Parametrizing modified gravities with vector degrees of freedom: anisotropic growth and lensing

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We consider the problem of parametrizing modified gravity theories that include an additional vector field in the sub-Hubble regime within the quasi-static approximation. We start from the most general set of second order equations for metric and vector field perturbations and allow for both temporal and spatial components of the background vector field. We find that in the case in which dark matter obeys standard conservation equations, eight parameters are needed to fully characterize the theory. If dark matter vorticity can be neglected, the number of independent parameters is reduced to four. In addition to the usual scale and redshift dependence, the effective parameters have an additional angular dependence induced by the preferred direction set by the background vector. In the considered sub-Hubble regime, we show that this angular dependence appears only through even multipoles and generates anisotropies in the growth function which translate into anisotropies in the galaxy and lensing convergence power spectra. The angular dependence generated by the preferred direction is different from that induced by redshift space distortions and could be disentangled in the data collected by future galaxy surveys.