

Background

Estimating cosmological parameters, and making maps of dark matter with gravitational lensing rely on measuring from images the apparent distortion of the galaxies in the background. The shapes of the galaxies provide the lensing signal, and the photometric redshifts obtained from their observed colours are a proxy for how far they are. Short of a few recent deep-learning methods that claims to extract cosmological information from pixel-level data, the standard procedure is to obtain a galaxy shape catalog from images and then measuring a cosmological signal from the catalog. Previous experiments have seen that scientists with the skills to do the former are much fewer than required, so this project is to teach you those skills for Vera C. Rubin Observatory/LSST.

Project Goal

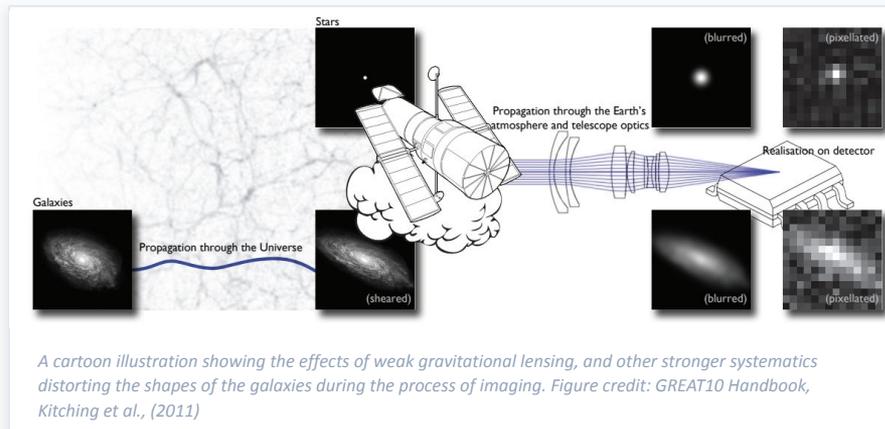
We will learn the basic characterization of galaxy shapes and colours, and understand the process of extracting these properties of galaxies (and stars) from processed images, paying attention to various ways they can be systematically affected. We will largely use the LSST Science Pipelines software to generate these catalogs from images available from the latest data release from Rubin Observatory and/or use images from the Hyper Suprime-Cam (HSC) survey.

Necessary Concepts

- Basics of linear algebra, Fourier transforms
- Basics of cosmology
- Python proficiency (matplotlib, numpy, scipy)

Computing Need

Analysis on simple simulations can be run on laptops, but looking into actual data from LSST or HSC may require access to computing clusters.



A cartoon illustration showing the effects of weak gravitational lensing, and other stronger systematics distorting the shapes of the galaxies during the process of imaging. Figure credit: GREAT10 Handbook, Kitching et al., (2011)

★ Background Resources

Weak Lensing for Precision Cosmology

R. Mandelbaum — <https://arxiv.org/abs/1710.03235>

Weak Lensing Shear Estimation methods and systematics

R. Mandelbaum (Dark Energy School) | [YouTube tutorial](#)

How bright is *that* object?

R. Lupton (Dark Energy School) | [YouTube tutorial](#)

The Hyper Suprime-Cam Software Pipeline

J. Bosch et al, - <https://arxiv.org/abs/1705.06766>



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