mercoledì 25 agosto 2021

Luca Paganin PhD third year report

Tutors: my PhD tutors are INFN staff researcher Stefano Davini and professor Silvano Tosi.

Research activity

During the last year of my PhD I continued the Fisher forecast work in the context of the ESA Euclid mission. Euclid will probe the expansion history of our Universe by probing weak lensing and galaxy clustering, this last being subdivided into photometric and spectroscopic. So Euclid main probes are essentially three: weak lensing (WL), photometric galaxy clustering ($\mathrm{GC_{ph}}$) and spectroscopic galaxy clustering ($\mathrm{GC_{sp}}$). With respect to last year the project has been enlarged, including in the forecast all the possible cross-covariances and cross-correlations between these three probes, and not only the ones between $\mathrm{GC_{ph}}$-$\mathrm{GC_{sp}}$. At an intuitive level the cross-covariance can be defined as follows. Two cosmological probes are said to have a non-zero cross-covariance if the total cosmological information they carry is *less* than the sum of the pieces of information carried by the two singularly. On the other hand, if the two probes have a zero cross-covariance they are said to be independent, and the total information is *equal* to the sum of the partial ones. With cross-correlation between two probes it is instead meant a cosmological observable, which contains new information about cosmological parameters compared to the probes taken singularly. Understanding the effect of cross-covariances between Euclid cosmological probes is therefore of primary importance to correctly assess the sensitivity of the mission to cosmological parameters values. On the one hand not accounting for a present cross-covariance leads to an overestimate of the constraining power. On the other hand not taking into account a present cross-correlation means to not fully exploit all the cosmological information available in the data. Moreover, the data analysis is computationally expensive and must be planned before the Euclid data will be available. Forecasts help to do this planning, allowing to get insights of what is important to take into account in the future official analysis. In a previous Euclid forecast it had been shown that covariance and correlation between WL and $\mathrm{GC_{ph}}$ are important, but the combinations WL-$\mathrm{GC_{sp}}$ and $\mathrm{GC_{ph}}$-$\mathrm{GC_{sp}}$ were not considered since the spectroscopic clustering $\mathrm{GC_{sp}}$ was treated with a different formalism with respect to WL and $\mathrm{GC_{ph}}$. In my work I have extended this forecast by including also the above mentioned combinations involving $\mathrm{GC_{sp}}$, treating it with the same formalism of the other probes, and this allowed to naturally compute the missing cross-

covariances and cross-correlations. What I have found is that these covariances and correlations are almost negligible: this result in practice means that in the official Euclid analysis these effects could probably be neglected. This is important since it helps to establish the minimal amount of computational resources that will be needed in the true analysis. Nonetheless this is not the final word on this subject, since some extensions of this work will be done in the next future. These extensions consist of including other physical effects and refining some of the calculations involved in the forecast.

Publications

- S. Davini, I. Risso, M. Scodeggio, **L. Paganin** et al., "*A Proposal for Relative In-flight Flux Self-calibrations for Spectro-photometric Surveys*", published on "Publications of the Astronomical Society of the Pacific", DOI, https://iopscience.iop.org/article/10.1088/1538-3873/ac102e
- M. Bonici, C. Carbone, S. Davini, P. Vielzeuf, **L. Paganin** et al., "*Euclid: Forecasts from the void-lensing cross-correlation*", in preparation
- **L. Paganin**, M. Bonici et al., "*Euclid preparation. 6×2pt analysis for Euclid main probes*", in preparation

Academic Teaching

- I performed a task of 30 hours of academic teaching support for the course "Fisica Generale I" of the first year of Electrical and Chemical Engineering degree course.