The Mechanism of Inertia

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Abstract. Previously the gravitational mass and inertial mass have been assumed to be equivalent, despite the lack of any way to tie the two models together. We develop a model which incorporates both types of mass, while showing that mass itself is in both cases merely apparent.

1. Introduction

The equivalence principle states that the gravitational mass and inertial mass are equivalent, but this has been an experimental observation, not the result of any model. In particular, the gravitational force between a gravitational mass m_1 of an object and another gravitational mass m_2 separated by distance r is given by

$$F_G = \frac{Gm_1m_2}{r^2} \tag{1}$$

where G is the Newtonian gravitational constant.

The inertial mass m of the same object is defined by the acceleration a imparted on the object by a force F_I:

$$F_I = ma \tag{2}$$

Experiments have shown that m_1 and m are equivalent to 1 x 10^{-15}. But there has been no way to tie these two models together.

2. Apparent mass

Our hypothesis that a gravitational field is created when a particle is created is explored in some detail elsewhere [2]. There in equation (6) we found

$$ {}^{A}_{G}U_{נ} = \frac{Gm_p}{{}^{A}ר_1^2}\left(\frac{A}{נ^4}\right) \tag{3}$$

Here, ${}^{A}_{G}U_{נ}$ is the gravitational field engendered by a nucleus with A nucleons (protons and, optionally, neutrons), and נ which is the נth nuclear quantum level (נ is the Hebrew letter nun, to distinguish it from *n* used to designate the electron quantum levels which are much larger.) G is the Newtonian gravitational constant, m_p is the mass of a proton (or neutron, see [4]), and ${}^{A}ר_1$ is the radius of the first nuclear quantum level of a nucleus with A nucleons (ר is the Hebrew letter resh.)

Equation (3) is the gravitational field at the נth nuclear quantum level. To get the total gravitational field generated by the nucleon we must sum up the fields at all the nuclear quantum levels.

$$ {}^{A}_{G}U = \sum_{ɹ=1}^{\infty} \frac{GAm_p}{A\,ר_1^{\,2}} \frac{1}{ɹ^4} = \frac{GAm_p}{A\,ר_1^{\,2}} \left(\sum_{ɹ=1}^{\infty} \frac{1}{ɹ^4} \right) \quad (4) $$

The summation is the Reimann zeta function [3]:

$$ \zeta(4) = \sum_{ɹ=1}^{\infty} \frac{1}{ɹ^4} = \frac{\pi^4}{90} \quad (5) $$

This gives

$$ {}^{A}_{G}U = \frac{GAm_p}{A\,ר_1^{\,2}} \left(\frac{\pi^4}{90} \right) \quad (6) $$

Let's consider $A = 1$, a single proton in the nucleus of simple hydrogen ^{1}H. We use these values for the constants:

Newtonian gravitational constant, *G*	6.6743E-11	Nm^2/kg^2
Proton mass, m_p	1.67262E-27	kg
Proton radius, $^1r_0$	8.4184E-16	m
Proton creation energy less quarks, E_p	1.49499E-10	N/m^2
Planck constant, *h*	6.6207E-34	Ns
Speed of light, *c*	299792458	m/s
Proton wavelength, $^1ר_1 = hc/E_p$	1.32766E-15	m

The values of these constants are being improved through continual experiments, so we note the ones we are currently using.

Evaluating (6) considering these constants and $A = 1$ gives ${}^{1}_{G}U = 6.85469E-8$ m/s^2, the Nucleon Gravitational Field. (To be clear, the "$E-8$" means "x 10^{-8}"; this form is used to make it easy to copy to spreadsheet programs.) This is the gravitational field exerted on another mass by a single nucleon. To get the total gravitational field exerted by a nucleus with A nucleons, use (6) or, equivalently, multiply the Nucleon Gravitational Field by A.

