# Gravity as a Unified Force

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Abstract

Model A is attractive; standard physics. Model AB is attractive / repulsive; Hermann Bondi. Model ABCD is likes vs opposites; non-standard physics. Also discussed is a is a new way of looking at Electron-Positron annihilation.

## Model A (Attractive)

Consider a unified model universe of particles where the only force acting between them is gravity. Newton's laws of motion apply at slow speeds, while Special Relativity enforces a global limit at the speed-of-light.

Assuming low speeds, Newton's law of gravity states:

$$F = - G\, m_{g1}\, m_{g2} / r^2$$

For the sake of simplicity, we'll assume that $G = 1$ from here on.

Newton's second law of motion states:

$$F = m_i\, a$$

In standard physics, all masses are constrained to be positive. This leads to a universe where gravity is always attractive, which was basically fine before 1998.

We can further simplify things by assuming that all particles in our model have the same mass $m = 1$. This means that all particles are essentially the same and we can give them the same label "A".

### 1-Body Problem

If we consider a single particle (or "body") of type A, then it either sits still or moves in a straight line according to Newton's first law of motion.

From a philosophical point of view, if there's only one particle then the concept of relative motion is somewhat redundant because there is nothing else to measure against. We can, however, consider the gravitational field to give an idea of what the effect would be on other particles, if there were any.

In particular, we can make a plot of the gravitational potential versus distance. Using the convention that higher potentials are plotted in lighter shades and lower potentials in darker ones, we get Figure 1. This shows us what the environment would be like around a single planet or star, for example, where the attractive force of gravity increases as you get closer.

We can make things a little easier to understand by plotting lines of equal potential, as shown in Figure 2. We can think of the lines as a bit like a "marble run" to give us an idea of how other particles would behave if they were introduced into the system. This leads us neatly on to the next section.

### 2-Body Problem

We can analyze what happens when two particles of type A attract each other due to the force of gravity. This is known as the 2-body problem.

They behave in a familiar way, either colliding, orbiting around each other according to Kepler's laws of planetary

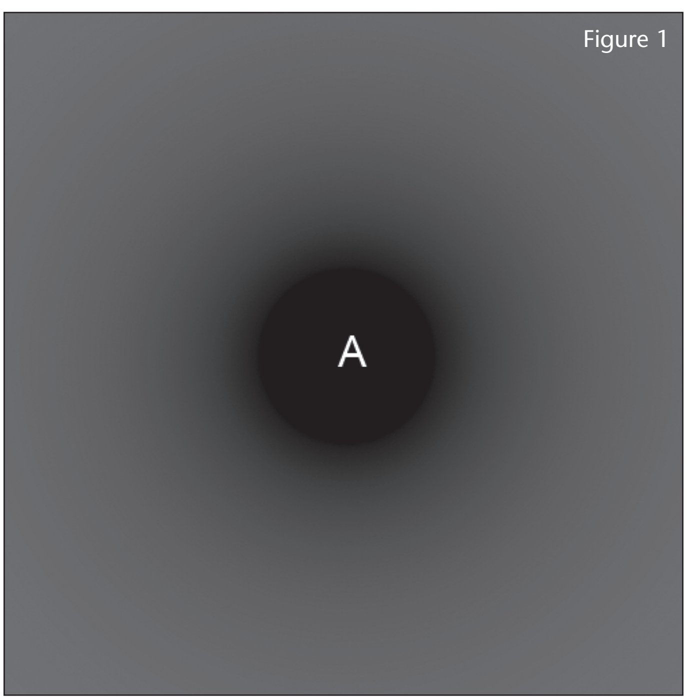



Figure 1

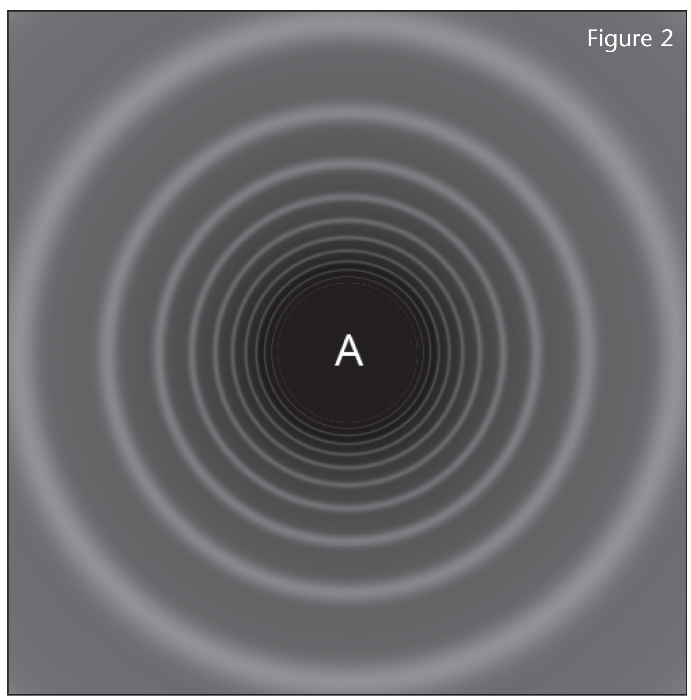
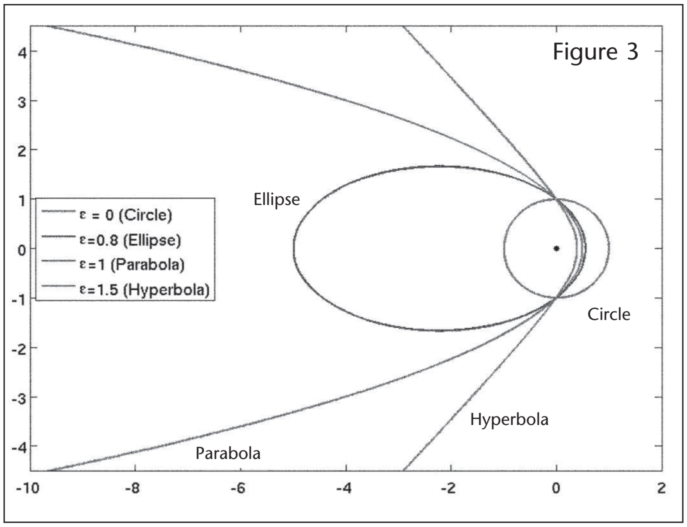



Figure 2




motion, or flying past each other if their relative speed is high enough.

The shape of each orbit is one of the following:

- Straight line
- Circle
- Ellipse
- Parabola
- Hyperbola

depending on their initial positions and velocity, as seen in Figure 3.

Note that because the mass of each particle is the same, they each move in a similar way due to the gravitational attraction from the other. Another way of expressing this is via Newton's third law of motion which states that "for every action, there is an equal and opposite reaction."

