 'P19' to 'P151'; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column 'C' and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.41. Velocity Unit Vectors Test : X differences (Address ‘Q8’)

The equation is ‘K19-N19’. This ‘velocity Unit vector Test : X differences’ gives the X portion of Unit vector differences between the final Unit Vector ‘positions and velocities’ achieved in the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘Q19’ to ‘Q151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.42. Velocity Unit Vectors Test : Y differences (Address ‘R8’)

The equation is ‘L19-O19’. This ‘velocity Unit vector Test : Y differences’ gives the Y portion of Unit vector differences between the final Unit Vector ‘positions and velocities’ achieved in the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘R19’ to ‘R151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns

(G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.3.43. Velocity Unit Vectors Test: Z differences (Address ‘S8’)

The equation is ‘M19-P19’. This ‘velocity Unit vector Test : Z differences’ gives the Z portion of Unit vector differences between the final Unit Vector ‘positions and velocities’ achieved in the *Resulting data* in the present iteration. This equation is Generic from cell addresses ‘S19’ to ‘S151’; there will be 133 such similar equations. The calculated values by the equation are in the range (-1, 1) calculates for mass whose mass value is in column ‘C’ and coordinates are given in columns (G, H, I), and velocities are given in columns (D, E, F). This equation is in sheet “vel unit vector”.

4.4. Single Equations used in SITA:

General format of explanation of equations is given here. All single equations will have a header line starting with equation serial number for example [4.4.1] for the first equation in the explanation sheets. The a simple technical name of the equation is given after the number [Mass*x]. It may be equation as it is as used in the sheet or with some common terms. Name of the excel sheet was given in the Beginning of all these generic equations. Next in the heading line comes equation address [(Address 'B141'):]. A general description of the equation is given in the paragraph followed by the equation. This paragraph contains the starting address of the Generic equations. Whether the equation is generic or non-generic, and how many such equations are used in the sheet. A small explanation of the equation is given. Additional information was also given such as the result of the equation is an intermediate result and that particular result is used somewhere else OR the result is final result. Later there is a sentence explaining where the equation is situated, such as excel sheet 'main'.

All these following equations are from sheet "main":

4.4.1. Mass Center X (Address 'B141'):

The equation is 'SUM(B8:B140)/G141'. This is a single equation. This means the total of '*mass multiplied by distance x*' in the column 'B8 to B140' divided by total mass is given as x coordinate of center of mass.

This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.2. Mass Center Y (Address ‘C141’):

The equation is ‘SUM(C8:C140)/G141’. This is a single equation. This means the total of ‘*mass multiplied by distance y*’ in the column ‘C8 to C140’ divided by total mass is given as y coordinate of center of mass. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.3. Mass Center Z (Address ‘D141’):

The equation is ‘SUM(D8:D140)/G141’. This is a single equation. This means the total of ‘*mass multiplied by distance* z’ in the column ‘D8 to D140’ divided by total mass is given as z coordinate of center of mass. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.4. Galaxy Center X (Address ‘B142’):

The equation is ‘SUM(B8:B117)/G141’. This is a single equation. This means the total of ‘*mass multiplied by distance x*’ in the column ‘B8 to B117’ divided by total galaxy mass is given as x coordinate of Galaxy center of mass. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.5. Galaxy Center Y (Address ‘C142’):

The equation is ‘SUM(C8:C117)/G141’. This is a single equation. This means the total of ‘*mass multiplied by distance Y*’ in the column ‘C8 to C117’ divided by total galaxy mass is given as Y coordinate of Galaxy center of mass. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.6. Galaxy Center Z (Address ‘D142’):

The equation is ‘SUM(D8:D117)/G141’. This is a single equation. This means the total of ‘*mass multiplied by distance Z*’ in the column ‘D8 to D117’ divided by total galaxy mass is given as Z coordinate of Galaxy center of mass. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.7. Total mass (Address ‘G141’):

The equation is ‘SUM(G8:G140)’. This is a single equation. This means the total of all point masses calculated here. This is an intermediate result used at two three places later. This equation is in sheet “Main”.

4.4.8. Total mass (Address ‘G142’):

The equation is ‘SUM(G8:G117)’. This is a single equation. This means the total of point masses up to G117 calculated here. This is an intermediate result used at two three places later. This equation is in sheet “Main”.

4.4.8. average sys*10^9 x coordinate (Address ‘H141’):

The equation is ‘SUM(H19:H117)/98’. This is a single equation. This means the total of ‘*X coordinate*’ in the range ‘H19 to H117’ divided by 98 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.9. average sys*10^9 Y coordinate (Address 'I141'):

The equation is 'SUM(I19:I117)/98'. This is a single equation. This means the total of '*Y coordinate*' in the range 'I19 to I117' divided by 98 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.10. average sys*10^9 Z coordinate (Address 'J141'):

The equation is 'SUM(J19:J117)/98'. This is a single equation. This means the total of '*Z coordinate*' in the range 'J19 to J117' divided by 98 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.11. average ensemble X coordinate (Address 'H142'):

The equation is 'SUM(H118:H125)/8'. This is a single equation. This means the total of '*X coordinate*' in the range 'H118 to H125' divided by 8 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.12. average ensemble Y coordinate (Address ‘I142’):

The equation is ‘SUM(I118:I125)/8’. This is a single equation. This means the total of ‘*Y coordinate*’ in the range ‘I118 to I125’ divided by 8 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.13. average ensemble Z coordinate (Address ‘J142’):

The equation is ‘SUM(J118:J125)/8’. This is a single equation. This means the total of ‘*Z coordinate*’ in the range ‘J118 to J125’ divided by 8 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.14. average aggregate X coordinate (Address ‘H143’):

The equation is ‘SUM(H126:H133)/8’. This is a single equation. This means the total of ‘*X coordinate*’ in the range ‘H126 to H133’ divided by 8 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.15. average aggregate Y coordinate (Address ‘I143’):

The equation is ‘SUM(I126:I133)/8’. This is a single equation. This means the total of ‘*Y coordinate*’ in the range ‘I126 to I133’ divided by 8 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.16. average aggregate Z coordinate (Address ‘J143’):

The equation is ‘SUM(J126:J133)/8’. This is a single equation. This means the total of ‘*Z coordinate*’ in the range ‘J126 to J133’ divided by 8 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.17. average Conglomeration X coordinate (Address ‘H144’):

The equation is ‘SUM(H134:H140)/7’. This is a single equation. This means the total of ‘*X coordinate*’ in the range ‘H134 to H140’ divided by 7 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.18. average Conglomeration Y coordinate (Address ‘I144’):

The equation is ‘SUM(I134:I140)/7’. This is a single equation. This means the total of ‘*Y coordinate*’ in the range ‘I134 to I140’ divided by 7 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.19. average Conglomeration Z coordinate (Address ‘J144’):

The equation is ‘SUM(J134:J140)/7’. This is a single equation. This means the total of ‘*Z coordinate*’ in the range ‘J134 to J140’ divided by 7 to get average. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.20. EQUATION OF PLANE PASSING THROUGH Galaxy 117 POINTS using LINEST function (Addresses ‘H168 to L172’):

The equation is ‘LINEST(H8:H117,I8:J117,TRUE,TRUE)’. This is a single equation in the array range ‘H168 to L172’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

	EQUATION OF PLANE PASSING THROUGH Galaxy 117 POINTS dt 310505				
galaxy 117 points	-0.125649783	1.026315532	3.02994E+19	#N/A	#N/A
	0.311514915	0.080124269	8.33789E+18	#N/A	#N/A
	0.625100529	8.67707E+19	#N/A	#N/A	#N/A
	89.20492267	107	#N/A	#N/A	#N/A
	1.34328E+42	8.0562E+41	#N/A	#N/A	#N/A

4.4.21. EQUATION OF PLANE PASSING THROUGH all 133 POINTS using LINEST function (Addresses ‘H175 to L180’):

The equation is ‘LINEST(H8:H117,I8:J117,TRUE,TRUE)’. This is a single equation in the array range ‘H175 to L180’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

	EQUATION OF PLANE PASSING THROUGH all 133 POINTS dt 210505				
all 133 points:	0.82495702	0.783529104	3.05366E+19	#N/A	#N/A
	0.008436523	0.006735629	1.22184E+19	#N/A	#N/A
	0.991642611	1.39868E+20	#N/A	#N/A	#N/A
	7712.548282	130	#N/A	#N/A	#N/A
	3.01761E+44	2.54319E+42	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A

4.4.22. 1_known _y (Addresses ‘BH145 to BL149’):

The equation is ‘LINEST(BH8:BH140,BI8:BI140,BJ8:BJ140,TRUE)’. This is a single equation in the array range ‘BH145 to BL149’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

1	KNOWN_Y			
0.44010293	5.31454E+19	#N/A	#N/A	#N/A
0.049436159	1.05075E+20	#N/A	#N/A	#N/A
0.376942931	1.20305E+21	#N/A	#N/A	#N/A
79.25361335	131	#N/A	#N/A	#N/A
1.14705E+44	1.89599E+44	#N/A	#N/A	#N/A

4.4.23. 2_known _y (Addresses ‘BH151 to BL155’):

The equation is ‘LINEST(BH8:BH140,BI8:BI140,TRUE,TRUE)’. This is a single equation in the array range ‘BH151 to BL155’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

2	KNOWN_Y			
0.44010293	5.31454E+19	#N/A	#N/A	#N/A
0.049436159	1.05075E+20	#N/A	#N/A	#N/A
0.376942931	1.20305E+21	#N/A	#N/A	#N/A
79.25361335	131	#N/A	#N/A	#N/A
1.14705E+44	1.89599E+44	#N/A	#N/A	#N/A

4.4.24. 3_known _y (Addresses ‘BH157 to BL161’):

The equation is ‘LINEST(BH8:BH140,BI8:BI140,TRUE,TRUE)’. This is a single equation in the array range ‘BH157 to BL161’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

3	KNOWN_Y			
- 0.653089501	2.03425E+20	#N/A	#N/A	#N/A
0.093379515	1.57489E+20	#N/A	#N/A	#N/A
0.271878442	1.81428E+21	#N/A	#N/A	#N/A
48.91501353	131	#N/A	#N/A	#N/A
1.61009E+44	4.31201E+44	#N/A	#N/A	#N/A

4.4.25. 4_ known _y (Addresses ‘BH163 to BL167’):

