Session: Dark matter and dark energy

Contributed paper:

Title: Unravelling the effective fluid approach for Modify Gravity and Dark Energy models.

Abstract:

In 1998, convincing evidence from observations of Supernovae type Ia (SnIa) showed that the Universe is undergoing a phase of accelerated expansion. Although the Lambda cold dark matter model (ΛCDM) has become the best phenomenological description for the late-time accelerating phase of the Universe and is in very good agreement with recent astrophysical measurements, the yet unsolved cosmological constant problem has driven an effort towards alternatives.

We will mention two leading approaches which avoid the introduction of a cosmological constant. On the one hand, Dark Energy (DE) models where yet unobserved scalar fields would dominate the energy content at late times, avoiding fine-tuning issues as well as accelerating the Universe. On the other hand, there are Modified Gravity (MG) models that instead modify the current theory of gravity. Both DE and MG models provide plausible, alternative scenarios for explaining the late-time acceleration of the Universe. It is known that both kinds of models can fit background astrophysical observations, as well as the standard model ΛCDM. These models are, therefore, degenerated at the background level despite several efforts to disentangle them with model independent approaches. Although the recent discovery of gravitational waves by the LIGO Collaboration allows us to rule out some families of MG models (e.g., from the so-called Horndeski theories), there remains a degeneracy between the two leading approaches. Among the remaining MG models one finds that the linear order perturbations could in principle be distinguishable from ΛCDM.

We will demonstrate how to work out solutions to the perturbations equations in MG and DE models under the sub-horizon approximation. We will see that one can derive analytical solutions for DE perturbations and test them numerically showing that the quasi-static approximation actually performs quite well for this kind of models. Using the latter and simple modifications to the CLASS Boltzmann code, which we call EFCLASS, in conjunction to very accurate analytic approximations for the background evolution, one can obtain competitive results in a much simpler and less error-prone approach. We then use the aforementioned models to derive constraints from the latest cosmological data, including Type Ia supernovae, Baryon Acoustic Oscillations (BAO), Cosmic Microwave Background (CMB), H(z) and growth-rate data, and find they are statistically consistent to the ΛCDM model.

Based on our recent published paper: arXiv:1811.02469. Journal ref: Phys. Rev. D 99, 043516 (2019).

Suggestion for another special session: Modify gravity

I am Rubén Arjona, a PhD student at the Instituto de Física Teórica (IFT) UAM-CSIC, Madrid, Spain. I am concerned about the registration fee.