Again we can make a plot of the gravitational potential to get an idea of what their combined gravitational effect would be on other particles (Figure 4). This shows us what the environment would be like around a binary star, for example.

Note that although there is a theoretical point mid-way between the two particles where the forces balance and other particles could be located, in practice this arrangement is only semi-stable.

## 3-Body Problem

Things get more involved as soon as we introduce a third particle. It turns out that it is not possible to solve this problem analytically and so we must resort to numerical methods (*i.e.* computer simulation) to find out what happens in the general case.

Nevertheless, we can get a flavor of what goes on if we start with just two of the particles and consider the environment around them, as experienced by the third particle.

With two particles we can assume that they will be rotating around each other in the general case. If we measure things relative to the rotating frame then there is also a rotational potential as well as the gravitational potential from the other two particles (Figure 5).

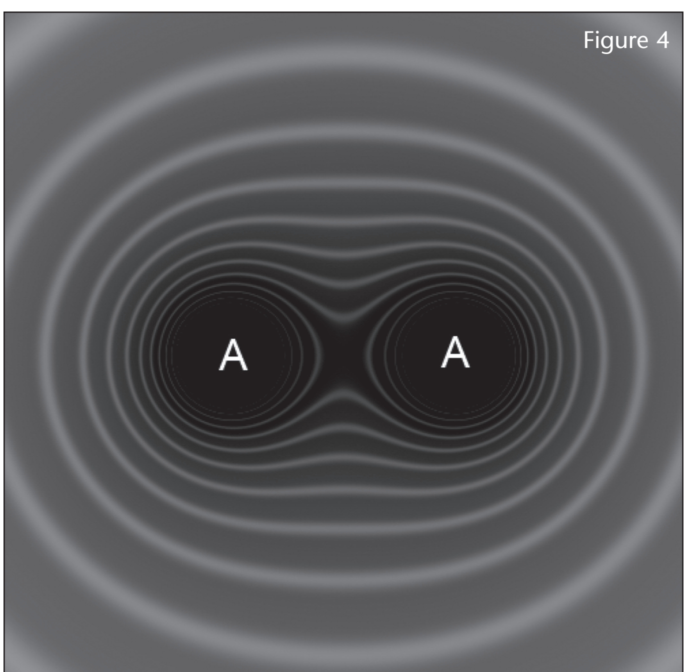
Effectively, a third particle experiences the rotating frame as a repulsion away from the center point, at the same time as still being gravitationally attracted to the other two particles. This is commonly known as centrifugal force.

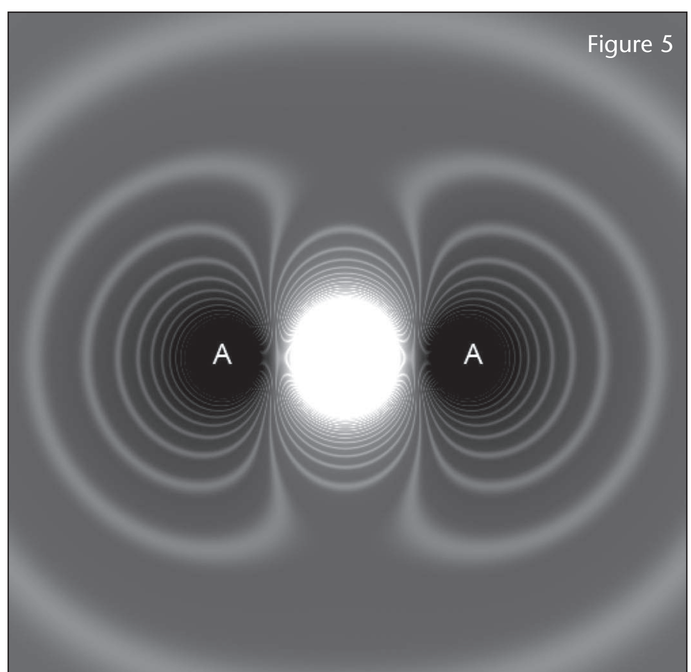
This tells us that if it's sufficiently far away from the first two then the third particle might orbit around them as if they are a single combined A particle with twice the mass, located at the center point.

On the other hand, if the third particle approaches either of the first two or flies between them near the center, then the resulting collision or a near miss can send them in all sorts of directions, disrupting whatever was going on beforehand.

## Lagrange Points

There is a further bit of investigation we can do with the 3-body problem, which is to consider the case when the masses of the first two particles are different and the mass of the third particle is negligible by comparison. This is known as



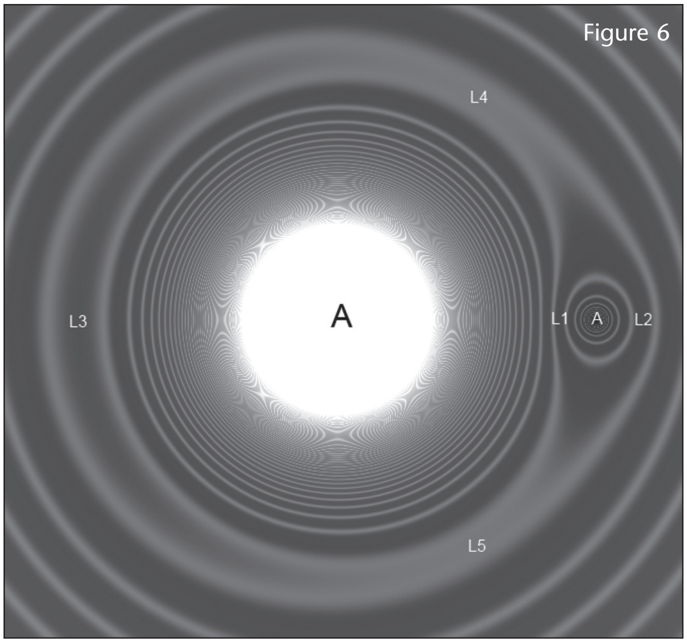


Figure 6

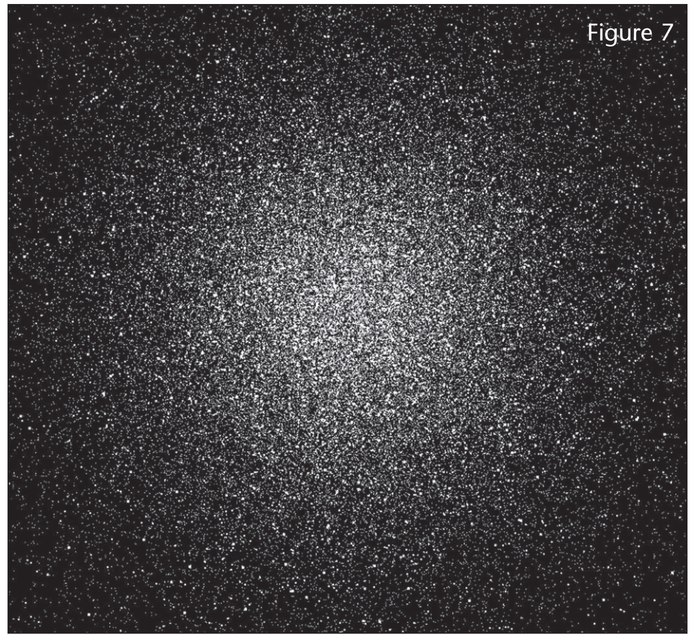


Figure 7

the restricted 3-body problem.

