Ilaria Risso - PhD third year report

AA: 2022/2023

Tutors: Enzo Branchini (Unige), Stefano Davini (INFN Genova) and Silvano Tosi (Unige & INFN Genova)

Research activity

During my third year of PhD, I kept on working on Cosmology within the Euclid Consortium, continuing and developing my previous activities. With respect to the previous years, I moved from activities predominantly related to experimental aspects to activities more focused on the transition from the data acquisition to the physical interpretation and derivation of cosmological parameters.

I focused on the impact of an incorrect redshift determination on the galaxy clustering measurements. Euclid is going to determine the redshift of more than 50 millions of galaxy through spectroscopic measurements: however, there can be mistakes in the redshift determination, both for physical and computational reasons. Since the redshift is directly related to the galaxy's distance from us, this means that the 3D mapping of the inhomogeneities in the Universe (which is one of the main probes of the Euclid mission) could be wrong, leading to an incorrect determination of the cosmological parameters related to the Euclid observables. The goal of my work is to assess the impact of the *interlopers* (i.e galaxies whose redshift was not correctly derived) on the galaxy clustering measurements and try to find a way to model and mitigate it. In practice, I study their effect on the amplitude and shape of the measured two-point correlation function (2PCF), which quantifies the excess probability of finding a pair of galaxies at a certain separation with respect to a random distribution without clustering. I perform simulations assuming different interlopers type and fractions. So far, I've based my work on simulated data: as soon as the real Euclid data will be available, I'll apply my analysis to the real data taken from the in-flight observations of the telescope.

My research activity on interlopers can be grouped in two steps. First of all, I evaluated the adequacy of the model for the measured 2PCF in presence of different types of redshift contaminants. The measured 2PCF (that is the one measured on the contaminated catalog) can be expressed as the sum of different contributions coming both from the target galaxies (i.e. those whose redshift was correctly measured), interlopers, and their cross correlations (if any). All contributions are weighted by specific prefactors, accounting for the redshift distribution of both target galaxies and either type of interlopers. I studied the shape of these prefactors and I proved that it is not correct in general to approximate them as constant terms, which would hugely simplify the analysis: their dependence on the the spatial scale can vary a lot, depending on the redshift distribution N(z) on target galaxies and interlopers.
Second of all, I defined a set of criteria to quantify the relevance of the various terms that contribute to the measured contaminated 2PCF. Some of them are expected to be small and, quite possibly, negligible. My goal is to assess the absolute and relative amplitude of all these terms and decide if some of them could be safely neglected, so that the 2PCF model can be simplified: indeed, the auto- and cross-correlation of objects characterized by very different redshift distributions are considerably challenging to describe. So far I based my analysis on the official Euclid reference catalog of galaxies, covering an area in the sky equivalent to the first couple of years of observations. There is some evidence that we are not allowed to safely neglect the correlation terms between different types of galaxies. However, considering the small expected fractions of interlopers, in order to provide more quantitative and reliable results we should repeat the analysis on many mock catalogs: this would allow to increase

the statistics and to reduce any sample variance artifact. This is an ongoing work, which I hope to include in the last part of my PhD thesis.

I lead this research group and, consequently, I am responsible for the Euclid scientific paper that will result from it.

Attended courses and exams

I attended and I passed the exam of:
- *Fisica delle strutture cosmiche*, by Prof. Marco Raveri (esame semestrale della magistrale seguito interamente —> equivalente di due corsi di dottorato).

Publications

1. Currently in preparation: “Euclid preparation: The need for photometric flats from dithered self-calibration images”
2. Currently in preparation: Key Paper on the impact of the interlopers on the galaxy clustering two-point statistics
3. F. Passalacqua et al, “Testing the spectroscopic reconstruction for the Euclid experiment”, IL NUOVO CIMENTO C (2023), DOI: 10.1393/ncc/i2023-23122-x.

Conference presentations

1. 6th Italian Euclid Collaboration Meeting, “Interlopers”, January 19-20, Roma, Italy
2. Euclid Galaxy Clustering Meeting, “Interlopers and how to tame them”, February 20-24, Milano, Italy
3. Euclid Consortium Meeting, “Modeling noise and line interlopers and their impact on clustering measurements”, June 19-23, Copenhagen, Denmark

Outreach activities

1. Organization of stages for high school students on cosmology
2. Representative of UniGe and INFN Genova at the Euclid launch on 1st July at Cape Canaveral
3. Contribution to the start of the outreach activities organized by the Italian Euclid Consortium team