Exploration

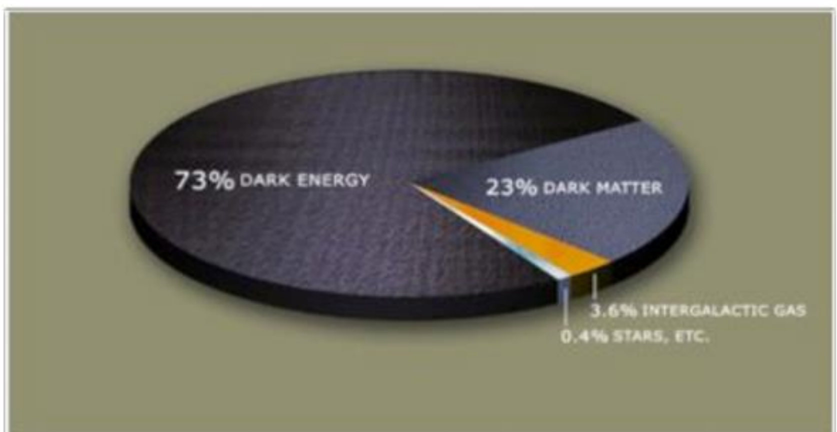
Exploration on the Geometry of Dark Energy

Don Limuti*

Abstract

This exploration is undertaken with the goal of accounting for dark energy and explaining why the universe expansion is accelerating. The fact that 96% of the mass in the universe is unknown is perplexing, as Adam Riess put it, "The Entire Universe is Being Pushed by an Unknown Force No One Can Locate" (1). I will explore this unknowingness and make suggestions which may be experimentally verifiable.

Keywords: Dark energy, geometry, universe, expansion, gravity.



Estimated distribution of dark matter and dark energy in the universe. Image Credit: NASA

1. Introduction

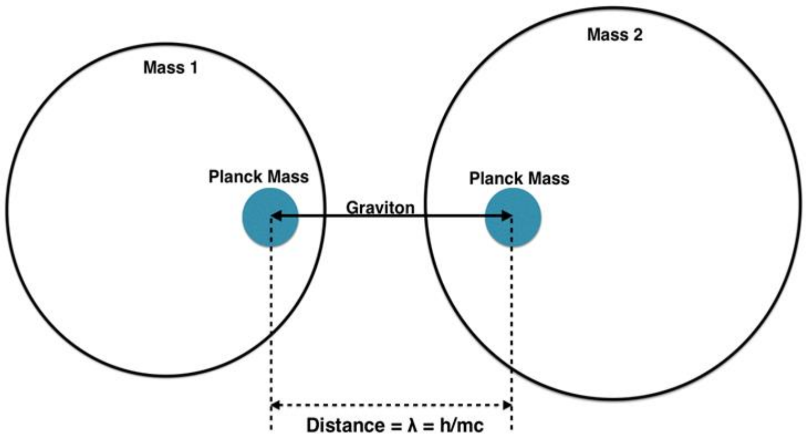
Scientists studying the brightness of some 50 type 1A supernovae at enormous distances found that the supernovae were dimmer than should be the case if the universe's expansion rate were slowing. After crunching the numbers, the data showed that the expansion was speeding up. The results were published in astronomy journals in 1998 and 1999. For more information see the website of Saul Perlmutter (2).

Why do we believe the universe expansion is accelerating? I propose the following possible explanations:

*Correspondence Author: Don Limuti, Independent Researcher, USA. E-mail: don.limuti@gmail.com

1. The attractive force of gravity is caused by gravitons: I use the term graviton to indicate a mediator particle of the gravitational force in the sense that the photon is a mediator particle of the electro-magnetic force.

2. A single graviton can be represented as a Compton wavelength: The equation of a Compton wavelength is $\lambda = h/mc$ (h = the Planck constant). Thus the mass of a single graviton is $m = h/\lambda c$. The wavelength λ is the distance (d) separating two basic masses (Planck masses).



3. The force that is accelerating the universe outward is due to the geometry of the gravitons (aka dark energy and dark matter): The galaxies in the universe are uniformly distributed (isotropic), however the gravitons they produce are not uniformly distributed, they accumulate at the periphery of the universe. This outer mass of gravitons pulls the inner observable mass outward creating some interesting illusions.