For example, if we use the relative masses of the Sun and Earth for the first two particles we get something like what is shown in Figure 6.

Interestingly, the repulsion due to the rotating frame dominates the attraction due to the Sun in all cases except a very close fly-by, which explains why comet orbits are very elongated.

The attraction due to the Earth dominates close to the Earth (an effect known as the Hill Sphere).

We notice that there are five points on the plot (L1 to L5) where the gravitational and rotational potentials balance. These are known as the Lagrange points.

It turns out that L1, L2 and L3 are unstable, but can be useful places to position spacecraft with a minor amount of stability correction. On the other hand, L4 and L5 (known as the Trojan points) are stable, which means that naturally-occurring bodies such as asteroids may be found there.

Near-misses can result in bodies orbiting around L4 or L5 in what are known as tadpole orbits.

Slightly further out we find that bodies can orbit around L3, L4 and L5 in what are known as horseshoe orbits.

## n-Body Problem

We can introduce yet more particles of type A, all of which attract each other gravitationally. Some restricted cases may be analyzed such as the Solar System or Moons of Jupiter.

In the general case there is little that can be done to study n-body systems analytically, but they are amenable to computer simulation, using readily-available software such as Grav-Sim.[2]

There are many examples of star systems that are essentially "stable," give-or-take the occasional close encounter which results in the ejection of a star at high speed. These systems can be found at a wide variety of scales. See Table 1.

At the Galaxy scale and above we find that there seemingly isn't enough matter there to hold everything together in purely gravitational terms. This is the problem known as dark matter.

Furthermore, at the scale of the entire universe, we find that gravity seemingly isn't attractive at all, but rather is repulsive. This is the problem known as dark energy.

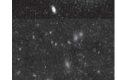
## Computer Simulation

All of the above can be simulated on a home computer using standard physics. A good place to start to understand the calculations can be found on the website The Art of Computational Science, courtesy of Professors Piet Hut and Jun Makino.[1]

You can even download some PC software from Grav-Sim, courtesy of the author.[2] Included are some ready-made models of globular clusters, which you can use as a starting point.

For example, see Figure 7, an artificially-generated cluster with 10,000 stars.

**Table 1.** Star systems.

| System | Number of Bodies | Example | Image |
|---|---|---|---|
| Open Clusters | 10-1k stars | Pleides |  |
| Globular Clusters | 10k-1m stars | Omega Centauri |  |
| Dwarf Galaxies | 10m-100m stars | Small Magellanic Cloud |  |
| Galaxies | 1b-100b stars | Andromeda |  |
| Galaxy Clusters | 10-10k galaxies | Virgo Cluster |  |
| Superclusters | 10-1k clusters | Coma Supercluster |  |

### Summary of Model A

Although we can get a long way with Model A and always-attractive gravity, we find that there are cases where it breaks down. In particular, it cannot model any situation where the bodies are repelled by each other, as appears to be happening at the largest scales in the universe.

Conversely, if we attempt to use it as a unified model at the smallest scales then it's a non-starter because electrons—the very first sub-atomic particles discovered by J.J. Thomson in 1897—repel each other.

## Model AB (Attractive vs. Repulsive)

Clearly in order to use a unified model of gravity as an explanation for everything that goes on in the universe, we will need both attractive and repulsive elements.

It turns out that it's a relatively simple matter to achieve this, starting with the always-attractive Model A and relaxing the constraint about masses being positive.

We can stick with Newton's law of gravitation and his second law of motion:

$$F = - G\, m_{g1}\, m_{g2} / r^2$$

$$F = m_i\, a$$

To keep things simple, we can still constrain the magnitude of the masses to be 1, but this time the sign can be either positive or negative.

**Table 2.** Model AB interactions.

| Interaction | A | B |
|---|---|---|
| A | Attract<br>→ ← | Combine<br>← ← |
| B | Combine<br>→ → | Repel<br>← → |

We can keep the label A for particles with mass +1 and introduce the label B for particles with mass -1.

### 1-Body Problem

Clearly the 1-body model for a particle of type A is the same as before and is always attractive.

Note that if we do the math, we find that particles of both types A and B respond in the same way to the presence of a gravitational field and are attracted, so there is nothing more to say about the 1-body model for type A.

In contrast, the 1-body model for a particle of type B has the opposite sign and is always repulsive. See Figure 8.

Because particles of both types A and B respond the same way, everything is repelled by a B particle.

We note that B particles repel each other according to an inverse square law, so we can imagine them as electrons, to a first approximation.

### 2-Body Problem

Things start to get more interesting when we consider the 2-body problem. Because there are now two distinct fundamental types of particle, there are four possible 2-body interactions for us to analyze. If we do the math, we get the results shown in Table 2.

### Attract

The AA pair is the same as before, with straight-line, circular, elliptical, parabola and hyperbola orbits.

### Repel

The BB pair can be analyzed with essentially the same mathematics and we find that the circular and elliptical orbits no longer apply. Instead, the particles move in one of:

- Straight line (directly towards or away from each other)
- Parabola
- Hyperbola

