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Testing the equivalence principle with Blackhole image observations

Observation of Blackhole shadows by the VLBI Telescopes provides an excellent opportunity to test General Relativity in the strong field regime. One can use these observations to test the fundamental foundations of GR, such as Einstein's equivalence principle. In simple terms, Einstein's equivalence principle refers to simply changing the partial to covariant derivatives of the matter fields. However, this assumes that matter fields (like electromagnetic fields) are minimally coupled to gravity. Thus, any detection of a non-minimal coupling of the electromagnetic field to gravity will imply a violation of the equivalence principle. In this talk, we discuss using the Blackhole image observations to constrain the non-minimal coupling via the Riemann tensor, which is also the leading-order quantum correction to gravity. First, we look at the photon trajectory in Schwarzchild space-time in the presence of the non-minimal coupling. We show that the non-minimal coupling can lead to unstable circular photon orbits, which can be used to constrain the coupling strength from the observed image of the black hole. We will also briefly discuss the effect of the coupling on the photon trajectory in the Kerr space-time, which is more relevant to the upcoming observations of the supermassive black holes by the next-generation VLBI observations.

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