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Linear perturbations in Horndeski models with spatial curvature

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This work aims to investigate the impact of spatial curvature in modified gravity models, specifically within the Horndeski framework. Typically overlooked in the literature due to the spatial flatness assumed in the ΛCDM model, this study aims to fill this gap. The ΛCDM model, rooted in General Relativity (GR), is in good agreement with observational data, but faces problems with cosmological parameters such as H0, σ8 and, more recently, Alens (the amplitude of the weak lensing signal from CMB photons). These discrepancies motivate the exploration of models beyond ΛCDM, such as the Horndeski model, the most comprehensive scalar tensor theory with second-order equations of motion.
My research is progressing in several stages, the topic of this talk will be to outline the theoretical results obtained: field equations for a curved Horndeski model derived using the effective field theory of dark energy. I will then show how these equations are implemented in the Einstein-Boltzmann code hi_CLASS to compute cosmological observables in order to study the influence of spatial curvature on the CMB anisotropy power spectrum and the matter power spectrum. Subsequently, a statistical analysis using the MCMC code MontePython will constrain the cosmological parameters by comparing observational and computed data.
The critical finding I want to highlight is that spatial curvature significantly modifies the equations of motion, introducing couples with the α-parameters of the Horndeski model. In particular, the spatial derivatives in the scalar perturbation equations gain an additional +3K term and new terms appear, showing that spatial curvature multiplies the scalar perturbation π and α functions. For gravitational waves, the derivative term receives a +2K addition. These modifications suggest that ignoring spatial curvature could miss crucial insights and potential solutions to the tensions in the ΛCDM model.

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