2. The attractive force of gravity is caused by quantized gravitons

First, a graviton is defined by the Compton wavelength $\lambda = h/mc$. Second, photons are the energy compliment to Compton wavelengths. A photon has a quanta of energy, $E = hc/\lambda$. If we convert this energy of the photon to mass using the equation $E = mc^2$, we have two equations for photon energy, $E = hc/\lambda = mc^2$. Solving for λ we get $\lambda = h/mc$, the Compton wavelength which we can think of as the mass equivalent of a photon energy. I find this symmetry compelling and believe it provides a hint that the graviton: 1. Is basically a Compton wavelength, and 2. Is quantized like the photon is quantized.

Let us see what happens when we assume the graviton is quantized like a photon is quantized:

a. The energy in a graviton is: $E = hf = hc/\lambda$ (the Planck-Einstein equation where f =frequency)
b. The graviton we are considering (shown in diagram above) has a wavelength that is the distance d between mass1 (m_1) and mass2 (m_2) . We can now say that $E = hf = hc/d$.
c. Let the total number of gravitons connecting m_1 and m_2 be N. Now the total gravitational energy is $E = Nhc/d$
d. We can convert this energy to force via the equation $F = E/d$. Substituting for E we get that $F = Nhc/d^2$.
e. Newton's law of gravity is $F = Gm_1m_2/d^2$.
f. Equating these two forces in d and e above to see if the result makes any sense.
g. $F = Nhc/d^2 = Gm_1m_2/d^2$. Solving for N we get $N = Gm_1m_2/(hc)$ as the number of gravitational photons connecting two ordinary mass objects m_1 and m_2.
h. This result in g above is interesting; but we can go further by noting that the Planck mass (P_m) squared is given by the equation $P_m^2 = hc/G$.
i. We can combine the two equations $N = Gm_1m_2/(hc)$ and $P_m^2 = hc/G$ to get the result that $N = m_1m_2/(P_m)^2$.

Thus, the assumption that a single graviton is a Compton wavelength (h/mc); and that it has quantum energy of (hc/d); results in a single graviton connecting two Planck masses. This result may not be rigorous, but it is insightful and gives some credence to the view that gravitational energy is quantized in the same way the photon energy is quantized. This also indicates that Newton's law of gravity is fundamental when relativistic effects are not taken into account.

3. There are two basic distributions of graviton mass

a. Dark Matter: The stars in a galaxy are close together (compared to free space) and usually rotate about a core. In this instance, we speak of dark matter instead of the dark energy contained in the galaxy because we can see the galaxy has an unexpected rotation due to the extra graviton mass. This mass adds to the total unseen mass in the universe, but it is different from the other type of graviton mass called dark energy. Dark matter is uniformly distributed; dark energy is non-uniformly distributed (to be shown shortly).

b. Dark Energy: The Hubble telescope gave us a view of the universe that showed not a uniform distribution of stars in the sky, but a uniform distribution of galaxies in the sky. These galaxies are connected together by bundles of gravitons (see diagram on page 5). These are the gravitons that are most effective in providing the outward acceleration of the universe expansion, because they are not distributed uniformly across the universe (are not isotropic) and they accumulate at the periphery of the universe.

4. The force that seemingly pushes the universe outward is also due to galaxy-to-galaxy graviton bundles

a. Calculation of the graviton mass between the earth and the moon:

1. The mass of the Earth: 5.972×10^{24} kg.
2. The mass of the Moon: $7.34767309 \times 10^{22}$ kg.
3. The distance between the earth and the moon: 3.844×10^{8} meters.
4. Assume all the gravitons have the same wavelength (distance).
5. Solve for the mass of one earth-moon graviton: $m = h/[c(3.844 \times 10^{8})]$.
6. Thus the mass of one earth-moon graviton is: 0.56866×10^{-50} kg.
7. The number of gravitons: $N=(m_1/P_m)(m_2/P_m) = 9.26 \times 10^{60}$.
8. The dark energy between the earth and the moon is:
   $N(0.56866 \times 10^{-50}$ kg$) = (9.26 \times 10^{60}) \times (0.56866 \times 10^{-50}$ kg$) = 5.266 \times 10^{10}$ kg.

This is a very small mass compared to the mass of the moon.

