Mathematical Calculation of the Gravitational Constant

Jeff Haley 5th April 2014

INTRODUCTION

It has always been a problem to find the value of the gravitational constant via mathematical calculation because of the direct mathematical link between the Planck scale and the value of G. As each depends upon the other this relationship produces circularity in the mathematical equations, which is difficult to resolve. This paper describes a method of calculating G by removing this circularity. Once this has been resolved the remaining problem concerns the precision of measurements of g, the gravitational acceleration, against precision measurements of radial distance. There is a method of at least making this determination more accurate, which will be discussed following the method description.

Calculating G

The method developed to calculate G mathematically considers two calculations. The equations used are those used in determining the Scwarzschild radius and gravitational acceleration. These are shown below as equations (1) and (2) respectively.

(1)

$$r_s = 2GM/c^2$$

(2)

$$g = -GM/r^2$$

If we start with equation (1) and consider that for the Planck mass the radius value is two Planck lengths we can substitute that value for r_S as if the Planck length actually measured 1 metre. This now gives us a known value and removes the necessity of calculating the Planck length which requires us to know G in advance. We have now scaled up our radius value. So what does this now tell us about equation (1)? Well if we rearrange the equation as shown in (3) we can easily see that for this scale GM must equal C^2. As we are eventually calculating for G we can at this point set it to 1 in natural units and take C^2 as our value for M.

(3)

$$2c^2 = 2GM$$

If we now go back to equation 2 we can make substitutions for G, M and r. This then gives us equation (4).

(4)

$$g = -1c^2/4$$

This gives us a value of g at our magnified Planck scale of 22468879468420441. However what if instead of using this g value we could calculate a magnified Planck mass to use instead. We can accomplish this by setting G = C^2 instead of M and using this value in the calculation for Planck mass (5).

(5)

$$m_p = SQRT((hbar*c)/G)*1.783E-27$$

Using G=C^2 here gives us a value of Mp of 1.0575E-48. We now multiply Mp by the mass of the earth and divide by the radius of the earth squared (6).

(6)
D = Mp*Me/Re (D = (1.0575E-48*5.97E+24)/ 6378100 = 1.55249E-37)

In doing this we arrive at a value of g of 1.55249E-37 which we can divide into a value for the gravitational acceleration of the earth (9.78/1.55249E-37) which now gives us a value for magnitude of 6.29954E+37. Multiplying this by out magnified Mp (6.29954E+37*1.0575E-48) we end up with a value for G of 6.66174E-11. The uncertainties left now no longer reside within the Planck dimensions but with any test mass to be used as a comparison. Therefore the more accurately the values for mass, radius and g can be known for a test mass the greater the accuracy of G that can be calculated.

This research shows the interplay between light speed and gravitation. As light is affected by gravitation and can be thought of in that respect as frame dependent then so is G. The only way to measure G is within the direct reference frame of the observer.

Ideas on calculating G using the earth as a test mass.

If we can measure g at the same elevation, thus the same radius from the center of gravity, at multiple points around the globe, we can then take the mean value of all the readings as a set value of g for that radius. This will leave only mass as an uncertain factor in determining G.