Stage 2020

Title Deep Learning on the Sphere and Reconstruction of Dark Matter Mass Maps

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Subject:

The Euclid satellite, to be launched in 2022, will observe the sky in the optical and infrared, and will be able to map large scale structures and weak lensing distortions out to high redshifts. Weak gravitational lensing is thought to be one of the most promising tools of cosmology to constrain models. Weak lensing probes the evolution of dark-matter structures and can help distinguish between dark energy and models of modified gravity. Thanks to the shear measurements, we will be able to reconstruct a dark matter mass map of 15000 square degrees. Mass mapping entails the construction of two-dimensional maps using galaxy shape measurements, which represent the integrated total matter density along the line of sight. Small- field mass maps have been frequently used to study the structure and mass distribution of galaxy clusters, whereas wide-field maps have only more recently become possible given the broad observing strategies of surveys like CFHTLenS, HSC, DES, and KiDS. Mass maps contain significant non-Gaussian cosmological information and can be used to identify massive clusters as well as to cross-correlate the lensing signal with foreground structures.

A standard method to derive mass maps from weak-lensing observations is an inversion technique formulated by Kaiser & Squires [2]. It has many limitations, however, including the need to smooth the data before (and often after) inversion, thereby losing small-scale information. An alternative method called GLIMPSE has been developed in the CosmoStat laboratory based on sparse reconstruction that avoids this problem and improves the recovery of non-Gaussian features [3, 4]. The algorithm has been tested on simulations and was also recently used to study the A520 merging galaxy cluster with Hubble Space Telescope data [5]. More recently, machine learning has emerged as a promising technique for mass map recovery [6].

The goal of this project is to first compare this technique to the state of the art and extend the method for spherical data.

References

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