DEPARTMENT
OF PHYSICS AND ASTRONOMY
"AUGUSTO RIGHI"

Title of the Project:

Cosmology from galaxy cluster statistics in the KiDS survey

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Scientific Case:
The aim of this research project is to conduct the final cosmological analysis of galaxy cluster samples extracted from the fourth and fifth data releases (DR4/DR5) of the Kilo-Degree Survey (KiDS). Building on the successful analyses of DR3, this project seeks to undertake a comprehensive study of the key large-scale statistics of the full cluster surveys. This includes cluster counts, weak-lensing mass profiles, and 2-point and 3-point correlation functions. Both three-dimensional and angular statistics will be considered, along with a joint statistical analysis using the primary clustering and lensing statistics from the complete KiDS galaxy samples. The main scientific goal is to test the standard cosmological model, provide new constraints on its cosmological parameters, and explore potential extensions. A particular focus will be on the $S_8 = \sigma_8(\Omega_m/0.3)^{0.5}$ parameter, leveraging the final KiDS data releases to quantify possible tensions in the predicted cosmological evolution, recently highlighted by S_8 measurements. A significant portion of the research will also address the systematic uncertainties that may arise in these analyses. The candidate will work within the KiDS collaboration, gaining access to the latest cluster catalogue data and various numerical tools for statistical analysis.

Outline of the Project:
The candidate is expected to undertake the following tasks:
- Investigate and apply optimal selection algorithms to construct DR4 and DR5 KiDS cluster samples to maximize cosmological constraints while minimizing systematic uncertainties.
- Validate the full cosmological pipelines using mock cluster catalogues. This includes validating estimators for cluster counts, mass profiles, and clustering measurements, as well as validating likelihoods and statistical modules specifically for DR4 and DR5 KiDS cluster samples within both standard and potentially alternative cosmological frameworks. Additionally, the mocks should be used to estimate the covariance among different cluster and galaxy probes, which is essential for the full cosmological joint analysis.
- Perform cosmological analyses on real KiDS data sets and compare the results with those obtained from KiDS DR3 and other surveys.