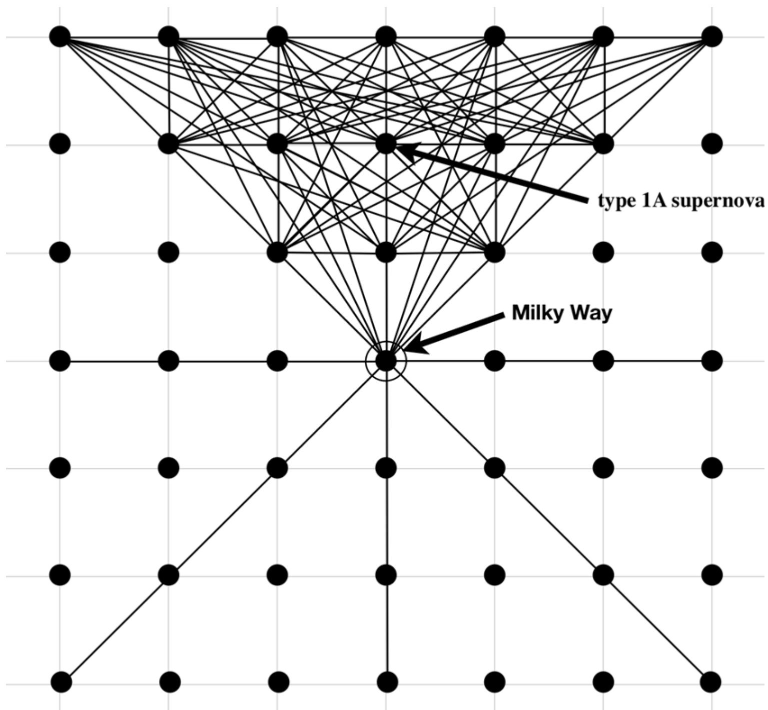
b. Calculation of the average graviton mass and wavelength (distance) for the entire universe (See end of paper for source astronomical of data):

1. The observable mass of the universe: 1.0×10^{53} kg. This is 4% of the total mass of the Universe.
2. The radius of the universe: 4.4×10^{26} meters.
3. The total number of gravitons: $m_U^2/P_m^2) = 0.2111 \times 10^{122}$ gravitons.
4. Let the length (wavelength) of an average graviton in the universe be X.
5. Then the mass of each graviton is given by $m = h/[cX]$.
6. We can form the ratio: 4% is to 96% as 1.0×10^{53} kg is to (dark matter plus dark energy). Thus the dark matter plus dark energy is 24 times the observed mass of 1.0×10^{53} kg.
7. We get the result that the dark matter plus dark energy in the universe is 24×10^{53} kg.
8. The total dark matter and dark energy (which is a mass, 24×10^{53} kg) would be the mass of each graviton $h/[cX]$ times the total number of gravitons. The equation looks like this: $24 \times 10^{53} = (0.2111 \times 10^{122})\ h/[cX]$. We can solve for X (the average graviton wavelength) with the result that $X=1.942 \times 10^{25}$ meters. This is 4.41% of the radius of the universe (4.4×10^{26}m).
9. We have shown that universe has 2.111×10^{121} gravitons with an average wavelength (distance) of 1.942×10^{25} meters. This is the nature of the dark stuff we cannot see.

Is this analysis completely satisfying? No, because we really want to know the exact geometry of the distribution of the graviton masses (not just the average value). With an exact distribution we can verify that this model of gravity accounts for the dark matter and dark energy in the universe. In the next section, I will make a two dimensional (2D) sketch that will highlight what needs to be done. It is not the answer that is required but does points to it.

c. Making a diagram of the dark energy in the universe:

The dark energy mass has a subtle aspect; there are more dark energy gravitons at the periphery of the universe sphere even though the density of the galaxies is essentially uniform. See diagram below.



Note 1: Dark energy (dark lines) increases with the distance from the observer in the Milky Way. Dark matter adds to each galaxy's observable mass. This observable mass is represented by a dot.

Note 2: If an observer were located at the type 1A supernova looking at the Milky Way, the diagram would be the same as above, only with the labels swapped. Dark energy content of the universe refers to the observer's point of view. Said another way: no matter the position of the observer, the dark energy background looks the same and increases toward the periphery of the universe.

