A gravitational field different from that of Newton

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ABSTRACT

A very large portion of modern astrophysics is based upon the alleged law of universal gravitation, where the force of attraction between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres of mass. In this paper another form of gravitational field is suggested, which agrees with the Newtonian field strength for altitudes $\leq$ 2,100-km, but which falls off more sharply thereafter. Furthermore, this new field does not depend upon mass.

Keywords: Newton, universal gravitation, gravity, inverse square law, cosmology, gravitational field strength.

1. INTRODUCTION

Prof. Sir Isaac Newton made an educated guess as to the nature of gravitational attraction and postulated that it existed between any two physical bodies. He thus produced a relation stating that the force of gravity, $\boldsymbol{F}$, attracting two centres of mass toward each other has a magnitude given by

$$|\boldsymbol{F}| \quad = \quad G\,\frac{m_1 m_2}{r^2}\,, \tag{1}$$

where G is the empirically derived *gravitational constant* and m_1 and m_2 are the respective masses of the objects whose centres of mass are separated by a distance r.

Equation 1 is referred to as *Newton's law of universal gravitation*, although Newton himself rejected the *action at a distance* requirement implicitly contained therein.

Although Eq. 1 has been verified by terrestrial laboratory experiments and via trajectories calculated for low earth orbit (LEO) satellites, to then extrapolate it such that this particular proportionality is deemed to apply to all physical bodies throughout the entire universe seems to be dangerously unjustified, for not only does it lead to the introduction of such imaginations as 'dark matter', but also it associates a field of gravity to everything that has mass, which precludes the possibility that this is a phenomenon with a cause unrelated to mass.

2. AN ALTERNATIVE GRAVITATIONAL FIELD

Following the method of handling initial value problems exemplified by Kreyszig,[1] we first represent the strength of the World's gravitational field, at an outward distance of x from the surface, as $g(x)$, usually denoted just by g. I.e., we take g as being time invariant.

The rate of change of gravitational acceleration with distance is then

$$\frac{\mathrm{d}}{\mathrm{dx}}\,g\,.$$

Since gravitational attraction is positive, by definition, and decreases with increasing x, $\mathrm{d}g/\mathrm{dx}$ will be negative. Assuming that this derivative varies in direct proportion to g will then result in the 1^{st}-order differential equation,

$$\frac{\mathrm{d}}{\mathrm{dx}}\,g \quad = \quad -kg \tag{2}$$

which has the general solution

$$g(x) \quad = \quad c\,e^{-kx}\,,$$

because

$$g'(x) \quad = \quad -ck\, e^{-kx} \quad = \quad -k\, g(x)\ ,$$

where c and k are constants.

From measurement we know that the acceleration due to gravity at the World's surface, g_0 say, is 9.8067 m s^{-2}, such that

$$g(0) \quad = \quad c\, e^0 \quad = \quad g_0$$

and hence

$$g(x) \quad = \quad 9.8067\, e^{-kx}\ .$$

To determine k, we make use of the fact that man-made LEO satellites, restricted to heights above the World's surface of between 320 and 640 kilometres (200 to 400 miles), must be possible, because of television broadcasting, for example, and that the physics associated with these things assumes Newton's inverse square relationship to hold. The value for k must therefore be such as to facilitate extremely close agreement between our proposed exponentially decaying field strength and the established Newtonian theory, for heights of up to at least LEO.

If R is the radius of the World at sea level (= 6,367.5 km, Microsoft[2]), and r is the satellite's altitude, then from Newton we would have that

$$g \quad = \quad \frac{R^2}{(R+r)^2}\, g_0\ . \tag{3}$$

At $r = 200$ miles ≈ 321.9 km,

$$g(321.9\,\mathrm{km}) \quad = \quad g_0\, e^{-321.9\,k} \quad = \quad \left(\frac{6,367.5}{6,689.4}\right)^2 g_0\ ,$$

such that

$$k \quad = \quad -\frac{1}{321.9}\ln\left(\frac{6,367.5}{6,689.4}\right)^2 \quad = \quad 3.06414\times10^{-4}\ \ \mathrm{km}^{-1}\ . \tag{4}$$

