PRESS RELEASE

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IMMEDIATE RELEASE May 18 2021

A BIG DILEMMA FOR THE HUBBLE CONSTANT:

To be or not to be constant

Boulder, Co, **May 18, 2021**

One of the most famous open problems of modern cosmology is the Hubble constant (H0) tension: measurements of H0, the expansion rate of the Universe, do not agree with one another. In sampling nearby versus faraway pieces of the Universe, the speed of growth is very different. There is a wide discrepancy (> 4 σ) between the value of H0 estimated with local observations of Supernovae Ia (SNe Ia), and the value of H0 computed with the Cosmic Microwave Background (CMB) probe by the Planck Collaboration, which highlights the first visible photons in the universe just 380,000 years after the Big Bang. According to the most accredited model used to describe the evolution of the Universe, the so-called Lambda Cold Dark Matter (ΛCDM) model, the H_0 constant is needed to estimate not only the expansion rate of the universe but also its age and its future destiny in terms of evolution. Despite the wide acceptance of the ΛCDM model in the scientific community, there are several open problems that this model struggles with, in particular the Hubble constant tension.

The H_0 tension has been the subject of investigation by an international team led by Dr. Maria Dainotti, Assistant Professor at the National Astronomical Observatory of Japan, The Graduate University for Advanced Studies, SOKENDAI (Japan) and Affiliate Research Scientist at Space Science Institute (USA). The team is of Dr. Dainotti; Biagio De Simone, a former master student in Physics at the University of Salerno (Italy); Tiziano Schiavone, a Ph.D. student at the University of Pisa (Italy); Dr. Giovanni Montani, Researcher in ENEA (Italy) and Adjunct Professor at the University la Sapienza of Rome (Italy) and Enrico Rinaldi, Researcher at the University of Michigan (US) and visiting Researcher at RIKEN-iTHEMS (Japan); Gaetano Lambiase, Full Professor at the University of Salerno. A new article released by this team, which has been recently published in the Astrophysical Journal (https://arxiv.org/abs/2103.02117, DOI: 10.3847/1538-4357/abeb73) investigates the H0 tension and checks if H0 is really constant. To this end, the team used a collection of 1,048 Supernovae Type Ia (the Pantheon sample) and divided it in 3, 4, 20 and 40 bins with an increasing order in redshift or distance. For each bin, they estimated the value of H_0 by fitting different H0 values in a computer model capable of describing the evolution of H0 with redshift. The parameter of this fitting model that describes the evolution is α and has been found to be around 10^{-2}. As illustrated in Figure 1, here is an observed decreasing trend in H0 as redshift or distance increases, which may affect cosmological results in a non-negligible way. To test out this hypothesis, the researchers extrapolated the value of H0 given by this model at the redshift of the Last Scattering Surface, corresponding to the CMB emitting surface. Surprisingly, the value obtained by this fitting model is compatible with the one measured by the Planck satellite.

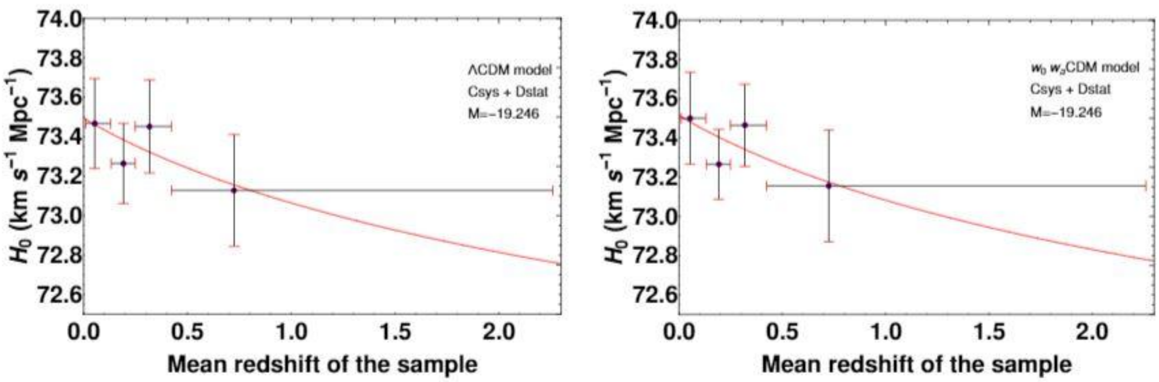

Figure 1: The evolving trend of H_0 in 4 bins with the ΛCDM model (left panel), and the w_0w_aCDM model (right panel).

The observed decreasing trend of H_0 has different interpretations: it could be due to astrophysical biases or systematic effects but, if this is not the case, it could be a symptom of a possible crisis of the actual picture of the universe. As an interpretation of the obtained behavior of the Hubble constant with the redshift, a new cosmology beyond the ΛCDM model may be necessary.

The H_0 tension remains an open debate and these results may usher in a new era for novel interpretative scenarios in modern astrophysics and cosmology.

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The paper "On the Hubble constant tension in the SNe Ia Pantheon sample" is based upon work supported in part by the National Astronomical Observatory of Japan (NAOJ), from Interdisciplinary Theoretical and Mathematical Sciences Program (iTHEMS) of RIKEN. The authors acknowledge financial support from University of Salerno.