Beyond Horndeski gravity: Phenomenology and Parameter Estimation

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Beyond Horndeski is a general scalar-tensor theory of gravity, which builds on the Horndeski class of theories by including higher order derivatives in the equations of motion. On cosmological scales this model can be characterised by the fraction of matter density today, the Hubble parameter, $H(t)$, and one extra function of time, $\alpha_{\rm H}$, as well as the usual four Horndeski set of free functions, $\{\alpha_{\rm K}, \alpha_{\rm B}, \alpha_{\rm M}, \alpha_{\rm T}\}$. The phenomenology of Horndeski gravity has been studied extensively and the parameters of the theory have been constrained with data, however this has not been done before for the the theories beyond Horndeski.

For this work we implemented the beyond Horndeski model in the Boltzmann solving code `hi_class` in order to study its phenomenology and derive constraints on $\alpha_{\rm H}$ from recent cosmological data; we show that it leads to new interesting properties that are not described by the Horndeski class [1]. In particular the results obtained with `hi_class` confirm that $\alpha_{\rm H}$ has an effect on the matter power spectrum, the growth rate of structure in the universe and the temperature and lensing power spectra of the cosmic microwave background (CMB). We put constraints on $\alpha_{\rm H}$ using measurements of the temperature and polarisation of the CMB, as well as the lensing potential derived from it, combined with baryon acoustic oscillations (BAO) and redshift space distortions (RSD) measurements from the most recent large scale structure data. We vary a number of different combinations of free parameters and find constraints on $\alpha_{\rm H}$ of order $\mathcal{O}(1)$. For most cases we considered the contours exclude zero, however, we do not find strong enough evidence to confirm that either of these models is preferred.

References

[1] Traykova D, Bellini E, Ferreira PG. The phenomenology of beyond Horndeski gravity. 2019;.