At $r = 400$ miles ≈ 643.7 km,

$$g(643.7\,\mathrm{km}) \quad = \quad g_0\, e^{-643.7\,k} \quad = \quad \left(\frac{6,367.5}{7,011.2}\right)^2 g_0\ ,$$

giving

$$k \quad = \quad -\frac{1}{643.7}\ln\left(\frac{6,367.5}{7,011.2}\right)^2 \quad = \quad 2.99214\times10^{-4}\ \ \mathrm{km}^{-1}\ . \tag{5}$$

Taking the arithmetic mean of the values derived in Eqs. 4 and 5, gives

$$k = 3.0281\times10^{-4}\ \mathrm{km}^{-1}\ ,$$

which allows us to finalize our proposed gravitational field as

$$\boxed{g(x) \quad = \quad 9.8067\, e^{-3.0281\times10^{-4}\, x}\ ,} \tag{6}$$

where x is the altitude with respect to mean sea level **and has to be specified in kilometres.**

This function varies in the way shown by the solid curve in Fig. 1, where the inverse square relationship (dashed curve) is displayed for comparative purposes.

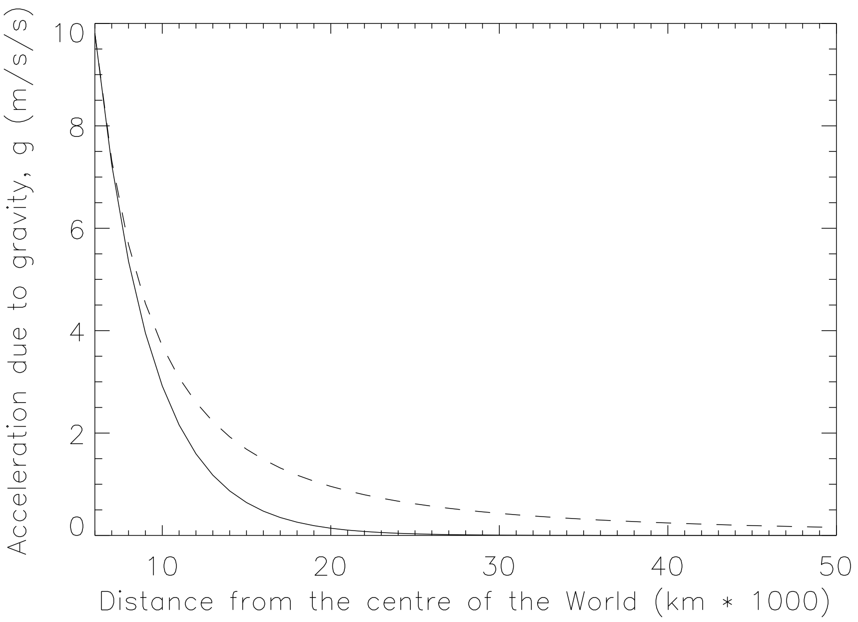

Figure 1. The strength of the World's gravitational field outwards from the surface, as predicted by Newton's inverse square function (dashed curve), as opposed to the exponential decay given in Eq. 6 (solid curve). The two gravitational field strength formulae continue in close agreement to one another for distances from the centre of the World of up to $\sim$ 8,500 km.

3. CONCLUSIONS

From Fig. 1, it is clear that Eq. 6 tallies with Newton's inverse square relationship very well at altitudes less than or equal to 2,100 km (i.e., 8,500 km - R, where R is the mean radius of the World).

In this model there is no gravitational field strength dependency on mass, which means, amongst other things, that there can be no 'black holes' and that 'dark matter' would not need to be invented to make observations match current cosmological theory.

The other major difference between this model and that of Newton is that the force of gravity in the latter is something inherent to anything which possesses mass. In this new model, however, there is no *mutual* attraction between objects, but only the effect of the gravitational field undeniably exerted by the World upon material objects close to it.

Finally, although modern physics attributes the cause of gravity to a warping of Minkowski's *space-time* fabric by mass, this paper makes no attempt at an explanation of what gravity really is. It does seem reasonable, however, to assume that whatever acts to produce this force within the World is unlikely to be present in, say, an apple.

REFERENCES

1. Kreyszig, E., 1993, "Advanced Engineering Mathematics," 7th ed., John Wiley & Sons, New York.
2. Microsoft Corporation, 1994, "Encarta '95," Multimedia Encyclopedia CD-ROM, Seattle, Washington.