In particular, these are mathematically the same parabolic

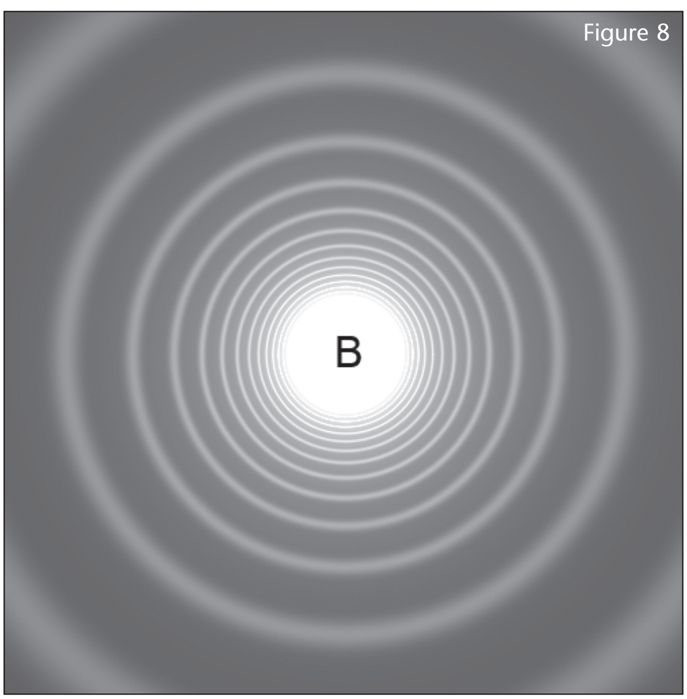



Figure 8

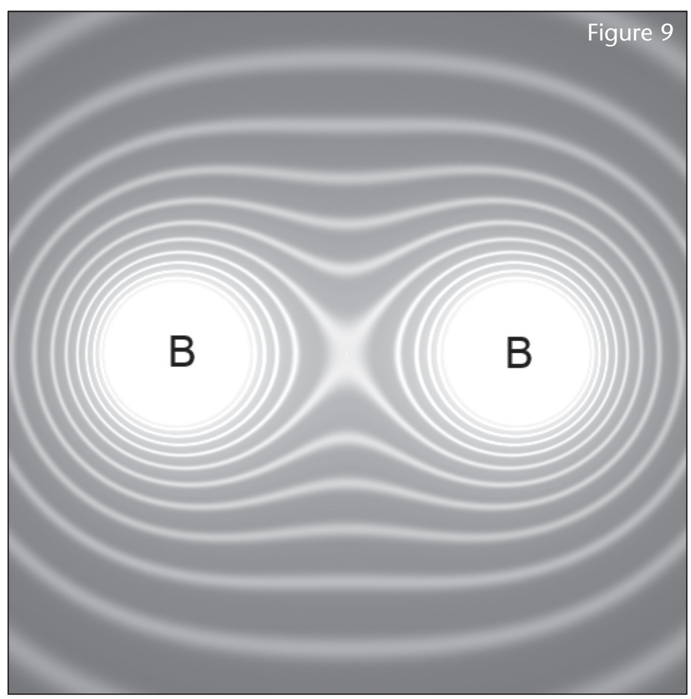



Figure 9

and hyperbolic solutions as before, but we are now using the negative part of the curves whereas previously we were restricted to just the positive part.

In the general case, because a pair of B particles are likely to be moving away from each other, it makes sense to view the gravitational field in a non-rotating frame (Figure 9).

We note that there is an unstable center point where other particles may be temporarily located.

## Combine

For cases AB and BA (which are just mirror images of each other), we find a new type of behavior.

If we do the math, we find that B is attracted to A at the same time as A is repelled by B. Essentially, they accelerate at a constant speed in a straight line, always remaining the same distance apart.

This continues until Special Relativity starts to take effect at high speeds and the particles approach the speed of light, without ever quite getting there.

Likewise, length contraction causes them to move closer together at high speed, as seen by a stationary observer.

Again, it makes sense to view the gravitational field around an AB pair in a non-rotating frame (Figure 10).

In terms of relating this to known phenomena, clearly we don't see this behavior at the macroscopic scale. Real world objects simply don't pair up and hare off at the speed of light.

We can make the following observations though:

- The combined mass of A and B is zero.
- They are unlikely to be observed travelling at anything other than the speed of light.
- They have a characteristic length governed by their initial separation, which is preserved (subject to length contraction).
- The long-range gravitational effect on anything else is effectively zero.
- The short-range effect manifests itself as a gravitational dipole, in the direction of motion.
- This can be thought of as a quantum of a longitudinal gravitational wave.
- It is likely that A will be in the lead followed by B (*i.e.* has a characteristic polarity).

## 3-Body Problem

There is little of interest to say about the 3-body problem for exclusively type A (which is the same as before) or exclusively type B (where everything repels everything else and the whole thing explodes).

This does, however, give us the basis of a model that can explain different areas of the universe:

— Attractive (*i.e.* dominated by particles of type A)
— Repulsive (*i.e.* dominated by particles of type B)

Conversely, if we start with an AB combination, then we have two cases to analyze depending on whether the third particle is of type A or B:

**AB + A**

1. AB + A → A + AB
2. AB + A → AA + B
3. AB + A → A + A + B

We note that the second and third cases seem unlikely because there will be a high tendency for the B to combine with one of the As. Therefore the most likely scenario would appear to be the first case where the "reaction" products are the same before and after.

**AB + B**

1. AB + B → B + AB
2. AB + B → A + B + B
3. AB + B → BAB

Again the most likely scenario appears to be the first case where AB is effectively preserved.

