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Lighting a path out of gravitational darkness – a variable mass and light speed

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A path to a gravitational theory that reproduces the predictions of General Relativity but removes the need for ad hoc hypotheses such as dark matter and dark energy exists. It has been shown that the flat space-time of Special Relativity can be replaced by a real background that affects the properties of moving objects. The next step is to show that General Relativity's distorted geometry of space-time can be replaced by a background that affects mass via the speed of light.

According to Newton's law of gravitation objects are attracted to each other in proportion to their mass. The initial expectation was therefore that a photon would not be attracted to a massive object. However, General Relativity has matter distorting the space-time in which all objects, including photons, exist. This led to Einstein's prediction of a gravitational redshift of light with increased gravitational potential. A photon appears to lose energy in escaping a gravitational field. Since a photon has no mass it was argued that it is attracted in proportion to its kinetic energy. It thus became a pillar of General Relativity that all objects are attracted, and space-time distorted, in proportion to energy. Hence, gravitational energy gives rise to increased gravitational energy which ultimately leads to the singularities of black holes.

The gravitational redshift was finally observed in the 1950s in a series of experiments by Pound and Rebka in which photons were not resonantly absorbed by a matched detector, higher in a tower, unless they were given a boost in energy. The opposite applied when the positions of emitter and detector were reversed. However, several authors [1,2] have pointed out that the energy of the photon is unchanged and instead, under General Relativity, the standards of time are changed so that the energy levels of the atoms appear blueshifted. The change in time, a faster clock-rate with distance from a massive object, is a confirmed observational effect seen in the needed adjustments to the satellite clocks of the global positioning system.

A subtly different explanation for the blueshift and change in time is that they arise from a real increase in the energy levels of atoms with gravitational potential. The mass (stored energy) of objects increases due to the work done in lifting them. The increased energy levels mean that frequencies and time are faster. The energy is released as the free kinetic energy of motion when a massive object falls. The beautiful change in perspective is that gravitational attraction arises from a loss of mass. Two immediate advantages are the removal of singularities because the change in mass decreases as gravitational fields increase and there is no need for an enormous pool of energy in empty space devoid of massive objects and distortion. However, $m = E / c^2$ means that the stored energy (m) of the same amount of matter (current energy E) decreases as the speed of light increases nearer to a massive object. Surprisingly, this appears consistent with all existing measurements and expectations. For example, measurements of the Shapiro delay only test for the change in timing due to the increased path length from bending.

Clock-rate increases but light-time intervals decrease with increasing c. This, and the change from redshift to blueshift, mimics the misinterpretation, in Special Relativity, that smaller time intervals mean less time. Changes in c and mass then give similar results to a distortion of space-time. However, differences appear when the background is or was substantially different, e.g. in earlier epochs. The apparent accelerating expansion seen in supernova data is removed by the integrated increase in distance per unit time from an earlier, faster speed of light. There is then no need for dark energy or cosmic inflation. The change in background with distance from the centre of a galaxy can also remove the need for dark matter. This can be achieved, without a distortion of space-time, by a chiral background that alters the inertia, local wavelength, and hence bending of photons.

[1] L. B. Okun, K. G. Selivanov, V.L. Telegdi, Am. J. Phys. **68**, 115 (2000).

[2] T. P. Cheng, Relativity, gravitation and cosmology: a basic introduction. (OUP) 2nd ed. pp.77-79 (2009).