The source of this acceleration is considered at some length in [2], but briefly it stems from an important property of nuclear quantum levels:

$$ {}^{A}ר_ɹ = {}^{A}ר_1 \cdot ɹ^2 \quad (7) $$

The radius of the ɹth nuclear quantum level is given by the radius of the first one multiplied by the square of ɹ. We call this the "home position" of the ɹth nuclear quantum level. If distorted from this radius, the quantum level, which is created when the particle is created, is going to attempt to spring back to this original radius. We call this the *home position principle*. We view this as

property of space and the quantum levels that are created within it when a particle is created. (7) is analogous to how electrical quantum radii are related in the Bohr model of hydrogen-like atoms.

For every pair of like particles in the universe, their outermost quantum levels intersect midway between them, depending on their current separation. Once they intersect, they become one quantum level and seek to restore to their original radius per (7). Here is a 2-dimensional diagram of a slice through the 3D spherical quantum levels:

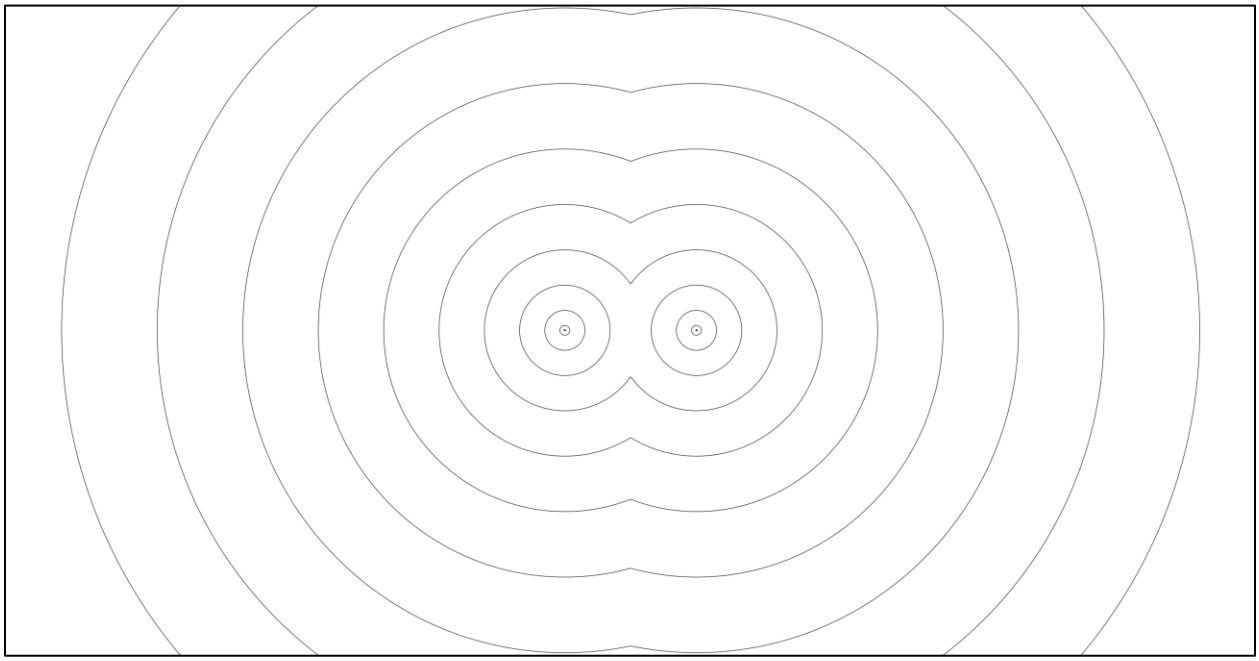


Figure 1. The nuclear quantum levels of two particles merge and drive towards their original size with acceleration (6). Diagram is to scale per (7).

For completeness we should mention that the actual acceleration felt by a like particle at distance d is due only to the quantum levels which have already intersected:

$$ {}^{A}_{G}U_d = \frac{GAm_p}{{}^{A}r_1^2}\left(\sum_{n=\frac{d}{2}}^{\infty} {}^{A}r_n \left(\frac{1}{n^4}\right)\right) \tag{8} $$

We are now well-armed to clarify the nature of gravitational mass. According to the model proposed in [4], when a nucleon is created, 99.5% of the energy of creation goes to making a bubble in space which displaces (rather than replaces) space. (The other 0.5% of creation energy goes to making the quarks which carry the electrical charge of the nucleon. In this regard note that neutrons do have internal charge densities from their quarks which cancel to 0 beyond the boundary of the neutron [4].)