The second case shows what happens when the AB com-

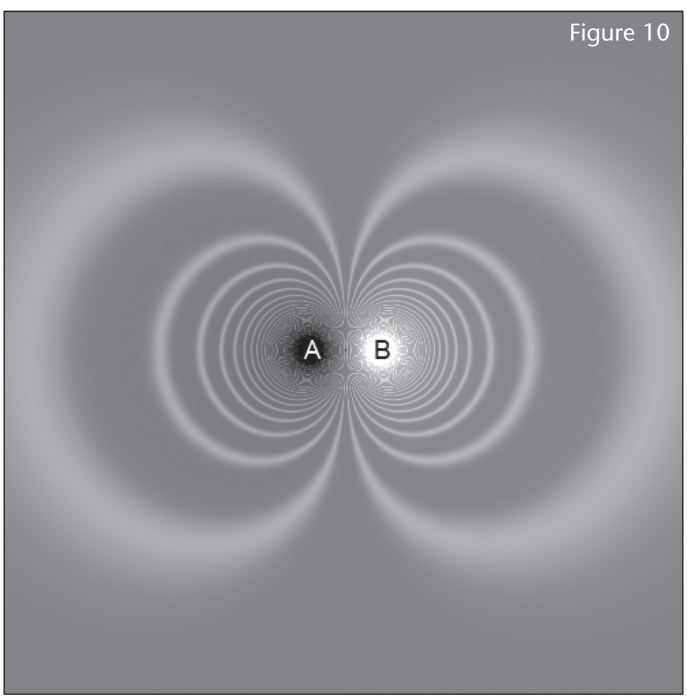


Figure 10

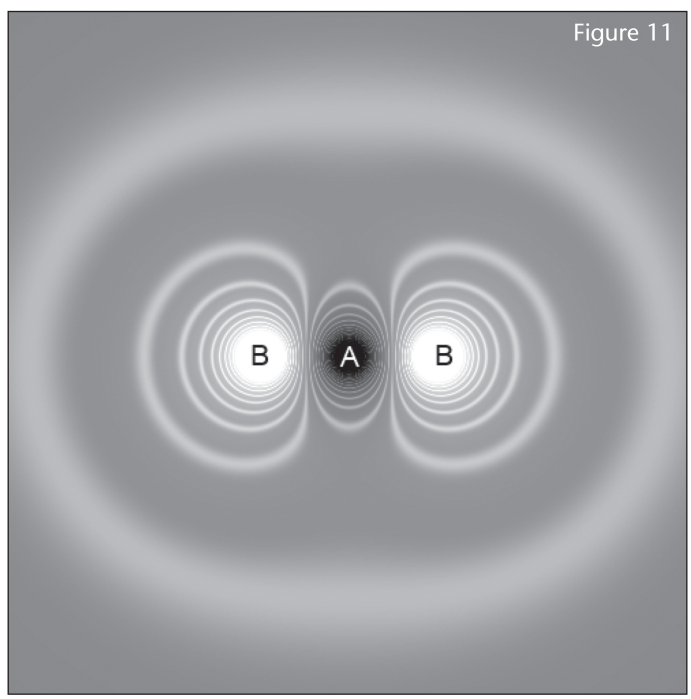
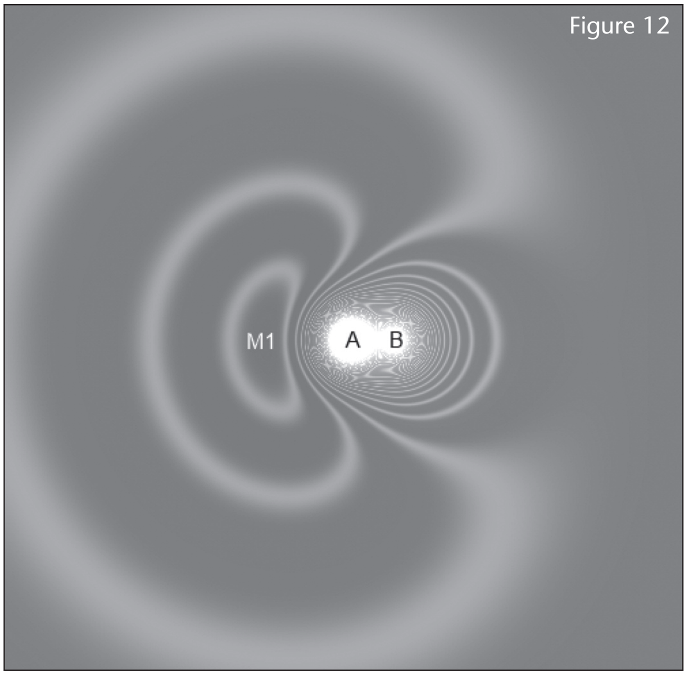


Figure 11




bination is ripped apart by an incoming B with sufficient speed.

The third case presents a very interesting new scenario, where the two B particles are in a stable orbit around the central A, by looking at the gravitational field in a non-rotating frame (Figure 11).

We note that the BAB triple behaves as a composite particle with a rotational symmetry of 1800.

We can see that at long-range, it looks very much like a single B particle, whereas from close-range the attractive vs. repulsive aspects start to take effect. On average we see an increased repulsive effect at short range before the attractive effect becomes apparent at very close range.

Is this a plausible explanation for the experimental result that electron repulsion increases by roughly 10% at very close range, compared to the inverse square law? This would imply that contrary to commonly-accepted wisdom, the electron is a composite particle after all.

Is it also possible that this kind of situation could provide an explanation for the strong and weak forces? Although all interactions may be subject to the same unified force, the existence of composite particles with varying components could make it appear as though one force takes effect at long range with another one at short range.

Although the central A is repelled by the pair of orbiting Bs, it is effectively sandwiched in the middle and so unable to go anywhere. To a first approximation, it makes little difference whether the A is attracted to or repelled by the Bs.

We can think of this as a bit like a pair of electrons orbiting around an atomic nucleus. Because the electrons repel each other, they act to keep the nucleus in the middle and to ward off any intruders.

## Simulation of Helium$^+$

Picking up on this theme, we can take a closer look at what happens when the masses vary for a central A particle with the mass of a helium nucleus and a single B particle with the mass of an electron in a rotating frame (Figure 12).

We can clearly see that there is a point M1 near which a second B particle would be stable. This starts to give us an idea of how a pair of electrons could behave in an atomic orbital, in purely inverse-square-law (*i.e.* electrostatic) terms.

In particular, this is the opposite scenario compared to the Lagrange points with the Sun and Earth, because the third particle is repelled by rather than attracted to the second one.

## Summary of Model AB

Model AB certainly allows us to simulate much more of the universe compared to Model A. In particular, the repulsive element introduced by the negative-mass B particle gives us a plausible mechanism for explaining dark energy.

We identified three cases where the individual particles can behave together as a composite particle. See Table 3.

The AA pair behaves like a binary star and is stable in either a circular or elliptical orbit.

If we were to start speculating a little, we could say that the properties of the AB composite particle make it look a bit like:

- Gravitational wave (hypothetical, has never been observed in practice)
- Neutrino (except that we haven't accounted for the spin-half property)
- Photon (except that a photon has a transverse electromagnetic component)

Furthermore, whichever interpretation we go with, we can imagine AB travelling at the speed of light through the quantum vacuum. On occasions where A or B particles arise from the vacuum, AB can react with them, but typically still carries on going, even though its constituents have changed places.

In the case of the BAB composite particle, we note that its overall properties appear to be identical to a single B particle. We can think of it as a bit like a B that has absorbed an AB.

There are still many aspects of the real universe that Model AB fails to deal with though. In particular, from the laws of electromagnetism:

- Opposites Attract
- Likes Repel

Neither of these can be catered for with Model AB (where opposites combine and only Bs repel).

In particular, protons were discovered by Ernest Rutherford in 1920 and are known to repel each other while being attracted to electrons. This means that at this stage, our unified approach is unable to model electrons and pro-

**Table 3.** Model AB composite particles.

| Composite Particle | Gravitational Mass $m_g$ | Inertial Mass $m_i$ | Location |
|---|---|---|---|
| AA | +2 | +2 | Stable |
| AB | 0 | 0 | Light Speed |
| BAB | -1 | -1 | Stable |

tons at the same time, even to a first approximation.

Clearly we need something extra.

## Model ABCD (Likes vs. Opposites)

The inspiration for the next step in generalizing our unified model comes from two places:

— The unconstrained Dirac equation which suggests four kinds of electrons
— The conflicting treatments of negative mass which suggest four kinds of matter

By sticking with gravity as our single unified force, restricting the magnitude of all masses $m = 1$, yet allowing positive vs. negative mass and introducing separate concepts of gravitational mass $m_g$ and inertial mass $m_i$, we get the results in Table 4.

