PhD position

Testing neutrino masses and dark energy with galaxy clustering and weak lensing from the Euclid survey

Keywords: Cosmology – Astrophysics – *Euclid* space mission

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Context

While the Universe is expanding with increasing velocity, the question of what is causing cosmic acceleration remains unsolved. A cosmological constant seems to fit current data, but its value is not understood theoretically and rather raises more open questions. Is it really a constant or is it associated with dynamical dark energy? Is there any chance to observe this evolution with future surveys? Can we measure neutrino masses and the neutrino density, and how will this measurement depend on assumptions done on dark energy?

The ESA *Euclid* satellite[1] is planned to be launched in 2023, and data will be available to the collaboration soon after: With 1.5 billion galaxy shapes in different redshift epochs, it will be the largest data set ever available to test the nature of dark energy and the laws of gravity. *Euclid* will be the first satellite to probe the Universe simultaneously with both galaxy clustering (GC) and weak lensing (WL) data and it is designed to minimize their systematic effects [1].
This PhD proposal is meant to contribute directly to develop the results of a space mission on which CEA has invested, with a concrete, useful addition to the standard pipeline, being actively involved in the scientific exploitation of the mission. This project will be an interesting opportunity for the PhD candidate to work at the interface between theory and the first real data of the Euclid mission.

The PhD Thesis

The PhD project will focus on how to best combine information from photometric galaxy clustering (GCph) and weak lensing data, and how to use their combination and cross-correlation to test cosmological parameters. The student will investigate the impact on gravitational potentials, and on degeneracies between neutrino masses and dark energy parameters. In this way, the PhD student will on one side learn how to use tools developed within the collaboration, and on the other side extend them to different samples, different cosmologies, different statistics.

[1] https://www.euclid-ec.org/

The student will be able to reliably include systematic effects, as modeled within the Euclid collaboration, and test the impact of different systematic modeling on the final parameters.

The PhD Candidate

The candidate would have a master in physics (cosmology and/or astrophysics). The candidate would have experience with the python programming language, in order to use and develop *Euclid* likelihood software. Furthermore, the candidate would show interest in working at the interface between data, software development, and theory. The PhD student will be able to concretely collaborate with a large collaboration, extending the likelihood software and joining the inter-science task force team led by the supervisor. At the same time, the student will be able to develop tools that can be used with other datasets, independently of the *Euclid* likelihood. The student will have the possibility to learn about different steps which are required to go from data to cosmological parameter inference: from the modification of the equations in a Boltzmann code, to the Likelihood development, to the comparison between data, simulations, and theory. Through the task force, the candidate will also 1) learn new statistical tools used to develop covariance matrices; 2) learn about current theoretical cosmologies.

The scientific environment

The thesis will take place within CosmoStat, within the Astrophysics Department (DAp) under the co-supervision of Valeria Pettorino, Martin Kilbinger and with the collaboration of Isaac Tutusaus (Toulouse). CEA, the CosmoStat group and Toulouse are key contributors to the Euclid mission.

The student will be able to take part in monthly group training sessions organized within CosmoStat on a variety of topics (from cosmology, to astrophysics to software development to communication). Mock interviews for postdoc applications are also organized every year.

References

[1] Euclid Collaboration, Euclid preparation: VII. Forecast validation for Euclid cosmological probes, arXiv:1910.09273 [astro-ph.CO] and A&A.

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Application process:

Candidates should send a cover letter, a CV, and a transcript of exams, with their marks, to valeria.pettorino@cea.fr and Martin.Kilbinger@cea.fr as soon as possible and within the deadline. Candidates should also arrange for 1-2 reference letters to be sent separately by e-mail to the same contacts. Interviews will then be arranged with a shortlist of candidates, after these documents have been received.
Deadline for applications: 1 February 2023
Start date: October 2023
Contract duration: 3 years