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Gravitational radiation from binary systems in f (R) gravity: A semi-classical approach

The rate of energy loss and orbital period decay of quasi- stable compact binary systems is a useful tool to constrain theories of gravity. In this talk, we present exact expressions for energy loss and orbital period decay are in three $f(R)$ theories derived using the method of a single vertex graviton emission process from a classical source. After linearising the f (R) action written in an equivalent scalar-tensor format in the Einstein frame, we identify the appropriate interaction terms between the massless spin-2 tensor mode, massive scalar mode, and the energy momentum tensor. Using the interaction vertex we compute the rate of energy loss due to spin-2 quadrupole radiation, which comes out to be the same as the Peter-Mathews formula with a multiplication factor, and also the energy loss due to the scalar dipole radiation. The total energy loss is the sum of these two contributions. Our derivation is most general as it is applicable for both arbitrary eccentricity of the binary orbits and arbitrary mass of the scalar field. Using the derived theoretical formula for the period decay of the binary systems, we compare the predictions of $f(R)$ gravity and general relativity for the observations of four binary systems, i.e. Hulse-Taylor Binary, PSR J1141-6545, PSR J1738+0333, and PSR J0348+0432. Thus we put bound on three well-known $f(R)$ dark energy models, namely the Hu-Sawicki, the Starobinsky, and the Tsujikawa model. We get the best constraint on $f'(R_0)-1$ (where R0 is the scalar curvature of the Universe at the present epoch) from the Tsujikawa model, i.e $|f'(R_0)-1| < 2.09 \times 10^{-4}$. This bound is stronger than those from most of the astrophysical observations and even some cosmological observations.

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