

Minigrant RSN1

Searching for clusters in the KiloDegree Survey

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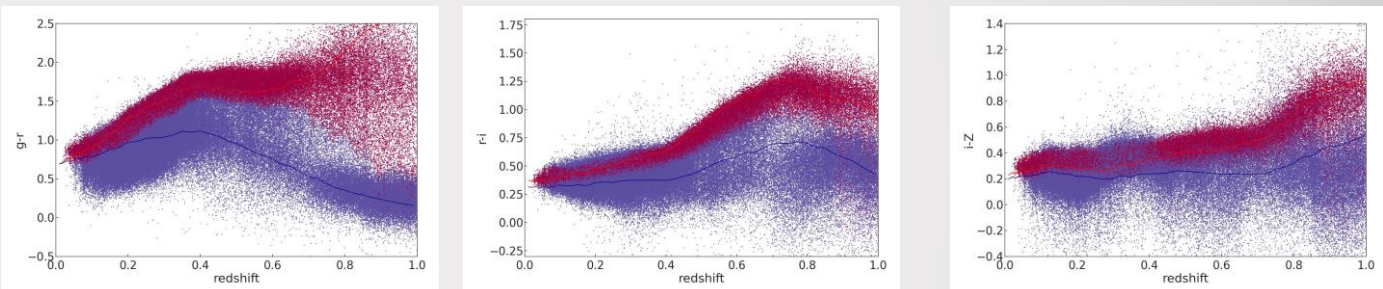
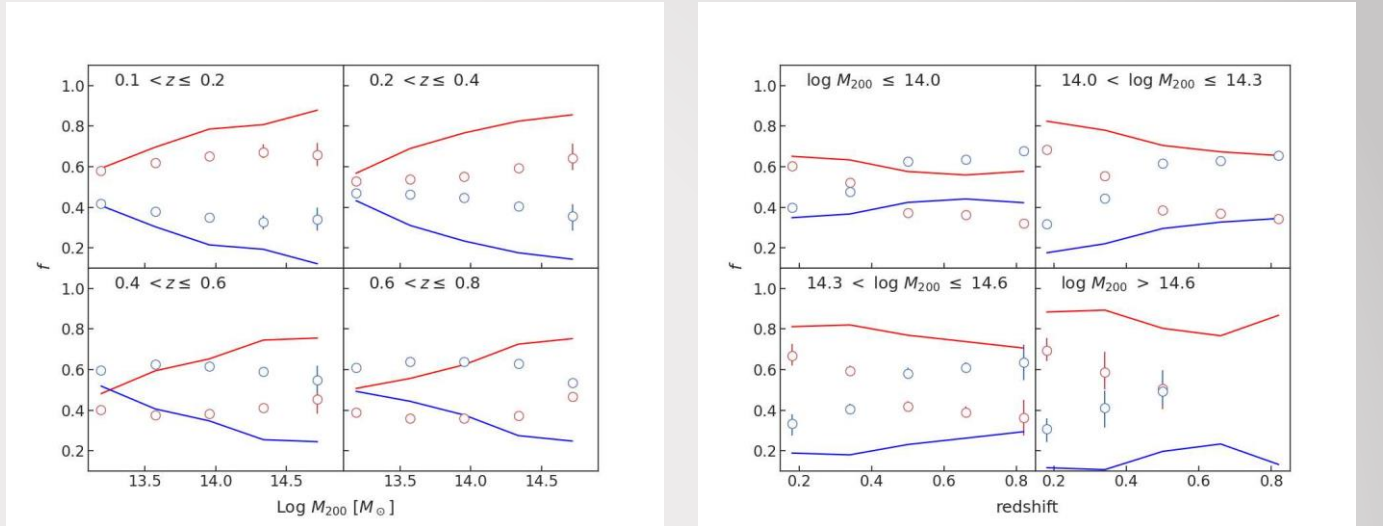
Status