The equation is ‘LINEST(BK8:BK140,BH8:BJ140,TRUE,TRUE)’. This is a single equation in the array range ‘BH163 to BL167’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4	KNOWN_Y			
0.129308477	0.746208287	-0.80172949	1.296E+22	#N/A
0.078640379	0.074544082	0.094685146	1.35E+19	#N/A
0.980478053	1.50998E+20	#N/A	#N/A	#N/A
2159.649149	129	#N/A	#N/A	#N/A
1.47723E+44	2.94125E+42	#N/A	#N/A	#N/A

4.4.26. 5_known _y (Addresses ‘BH169 to BL173’):

The equation is ‘LINEST(BJ8:BJ140,BH8:BH140,TRUE,TRUE)’. This is a single equation in the array range ‘BH169 to BL173’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

5	KNOWN_Y			
0.388576899	-1.42892E+20	#N/A	#N/A	#N/A
0.091196754	1.38767E+20	#N/A	#N/A	#N/A
0.121718756	1.59087E+21	#N/A	#N/A	#N/A
18.15495558	131	#N/A	#N/A	#N/A
4.59476E+43	3.31542E+44	#N/A	#N/A	#N/A

4.4.27. EQUATION OF PLANE PASSING THROUGH all 133 POINTS (Addresses ‘BH175 to BL180’):

The equation is ‘LINEST(BH8:BH132,BI8:BJ132,TRUE,TRUE)’. This is a single equation in the array range ‘BH175 to BL180’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

EQUATION OF PLANE PASSING THROUGH all 133 POINTS				
0.662909986	0.992504726	3.13215E+19	#N/A	#N/A
0.172215936	0.110500388	1.22428E+19	#N/A	#N/A
0.444567417	1.35536E+20	#N/A	#N/A	#N/A
48.82430968	122	#N/A	#N/A	#N/A
1.79381E+42	2.24115E+42	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A

4.4.28. Indexing table (Addresses 'BD144 to BF152'):

The equations using LINEST functions are used and indexed here in this table below. There are 12 single equations in the array range 'BD144 to BF152'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Because this function returns an array of values, it must be entered as an array formula (Single formula). Index returns the reference of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

Indexing		
	XY	B
XY	0.44010293	5.31454E+19
YX	0.856488121	1.13237E+20
	YZ	B
YZ	-0.653089501	2.03425E+20
ZY	-0.416295839	2.7406E+19
	ZX	B
ZX	0.388576899	-1.42892E+20
XZ	0.313242388	1.89926E+20

4.4.28. Index value XY-XY (Address ‘BE145’):

The equation using INDEX & LINEST functions at address ‘BE145’ is ‘INDEX(LINEST(BH8:BH140,BI8:BI140),1)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.29. Index value XY-XY (Address ‘BE145’):

The equation using INDEX & LINEST functions at address ‘BE145’ is ‘INDEX(LINEST(BH8:BH140,BI8:BI140),1)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.30. Index value XY-YX (Address 'BE146'):

The equation using INDEX & LINEST functions at address 'BE146' is 'INDEX(LINEST(BI8:BI140,BH8:BH140),1)'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.31. Index value B-XY (Address 'BF145'):

The equation using INDEX & LINEST functions at address 'BF145' is 'INDEX(LINEST(BH8:BH140,BI8:BI140),2'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.32. Index value B-XY (Address ‘BF146’):

The equation using INDEX & LINEST functions at address ‘BF146’ is ‘INDEX(LINEST(BI8:BI140,BH8:BH140),2)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.33. Index value YZ-YZ (Address ‘BE148’):

The equation using INDEX & LINEST functions at address ‘BE148’ is ‘INDEX(LINEST(BI8:BI140,BJ8:BJ140),1)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.34. Index value ZY-YZ (Address 'BE149'):

The equation using INDEX & LINEST functions at address 'BE149' is 'INDEX(LINEST(BJ8:BJ140,BI8:BI140),1)'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.35. Index value B -YZ (Address 'BF148'):

The equation using INDEX & LINEST functions at address 'BF148' is 'INDEX(LINEST(BI8:BI140,BJ8:BJ140),2)'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.36. Index value B-ZY (Address 'BF149'):

The equation using INDEX & LINEST functions at address 'BF149' is 'INDEX(LINEST(BJ8:BJ140,BI8:BI140),2)'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.37. Index value XY-ZX (Address 'BE151'):

The equation using INDEX & LINEST functions at address 'BE151' is 'INDEX(LINEST(BJ8:BJ140,BH8:BH140),1)'. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet "Main".

4.4.38. Index value XY-XZ (Address ‘BE152’):

The equation using INDEX & LINEST functions at address ‘BE152’ is ‘INDEX(LINEST(BH8:BH140,BJ8:BJ140),1)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.39. Index value B-XY (Address ‘BF151’):

The equation using INDEX & LINEST functions at address ‘BF151’ is ‘INDEX(LINEST(BJ8:BJ140,BH8:BH140),2)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.40. Index value B-XZ (Address ‘BF152’):

The equation using INDEX & LINEST functions at address ‘BF152’ is ‘INDEX(LINEST(BH8:BH140,BJ8:BJ140),2)’. The LINEST function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits our data, and then returns an array that describes the line. Index returns the contents of the cell at the intersection of a particular row and column. This equation varies according to the mass distributions in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.41. Movement of test particle (Address ‘H4’):

The equation at ‘H4’ is ‘H8 – H13*1.1’ is used for tracking test particle from iteration to iteration. This equation varies according to the mass distributions and requirement to track some of the point masses in the scheme. This is an intermediate result used two three places later. This equation is in sheet “Main”.

4.4.42. accl (Address ‘K2’):

The equation at address ‘K2’ is ‘$J$1*G2/((($H$140-H2)^2+($I$140-I2)^2+($J$140-J2)^2))^1.5’. This is the basic Newtonian force acting on the mass at G2 causing this acceleration. This is an intermediate result used to calculate acceleration in x, y, z coordinates on the particle. This is starting equation. This equation is in sheet “Main”.

4.4.43. accl x (Address ‘L2’):

The equation at address ‘L2’ is ‘K2*(H2-$H$140)’. This is the basic x component of Newtonian force acting on the mass at G2 causing this acceleration. This is an intermediate result used to calculate acceleration in x coordinate of the particle based on earlier equation accl. This is an intermediate equation. This equation is in sheet “Main”.

4.4.44. accl y (Address ‘M2’):

The equation at address ‘M2’ is ‘K2*(I2-$I$140)’. This is the basic y component of Newtonian force acting on the mass at G2 causing this acceleration. This is an intermediate result used to calculate acceleration in y coordinate of the particle based on earlier equation accl. This is an intermediate equation. This equation is in sheet “Main”.

4.4.45. accl z (Address ‘N2’):

The equation at address ‘N2’ is ‘J2*(H2-$J$140)’. This is the basic x component of Newtonian force acting on the mass at G2 causing this acceleration. This is an intermediate result used to calculate acceleration in x coordinate of the particle based on earlier equation accl. This is an intermediate equation. This equation is in sheet “Main”.

4.4.46. sums x (Address ‘L4’):

The equation at address ‘L4’ is ‘SUM(L8:L140)’. This is the total of basic x component of Newtonian force acting on the mass at G2 causing this acceleration with N^2 complexity. This is an intermediate result used to calculate acceleration in x coordinate of the particle based on earlier equation accl. This is an intermediate equation. This equation is in sheet “Main”.

4.4.47. sums y (Address ‘M4’):

The equation at address ‘M4’ is ‘SUM(M8:M140)’. This is the total of basic y component of Newtonian force acting on the mass at G2 causing this acceleration with N^2 complexity. This is an intermediate result used to calculate acceleration in y coordinate of the particle based on earlier equation accl. This is an intermediate equation. This equation is in sheet “Main”.

4.4.48. sums z (Address ‘N4’):

The equation at address ‘N4’ is ‘SUM(N8:N140)’. This is the total of basic z component of Newtonian force acting on the mass at G2 causing this acceleration, with N^2 complexity. This is an intermediate result used to calculate acceleration in z coordinate of the particle based on earlier equation accl. This is an intermediate equation. This equation is in sheet “Main”.

4.4.49. time (Address ‘O1’):

The equation at address ‘O1’ is ‘AY1’. This is basic timestep in seconds, used everywhere in this calculations. This is variable and transferred from AY1. This equation is in sheet “Main”.

4.4.50. accl (Address ‘P2’):

The equation at address ‘P2’ is ‘$J$1*G2/((($H$140-H2)^2+($I$140-I2)^2+($J$140-J2)^2))^1.5’. This is the basic Newtonian force acting on the mass at G2 causing this acceleration. This is an intermediate result used to calculate acceleration in x, y, z coordinates on the particle. This equation is used for testing purposes from iteration to iteration and is same as equation at ‘K2’. This is a starting equation. This equation is in sheet “Main”.

4.4.51. Vak Pioneer Anomaly calculation actual accl x (Address 'S2'):

The equation at address 'S2' is 'P19-P8'. Here we calculate the difference between the acceleration between actual on the test particle and acceleration experienced by SUN in the x direction. This is an intermediate result used to calculate EXESS acceleration in x coordinate on the particle explaining the pioneer anomaly. This equation is in sheet "Main".

4.4.52. Vak Pioneer Anomaly calculation actual accl y (Address 'T2'):

The equation at address 'T2' is 'Q19-Q8'. Here we calculate the difference between the acceleration between actual on the test particle and acceleration experienced by SUN in the y direction. This is an intermediate result used to calculate EXESS acceleration in y coordinate on the particle explaining the pioneer anomaly. This equation is in sheet "Main".

4.4.53. Vak Pioneer Anomaly calculation actual accl z (Address 'U2'):

The equation at address 'U2' is 'R19-R8'. Here we calculate the difference between the acceleration between actual on the test particle and acceleration experienced by SUN in the z direction. This is an intermediate result used to calculate EXESS acceleration in z coordinate on the particle explaining the pioneer anomaly. This equation is in sheet “Main”.

4.4.54. Vak Pioneer Anomaly calculation Total actual accl (Address ‘V2’):

The equation at address ‘V2’ is ‘SQRT(S2^2+T2^2+U2^2)’. Here we calculate the total modulus of differences between the acceleration between actual on the test particle and acceleration experienced by SUN in the x, y, & z directions. This is an intermediate result used to calculate EXESS acceleration on the particle explaining the pioneer anomaly. This equation is in sheet “Main”.

4.4.55. Vak Pioneer Anomaly calculation theoretical SUN accl due to Gravity (Address ‘X2’):

The equation at address ‘X2’ is ‘J1*G19/((Y19-Y8)^2+(Z19-Z8)^2+(AA19-AA8)^2)’. Here we calculate the theoretical SUN’s acceleration due to Newtonian Gravity at the (x, y, z) position of test particle. This is an intermediate result used to calculate EXESS acceleration on the particle explaining the pioneer anomaly. This equation is in sheet “Main”.

