A clock paradox in gravity

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Abstract

We consider a static spherically symmetric distribution of matter. Time intervals for a free falling and a stationary clock are compared. This does not agree with that calculated using Newton approximation to gravity and the equivalence principle.

Let there be a static spherically symmetric distribution of matter with centre at the origin. Let U be a clock. Let there be a U always at rest at $\mathbf{r}$ and let t be the time measured by this U. Let τ be the time measured by a free falling U that begins at rest at $\mathbf{r}$. Define

$$f(r) = \frac{d\tau}{dt}(\mathbf{r}) \tag{1}$$

A U always at rest at the origin is in free fall hence $f(0) = 1$. Also the effects of gavity go to zero as $r \to \infty$ hence $f(r) \to 1$ as $r \to \infty$.

Assuming Newton approximation to gravity and the equivalence principle we have using [1] that $f(r_1) < f(r_2)$ when $r_1 < r_2$. Letting $r_1 = r$ and $r_2 \to \infty$ we have $f(r) < 1$. This contradicts $f(0) = 1$.

References

[1] A. Einstein, Annalen der Physik, **35** (1911). English translation in *The Principle of Relativity* translated by W. Perrett and G. B. Jeffery (Dover Publications, 1952).

[2] Physics Essays, December 2015

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