Displacing space, the bubble pushes space aside and compresses it into nuclear quantum layers. We can observe the first nuclear quantum layer in ^{1}H as the fuzzy outer boundary of the nucleus, which has a radius equal to the wavelength of the proton, the only occupant of the nucleus (see [4] for details.) The compression of space pushing in on the bubble holds the quarks in place. This is

the true nature of what has previously been called the strong force. (Nucleons are held together by the binding energy, not some strong force, which results in a model of nuclear fusion which was 7 times better than any existing model of small nuclei up to carbon at the time it was first proposed by us in 2011 and revised slightly in [4].)

The same compression of space itself engenders nuclear quantum levels according to (7), which propagate across the universe (we assume with the speed of light) starting with the creation of the particle.

In this model nucleons are 99.5% empty of material, or what we commonly think of as mass. The bubbles are not solid matter: far from it, they are even empty of space itself. This fits the data because when protons are destroyed in particle acceleration experiments, the only things that come out are 99.5% of the creation energy, and 0.5% of the creation energy in the form of (short-lived) quarks. This model fits all the facts.

We conclude that particles are 99.5% empty, and that mass is only apparent. Gravitation and hence the illusion of gravitational mass arise from nuclear quantum levels attempting to restore to their "home position" as described by (7), with effective acceleration given by (8). The model also clarifies why, although a nucleon has its Nucleon Gravitational Field, no acceleration takes place until at least one more particle is involved.

Equation (3) provides a constant field, independent of the degree of distortion from home position of the quantum level. Any dislocation from home position results in the acceleration of the field activating; if free to move, the nucleons will drift towards each other.

A couple of final points: firstly, gravitation is not what has been called "spooky action at a distance." Secondly, although gravitation can be modelled with mathematics that imply objects warp space, that is not a particularly refined model, ignoring as it does the creation of particles being the source of gravitation; hence the difficulty integrating that model with quantum phenomena. Thirdly, the degree to which particles (and hence objects) are directly interconnected through the merging of their quantum levels right across the entire universe has heretofore not been properly appreciated.

3. Inertial mass

If particles are 99.5% bubbles, why do they require force to accelerate per (2)? To understand inertial mass and its relationship to gravitational mass, we must only think through the mechanics at work.

When one object pushes on another, the electrons in the outermost layer of atoms of the pushing object are repelling the outermost layer of the atoms of the object being pushed. The outermost electron quantum level of the pushed object begins to accelerate. But what is happening to the nucleus? Consider the simplest case: ^{1}H, with one proton in the nucleus and one electron orbiting it (Figure 2.)

