PhD in Physics and Nanoscience – XXXVIII cycle
Second year report
Antonio Farina

Tutors : Enzo Franco Branchini (UniGe)
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Research acvtivity

During my second PhD year, I advanced my research in Cosmology as part of the European Space Agency's Euclid mission. I continued to build on my previous work while actively branching out into new areas of study.

First of all, I concluded my work on the characterization of the anisotropic multipoles of the 3-point correlation function (3PCF) of Dark Matter halos.
In this work, I presented an original and efficient implementation of both a model for the multipole moments of the 3PCF and for their estimator. To assess the adequacy of this tools, I have predicted the anisotropic 3PCF for a set of Dark Matter halos at redshift z = 1 and compared the predictions with the 3PCF measurement obtained by applying our estimator to a suite of simulated catalogs. This research demonstrates that incorporating the anisotropic component of the 3PCF effectively resolves degeneracies between key cosmological parameters, such as the growth rate of cosmic structures (f) and the linear bias coefficient (b), allowing for unbiased estimates of these parameters from ongoing spectroscopic surveys, such as Euclid. Moreover, the study shows that a combined analysis conducted using both the full anisotropic 2PCF and 3PCF can also constrain the clustering *rms* amplitude (σ8), along with f and b. However, this result is largely dominated by the isotropic component of the 3PCF; adding anisotropic multipoles tighten parameter constraints modestly, by up to 5%. This limited gain likely reflects the use of a simplified cosmological model that only accounts for anisotropy caused by galaxies' dynamics through Redshift Space Distortions. The anisotropic multipoles of the 3PCF are expected to be more impactful when additional sources of anisotropy, such as the Alcock-Paczynski effect, are considered. Addressing this will be one of the focuses of my future work.

Finally, I have recently embarked on a new endeavor more closely focused on Euclid's systematic effects. To effectively extract cosmological information from spectroscopic surveys, it is crucial to accurately characterize their selection function. This is typically achieved through the use of a random catalog, i.e. a catalog of synthetic, unclustered objects reproducing the systematic variations in the galaxy mean number density. In the context of the Euclid spectroscopic survey, random catalogs will be generated using the so-called spectroscopic visibility mask (VMSP). This mask allows us to modulate the number density of galaxies correcting for effects like spectrophotometric zero-point calibration, Milky Way extinction and interlopers, among others. The VMSP relies on the highly pure and complete

measurements from a small area of the sky: the Euclid Deep Field Survey. My work consists of exploring alternative methods for generating random catalogs. This serves a dual purpose: validating results obtained with the official VMSP code and performing galaxy clustering measurements on early data, for which the Euclid Deep Field Survey will not be available.

Attended courses

I passed the courses I followed during the last academic year:

1. The double trouble of the missing matter in the Universe – PhD course by Prof. Enzo Branchini
2. Fisica delle strutture cosmiche – Master degree course by Prof. Marco Raveri

And I attended the following courses and PhD schools (exams to be done):

1. Metodi di machine learning per la Fisica – Master degree course by Prof. Andrea Coccaro, Prof. Francesco Armando di Bello, Prof. Riccardo Torre
2. 5th Azores PhD school on Observational Cosmology, 02-08 September 2024, Angra do Heròismo, Açores, Portugal

Publications

1. A. Farina, A. Veropalumbo, E. Branchini, M. Guidi, "*Modeling and measuring the anisotropic halo 3-point correlation function: a coordinated study",* submitted for publication to Journal of Cosmology and Astrophysics (arXiv:2408.03036)
2. Euclid Collaboration: Y. Mellier et al., *"Euclid. I. Overview of the mission",* submitted for publication to Astronomy and Astrophysics (arXiv: 2405.13491)

Conference presentations

1. Speaker at the Euclid Collaboration meeting, 17th-21th June 2024, Roma, Italy – **Random catalogs for early spectroscopic data**
2. Speaker at the "Understanding the Galaxy/Matter Connection in the Era of Large Surveys" meeting, 16th-17th September 2024, Sestri Levante (GE), Italy - **Characterizing the Euclid selection function: overview of the visibility mask procedure and alternatives for early spectroscopic data**
3. Speaker at the Euclid OU-LE3 meeting, 30th September - 4th October 2024, Heraklion- Chrete, Greece - **Random catalogs for early spectroscopic data**

Teaching activity

1. Tutor of General Physics for 1st year Management Engineering students
2. Tutor of General Physics for 1st year Biomedical Engineering students