**Table 4.** Model ABCD particles.

| Particle | Gravitational Mass $m_g$ | Inertial Mass $m_i$ |
|---|---|---|
| A | +1 | +1 |
| B | -1 | -1 |
| C | -1 | +1 |
| D | +1 | -1 |

The A and B particles behave the same as before, so the interesting part comes from studying the newcomers C and D. We can think of these as opposites or mirror images of A and B, a bit like antimatter compared to matter.

The first thing to do is to draw up a chart of how the particles interact with each other. See Table 5.

**Table 5.** Model ABCD interactions.

| Particle | A | B | C | D |
|---|---|---|---|---|
| A | Attract → ← | Combine ← ← | Repel ← → | Combine → → |
| B | Combine → → | Repel ← → | Combine ← ← | Attract → ← |
| C | Repel ← → | Combine → → | Attract → ← | Combine ← ← |
| D | Combine ← ← | Attract → ← | Combine → → | Repel ← → |

We can think of the B particle as a bit like an electron, given that they repel each other. On the basis that opposites attract, this would make the D particle a positron.

We could use a similar line of reasoning for protons vs. antiprotons, or muons vs. antimuons, or indeed any charged particle vs. its antimatter equivalent.

Note that it doesn't matter whether we assign B or D as the positive or negative charge. This is just a convention and the maths works equally well whichever way round we choose.

This makes B and D suitable for simulating electromagnetic particles, at least in electrostatic terms.

Conversely, A and C have the opposite behavior, where likes attract and opposites repel.

The A particle remains suitable for simulating standard gravity, whereas we expect the C particle to be its antimatter equivalent.

We note that C particles are attracted to each other, just the same as A particles. This means that if the C particle really is a good way of thinking about antimatter in gravitational terms then we would expect it to be repelled by matter.

This is the first prediction that we can make from our unified model. In gravitational terms, we expect antimatter to be repelled by matter, while still being attracted to itself. We therefore predict that the CERN experiments will confirm that anti-gravity is possible.

### Three Binary Pairs (Cold)

In much the same way as stars frequently form binary pairs due to the attraction of gravity, we would expect a universe full of As, Bs, Cs and Ds to generate binary pairs in cases where the mutual force is attractive.

From Table 5 we can identify three such cases. See Table 6. In each case the pair can be stable on an indefinite basis if the orbit is circular or elliptical.

**Table 6.** Model ABCD binary pairs.

| Binary Pair | Gravitational Mass $m_g$ | Inertial Mass $m_i$ |
|---|---|---|
| AA | +2 | +2 |
| CC | -2 | +2 |
| BD | 0 | -2 |

We note that the BD pair is unlike AA and CC as it is neutral in gravitational terms and has a negative inertial mass.

As with the AB combination, it would manifest itself as a gravitational dipole, but this time it would be stable *in situ* rather than accelerating to light speed.

On the basis that the binary pairs are stable *in situ*, we refer to them as "cold."

### Four Light Combinations (Hot)

As we saw with Model AB, it is possible for particles with opposite inertial masses to combine and accelerate to the speed of light. This time there are four cases to consider, as shown in Table 7.

**Table 7.** Model ABCD light combinations.

| Binary Pair | Gravitational Mass $m_g$ | Inertial Mass $m_i$ |
|---|---|---|
| AB | 0 | 0 |
| BC | -2 | 0 |
| CD | 0 | 0 |
| DA | +2 | 0 |

Clearly they are all similar in the sense that the combined inertial mass is zero.

We can think of AB and CD being matter/antimatter equivalents of each other. Likewise with BC and DA.

The big difference comes when we look at the combined gravitational mass, where BA and DA have double-magnitude masses with opposite signs. We would therefore expect their behavior to be different when interacting with other particles.

Conversely, whereas the individual components of AB and CD have the same response to an external field, we find that the components of BC and DA have opposite responses. In particular, this means that BC and DA would be unstable and hence dissociate in the presence of a strong field.

On the basis that all of the light combinations accelerate to light speed, we refer to them as "hot."

## Four Symmetric Triples (Warm or Cold)

Whereas Model AB gave us the BAB triple, Model ABCD gives us another three cases to consider (Table 8). Again we can think of BAB and DCD as matter/antimatter equivalents.

Given that the central A is repelled by the two Bs in the BAB triple, it is possible to replace it with a central D particle that still attracts the two Bs but is also attracted to them itself.

This gives rise to the BDB triple and its antimatter equivalent DBD. In these cases the components add up to a triple-magnitude inertial mass overall.

On the basis that all of the symmetric triples are stable in-situ, we might refer to them as "cold." However, there is a scenario where BAB and DCD will decompose and release "hot" particles as we will see next. Hence we refer to them as "warm."

## Simulation of Electron-Positron Annihilation

At this point, it is tempting to compare our generalized version of gravity with electromagnetism. Although we now have candidates for electrons and positrons (B and D respectively) on the grounds that likes repel and opposites attract, what happens when they encounter each other?

In the real world, we get a phenomenon known as electron-positron annihilation, whereas in our model it seems that B and D simply orbit each other to form a BD pair.

If we look a little closer though, we find that electrons and positrons do indeed start to orbit each other in a configuration known as positronium. In fact they never appear to get closer than the size of the atomic ground state in neutral hydrogen (56,000 times the diameter of a proton), yet after 125 picoseconds they emit two gamma ray photons (or three photons after 142 nanoseconds) totalling the sum of their mass energies according to Einstein's formula $E = mc^2$.

Whilst we don't see this behavior with just B and D, we can see something similar if we look at the interaction of BAB with DCD:

$$\text{BAB} + \text{DCD} \rightarrow \text{AB} + \text{CD} + \text{BD}$$

Effectively, the reaction generates the two light combinations AB and CD, which start to accelerate in opposite directions because the A and C repel each other. It also generates the neutral BD pair.

If BAB and DCD are analogous to the electron and positron and AB and CD are similar to photons, then what do we make of BD?

This leads to the second prediction from our unified gravitational model. In the case of electron-positron annihilation, we expect a third (neutral) particle to be generated by the reaction. In contrast to the photons which accelerate to the speed of light, the neutral particle remains *in situ* in the original frame of reference.

In particular, this prediction is consistent with the analysis from Don Hotson,[3] based on conservation of angular momentum. In his third paper,[4] Hotson refers to the electron-positron pair or "epo" as part of the quantum vacuum. The epo is equivalent to the neutral composite BD particle in our model.

We might further speculate that singletons or neutral pairs are undetectable with current technology and hence part of the quantum vacuum. With this line of reasoning, only charged composites, heavy composites or light combinations would be detectable.

