Project 5.1 COLAB: COsmic LAboratory for Baryons and dark matter.

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Background:

The physical nature of dark matter remains one of the most pressing open questions in physics. An extensive research program has been brought forward, with the aim to determine the cosmological origin, fundamental constituents, and interaction mechanisms of dark matter. So far all laboratory experiments have failed to detect the elusive dark matter particles, and the only direct empirical measurements of dark matter properties to date come from astrophysical and cosmological observations. In the coming decade many grand-design observational campaigns such as LSST, Euclid, DESI, 4HS, SKA will provide us with a deluge of new data of unprecedented scale and precision. This makes the goal of searching for astrophysical observables optimal for constraining the nature and physics of dark matter urgent and pressing. This project addresses the heart of this urgency by proposing an ambitious program for a novel systematic study of the theoretical connection between microscopic dark matter physics and macroscopic properties of haloes galaxies. We will search for observables offering the potential to discriminate among three main particle dark matter models: cold (CDM), warm (WDM), and self-interacting (SIDM).

The PhD student will learn new essential skills and knowledge during implementation of this project. This person's main task will be to build and develop cosmological simulation codes and help to conduct, post-process and participate in analysis of numerical simulations.

Aim:

The position is within the “COLAB” project in which we employ various Cosmic Web identification algorithms to new high-resolution simulations of the three dark matter variants. We will use newest N-body and hydrodynamical schemes to generate artificial galaxy catalogs. Results will be used to forecast observables and dark matter model discriminatory power, with the final aim of finding the best environmental samples and observables for yielding the astrophysical dark matter nature detection.

Requirements:

We are looking for a highly motivated student. An ideal candidate would be:
- a person with a good background in theoretical physics and/or computational sciences with a relevant MSc in physics, astronomy or computer sciences,
- fluency in written and spoken English is required,
- a good track-record of involvement in any previous research project will be an additional asset.

Our team is an affirmative action/equal opportunity group and values equality of opportunity, human dignity and diversity, thus females and minorities are particularly encouraged to apply.