In the diagram, we can see how the dark energy in the universe creates an outward pull on the type 1A supernova. And since we cannot "see" the dark energy (gravitons) we are being fooled into believing that somehow anti-gravity is involved. There is no anti-gravity, the expansion of the universe is accelerating for the type 1A supernova because it "sees" an increase of mass ahead of it due to dark energy mass graviton accumulation. The acceleration of the expansion of the universe is caused by plain old gravity produced by gravitons.

Note: Things get interesting at the extreme periphery of the universe where the accelerated expansion stops and reverses.

5. Questions & Answers

Question: Does your "graviton" match what one think of as a subatomic particle?

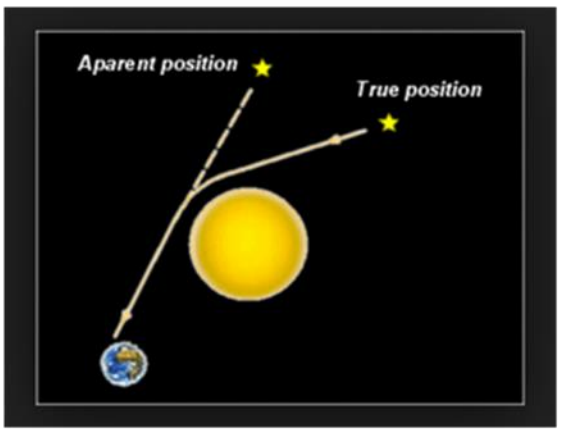
Answer: I define the graviton as a Compton wavelength (λ = h/mc) where λ is the distance between masses. Thus the graviton can have a wide range of wavelengths, from subatomic to astronomical. For the purposes of this exploration, I am only looking on the astronomical scale.

Question: You have calculated that the average graviton in the universe needs to be 1.942×10^{25} meters long (there are 2.111×10^{121} of them) to account for all the gravitons in the universe. Where do you get your numbers for making these calculations?

Answer: For constants like the h, G, c, and Planck mass, I used the website: https://en.wikipedia.org/wiki/Planck_units For astronomical numbers like the mass and radius of the universe, I used the website: https://en.wikipedia.org/wiki/Observable_universe

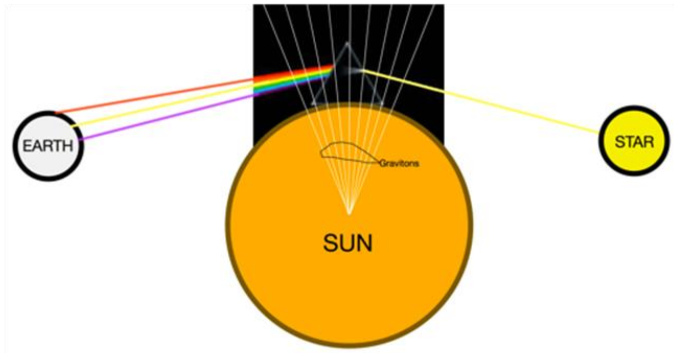
Question: Doesn't this graviton theory contradict Einstein's general theory of relativity?

Answer: Not necessarily. I believe that both theories are essentially the same with just a slight change of viewpoint. General relativity posits that mass causes space-time to curve. If instead we say mass produces gravitons, which then cause space-time to curve, both theories are basically the same. Below are two diagrams to show this:



The diagram above reflects Einstein's view that the observable mass of the sun curves space-time, as verified by Eddington and others. However, this curving of space-time can also be accounted for via the diagram below, which shows that the sun first produces graviton couplings to the rest of the universe. It could be that these graviton couplings act like a prism to curve space-time.

Question: Can gravitons make space-time look like a prism?



Answer: For convenience in making this drawing the graviton pattern is shown as pure radial lines.

Conclusions

I have made a case that the graviton is quantized like the photon is quantized. It is not a far stretch from this to imagine that the graviton, like the photon, is composed of electric and magnetic fields.

If dark energy gravitons have 1) real mass and 2) associated magnetic and electric fields, then dark energy may well act as a gradient index of refraction prism (as shown above). It is also possible that these dark energy prisms may curve the path of light (as shown), and also curves the path of massive objects that pass through it. I believe that, in the future, experiments can be made to verify or disprove these conjectures.

This theory of gravitons may be very close to the general theory of relativity or even identical to it. That would be nice. However, this graviton viewpoint by itself has a very big benefit, for it makes it possible to visualize something that is invisible…. dark energy and dark matter.

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