4.4.56. Vak Pioneer Anomaly calculation Difference between two (Address ‘Z2’):

The equation at address ‘Z2’ is ‘X2-V2’. Here we calculate the difference between actual acceleration experienced by the particle and the theoretical SUN acceleration due to Newtonian Gravity. This final result thus calculated, shows EXESS acceleration on the particle towards SUN, explaining the pioneer anomaly. This equation is in sheet “Main”.

4.4.57. Polar Moment of Inertia: Center of mass x (Address ‘BR3’):

The equation at address ‘BR3’ is ‘B141’. Here we bring x component of center of mass from address B141. This is an intermediate result used later to calculate Polar moment of Inertia. This equation is in sheet “Main”.

4.4.58. Polar Moment of Inertia: Center of mass y (Address ‘BS3’):

The equation at address ‘BS3’ is ‘C141’. Here we bring y component of center of mass from address C141. This is an intermediate result used later to calculate Polar moment of Inertia. This equation is in sheet “Main”.

4.4.59. Polar Moment of Inertia: Center of mass z (Address ‘BT3’):

The equation at address ‘BT3’ is ‘D141’. Here we bring z component of center of mass from address D141. This is an intermediate result used later to calculate Polar moment of Inertia. This equation is in sheet “Main”.

4.4.60. Polar Moment of Inertia: (Address ‘BS5’):

The equation at address ‘BS5’ is ‘SUM(BS8:BS140)’. Here we get the total Polar Moment of Inertia for the whole set of masses. This is final result calculating Polar moment of Inertia. Here we see non-zero Polar moment of inertia showing that dynamic universe model is singularity free. This equation is in sheet “Main”.

4.4.61. Polar Moment of Inertia: Angle test (Address ‘BT4’):

The equation at address ‘BT5’ is ‘ATAN2(BI4,BH4)’. Here we get the angle of Polar Moment of Inertia for a single set of masses for testing purposes. This is an intermediate result while testing Polar moment of Inertia. This equation is in sheet “Main”.

4.4.62. V cross product SUM: ‘x=szuy-syuz=a3 b2- a2 b3’ (Address ‘BO5’):

The equation at address ‘BO5’ is ‘SUM(BO8:BO140)’. Here we get the sum of x coordinate of Vector cross product of ‘position & velocity’ of all point masses. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Main”.

4.4.63. V cross product SUM: ‘y=szux-sxuz=a3b1-a1b3’ (Address ‘BP5’):

The equation at address ‘BP5’ is ‘SUM(BP8:BP140)’. Here we get the sum of y coordinate of Vector cross product of position and velocity of all point masses. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Main”.

4.4.64. V cross product SUM: ‘z=sxuy-syux=a1b2-a2b1’ (Address ‘BQ5’):

The equation at address ‘BQ5’ is ‘SUM(BQ8:BQ140)’. Here we get the sum of z coordinate of Vector cross product of position and velocity of all point masses. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Main”.

4.4.65. V cross product: ‘x=szuy-syuz=a3 b2- a2 b3’ (Address ‘BO4’):

The equation at address ‘BO4’ is ‘BJ4*BF4-BI4*BG4’. Here we see the x coordinate of Vector cross product of position and velocity of a point mass for testing. This equation is in sheet “Main”.

4.4.66. V cross product: ‘y=szux-sxuz=a3b1-a1b3’ (Address ‘BP4’):

The equation at address ‘BP4’ is ‘BJ4*BE4-BH4*BG4’. Here we see the y coordinate of Vector cross product of position and velocity of a point mass for testing. This equation is in sheet “Main”.

4.4.67. V cross product: ‘z=sxuy-syux=a1b2-a2b1’ (Address ‘BQ4’):

The equation at address ‘BQ4’ is ‘BH4*BF4-BI4*BE4’. Here we see the z coordinate of Vector cross product of position and velocity of a point mass for testing. This equation is in sheet “Main”.

The following equations are from sheet “Previous itr”

4.4.68. V cross product SUM: ‘x=szuy-syuz=a3 b2- a2 b3’ (Address ‘N5’):

The equation at address ‘BO5’ is ‘SUM(N8:N140)’. Here we get the sum of x coordinate of Vector cross product of ‘position & velocity’ of all point masses at the beginning of present iteration. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Previous itr”

4.4.69. V cross product SUM: ‘y=szux-sxuz=a3b1-a1b3’ (Address ‘O5’):

The equation at address ‘O5’ is ‘SUM(O8:O140)’. Here we get the sum of y coordinate of Vector cross product of position and velocity of all point masses at the beginning of present iteration. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Previous itr”.

4.4.70. V cross product SUM: ‘z=sxuy-syux=a1b2-a2b1’ (Address ‘P5’):

The equation at address ‘P5’ is ‘SUM(P8:P140)’. Here we get the sum of z coordinate of Vector cross product of position and velocity of all point masses at the beginning of present iteration. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Previous itr”.

4.4.71. V cross product SUM: ‘Magnitude xyz prev itr’ (Address ‘Q5’):

The equation at address ‘Q5’ is ‘SQRT(N5^2+O5^2+P5^2)’. Here we get the vector magnitude of sum of xyz coordinate of Vector cross product of position and velocity of all point masses at the beginning of present iteration. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Previous itr”.

4.4.72. V cross product SUM: ‘Magnitude xyz present itr’ (Address ‘Q4’):

The equation at address ‘Q4’ is ‘SQRT(N4^2+O4^2+P4^2)’. Here we get the vector magnitude of sum of xyz coordinate of Vector cross product of position and velocity of all point masses at the END of present iteration. This is final result while testing for singularities in Dynamic universe model. This constant specific relative angular momentum (velocity position vector cross product) shows that Dynamic universe model is continuous function. This equation is in sheet “Previous itr”.

4.4.73. SUM of Angular momentum: Mass velocity position cross product X (Address ‘R5’)

The equation is ‘SUM(R8:R140)’. This ‘Sum of Angular momentum: Mass velocity position cross product’ gives total x value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation sums from cell addresses ‘R8’ to ‘R140’. This equation is in sheet “Previous itr”.

4.4.74. SUM of Angular momentum: Mass velocity position cross product Y (Address ‘S5’)

The equation is ‘SUM(S8:S140)’. This ‘sum of Angular momentum: Mass velocity position cross product’ gives total Y value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation sums from cell addresses ‘S8’ to ‘S140’. This equation is in sheet “Previous itr”.

4.4.75. Sum of Angular momentum: Mass velocity position cross product Z (Address ‘R5’)

The equation is ‘SUM(T8:T140)’. This ‘Sum of Angular momentum: Mass velocity position cross product’ gives Z value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation sums from cell addresses ‘T8’ to ‘T140’. This equation is in sheet “Previous itr”.

4.4.76. Magnitude of XYZ Sums of Angular momentum: Mass velocity position cross product (Address ‘U5’)

The equation is ‘SQRT(R5^2+S5^2+T5^2)’. This ‘vector magnitude of XYZ Sums of Angular momentum: Mass velocity position cross product’ gives total value for the *starting data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation is in sheet “Previous itr”.

4.4.77. Magnitude of XYZ Sums of Angular momentum: Mass velocity position cross product (Address ‘U4’)

The equation is ‘SQRT(R4^2+S4^2+T4^2)’. This ‘vector magnitude of XYZ Sums of Angular momentum: Mass velocity position cross product’ gives total value for the *Ending data* of present iteration, which shows that no singularity exists in the present iteration due to its non-zero value. This equation is in sheet “Previous itr”.

The following equations are from sheet “Stability”

4.4.78. Necessary Condition for Stability: SUM of ‘T’ for (KE) (Address ‘K18’)

The equation is ‘SUM(K19:K151)’. This ‘Necessary Condition for Stability T (the total energy h = T –V is negative)’ gives sum of ‘T’ the Kinetic Energy value for the *Resulting data* in the present iteration. This equation sums from cell addresses ‘K19’ to ‘K151’. This is an intermediate equation. This equation is in sheet “Stability”.

4.4.79. Necessary Condition for Stability: sum of V (PE) for mass 133 (Address ‘L18’)

The equation is ‘SUM(L19:L150)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives sum of ‘V’ the Potential Energy value for the mass 133 for the *Resulting data* in the present iteration. This equation sums from cell addresses ‘L19’ to ‘L151’. This equation is in sheet “Stability”.

4.4.80. Necessary Condition for Stability: sum of V (PE) for mass 132 (Address ‘M18’)

The equation is ‘SUM(M19:M150)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives sum of ‘V’ the Potential Energy value for the mass 132 for the *Resulting data* in the present iteration. This equation sums from cell addresses ‘M19’ to ‘M151’. This equation is in sheet “Stability”.

4.4.81. Necessary Condition for Stability: sum of V (PE) for mass 131 (Address ‘N18’)

The equation is ‘SUM(N19:N150)’. This ‘Necessary Condition for Stability V (the total energy h = T –V is negative)’ gives sum of ‘V’ the Potential Energy value for the mass 131 for the *Resulting data* in the present iteration. This equation sums from cell addresses ‘N19’ to ‘N151’ This equation is in sheet “Stability”.

4.4.82. Necessary Condition for Stability: sum of V (PE) for mass 130 (Address 'O18')

The equation is 'SUM(O19:O150)'. This 'Necessary Condition for Stability V (the total energy h = T –V is negative)' gives sum of 'V' the Potential Energy value for the mass 130 for the *Resulting data* in the present iteration. This equation sums from cell addresses 'O19' to 'O151' This equation is in sheet "Stability".

4.4.83. Necessary Condition for Stability: sum of V (PE) for masses133 to 1 (Address 'N16')

The equation is 'SUM(L18:EM18)'. This 'Necessary Condition for Stability V (the total energy h = T –V is negative)' gives sum of 'V' the Potential Energy value for the mass 133 to 1 for the *Resulting data* in the present iteration. This equation sums all the sums from cell addresses 'L18' to 'EM18'. Here we can clearly see this sum V (=4.54794E+62) is much MORE higher than the sum T (=1.16843E+40). So h= T-V is negative. THIS SHOWS DYNAMIC UNIVERSE MODEL IS STABLE. This equation is in sheet "Stability".

