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THE FIFTH FORCE: FROM PLANCK TO EUCLID

Abstract

Understanding the nature of Dark Matter (DM) and Dark Energy (DE) are the most important problems in modern cosmology, with profound implications for astronomy, high-energy physics and general relativity, that demands ambitious programs at both theoretical and observational level. In particular, the Euclid mission, an ESA scientific mission selected to be launched at the end of 2020, is conceived to probe the physical origin of the DE and DM by using two independent probes, the redshift clustering and the weak lensing tomography of about a billion of galaxies.

In this paper we investigate the possibility of the DE coupling with different matter components that introduces a new force, the *fifth force*, mediated by the DE.

In particular, we will consider the possibility that DE, in the form of a dynamical scalar field, can interact with a fraction of DM particles in the form of sterile neutrinos. In this scenario, the sterile neutrino mass changes in time due to the energy exchange with the DE scalar field. The presence of the *fifth force* changes the stress-energy tensor for all components in the expanding Universe (general covariance requires that the sum of stress-energy tensor components is conserved) modifying the background and perturbations evolution. We will evolve the perturbed Einstein's equations in the expanding Universe and compute the matter and radiation power spectra.

We will employ a Monte Carlo technique to place constraints on DM particle masses and couplings, the DE properties and the main cosmological parameters, by using the mock Euclid datasets for both spectroscopic and weak lensing surveys, complemented with Planck and other existing cosmological observations.

We will also quest for basic cosmological hypothesis at different scales: the consistency relation between the expansion rate and angular diameter distance (Copernican Principle) and the consistency relation between angular diameter distance and luminosity distance (Etherington Principle).