Remark Concerning the Gravitational Interaction of Matter and Anti-Matter.

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A number of speculations have been made recently about the question whether the gravitational interaction of matter and anti-matter is different from that of matter with matter. More specifically it is argued that the gravitational interaction of matter and anti-matter may have the same magnitude as for matter with matter but being of opposite sign.

One can easily show that under the existence of a red-shift of light-rays in a gravitational field such an assumption leads to a violation of the law of energy-conservation.

The proof of this statement can be given by considering a simple cycling process. A sufficient amount of energy say $E_0$ may produce at a place in the gravitational field with the potential $\Phi_0$ a particle-anti-particle pair. If the anti-particle shows an "anti-gravity" rather than an ordinary gravitational attraction the pair is weightless. It is therefore possible to lift the pair without work to another place in the gravitational field possessing the potential $\Phi_1$. Both particles shall be destructed at this place creating a photon. The photon is sent back to the place on the field where the potential is $\Phi_0$. It gains energy equal to

$$ \Delta E = \left(\frac{\Phi_1 - \Phi_0}{c^2}\right)E_0 $$

The energy at the end of this cycling process is therefore

$$ E_0 + \Delta E = E_0 \left(1 + \frac{\Delta \Phi}{c^2}\right) > E_0, $$

a result which is in contradiction with the energy-conservation-law. This consideration is not confined to light-rays. An analogical situation is given if instead of light rays, $\pi$-mesons are produced as a result of the pair annihilation.

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