Gravity Depends on Another Constant Besides c and G

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Abstract

We consider a system of two free particles on a fixed line. We show gravity depends on another constant besides c and G.

Units are chosen so that $c = G = 1$. Let x, y, z be coordinates of space. Let A and B be free particles on the x axis. Gravitational attraction causes A and B to move towards each other. Let B come from positive x infinity. When B is at infinity let A be at rest and have total energy M and B be at rest and have total energy m.

Let $h \geq 0$ and let the energy gain function $E(M, m, R, h)$ be the amount of energy B gains as it moves from an absolute difference $R + h$ to an absolute difference R between the x values of A and B. Let $a > 0$ and define

$$L(M, h) = \lim_{a \to 0} E\left(M + a, \frac{M + a}{N}, N(M + a), h\right) \tag{1}$$

where $N > 0$ is a natural number. For small $m/M, M/R$, and h/R we have from Newton approximation to gravity the amount of energy B gains on moving from infinity to an absolute difference of R between the x values of A and B is approximately Mm/R hence E is approximately Mmh/R^2. Consequently L for large N is approximately h/N^3. There is then a dimensionless function $f(h/M)$ of the dimensionless variable h/M such that

$$L(M, h) = \frac{h}{N^3} f\left(\frac{h}{M}\right) \tag{2}$$

The left hand side of (2) is defined for $M = 0$ but the right hand side is not unless $f(h/M)$ is a constant. Let $f(h/M) = b$. Now $L(0, h) = 0$ hence $b = 0$ so $L = 0$. This contradicts B gaining energy as it moves towards A. For a gravity with constants c, G, and l where l has dimensions of length we could have f dependent on variables h/l and M/l so that

$$f\left(\frac{\frac{h}{l}}{\frac{M}{l}}\right) = f\left(\frac{h}{M}\right) \tag{3}$$

when $M/l \neq 0$ and $f = 0$ when $M/l = 0$.

References

[1] Physics Essays, September 2016

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