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Horndeski theory on a dynamical spherically-symmetric background

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We study the stability of classical solutions in Horndeski theory, which is the most general scalar-tensor theory of gravity with an additional scalar field and second-order motion equations, which in turn provides absence of Ostrogradski ghosts. In this work, we address a general dynamical spherically symmetric background. We derive the set of stability conditions in the cubic subclass of Horndeski theory and formulate the no-go theorem for this subclass.

For full Horndeski theory and beyond Horndeski theory we formulate a set of linear stability conditions for high energy odd parity perturbation modes above an arbitrary solution. In this general setting we derive speeds of propagation in both radial and angular directions for gravity waves and compare them with the speed of light in the case of minimally coupled photon. In particular, we find that the class of beyond Horndeski theories, which satisfy the equality of gravity waves' speed to the speed of light over a cosmological background, feature gravity waves propagating at luminal speeds above a time-dependent inhomogeneous background as well. [arXiv:2408.01480]

We revisit the models recently derived from a Kaluza-Klein compactification of higher dimensional Horndeski theory, where the resulting electromagnetic sector features non-trivial couplings to Horndeski scalar. In this work we prove that both gravitational wave and its electromagnetic counterpart propagate at the same, although non-unit, speed above an arbitrarily time-dependent, spherically symmetric background within the theories in question. Hence, we support the statement that several subclasses of Horndeski theories are not necessarily ruled out after the GW170817 event provided the photon-Galileon couplings are allowed. We also formulate the set stability conditions based on odd parity perturbations for an arbitraty solution within the discussed theoretical setting. [arXiv:2408.06329]

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