Two particles and gravitation

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Abstract

We consider a particle $B$ moving towards a particle $A$ along a fixed line containing $A$. We show the force between $A$ and $B$ is not described by the law of universal gravitation. We also show gravitation must depend on another constant besides $c$ and $G$.

1 Introduction

Units are chosen so that $c = G = 1$. Let $x, y, z$ be coordinates of space. Let $A$ be a particle on the $x$ axis and $B$ be a particle moving from positive $x$ infinity along the $x$ axis towards $A$. When $B$ is at infinity let $A$ be at rest with total energy $M$ and $B$ be at rest with total energy $m$. Gravitational attraction between $A$ and $B$ causes $B$ to move towards $A$.

2 Energy gain function

Let the energy gain function $W(M, m, R, h)$ be the amount of energy $B$ gains as it moves from a separation distance of $R + h$ to a separation distance of $R$ between the $x$ values of $A$ and $B$. Define

$$L(M, h) = W\left(M, \frac{M}{N}, NM, h\right)$$  (1)

where $N$ is a large natural number. Using the law of universal gravitation, the amount of energy $B$ gains on moving from $R + h$ to $R$ for small $\frac{m}{M}$ and

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\( \frac{M}{R} \) is approximately \( \frac{Mnh}{R(R+h)} \). Consequently

\[
L(M, h) = \frac{Mh}{N^2(NM + h)} Q(M, h)
\]

(2)

where the dimensionless function \( Q(M, h) \) is approximately one.

### 3 Contradictions

The function \( W \) has a value when \( M = h = 0 \) so the left hand side (2) is defined for \( M = h = 0 \) but the right hand side is not which is a contradiction. The function \( L \) must have a different form than (2). Consequently the force between \( A \) and \( B \) is not approximated by the law of universal gravitation.

Let us now begin with a theory of gravitation having only constants \( c \) and \( G \) with dimension. An example is general relativity. If \( Mh = 0 \) particle \( B \) does not gain any energy as a result \( L(M, 0) = L(0, h) = 0 \). Also \( L \) has dimensions of energy and since \( c \) and \( G \) are the only constants with dimension we must have \( L = 0 \) which is a contradiction.

### 4 Conclusion

We showed the force between \( A \) and \( B \) is not determined by the law of universal gravitation. We also showed a theory of gravitation must depend another constant besides \( c \) and \( G \). It follows that general relativity does not describe classical gravity.