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Gravitational Interaction of The Higgs and Dark Matter

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With the LHC Higgs discovery, we are strongly motivated to study gravitational interactions of the Higgs boson. In this talk, we study the unique dimension-4 operator of the Higgs with Ricci curvature in the effective field theory. This dimensionless nonminimal coupling affects weak gauge boson scattering amplitudes and yields perturbative unitarity violation in high energy. The same operator makes it possible to drive inflation by the Higgs in early universe. The analysis of unitarity constraints is extended to the Higgs inflation with large background field. It also modifies the Higgs self-interactions. Generally speaking, we could study Higgs self-interactions via dihiggs production with new physics contribution parametrized by dimension-6 operators. As motivated by this model, we identify a 2d parameter space and perform full analysis of $gg \to hh \to b\bar{b}\gamma\gamma$ process at pp(100TeV) hadron collider. We construct various benchmarks to explore the sensitivity in different region of parameter space. Along the same line, we study the possibility that the dark matter only talks to the SM via gravity. We construct a simple model with a scalar dark matter coupled nonminimally to the Ricci curvature. We find that only with the Higgs nonminimal coupling, the induced effective interactions between the DM and SM particles are able to account for the observed thermal relic abundance perturbatively. Such a scalar gravitational dark matter turns out to be highly predictive and testable in various searches.

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