Advances in Astronomy

Special Issue on

Theoretical, Observational, and Simulation Properties of Models beyond ΛCDM

CALL FOR PAPERS

As many different cosmological probes showed in the last two decades, the universe is undergoing an accelerated expansion. The simplest explanation, which is also at the core of the standard cosmological model, is the effect due to the cosmological constant, which was introduced by Einstein himself as first modification to his theory of General Relativity to achieve a static universe. The cosmological constant can be associated with the vacuum energy and be described as a fluid with constant energy density and equation of state $w\Lambda = -1$. The evidence for a matter component which causes structures to form is also striking. Usually, this is described as a nonbaryonic matter component which interacts only gravitationally with particles we know but at the same time might have a rich phenomenology in its own dark sector and that provides the seeds for the collapse of baryons which form galaxies and galaxy clusters we observe.

Despite the good agreement between theoretical predictions and observations, many problems arise within this simple model and several options have been and are currently explored. Being the nature of the two main ingredients of the ΛCDM model, the cosmological constant Λ and the Cold Dark Matter (CDM) component unknown, and presenting well known drawbacks, with the first one being plagued by the so-called cosmological constant problem and the second one by problems on small scales and the lack of detection of candidates, it is natural to investigate extensions and alternatives to the standard picture by modifying the properties of either one or both of them. The modifications required to have an accelerated expansion usually assume either the introduction of an additional fluid with negative equation of state dubbed dark energy (DE) or a modification to the law of gravity, the so-called modified gravity (MG) approach. Finally, one could consider the accelerated expansion as caused by inhomogeneities in the universe.

CDM is assumed to be cold, such that its pressure is negligible. Going beyond this assumption, it is natural to consider warm dark matter models (WDM) or explain the properties of DM within proposed particles in/and beyond the Standard Model of particle physics, which may decay, self-annihilate, and self-scatter.

This special issue aims to focus on the aspects and consequences of extending the standard cosmological model from several points of view. The goal is to bring together theoretical and observational researchers in order to outline what has been done and to pave the road for future directions in the field. Particular emphasis is devoted to the phenomenological aspects and theoretical foundations of the alternative models (what makes them viable, why is that particular model interesting, and what it achieves), how they can be efficiently simulated in a computer (can we reach the same accuracy of the ΛCDM model without sacrificing speed and which models can actually be simulated today), what the observational imprints observers should look at are (is there a clear smoking-gun for that particular model), and what alternatives exist to correlation functions to quantify non-Gaussian structures. We accept original research results as well as review articles.

Potential topics include but are not limited to the following:

- How can we put constraints on alternative models using current and future observations?
- Phenomenological and theoretical properties of the models: what are the main outcomes of the model investigated? What makes them viable and interesting?
- Simulation techniques: how can we effectively simulate alternative models of gravity?
- How is particle physics helping us to understand dark matter and what are the predictions of the models proposed?
- What are the observational effects of alternative models on cosmological and astrophysical scales?
- Back-reaction mechanism: how can we distinguish dark energy and modified gravity from inhomogeneous cosmology?
- Alternative descriptors of the cosmic large-scale structure and their relation to the underlying physical model

Authors can submit their manuscripts through the Manuscript Tracking System at https://mts.hindawi.com/submit/journals/aa/tospm/.

Papers are published upon acceptance, regardless of the Special Issue publication date.

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