The following equations are from sheet “vel unit vector”

4.4.84. Velocity Unit Vectors Test : sum of X differences (Address ‘Q16’)

The equation is ‘SUM(Q19:Q151)’. This ‘velocity Unit vector Test : sum of X differences’ gives the sum of X portion of Unit vector differences between the final Unit Vector ‘positions and velocities’ achieved in the *Resulting data* in the present iteration. This equation sums from cell addresses ‘Q19’ to ‘Q151’. If the differences are all zeros, then the velocities are directed towards the center of mass, then all the point masses will collapse. But here the X value of sum calculated to be ’13.667’. This shows that DYNAMIC UNIVERSE MODEL IS NOT COLLAPSING. This equation is in sheet “vel unit vector”.

4.4.85. Velocity Unit Vectors Test : sum of Y differences (Address ‘R16’)

The equation is ‘SUM(R19:R151)’. This ‘velocity Unit vector Test : sum of Y differences’ gives the sum of Y portion of Unit vector differences between the final Unit Vector ‘positions and velocities’ achieved in the *Resulting data* in the present iteration. This equation sums from cell addresses ‘R19’ to ‘R151’. If the differences are all zeros, then then the velocities are directed towards the center of mass, then all the point masses will collapse. But here the Y value of sum calculated to be ’88.679’. This shows that DYNAMIC UNIVERSE MODEL IS NOT COLLAPSING. This equation is in sheet “vel unit vector”.

4.4.86. Velocity Unit Vectors Test : sum of Z differences (Address ‘S16’)

The equation is ‘SUM(S19:S151)’. This ‘velocity Unit vector Test : sum of Z differences’ gives the sum of Z portion of Unit vector differences between the final Unit Vector ‘positions and velocities’ achieved in the *Resulting data* in the present iteration. This equation sums from cell addresses ‘S19’ to ‘S151’. If the differences are all zeros, then then the velocities are directed towards the center of mass, then all the point masses will collapse. But here the Z value of sum calculated to be ’-11.477’. This shows that DYNAMIC UNIVERSE MODEL IS NOT COLLAPSING. This equation is in sheet “vel unit vector”.

4.5 Ranges used SITA equations

There are various fixed addresses used in equations and some ranges were defined in the SITA Excel Sheet for calculation purposes. All such range names are defined below.

4.5.1. 'a'

Range L8:N140. Used for accl x, accl y, and accl z. These are intermediate results storage areas

4.5.2. 'lastdata'

Range BE8:BM140. Used for keeping the output of the present iteration. Data available are ux, uy, uz, sx, sy, sz, y, s=dist, v= vel, & dz. For 133 masses.

4.5.3. mercury

Range BE9:BN9. Data available are ux, uy, uz, sx, sy, sz, y, s=dist, v= vel, & dz, for this one row. This is also output data.

4.5.4 New Horizons

Range BE8:BN8. Data available are ux, uy, uz, sx, sy, sz, y, s=dist, v= vel, & dz, for this one row. This is also output data.

4.5.5. newdata

Range BE8:BN140. Data available are ux, uy, uz, sx, sy, sz, y, s=dist, v= vel, & dz. This also output data for 133 masses.

4,5.6. newdist

Range BH8:BJ140. Data available are sx, sy, & sz. for 133 masses. This also output data.

4.5.7. newsimulation

Range D7:D117. Data available are mass*x, sl no This can be input / output data.

4.5.8. newgalaxy

Range Y7:Y117. Data available are sx, sy. This also output data.

4.5.9. oldgalaxy

Range H7:I117. Data available are xecliptic &yecliptic. This also input data.

4.5.10 Pioneer _anomaly

Range R2:Z2. Pioneer anomaly data actual accl x,y,z; Modulus of actual acceleration, Sun acceleration due to gravity, & difference between the two are available for this one row. This also output data.

4.5.11. rel_ref8

Range ‘O8’. Accl reference cell

4.5.12. s

Range L4:N4. Sums accl x,y,z

4.5.13 SUN

Range BE19:BN19. Data available are ux, uy, uz, sx, sy, sz, y, s=dist, v= vel, & dz, for this one row. This is also output data.

4.5.14. time

Range ‘O1’. ‘Timestep’ in seconds.

4.5.16. xyzaccl

Range P8:R8. Data available are accl x, accl y and accl z. This is also output data.

4.6. Macros used SITA

Various macros are used for semi-automating the calculation processes. They are listed and explained below. I will tell the central idea what each of these macros supposed to do. As most part of was written by the Excel itself, I don’t know the exact syntax of writing the commands. I only modified the Excel created commands to suite the requirements. That’s why there exist two or three variations of macros for every requirement. Some macros are half finished and I am doing the further work on them. I listed them all for everybody’s to see.

4.6.1 Mercury_iteration_data

This is one of the macros which were tried to record data of Mercury from iteration to iteration. This macro records data in the range named ‘mercury’ in the active cell in sheet 4. Later it records the range named ‘Pioneer anomaly’ also on the same line.

```
====================================

Sub mercury_itr_data()

' mercury_itr_data Macro
```

```
' Macro recorded 1/6/2009 by admin

    Sheets("Sheet4").Select

    ActiveCell.Select

    ActiveCell.FormulaR1C1 = "1"

    ActiveCell.Offset(0, 1).Range("A1").Select

    Application.Goto Reference:="mercury"

    Selection.Copy

    Sheets("Sheet4").Select

    ActiveSheet.Paste

    ActiveCell.Offset(0, 10).Range("A1").Select

    Sheets("Sheet1").Select

    Application.Goto Reference:="Pioneer_anomaly"

    Application.CutCopyMode = False

    Selection.Copy

    Sheets("Sheet4").Select

    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _

        :=False, Transpose:=False

    ActiveCell.Offset(1, -11).Range("A1").Select

    Sheets("Sheet1").Select

    ActiveWindow.SmallScroll ToRight:=-11

    ActiveCell.Offset(6, -3).Range("A1").Select

End Sub
```

====================================

4.6.2 Mercury_itr_data

This is one of the macros which were tried to record data of Mercury from iteration to iteration. This macro records data in the range named ‘mercury’ in the active cell in sheet 4. Later it records the range named ‘Pioneer anomaly’ also on the same line.

====================================

```
Sub mercury_itr_data()

'

' mercury_itr_data Macro

' Macro recorded 1/6/2009 by admin

    Sheets("Sheet4").Select

    ActiveCell.Select

    ActiveCell.FormulaR1C1 = "1"

    ActiveCell.Offset(0, 1).Range("A1").Select

    Application.Goto Reference:="mercury"

    Selection.Copy
```

```
    Sheets("Sheet4").Select

    ActiveSheet.Paste

    ActiveCell.Offset(0, 10).Range("A1").Select

    Sheets("Sheet1").Select

    Application.Goto Reference:="Pioneer_anomaly"

    Application.CutCopyMode = False

    Selection.Copy

    Sheets("Sheet4").Select

    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _

        :=False, Transpose:=False

    ActiveCell.Offset(1, -11).Range("A1").Select

    Sheets("Sheet1").Select

    ActiveWindow.SmallScroll ToRight:=-11

    ActiveCell.Offset(6, -3).Range("A1").Select

End Sub
```

=======================================

4.6.3 n2l

This macro copies data from range ‘newdata’ to ‘BE8’

=======================================

```
Sub n2l()
```

```
'
' n2l Macro
' Macro recorded 8/8/2004 by  snpgupta
    Application.Goto Reference:="newdata"
    Selection.Copy
    Range("be8").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
End Sub
```

=====================================

4.6.4 next10

This macro runs the vak1 macro once. That means one iteration. As a preparation it will rum the macro ‘xfernew2old’ after running ‘vak1’ macro. Then this macro writes ‘DONE100’ in address ’AY7’, indicating that it has completed its job. Then it executes ‘n2l’ macro.

=====================================

```
Sub next10()
'
' next10 Macro
' Macro recorded 3/18/2004 by snp
'
' Keyboard Shortcut: Ctrl+n
'
    Application.Run "'vak variable time create.xls'!xfernew2old"
    Application.CutCopyMode = False
    Application.Run "'vak variable time create.xls'!xfervu"
    Application.Goto Reference:="rel_ref8"
    Application.CutCopyMode = False
    Application.Run "'vak variable time create.xls'!vak1"
    ActiveWindow.SmallScroll ToRight:=25
    Range("Ay7").Select
    Application.CutCopyMode = False
    ActiveCell.FormulaR1C1 = "DONE100"
'for storing final results
    Application.Run "'vak variable time create.xls'!n2l"
    Application.CutCopyMode = False

End Sub
```

=====================================

4.6.5 repeat100

This macro runs the ‘next10’ macro 100 times. This macro records data in the range named ‘mercury’ in the active cell in sheet 4. Later it records the ranges named ‘Pioneer anomaly’, ‘SUN’ and ‘New_Horizons’ also on the same line.

====================================

```
Sub repeat100()
'
' repeat100 Macro
' Macro recorded 12/2/2008 by vak
'
' Keyboard Shortcut: Ctrl+p
' This macro repeats the Next10 macro 100 times.
' Intialize Repeat
    Dim Repeat As Integer
'
    Repeat = 1
    For Repeat = 1 To 100
'for loop for 100 values
```

```
    Application.Run "'vak variable time create.xls'!next10"
    Application.CutCopyMode = False
'
'copy mercury itearation data
'
Sheets("Sheet5").Select
    ActiveCell.Select
    ActiveCell.FormulaR1C1 = Repeat
    ActiveCell.Offset(0, 1).Range("A1").Select
    Application.Goto Reference:="mercury"
    Selection.Copy
    Sheets("Sheet5").Select
    ActiveSheet.Paste
    ActiveCell.Offset(0, 10).Range("A1").Select
    Sheets("Sheet1").Select
    Application.Goto Reference:="Pioneer_anomaly"
    Application.CutCopyMode = False
    Selection.Copy
    Sheets("Sheet5").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False
```

```
    ActiveCell.Offset(0, 13).Range("A1").Select

    Application.Goto Reference:="SUN"

    Selection.Copy

    Sheets("Sheet5").Select

    ActiveSheet.Paste

      ActiveCell.Offset(0, 10).Range("A1").Select

    Application.Goto Reference:="New_Horizons"

    Selection.Copy

    Sheets("Sheet5").Select

    ActiveSheet.Paste


    ActiveCell.Offset(1, -34).Range("A1").Select


    Application.Goto Reference:="rel_ref8"


    Next Repeat


End Sub
```

======================================

4.6.6 store

Copies range ‘newdist’ to address ‘M8’

```
======================================
Sub store()
'
' store Macro
' Macro recorded 3/20/2004 bysnp
'
' Keyboard Shortcut: Ctrl+s
'
    Application.Goto Reference:="newdist"
    Selection.Copy
    Windows("Vak variable time storage.xls").Activate
    ActiveWindow.SmallScroll ToRight:=3
    Range("M8").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
End Sub
======================================
```

4.6.7 vak

This macro copies acceleration and xyz acceleration formulae into the Excel sheet. These formulae calculate Newtonian acceleration on each point mass.

```
================================

Sub vak()

'

' vak Macro

' Macro recorded 25-02-04 by snp

'

' Keyboard Shortcut: Ctrl+a

'

    Range("K8:N8").Select

    ActiveCell.FormulaR1C1 = _

        "=R1C10*RC[-4]/((R15C8-RC[-3])^2+(R15C9-RC[-2])^2+(R15C10-RC[-1])^2)^1.5"

    Range("K8:N8").Select

    Range("L8").Activate

    ActiveCell.FormulaR1C1 = "=RC[-1]*(RC[-4]-R15C8)"

    Range("K8:N8").Select

    Range("M8").Activate

    ActiveCell.FormulaR1C1 = "=RC[-2]*(RC[-4]-R15C9)"

    Range("K8:N8").Select

    Range("N8").Activate

    ActiveCell.FormulaR1C1 = "=RC[-3]*(RC[-4]-R15C10)"

    Range("K8:N8").Select

    Selection.Copy
```

```
    Range("K9:N140").Select
    ActiveSheet.Paste
    Range("K15").Select
    Application.CutCopyMode = False
    Selection.ClearContents
    Range("L4:N4").Select
    Selection.Copy
    Range("P15").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
End Sub
```

======================================

4.6.8. vak1

This macro copies 133 acceleration and xyz acceleration formulae into the Excel sheet. These formulae calculate Newtonian acceleration on each point mass.

