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Neutrino Cosmology - Weighing the Ghost Particle with the Universe

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Over the past decades, the high-precision cosmological data have significantly improved our understanding of the Universe, contributing greatly to the establishment of the standard model of cosmology. However these results have also opened new questions in both fundamental physics and astrophysics. One of the great mystery of the universe is that more than 80% of the matter in our Universe is made up of material that is invisible (dark matter). This component has important consequences in the evolution of the Universe and in the structure formation processes. While the major contribution to the dark matter should arise from cold dark matter (CDM), a small component of hot dark matter (HDM) can also be present. A natural candidate for the HDM is neutrino. Neutrinos physics is one of the most fascinating research areas that has stemmed from the interplays between cosmology, astrophysics and particle physics. Cosmology provides an independent tool for the investigation of neutrino properties since it is sensitive to the absolute scale of neutrino masses. Measuring the masses of these particles would be of extreme value to unravel the departure from the Standard Model (SM) of Particle Physics. A robust detection of neutrino masses is among the key goals of upcoming Cosmic Microwave Background (CMB) and Large-Scale Structure (LSS) surveys. In this talk, I will review the main physical effects of massive neutrinos on cosmological observable and summarize recent progress on neutrino mass constraints obtained by combining different cosmological measurements. I will also show a new approach to produce fast non-standard cosmological simulations with massive neutrinos by applying deep learning algorithms.

Presenter: Dr GIUSARMA, Elena (Flatiron Institute, New York)

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