## Dark Matter and WIMPs

If we take a closer look at the BD particle, we can characterize it as:

- Neutral (gravitational mass = 0)
- Massive (inertial mass = -2)
- Cold (rotates *in situ*)
- Unmagnetized (contributions from B and D cancel)
- Weakly interacting (rotating gravitational/electrostatic dipole)

We note that this fits the description of a Weakly Interacting Massive Particle (WIMP), which is one of the favorite candidates for Cold Dark Matter (CDM).

Whereas BD is neutral, AA and CC are doubly-charged (gravitational mass = +2 or -2) and so would be expected to strongly interact. Hence they are not dark matter candidates.

Conversely, we might consider the light combinations AB and CD as possible candidates for hot dark matter.

Whereas AB and CD are neutral and therefore fit the description, BC and DA are doubly-charged and so again are strongly interacting.

Furthermore, we can imagine a sea of BD particles as part of a quantum vacuum. Occasionally an interaction between two of them could temporarily generate a charged pair via the following reaction (see Figure 13):

$$\text{BD} + \text{BD} \leftrightarrow \text{BDB} + \text{D}$$

Both of the resulting charged particles are classified as cold and hence equilibrium with the original neutral state seems to be the most likely outcome. Is this a plausible mechanism for the large-scale emergence of gravity?

**Table 8.** Model ABCD triple systems.

| Symmetric Triple | Gravitational Mass $m_g$ | Inertial Mass $m_i$ | Rating |
|---|---|---|---|
| BAB | -1 | -1 | Warm |
| DCD | +1 | -1 | Warm |
| BDB | -1 | -3 | Cold |
| DBD | +1 | -3 | Cold |

## Comparison with Cygnus A

The strongest radio source outside of the Milky Way is a radio galaxy known as Cygnus A.

Discovered by Grote Reber in 1939, it appears unremarkable in visible light but has an astonishing structure when viewed with a radio telescope. See Figure 14. It has two near-light-speed jets (assumed to be electrons) travelling in opposite directions from a massive, compact central object (assumed to be a black hole). At the ends of the jets are two lobes which are themselves strong radio sources where the jets collide with the intergalactic medium. The whole structure is truly enormous, nearly 100,000 light years across.

We can speculate that Cygnus A may be driven by the electron-positron annihilation mechanism, as above. This would explain the two jets travelling in opposite directions, as well as the acceleration to light speed. It would then lead to the prediction that one of the jets is formed from matter, the other from antimatter, although in the case of photons it isn't clear what this distinction would mean in practice.

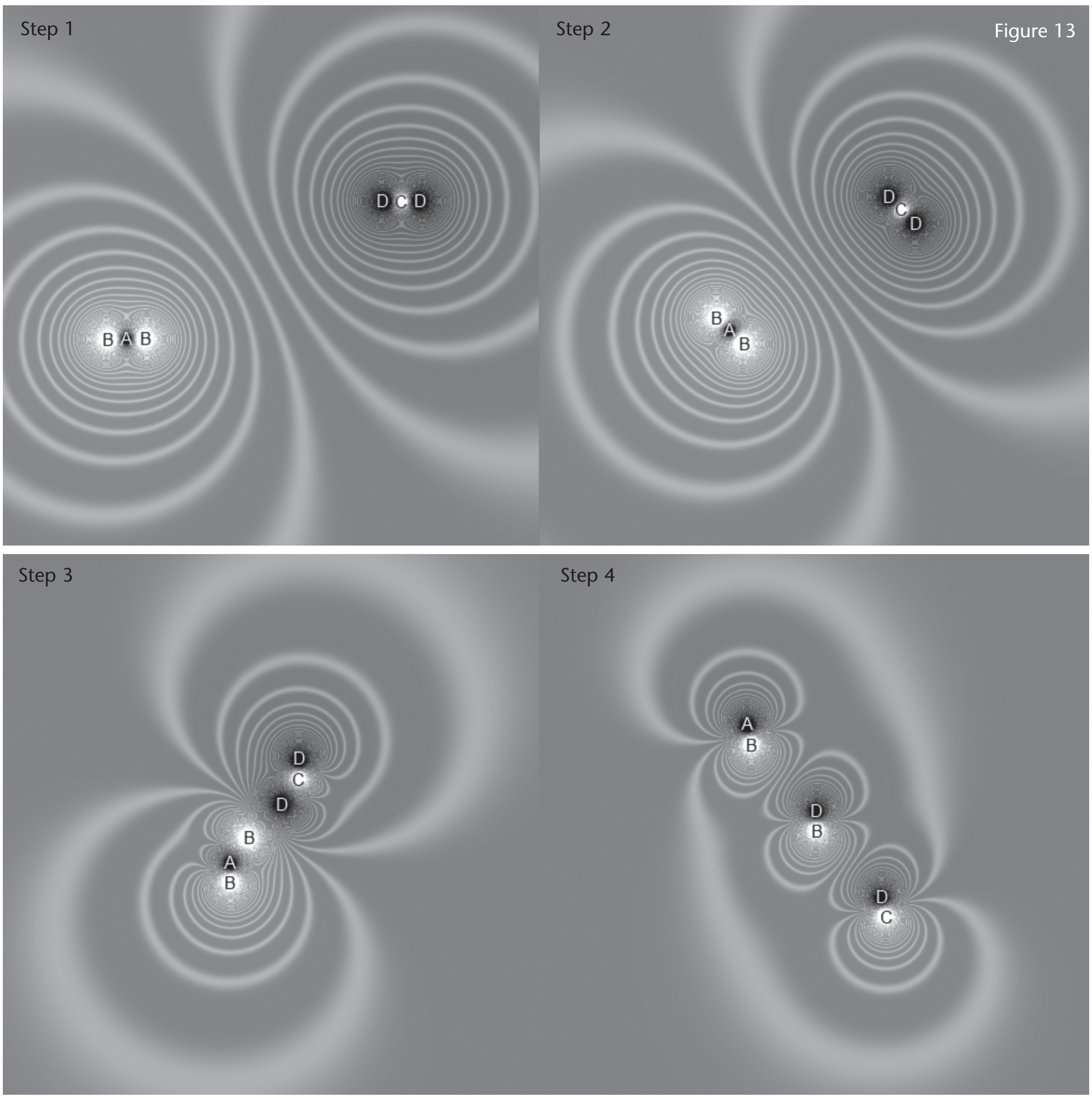
## Electron Spin and g-Factor

Up to this point, we have modelled things in purely classical (*i.e.* continuous) gravitational terms, albeit with a nonstandard adaptation for negative mass and a variation between gravitational and inertial mass. We have made comparisons with electromagnetism, purely on the basis of attraction vs. repulsion, without getting into Maxwell's field theories or any quantum mechanics.