======================================

```
Sub vak1()
'
```

```
' vak1 Macro
' Macro recorded 3/12/2004 by snp
'
    Dim row As Integer
    Dim absaddress As Integer
    Dim formulaforf As String
    Dim formulaforx As String
    Dim formulafory As String
    Dim formulaforz As String

'this gives changing values of rows and for writing new values in new row
    row = 0
    absaddress = 0

    For row = 0 To 132
'for loop for 132 values
    absaddress = row + 8

 ' Recording done  in excel

    formulaforf = "=$j$1*g2/((($h$" & absaddress & "-h2)^2+($i$" & absaddress & "-i2)^2+($j$" & absaddress & "-j2)^2))^1.5"
    formulaforx = "=k2*(h2-$h$" & absaddress & ")"
```

```
formulafory = "=k2*(i2-$i$" & absaddress & ")"

formulaforz = "=k2*(j2-$j$" & absaddress & ")"


ActiveCell.Offset(-6, -4).Range("A1").Select

ActiveCell.Formula = formulaforf


ActiveCell.Offset(0, 1).Range("A1").Select

ActiveCell.Formula = formulaforx


ActiveCell.Offset(0, 1).Range("A1").Select

ActiveCell.Formula = formulafory


ActiveCell.Offset(0, 1).Range("A1").Select

ActiveCell.Formula = formulaforz


ActiveCell.Offset(0, -3).Range("A1:d1").Select

Selection.Copy


ActiveCell.Offset(6, 0).Range("A1:D133").Select

ActiveSheet.Paste


ActiveCell.Offset(0 + row, 0).Range("A1:D1").Select
```

```
    Application.CutCopyMode = False

    Selection.ClearContents


    Range("l4:n4").Select

    Selection.Copy


    ActiveCell.Offset(4 + row, 4).Range("A1").Select

    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _

        False, Transpose:=False




    Range("o8").Select

    Next row


' testing

    formulaforf = "=$j$1*g2/(($h$" & absaddress & "-h2)^2+($i$" & absaddress & "-i2)^2+($j$" & absaddress & "-j2)^2) ^1.5"


    ActiveCell.Offset(-6, 1).Range("A1").Activate

    ActiveCell.Formula = formulaforf

  '

  End Sub
```

=====================================

4.6.9. vak2

This macro copies 133 acceleration and xyz acceleration formulae into the Excel sheet. This is another variation. These formulae calculate Newtonian acceleration on each point mass.

```
=====================================

Sub vak2()

'

' vak2 Macro

' Macro recorded 3/11/2004 by snp

'



'

    Dim row As Integer ' for writing new values in new row

    row = 1



    For row = 0 To 132

'for loop for 132 values



    ActiveCell.Offset(-6, -4).Range("A1:D1").Select

    ActiveCell.FormulaR1C1 = _

        "=R1C10*RC[-4]/((R8C8-RC[-3])^2+(R8C9-RC[-2])^2+(R8C10-RC[-1])^2) ^1.5"
```

```
    ActiveCell.Offset(0, 1).Range("A1").Activate

    ActiveCell.FormulaR1C1 = "=RC[-1]*(RC[-4]-R8C8)"

    ActiveCell.Offset(0, 1).Range("A1").Activate

    ActiveCell.FormulaR1C1 = "=RC[-2]*(RC[-4]-R8C9)"

    ActiveCell.Offset(0, 1).Range("A1").Activate

    ActiveCell.FormulaR1C1 = "=RC[-3]*(RC[-4]-R8C9)"

    Selection.Copy

    ActiveCell.Offset(6, -3).Range("A1:D133").Select

    ActiveSheet.Paste

    ActiveCell.Offset(0, 0).Range("A1:D1").Select

    Application.CutCopyMode = False

    Selection.ClearContents

    ActiveCell.Offset(-4, 1).Range("A1:C1").Select

    Selection.Copy

    ActiveCell.Offset(4 + row, 4).Range("A1").Select

    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _

        False, Transpose:=False

    Range("o8").Select

    Next row

End Sub
```

======================================

4.6.10 xfernew2old

Copies range named ‘newdist’ to range "H8:J140"

```
====================================
Sub xfernew2old()
'
' xfernew2old Macro
' Macro recorded 3/14/2004 by snp
'
'
    Application.Goto Reference:="newdist"
    Selection.Copy
    ActiveWindow.SmallScroll ToRight:=-18
    ActiveWindow.SmallScroll Down:=-7
    ActiveWindow.SmallScroll ToRight:=4
    ActiveWindow.SmallScroll Down:=1
    Range("H8:J140").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
End Sub
====================================
```

4.6.11 xfervu

Copies range named ("S8:U140") to range ("V8:X140")

```
====================================
Sub xfervu()
'
' xfervu Macro
' Macro recorded 3/14/2004 by snp
'

'
    Range("S8:U140").Select
    Selection.Copy
    ActiveWindow.SmallScroll Down:=-120
    Range("V8:X140").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
End Sub
====================================
```

4.7. SITA: Graphs

These Graphs show the progress and movement of various point masses in the system. It may please be noted that these graphs are to be tuned for the required point mass distribution, which may vary from one set up to another setup. For the same point mass setup, the XY coordinate graphs and ZX coordinate graphs are different, in some cases we have shown both the graphs to visualize the three dimensional view in a better way.

It may please be noted all the graphs are not used in all the simulations. Some Graphs used in New Horizons satellite trajectory calculations are not used in earlier simulations and vice versa…

Start graphs indicate the starting setup before any iteration started. All the graphs showing the present iteration beginning positions are named as Old position graphs for some group of masses. The graphs showing the positions achieved after the present iteration are named as New position graphs .

All the xyz scales are indicated in the units of meters, but with appropriate powers of tens as required.

The groupings of masses are required as ‘solar system’, ‘Globular clusters’ or ‘Clusters of Galaxies’. As we increase the scale, the point masses in the smaller scales are clumped and bundled together. All those at the smaller scale will be shown as single point and it will be difficult to visualize the finer motions. Logarithmic graphs may overcome such problem. But these logarithmic graphs have another disadvantage that they cannot show negative values in the graph and they are non-linear. Hence mass grouping was the solution that could be thought of as a possible way to show the positions in a graph as many number of masses are involved.

4.7.1 Graph: ‘Start Near Stars XY’

This Graph shows an XY coordinate plot of Stars that are nearer to our SUN. This graph shows the positions at the start of simulation before starting any iteration. This is a reference graph for comparing the position achieved later after some iterations.

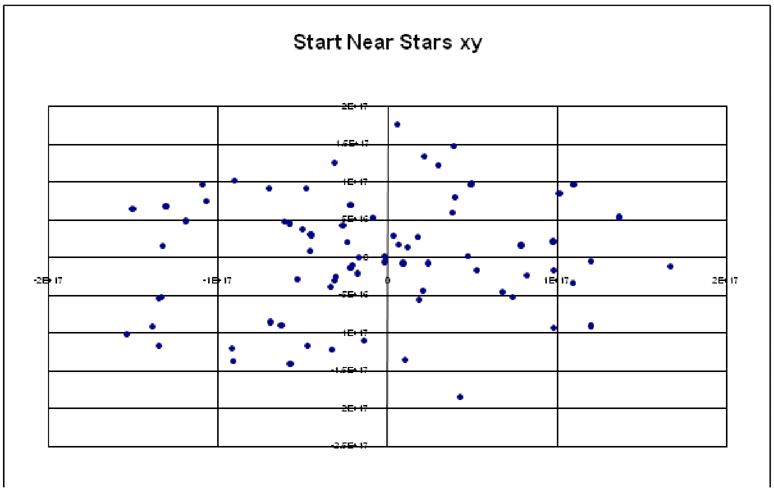

Figure 1 : This Graph shows an XY coordinate plot of Stars NEAR to our SUN at the start of simulation before all the iterations

4.7.2 Graph: 'Old Near Stars XY'

This Graph shows an XY coordinate plot of Stars that are nearer to our SUN. This graph shows the positions at the start of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

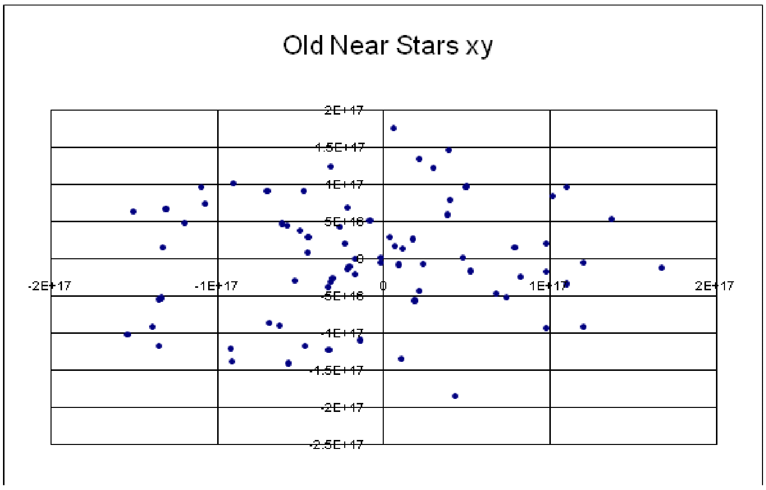

Figure 2: This Graph shows an XY coordinate plot of Stars NEAR to our SUN at the start of present iteration

4.7.3 Graph: ‘New Near Stars XY’

This Graph shows an XY coordinate plot of Stars that are nearer to our SUN. This graph shows the positions at the end of present iteration. This graph is useful for comparing the positions before and after present iteration.