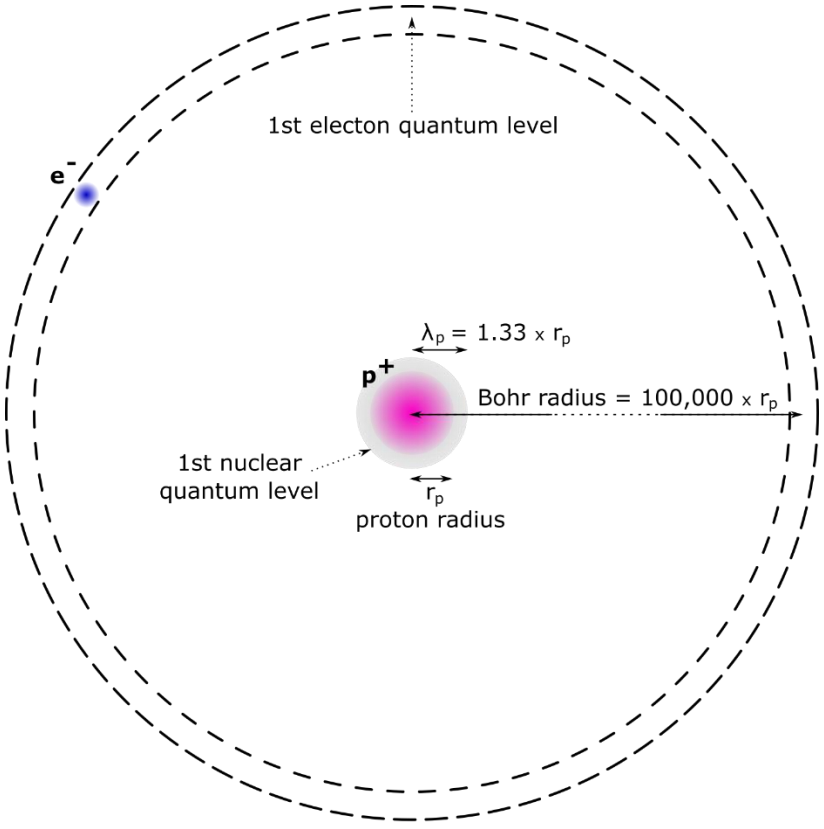
The distance of the electron orbital from the nucleus is determined by the electrical attraction between the positive proton and the angular velocity of the electron. This is like the earth orbiting

the sun, with the gravitational attraction between them balanced by the orbital velocity of the earth. But this analogy breaks down immediately: if the earth were pushed towards the sun, it would run into the sun. However, an electron pushed toward the nucleus does not run into the nucleus, despite the strong electrical attraction between them. Instead, it appears the electron radius is quite rigid. When the electron is pushed by another electron, the proton is also pushed.

Our model suggests that when a proton is created, not only are its nuclear quantum levels created, but also its electron quantum levels. Space is fractured into electrical quantum levels that can hold electrons. Their relationship to the nucleus is a property of how space is fractured, and does not vary; electrons have their own home position which follows a relationship analogous to (7):

$$ {}^{A}r_n = {}^{A}r_1 \cdot n^2 \tag{9}$$

where ${}^{A}r_n$ is the radius of the n^{th} electron quantum level of an atom with A nucleons and is known as the Bohr radius. For completeness we mention that it has been determined experimentally that ${}^{A}r_1$ depends inversely on the number of protons in the nucleus [5]. For simple hydrogen with just a single proton in the nucleus (^{1}H) a 2-dimensional view looks like:



Bohr radius & 1st electron quantum level necessarily not drawn to scale

Figure 2. Diagram of simple Hydrogen atom using the Bohr model.

This would be difficult to draw to scale. If the proton were shown as the size of the period at the end of this sentence (0.7 mm), the electron orbital diameter would be over 44 meters.

When the electron is pushed, the shape of the electron orbital remains the same. This dislocates the proton with respect to its nuclear quantum levels as in Figure 3 (which is drawn to scale.) While the acceleration of the electron continues, the nuclear quantum levels are out of home position. But we know what happens when a nuclear quantum level is out of home position: it accelerates per (3). Since all of the proton's nuclear quantum levels are similarly displaced, the full sum of all their counter-accelerations is experienced. Each nucleon experiences the acceleration of the Nucleon Gravitational Field computed above: $\frac{1}{G}U \ = 6.85469E - 8$ m/s^2. This acceleration counter to the push is experienced as inertia. It creates the impression that the object has mass precisely equal to its gravitational mass.

The same effect occurs when no electron is present, and the proton is accelerated on its own. This occurs in a particle accelerator, when the proton with its positive charge is accelerated by a succession of negative electric fields. The apparent mass of the proton is really the restoring forces of the nuclear quantum levels trying to keep up: to return to their home positions.

Figure 3. is a scale illustration of a proton which has been pushed out of home position with respect to the first couple of nuclear quantum levels.