Our first foray into the quantum world will be to consider the case of electron spin.

In particular, the building blocks in our unified model are point masses with no angular momentum, which makes them "spinless." Therefore single A, B, C and D are by themselves not candidates for electrons.

The challenge is to see if we can model particles with quantized spin according to the known experimental results.



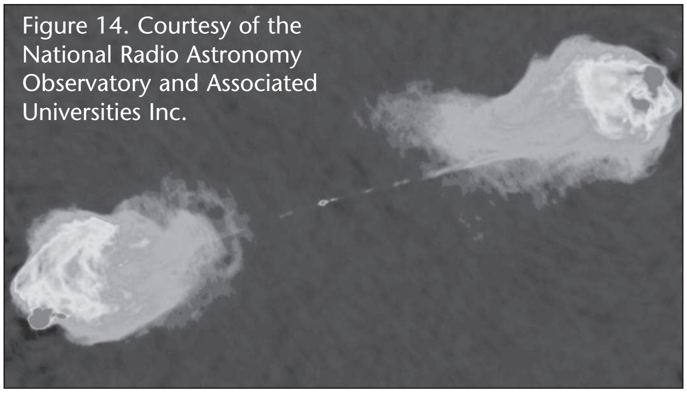


Figure 14. Courtesy of the National Radio Astronomy Observatory and Associated Universities Inc.

The natural way to do this is via composite particles, where the spin is introduced as a net rotation about the center point.

Drawing on the results from electron/positron annihilation, we will start with the BAB composite triple.

Without getting distracted by units, we will assume that the B particles are a distance of 1 from the central A and are travelling in a circle with speed 1. This gives them 1 unit of angular momentum each (or -1 depending on how we want to define it). [Note: Actually we can calculate a realistic speed based on the force of gravity, but that isn't important for the purposes of this discussion.]

The view from above (see Figure 15) in a slowly-rotating frame is as follows: Effectively the two orbiting Bs form a current loop, without the A taking part. If we assume that the gravitational mass is taking the place of electric charge, then we can use the Biot-Savart Law to calculate the magnetic moment at the center-point:

$$B = \mu_0\, I/R$$

In our unified model, the magnetic constant $\mu_0 = 1$, the loop radius $R = 1$ and the current $I = 2$ because there are two B particles and hence two units of charge.

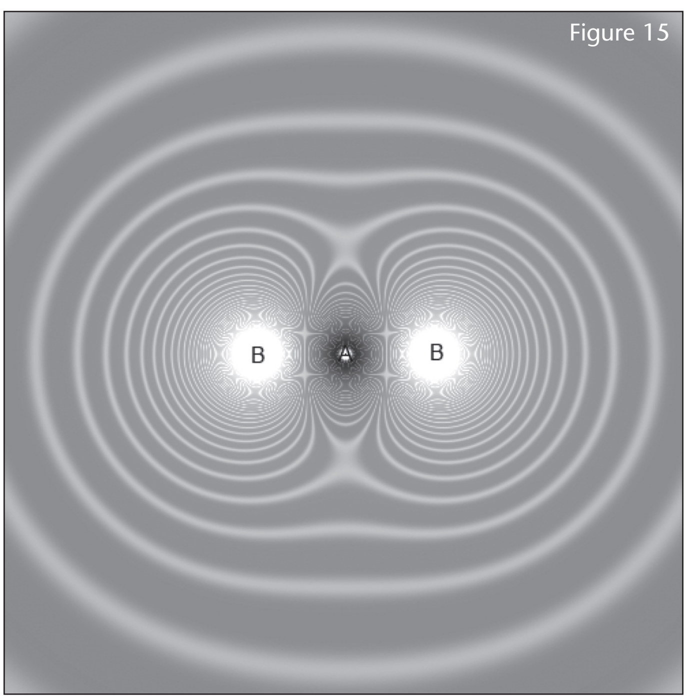


Figure 15

The net effect of this is that we find for the BAB particle:

Angular Momentum = 2
Magnetic Moment = 2

This gives us a ratio (known as the g-factor) of 1.

This should come as no surprise because in our model the distribution of charge (*i.e.* gravitational mass) and the distribution of mass (*i.e.* inertial mass) is the same.

Yet, here we have a problem because in the real world the electron is known to have a g-factor close to 2 (actually 2.002319304361).

There are potentially a number of ways of resolving this problem:

* A more complex model of the electron based on the existing A, B, C and D
* Building blocks with different gravitational vs. inertial mass ratios
* Building blocks with built-in spin
* Introduction of a simple rule

It turns out we can keep the simple spinless A, B, C and D building blocks and the simple BAB electron model (which also does a good job of simulating electron-positron annihilation), if we opt for the latter approach. The rule is as follows: In the context of composite particles, gravitational mass (a.k.a. charge) remains *in situ* while inertial mass (a.k.a mass) levels out as far as possible.

For the BAB model, this means that the +1 inertial mass associated with the central A levels out -1 of the inertial mass from the surrounding Bs, in equal proportion. This leaves an inertial mass of 0 with the A particle and a remainder of -0.5 associated with each B. See Table 9.

If we now redo the calculations based on the residual inertial mass, we find:

Angular Momentum = 1
Magnetic Moment = 2

This gives us a semi-classical picture of an electron with a g-factor of 2.

We note that this is as close as the Dirac equation gets, whilst acknowledging that quantum electrodynamics still has the edge in predicting a fully-accurate value.

# Summary

Again we can simulate a Model ABCD universe with a computer. There is certainly a lot more going on compared to Model AB. After extensive analysis we come to much the same conclusion though, *i.e.* that it's too simple to simulate everything that goes on in the real universe.

The sticking point this time surrounds particles with dif-

**Table 9.** Reduced inertial mass.

| Component | B | A | B |
|---|---|---|---|
| Gravitational Mass $m_g$ | -1 | +1 | -1 |
| Inertial Mass $m_i$ | -1 | +1 | -1 |
| Residual Inertial Mass $m_l$ | -0.5 | 0 | -0.5 |

fering masses. Although we might take the approach that heavier particles (such as the proton and neutron) are composite particles made from large numbers of smaller ones (such as the electron and positron), we have no way of explaining why the proton and neutron in particular are stable, while pretty much everything else isn't.

At this point, it might be tempting to go looking for the meaning of life in the bottom of a beer glass. What we need is another bit of inspiration...

## References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**About the Author**
Mark Ridler is an amateur physicist by night and a software engineer by day. He was inspired by the work of Don Hotson in *Infinite Energy*, wishing to develop those ideas further. He retained the concept of four electrons while considering the case for negative mass, not just negative energy.

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