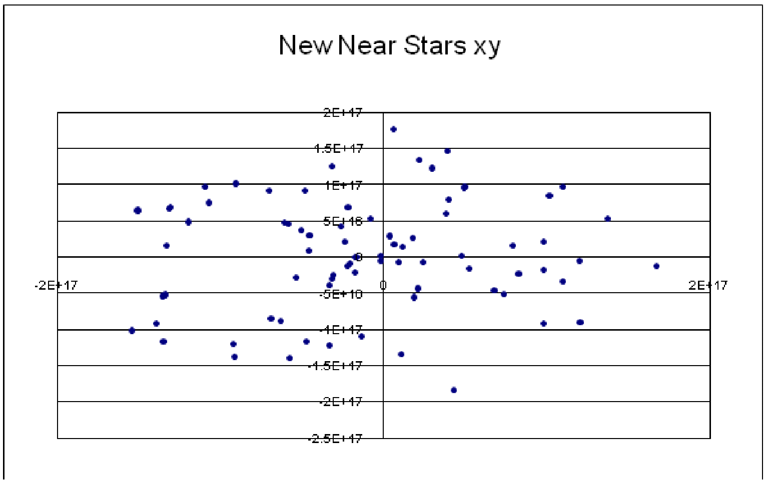

Figure 3: This Graph shows an XY coordinate plot of Stars NEAR to our SUN at the END of present iteration

4.7.4 Graph: 'Start Galaxy ZY'

This Graph shows a ZY coordinate plot of galaxies. This graph shows the positions at the start of simulation before starting any iteration. This is a reference graph for comparing the position achieved later after some iterations.

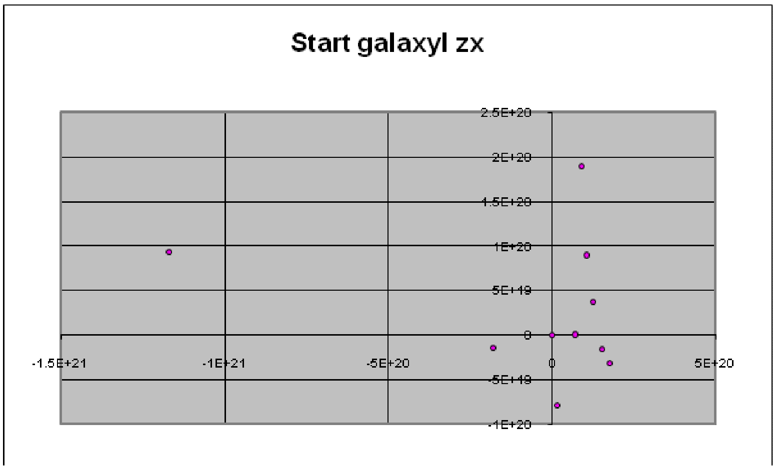

Figure 4: This Graph shows an XY coordinate plot of Galaxies at the start of simulation before all the iterations

4.7.5 Graph: ‘Old Galaxies ZX’

This Graph shows a ZX coordinate plot of Galaxies in the present setup. This graph shows the positions at the start of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

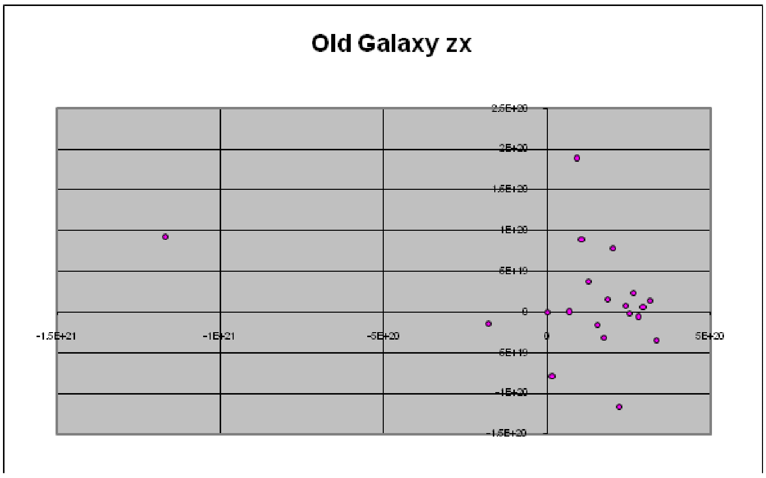

Figure 5: This Graph shows an ZX coordinate plot of Galaxies at the START of present iteration

4.7.6 Graph: ‘New Galaxy ZX’

This Graph shows a ZX coordinate plot of Galaxies in the present setup. This graph shows the positions at the end of present iteration. This graph is useful for comparing the positions before and after present iteration.

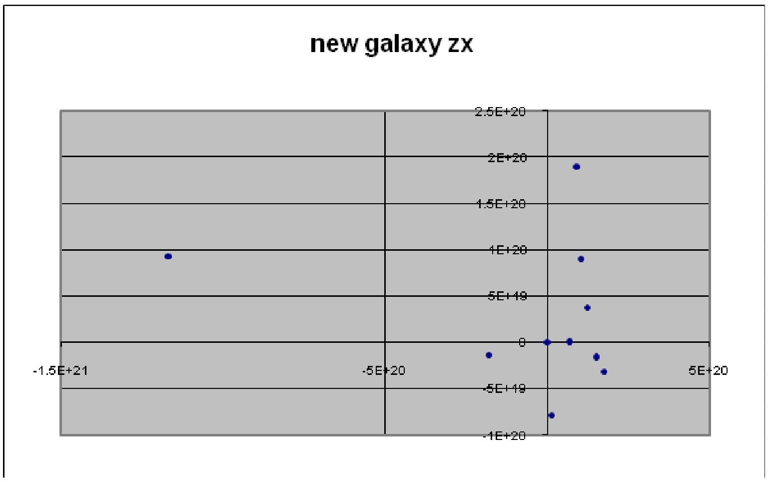

Figure 6: This Graph shows an ZX coordinate plot of Galaxies at the END of present iteration

4.7.7 Graph: 'Start Clusters XY'

This Graph shows an XY coordinate plot of Clusters in this setup. This graph shows the positions at the start of simulation before starting any iteration. This is a reference graph for comparing the position achieved later after some iterations.

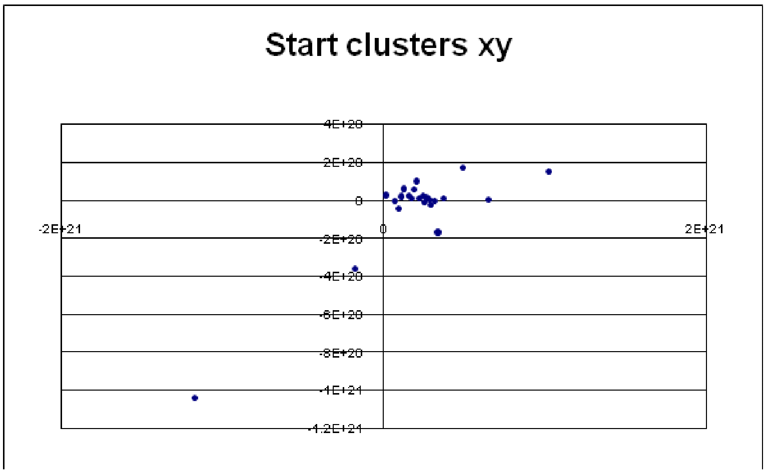

Figure 7: This Graph shows an XY coordinate plot of Clusters of Galaxies at the start of simulation before all the iterations

4.7.8 Graph: ‘Old Clusters XY’

This Graph shows a XY coordinate plot of Clusters in this setup. This graph shows the positions at the start of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

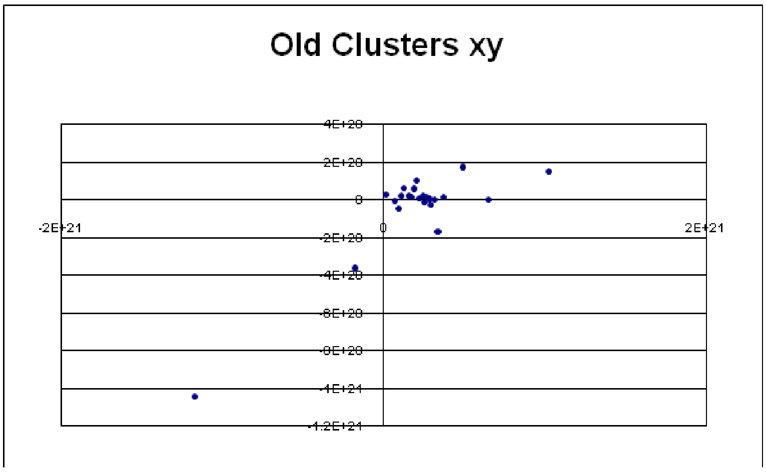

Figure 8: This Graph shows an XY coordinate plot of Clusters of Galaxies at the start of the present iteration

4.7.9 Graph: ‘New Clusters XY’

This Graph shows a XY coordinate plot of Clusters in this setup. This graph shows the positions at the end of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

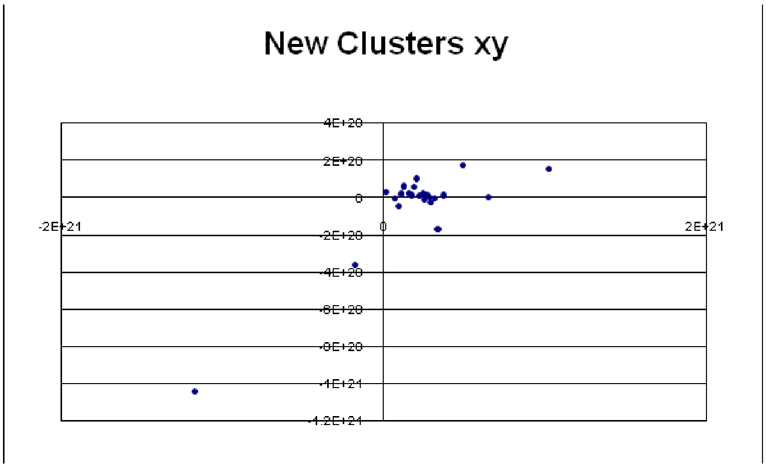

Figure 9: This Graph shows an XY coordinate plot of Clusters of Galaxies at the end of the present iteration

