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Gravitational Wave Propagation and Polarizations in the Teleparallel analog of Horndeski Gravity

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Gravitational waves (GWs) have opened a new window of fundamental physics in a number of important ways. The next generation of GW detectors may reveal more information about the polarization structure of GWs. Additionally, there is growing interest in theories of gravity beyond GR. One such theory which remains viable within the context of recent measurements of the speed of propagation of GWs is the teleparallel analogue of Horndeski gravity. In this work, we explore the polarization structure of this newly proposed formulation of Horndeski theory. In curvature-based gravity, Horndeski theory is almost synonymous with extensions to GR since it spans a large portion of these possible extensions. We perform this calculation by taking perturbations about a Minkowski background and consider which mode propagates. The result is that the polarization structure depends on the choice of model parameters in the teleparallel Horndeski Lagrangian with a maximum of seven propagating degrees of freedom. While the curvature-based Horndeski results follows as a particular limit within this setup, we find a much richer structure of both massive and massless cases which produce scalar–vector–tensor propagating degrees of freedom. We also find that the GW polarization that emerges from the teleparallel analogue of Horndeski gravity results in analogous massive and massless modes which take on at most four polarizations in the massless sector and two scalar ones in the massive sector. In none of the cases do we find vector polarizations.

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