Massive neutrinos and new standard cosmological model: No concordance yet

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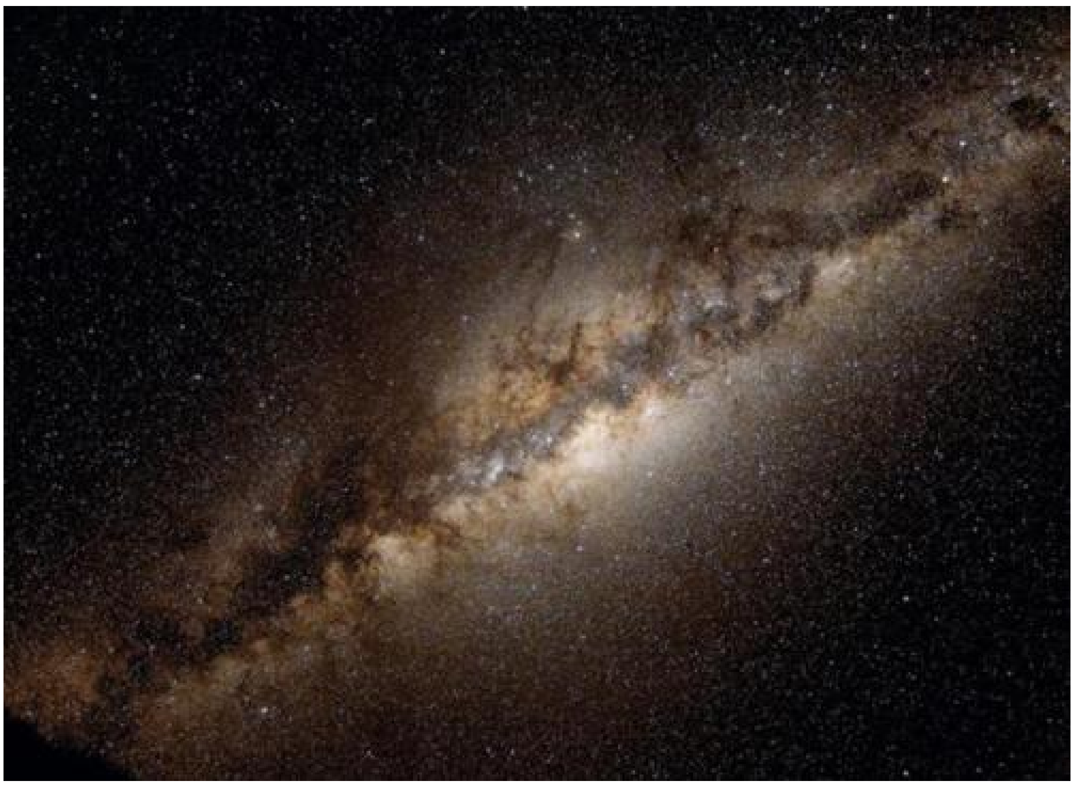

The research group demonstrates that adding such massive neutrinos to the standard model does not really explain all datasets. Credit: The Milky Way, NASA.

Neutrinos, also known as 'ghost particles' because they barely interact with other particles or their surroundings, are massless particles according to the standard model of particle physics. However, there is a lot of evidence that their mass is in fact non-zero, but it remains unmeasured. In cosmology, neutrinos are suspected to make up a fraction —small but important— of the mysterious dark matter, which represents 90% of the mass of the galaxy. Modifying the standard cosmological model in order to include fairly massive neutrinos does not explain all the physical observations simultaneously.

This is the conclusion of a new scientific paper published in the journal *Physical Review Letters*, signed by Licia Verde, ICREA researcher from the Institute of Cosmos Sciences of the University of Barcelona (ICCUB), Boris Leistedt and Hiranya V. Peiris, from the University College London.

A model that does not meet observed data

Some scientific studies suggest that the existence of massive neutrinos could potentially explain other physical anomalies and phenomena observed in the Universe (for instance, the number of galaxy clusters observed by the Planck satellite). This hypothesis represents an extension of the standard cosmological model and may have profound implications for both cosmology and particle physics.

In the article published in the journal *Physical Review Letters*, the research group demonstrates that adding such massive neutrinos to the standard model does not really explain all datasets. Researcher Licia Verde affirms that "the new paper proves that the new model is in fact not a satisfying solution, in the sense that it is not able to explain all data sets simultaneously. Therefore, it cannot be the correct model of the Universe".

Neutrinos: elusive and difficult to detect particles

Neutrinos travel almost at the speed of light. Most of thousands of millions of neutrinos passing through the Earth emanate from the Sun and the atmosphere. However, gamma ray explosions, star formation and other cosmic phenomena can produce these particles, which are extremely hard to detect. Huge laboratories, such as the IceCube in Antartica, are necessary, and they only capture a few neutrinos (leading to poor measurements of neutrinos masses). Therefore, measuring the exact masses of the neutrinos is a major milestone for the entire physics community.

"Neutrinos' properties can be also measured by studying the cosmos —explains researcher Licia Verde—, but cosmological observations have not detected neutrinos' mass yet". According to Licia Verde, "we know that the mass of neutrinos is between ~0.05 eV and ~0.2 eV, so cosmology is closing in. There is a lot of work to do in order to get a robust measure but we hope that the next generation of cosmological data will be able to 'see' the mass of neutrinos and provide a more accurate measure of the mass of these particles".

Licia Verde, ICCUB researcher, also participates in the international project Sloan Digital Sky Survey (SDSS-III), one of the largest galaxy survey. She was member of the Wilkinson Microwave Anisotropy Probe (WMAP) team, and was awarded with the 2012 Gruber Cosmology Prize for her pioneering contributions to the study of primitive Universe.

More information: "No New Cosmological Concordance with Massive Sterile Neutrinos." Boris Leistedt, Hiranya V. Peiris, Licia Verde. *Physical Review Letters*. dx.doi.org/10.1103/PhysRevLett.113.041301

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