4.7.10 Graph: ‘ZX- new solar sys’

This Graph shows a ZX coordinate plot of planets of our solar system in this setup. This graph shows the positions at the end of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

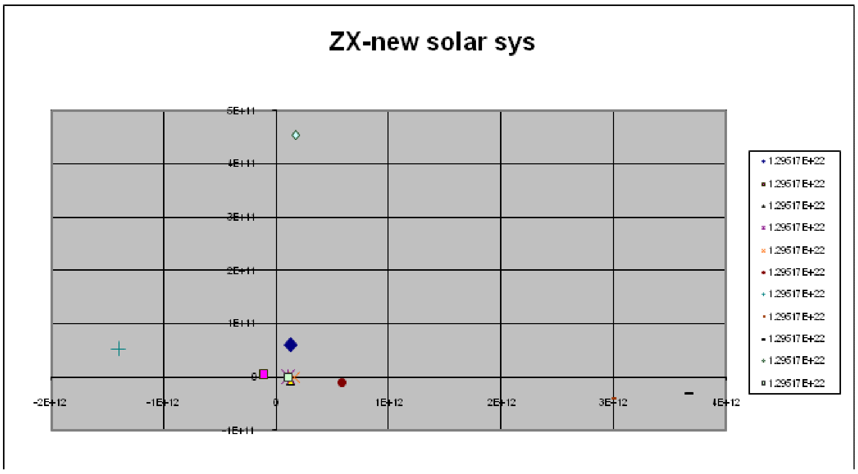

Figure 10: This Graph shows an XY coordinate plot of 10 planets in the solar system at the end of the present iteration

4.7.11 Graph: ‘Old ALL ZX’

This Graph shows a ZX coordinate plot of ALL point masses in the present setup. This graph shows the positions at the start of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

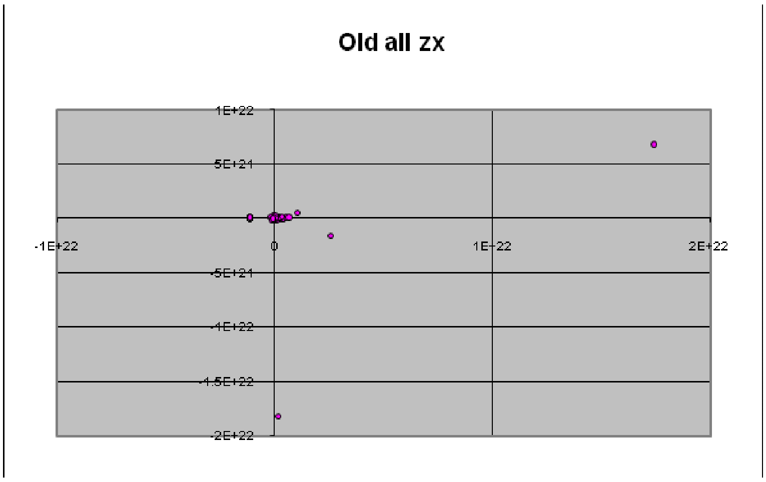

Figure 11: This Graph shows an ZX coordinate plot of ALL point masses in the present simulation system at the start of the present iteration

4.7.12 Graph: ‘New ALL ZX’

This Graph shows a ZX coordinate plot of ALL point masses in the present setup. This graph shows the positions at the end of present iteration. This graph is useful for comparing the positions before and after present iteration.

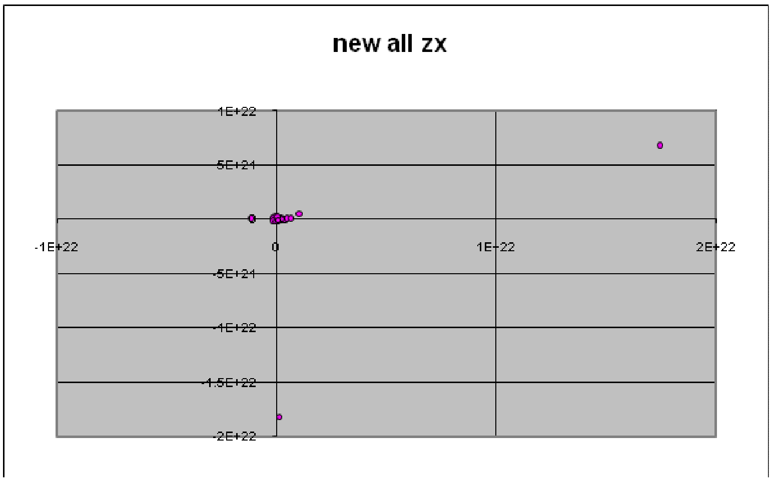

Figure 12: This Graph shows a ZX coordinate plot of ALL point masses in the present simulation system at the end of the present iteration

4.7.13 Graph: ’10 start’

This Graph shows a XY coordinate plot of planets of our solar system in this setup at the start before any iteration. This is a reference graph for comparing the position achieved later after some iterations.

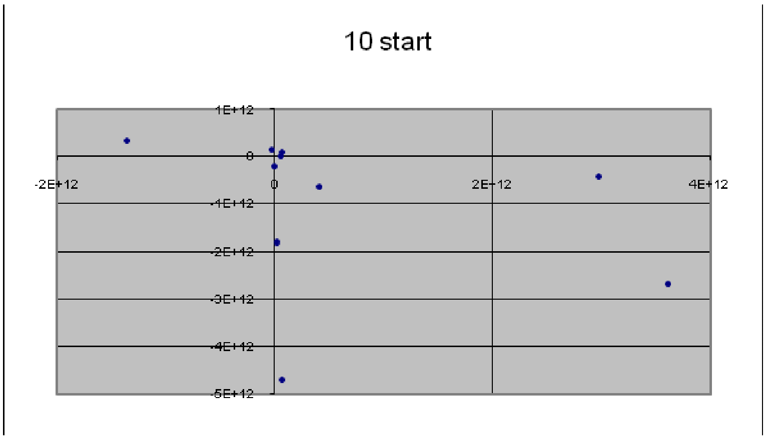

Figure 13This Graph shows an XY coordinate plot of 10 planets in the solar system at the start of simulation before all the iterations

4.7.14 Graph: ‘Old Solar sys’

This Graph shows a XY coordinate plot of planets of our solar system in this setup. This graph shows the positions at the start of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

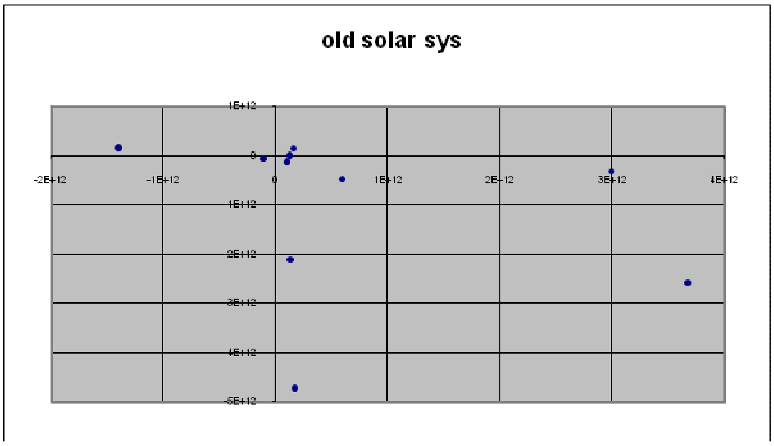

Figure 14: This Graph shows an XY coordinate plot of 10 planets in the solar system at the start of the present iteration

4.7.15 Graph: 'New Solar sys'

This Graph shows a XY coordinate plot of planets of our solar system in this setup. This graph shows the positions at the start of present iteration. This graph can be used for comparing the positions changed before and after present iteration.

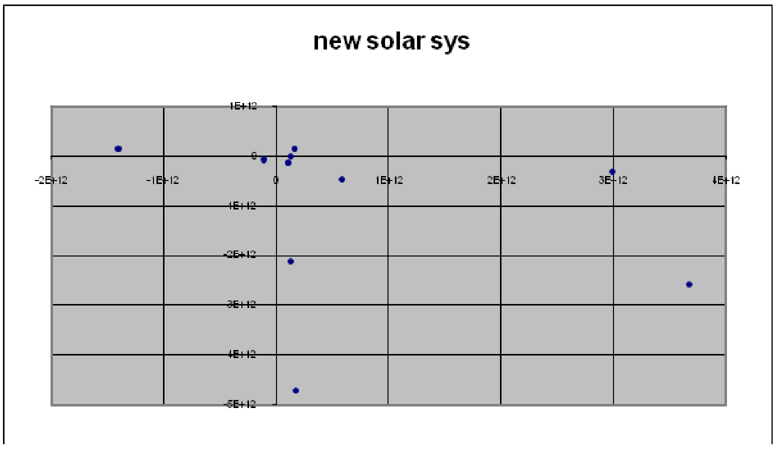

Figure 15: This Graph shows an XY coordinate plot of 10 planets in the solar system at the end of the present iteration

4.7.16 Graph: 'Galaxy star circular velocity Dist- Vel- all'

This Graph shows Galaxy star circular velocity curves for all point masses in this setup. Based on the usual Newtonian physics or Gr based physics, we get the theoretical velocity curves as drooping curves with distance. But these theoretical curves are not drooping but straight. These graphs are to be tuned for the present mass setup.

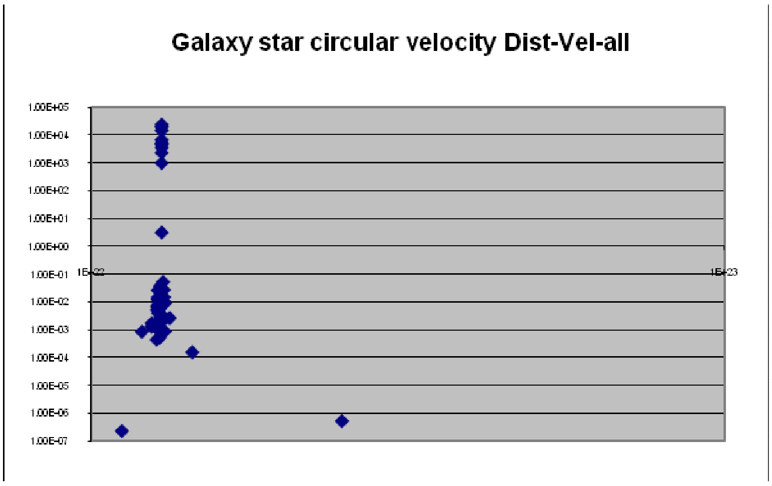

Figure 16: Galaxy star circular velocity curves: Distance velocity plot for all point masses in simulation

4.7.17 Graph: 'Galaxy star circular velocity Dist- Vel- all CG'

This Graph shows Galaxy star circular velocity curves for all point masses in this setup with center of gravity as reference. Based on the usual Newtonian physics or Gr based physics, we get the theoretical velocity curves as drooping curves with distance. But these theoretical curves are not drooping but straight. These graphs are to be tuned for the present mass setup.

