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DARK MATTER NATURE: PROSPECTS FOR FUTURE SCIENCE MISSIONS

Abstract

The nature of Dark Matter (DM) and Dark Energy (DE) and their possible interaction are outstanding problems in the modern cosmology, with profound implications for astronomy, high-energy physics and general relativity. The Euclid mission, an ESA scientific mission selected to be launched at the end of 2022, is conceived to probe the physical origin of the DM and DE by using two independent probes, the redshift clustering and the weak lensing tomography of about a billion of galaxies.
Presently, the nature and composition of DM is still unknown. Attempts involving collision-less DM particles fail to solve the ΛCDM problems at reproducing the cosmological structures at small scales, suggesting that DM particles may also exhibit gravitational properties and requiring the extension of the Standard Model (SM) of particle physics.
One of the theoretically well-motivated DM candidates is sterile neutrino. Arising in the minimal extension of SM, sterile neutrino with mass in keV range can simultaneously explain the active neutrino oscillations, the DM properties and the matter-antimatter asymmetry of the Universe. Detection of a weak X-ray emission line at an energy of 3.5 keV from clusters and Andromeda galaxy independently reported by XMM-Newton and Chandra satellites open the debate on the possibility this signal could be the signature of decaying sterile neutrino DM with a mass of 7.1 keV.
In this paper we will investigate the possibility that a fraction of DM particles is in the form of sterile neutrinos produced by two complementary mechanisms: 1) Neutrino oscillations in a lepton-asymmetric Universe leading to sterile neutrino resonant production (RP); 2) The decay of a heavy scalar singlet with non-zero vacuum expectation value produced via SM Higgs interactions (SDP).
Our goal is to understand to which extend the present and near future astrophysical and cosmological measurements can disentangle between RP and SDP mechanisms. We will employ the Monte Carlo Markov Chains technique to place constraints on DM particle masses and couplings, the sterile neutrino 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 astrophysical observations.