Weak lensing in the era of Rubin Observatory

Internship location: Virginia Cosmology Group, Galaxy Evolution and Cosmology Initiative, Astronomy Department, University of Virginia, Charlottesville, VA, USA
Internship supervisor: Prof. Satya Gontcho A Gontcho
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International collaborations: Rubin Observatory, Dark Energy Spectroscopic Instrument
Internship duration: minimum 4 months. [M.Sc. internships or Gap Year]
Funding: Yes.

Proposition de stage / Internship topic:

We are inviting applications for a research opportunity that centers on improving the precision and accuracy of the information extracted from weak gravitational lensing, where the subtle distortion of distant galaxy shapes by intervening dark matter encodes crucial cosmological information. The ultimate goal being to learn about the expansion history and the growth of structures in the universe.

This endeavor presents multiple challenges. On one end, extracting this information requires knowing precisely how far away these galaxies are, quantified by their redshift. Spectroscopic observations provide highly accurate redshifts by measuring detailed spectral features, but are observationally expensive and can only target a small fraction (1%) of detected galaxies. Photometric surveys can observe billions of galaxies by measuring their brightness through multiple color filters, but the resulting redshift estimates are significantly less precise and can contain systematic biases. These photometric redshift uncertainties directly propagate into errors in cosmological parameters like the matter density and dark energy properties, currently contributing 30-50% of the total systematic error budget in weak lensing analyses. On the other end, how gas, stars, and supermassive black holes interact within galaxies - alters the distribution of matter on the scales we measure with weak lensing, potentially biasing our cosmological inferences if not properly modeled. Our incomplete understanding of these astrophysical processes is becoming a limiting factor for extracting precise dark energy constraints from next-generation lensing surveys.

Factoring in your interests and background, we will tune the project emphasis towards analytical modeling, advanced statistical and machine learning methods, or hands-on analysis of real data from major surveys like Hyper Suprime Camera, Rubin Observatory, even leveraging complementary datasets such as that of the Dark Energy Spectroscopic Instrument. The project we will define will be an opportunity to work on a limiting systematic for next-generation cosmological surveys while developing valuable skills in scientific inference, optimization, and astronomical data analysis.

To Apply: send a concise introductory email highlighting your interests and relevant experience, along with a CV. Applications are considered on a rolling basis. For longer stays and gap-year, there is the possibility to visit collaborators at UC Berkeley / Lawrence Berkeley National Laboratory.