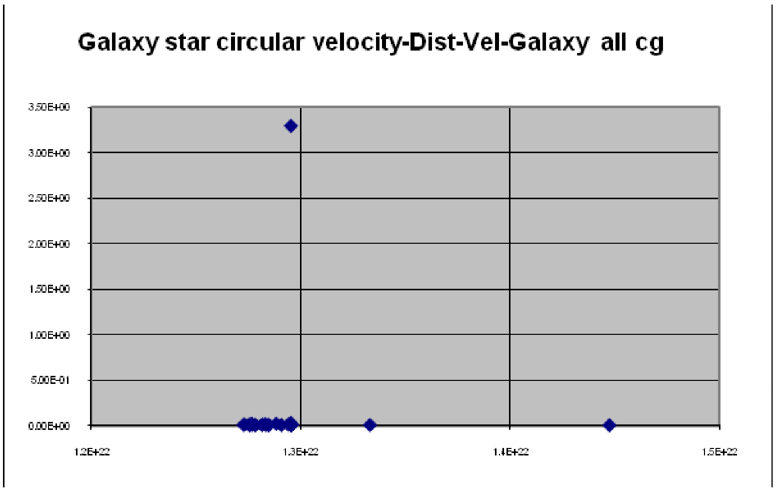

Figure 17: Galaxy star circular velocity curves: Distance velocity plot for all point masses in simulation using Center of gravity as center

4.7.18 Graph: 'Galaxy star circular velocity Dist- Vel- Galaxy CG'

This Graph shows Galaxy star circular velocity curves for the milkyway point masses in this setup with center of gravity as reference. Based on the usual Newtonian physics or Gr based physics, we get the theoretical velocity curves as drooping curves with distance. But these theoretical curves are not drooping but straight. These graphs are to be tuned for the present mass setup.

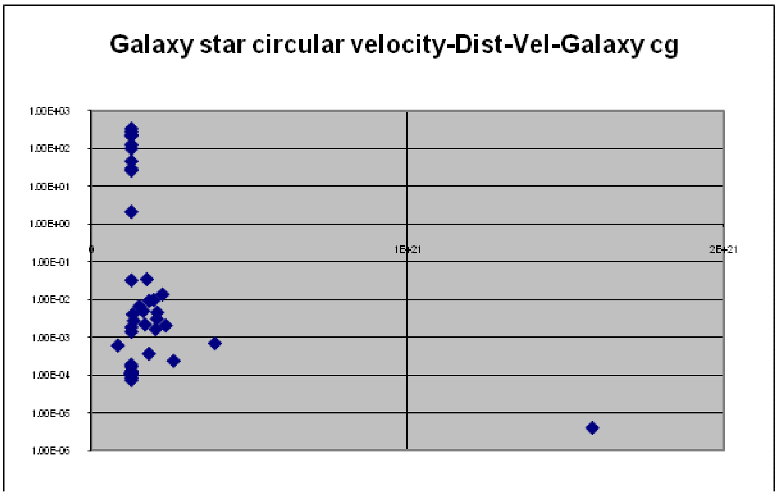

Figure 18: Galaxy star circular velocity curves: Distance velocity plot for all point masses in Milkyway using CG

5. SITA- ‘no singularity’ calculations

5.1. Introduction and reference

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).

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For all the singularity tables actual explanations text is given here. For the actual tables and data we have to refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1).

These tables are referenced in the accompanying software with Excel program name…………

"SITA book vak variable time create singul free.xls"

5.2. 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.

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

5.3.1. 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…

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

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

5.3.2. 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 2: 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 3 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.

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections 4.4.62 to 4.4.72 in this book

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 after the END of iteration (Table 5)

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections 4.4.62 to 4.4.72 in this book

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

5.4.1. 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* ***I****(t) → 0 as t →*t_o *, then the constant vector of angular momentum is equal to zero:*

$$\boldsymbol{K} = \sum \boldsymbol{m}_i \, (\boldsymbol{r}_i \times \dot{\boldsymbol{r}}_i) = \boldsymbol{0}$$

Weierstrass also mentioned this result in his works.

5.4.2. 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 5 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 6 This table describes non-zero Angular Momentum : MASS Velocity Position Vector cross product for iteration Start

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections 4.4.62 to 4.4.72 in this book

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

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections 4.4.62 to 4.4.72 in this book

5.5. Non-zero Polar moment of Inertia

5.5.1. 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 $t \to t_o$ 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 $t \to t_o$.'***

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

5.5.2. 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 8: This table describes Polar Moment of Inertia for iteration Start

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections '4.3.21 to 4.3.22' and '4.4.57 to 4.4.61' in this book

Table 9 This table describes Polar Moment of Inertia for iteration END

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections '4.3.21 to 4.3.22' and '4.4.57 to 4.4.61' in this book

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

5.6.1. 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)

$$V = \sum_{j<k} \frac{m_j m_k}{r_{jk}}, \quad r_{jk} = |\mathbf{r}_j - \mathbf{r}_k|$$

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].

5.6.2. 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 10 : 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

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.30 to 4.3.34’ and ‘4.4.78 to 4.4.83’ in this book

Table 11 : This table shows how Dynamic Universe Model is stable:” Total Energy = h=T-V” is NEGATIVE

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.30 to 4.3.34’ and ‘4.4.78 to 4.4.83’ in this book

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

5.7.1. 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. $\dot{\boldsymbol{r}}_1 \dots \dot{\boldsymbol{r}}_n$ are the present actual velocities. $\dot{\boldsymbol{r}}_{c1} \dots \dot{\boldsymbol{r}}_{cn}$ 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 $\hat{\dot{\boldsymbol{r}}}_1 \dots \hat{\dot{\boldsymbol{r}}}_n$, $\hat{\dot{\boldsymbol{r}}}_{c1} \dots \hat{\dot{\boldsymbol{r}}}_{cn}$ are the corresponding Unit vectors for these velocities. Then

$$\sum_1^n \left(\hat{\dot{\boldsymbol{r}}}_{ci} - \hat{\dot{\boldsymbol{r}}}_i \right) = \mathbf{0}$$

5.7.2. 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 12: 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 13: 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.

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.35 to 4.3.43’ and ‘4.4.84 to 4.4.86’ in this book

5.8. Non-zero Internal Distances between all pairs of point masses

5.8.1. 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

5.8.2. 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 14 This table gives internal distances of masses 133—128

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 15 This table gives Internal distances between masses 127--119

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 16: This table gives internal distances between masses 118--110

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 17: This table gives internal distance for point masses 109-100

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 18: This table gives internal distances for masses 99-90

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 19: This table gives internal distances for masses 89-80

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 20: This table gives internal distances for masses 79-70

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 21 : This table gives internal distances table

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 22: This table gives internal distances table

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 23 : This table gives internal distances for masses 49—40

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 24: This table gives internal distances for masses 39—30

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 25 : This table gives internal distance for masses 29—20

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 26 : This table gives internal distances for masses 19—10

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

Table 27 : This table gives internal distances for masses 9—1

For actual tables refer the book Dynamic Universe model _ a singularity free N-body problem solution by me. (ISBN 978-3-639-29436-1). For equations see sections ‘4.3.23’ in this book

A message on Tables:

Please see the book, “Dynamic Universe Model- a singularity free N-body problem solution” (ISBN 978-3-639-29436-1) for the actual data of the tables. This data is not repeated here. Any other data can also be supplied on request. I stopped here as this increases the page count.

6. SITA: Numerical outputs: Place to record iteration to iteration outputs and related procedures (macros)

6.1. 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 28: 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	-1126202600

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
						7
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

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
33	-0.002470083	0.000160161	-0.001375966	-5.04468E+16	3.78032E+16	-1.03142E+17
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

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
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
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

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
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

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
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

7. 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.

You must understand that offering an alleged solution for N=133 raises many questions. An ungenerous skeptic might suspect that offering a solution for such a large number of bodies is motivated by the knowledge that no analytical solution is available to falsify it. So here's one direct question:

Q: What checks, if any, did you perform to validate your code?

A. You are correct. As there are no solutions available for more than 3 / 4 bodies, I have to subdivide the equation 25 into small testable equations, test the total set for known physical situations and test for singularities as a whole.

1. **Testing Individual Equations:** All those equations derived from equation 25 are worked out and written in such a way that each can be tested for valid numerical outputs. These equations were tested in excel well.

2. **Testing with a known physical situations:** The total set of equations is tested for known physical situations like Missing mass in Galaxies, Pioneer anomaly and New Horizons satellite tracking etc., which are not possible with GR.

3. **Testing for singularities:** The various known methods in literature and some new methods were taken for testing for singularities and collisions between bodies. All these were discussed in chapter 5 thoroughly.

Q. You should not have to supply any values for the accelerations. The should come from the masses of the bodies and the force law of Newtonian gravity.

Are you really inputting the accelerations by hand?

No never, but possibility and provision exists....

8. 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 similarly charged particles 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 UGF: the Universal Gravitational 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.

8.1. 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 29. Here we can see the Bigbang based cosmological models and their problems with achievements of Dynamic Universe Model.

Table 29 : 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 to be answered by any theory (Cosmology condition)	**Bigbang based cosmologies**	**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.
3	It should say about the universe closed-ness,	Due to Space-time continuum and curvature.	Due to Classical Physics

	General question to be answered by any theory (Cosmology condition) ………	**Bigbang based cosmologies**	**Dynamic Universe Model**
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 to be answered by any theory (Cosmology condition) ………	**Bigbang based cosmologies**	**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

9. Dynamic Universe model results

9.1. 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.

9.2. 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.*

9.3. 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.

SITA software was explained in chapter 4. All the equations like Generic Equations, Non-Generic Non-repeating equations, Generic but not for 133 masses were discussed. Names of Ranges used in equations and sheets, Graphs and processes (macros) used in SITA were given. All the macro listings were given.

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 references for 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 summation of Velocity unit vector differences Test

6. The non-zero Internal Distance between all pairs of point masses.

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 →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 .'* 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.

10. 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, 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.

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