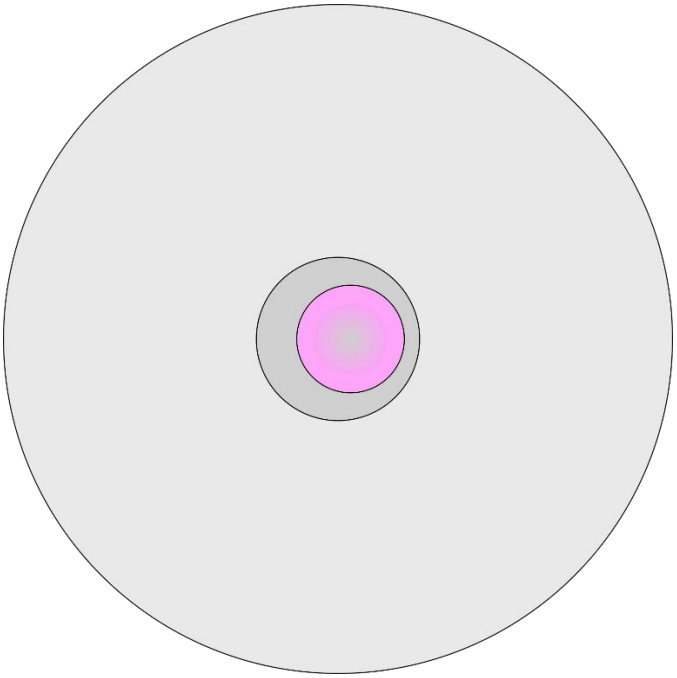


Figure 3. A proton experiences a pushing force coming from the left onto its orbiting electron by moving to the right, forcing its nuclear quantum levels out of home position. Although only two quantum levels are shown, all its nuclear quantum levels are pushed out of home position. Drawn to scale.

4. Conclusion

We have explored in some detail the origins of the illusions of gravitational and inertial mass and show how they are related. By the model we have suggested, particles are bubbles in space with

almost no mass, but their creation fractures space itself by pushing it aside, compressing it in layers, and thus generating the nuclear and electron quantum levels that extend at the speed of light throughout the universe. These quantum levels have a clear mathematical relationship to each other, which we call their home position. This relationship was initially established for electron quantum levels from experimental data by Niels Bohr.

As these nuclear quantum levels are distorted by joining with those of other particles, they attempt to return to their home position with a known acceleration depending on their distance from the particle, and thus create the effect of gravitational mass. When an atom is pushed, its nucleus is displaced from its home position with respect to its nuclear quantum levels, and the same restorative force gives the appearance of inertial mass. This apparent inertial mass is equivalent to the apparent gravitational mass because the accelerations back to home position are identical. The two effects stem from the same restorative force, but gravitational mass requires at least two particles, whereas inertial mass does not.

The notion that particles are not solid but are bubbles in space that (a) have almost no material content and (b) displace space upon their creation is new. It is equivalent to the proposal by Rutherford over a century ago that atoms are almost entirely empty. Now we propose that nuclei are also almost entirely empty. The effect of this proposal, once accepted, will have equivalent far-reaching consequences regarding our understanding of the universe.

This model resolves some important issues. When proposing his theory of General Relativity, Einstein had to assume gravitational mass and inertial mass were equivalent, based on literally centuries of experimental evidence showing they are numerically the same. We have now resolved this assumption into a unifying model based on the hypothesis that gravitation begins with the creation of particles. This approach inherently unifies quantum phenomena with gravitation, which should make the detailed exposition of a theory unifying the subatomic domain with that of cosmic objects much easier to achieve.

5. References

[1] Touboul, Pierre; et al. (8 December 2017). "*MICROSCOPE* Mission: First Results of a Space Test of the Equivalence Principle". *Physical Review Letters*. **119** (23). 231101.

[2] Physicist, E., “The Mechanism of Quantum Gravity”, https://NewPhysics.Academy (accessed 2024-02-20).

[3] https://en.wikipedia.org/wiki/List_of_mathematical_series, section “Sums of Powers", (accessed 2024-02-20.)

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[5] https://en.wikipedia.org/wiki/Bohr_radius (accessed 2024-02-27).

