Borsa di Ricerca – Piano Formativo

Title of the Project: Characterising Optically-Detected and X-ray-Selected Galaxy Groups & Clusters

Durata: 12 mesi

Supervisor: Lauro Moscardini

Piano Formativo:

Galaxy clusters identified through galaxy overdensities in the optical and near-infrared, and those detected via their hot intracluster gas emission in X-rays, often yield distinct populations, each shaped by its own selection biases, advantages, and limitations. A combined analysis of both detection methods over the same sky regions provides a powerful way to assess sample completeness and purity, to calibrate mass–observable scaling relations, and to explore correlations with redshift and large-scale environment.

The main goals of this project will be: (1) cross-match optically/NIR-detected groups and clusters with X-ray-selected systems in order to build a unified catalogue; (2) quantify selection effects, in particular completeness and purity as a function of richness, X-ray luminosity, and redshift; (3) calibrate mass proxies by comparing optical richness and stellar mass to X-ray luminosity, X-ray-derived mass, and, when available, gas temperature, and test for possible redshift evolution; (4) identify "discordant" systems, such as optically rich but X-ray faint structures, and vice versa, to investigate the roles of non-thermal pressure, feedback, projection effects, and dynamical youth.

The project will proceed in three main phases. First, existing optical/NIR and X-ray catalogues will be collected and pre-processed. Second, different cross-matching techniques will be compared to find or develop an appropriate cross-matching criterion, which is crucial and not trivial when comparing multi-wavelength data. The cross-matching will be done in three dimensions, with the possibility of using simulations to evaluate false-match/random-match probabilities. Third, scaling relations will be derived and analysed, and outlier systems will be investigated through a combination of individual inspection and stacking analyses. The outcome will be a value-added sample of cross-identified clusters and groups with well-characterised selection properties, providing an essential resource for future studies of cluster physics and cosmology.

As concerns the dataset to be used, the project will benefit from recent and upcoming deep multi-wavelength surveys with high-quality photometry, such as the COSMOS-Web field (Casey+2023) and the Euclid Deep Fields (EDFs; https://euclid.caltech.edu/page/euclid-deep-fields), especially the EDFF -- Fornax which boasts the availability of a dedicated XMM-project (and includes the Chandra Deep Field South), which will allow the extension of this multi-wavelength analysis to the group regime and to high redshifts.

Contact:
Lauro Moscardini (lauro.moscardini@unibo.it)