- **Aims of the project:** KiDS is a public ESO survey imaging in ugri (OmegaCAM@VST) and ZJYHKs (VIRCAM@VISTA) an area of 1300 sq. degrees. Four Data Releases were published and DR5 (the Legacy Release) is internally available to the KiDS consortium (to be released soon). Within the KiDS collaboration, our group (INAF-Padova, INAF-Napoli, INAF-Bologna, Dept. of Physics University of Bologna and Univ. Heidelberg) leads the activities for the search of clusters of galaxies using the AMICO code, both for cosmology and astrophysical processes. This minigrant is mainly focused on the following activities for KiDS DR4 and DR5: optimization of the data for the processing by AMICO and extraction of the cluster catalog; analysis of the cluster properties (e.g. BCG selection, red/blue fraction of cluster members, luminosity function from $z=0$ to $z=1$).
- **Funds:** 10keuro were allocated to the minigrant and received on January 2023. 6 k euros were used to buy a server with the data storage (50 TB) and CPU needed to handle the data (images and catalogs) from KiDS. The server is now fully operative.
- **Status of the project** (January-November 2023). A catalog of $\sim 25k$ clusters at redshift $z \sim 0-1$ has been derived with AMICO for KiDS DR4. Compared to what already done in past works with KiDS-DR3, our goal is to improve the accuracy in the analysis, using state of the art techniques using Machine Learning photometric redshifts ([Li et al. 2023](#)), as well as complementary data available from other surveys. For instance, in Summer 2023 the DESI collaboration released an Early Data Release of spectroscopic redshifts, that partially overlaps with KiDS: this gives a small (~ 100) subsample of clusters detected in KiDS, with however a fraction of spectroscopic cluster members much larger than what available with other survey such as the SDSS. Work is in progress to exploit these data, as a preparation for the the spectroscopic surveys that DESI and other facilities will provide in the next future.
- **Criticalities:** there was some delay since the server was purchased soon after the availability of the funds, but it was received only in August and became fully operative in September 2023
- **To be done in 2024:** finalize results for KiDS DR4, extend the analysis to KiDS DR5

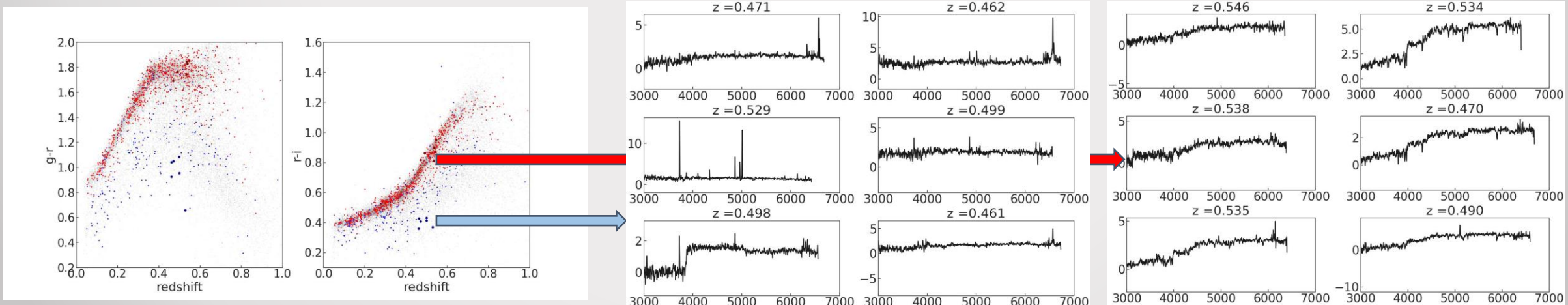
Some results

Fraction of red/blue cluster galaxies vs. redshift Establishing how star formation in clusters evolves with redshifts requires an accurate selection of the member galaxies. In KiDS DR3 (Radovich et al. 2020) it was found that the fraction of blue, star forming galaxies increases with increasing redshift/decreasing cluster mass (right plot, obtained with KiDS DR4), at odds with what expected from e.g. Illustris-TNG simulations (red/blue lines). Here red/blue galaxies were separated using colors from galaxy models: can we improve these results with a more accurate selection ?

For ~ 500k galaxies in KiDS, public spectroscopic redshifts are available from the DESI EDR and other surveys (e.g. SDSS, VVDS). This allows to train Gaussian Mixture Models (RedDragon library: Black et al. 2022, 2023) and have a model independent classification of blue/red galaxies: preliminary results for the training set, based on $grIZ$ colors are displayed in these plots (model colors are displayed by the lines). Work is in progress to optimize the results and apply this selection to the full sample of cluster members.



Searching for star-forming BCGs Based on this new red/blue member selection, we'll increase the sample of star forming BCGs (see Castignani et al. 2022, 2023). The plots below shows as an example the selection of BCGs with DESI spectra, displayed for 6 blue and red BCGs at $z \sim 0.5$



Luminosity functions of clusters The luminosity function (LF) in KiDS-DR3 clusters and the redshift evolution of its parameters was analyzed in [Puddu et al. 2021](#). In KiDS-DR4, an improved approach is being developed, based on the Markov Chain Monte Carlo (MCMC) algorithm, allowing a stacked analysis of the cluster LF in bins of redshift and cluster mass. The plots below shows an example of the MCMC fitting procedure, and preliminary results obtained for the redshift evolution of the LF slope in «rich» ($M_{200} > 10^{14} M_{\odot}$) clusters, compared with mock catalogs, and the input model used by AMICO for the cluster detection

