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Interactions between photons and gravitational field beyond the general theory of relativity

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According to Einstein's general theory of relativity, photons—though massless—are influenced by gravitational fields because gravity acts not as a force in the Newtonian sense but as a manifestation of spacetime curvature. In this framework, a photon follows a null geodesic, meaning its path bends when passing near massive objects due to the warping of spacetime. This leads to several key phenomena: gravitational lensing, where light from distant sources is deflected and magnified by intervening mass distributions; gravitational redshift, in which photons climbing out of a gravitational potential well lose energy and are observed at longer wavelengths; and Shapiro time delay, where light signals take slightly longer to travel past a massive body than they would in flat spacetime. These effects have been experimentally confirmed in contexts ranging from Eddington's 1919 eclipse observations to modern high-precision measurements with radio signals and space telescopes, and they remain essential tools for probing both astrophysical structures and the fundamental nature of gravity. Here we further explore the interactions between photons and gravitational fields beyond above mentioned effects predicted by the general theory of relativity. By utilising the laboratory-based experiments, we show the dependence of the speed of light on the gravitational fields and also demonstrate another source for generating redshift under the influence of the earth gravity.

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