SF2A 2023
M. N'Diaye, A. Siebert, N. Lagarde, O. Venot, K. Baillié, M. Béthermin, E. Lagadec, J. Malzac, J. Richard (eds)

OBSERVATIONS OF THE XMM X-CLASS CLUSTERS OF GALAXIES WITH MISTRAL AT OHP

G. Soucail[1], N. Clerc[1], R. Cabanac[1], L. Paquereau[1,2], Q. Moysan[1], B. Altieri[3] and F. Sarron[1]

Abstract. We present the preliminary results of a spectroscopic follow-up of a sub-sample of low redshift clusters and groups of galaxies identified in the XMM Cluster Archive Super Survey (X-CLASS). These clusters were observed with MISTRAL at OHP over 16 nights allocated between October 2021 and January 2023. A semi-automatic data reduction pipeline was developed and all data are fully reduced. 130 redshifts of galaxies are measured and 46 new structures (clusters or groups) have a confirmed redshift ($0.1 < z < 0.4$). Further studies of the physical properties of low mass and low redshift structures will be addressed.

Keywords: catalogues, galaxies: clusters: general, cosmology: observations, X-rays: galaxies: clusters

1 Introduction

The XMM CLuster Archive Super Survey (X-CLASS) is a complete sample of clusters of galaxies detected serendipitously in the full XMM-Newton archive, using dedicated source detection algorithms (Clerc et al. 2012). This sample has already been used to test cosmological models through the mass function of large scale structures and and to put constraints on the σ_8 and Ω_m cosmological parameters. After reprocessing the archive with improved algorithms for detection (Faccioli et al. 2018), the present sample contains 1688 clusters observed within an area of 269 deg^2 (Koulouridis et al. 2021). But only 60% have a confirmed redshift and complementary spectroscopic identifications are on-going.

The new instrument MISTRAL mounted on the T193 telescope at OHP is well suited to our follow-up program, limiting ourselves to relatively bright objects ($V < 21.0$) to fit its performances (Adami et al. 2018). We have set-up a spectroscopic survey aimed at measuring cluster redshifts for Northern candidates extracted from the X-CLASS database ($z < 0.3$ and $\delta > -5°$). We present in this poster the first results of the survey.

2 Observations and data reduction

A total of 16 observing nights was allocated to the program, split into 5 runs from October 2021 to January 2023. Observing conditions were acceptable for 66% of the time (low extinction and seeing $< 4''$). Exposure time was limited to at most 30 minutes and duplicated if needed to get total integration times of 1 to 2 hours.

Several technical difficulties were encountered, in particular with the slit rotation. It was quasi impossible to rotate the bonette over the 2022 runs and even if it is now functional, the rotation is still manually applied on the instrument. This difficulty generated large overheads for the objects positioning. We are confident that significant improvements are possible to reduce these overheads and allow a more efficient use of telescope time.

A semi-automatic pipeline was developed to reduce the data in the Pyraf environment. Spectra are extracted manually for each object and then rebinned with a 2Å/pixel step, from 4000 to 8000Å typically. Final spectra were processed by adding individual ones when several observations were available.

In total, 130 new redshifts of galaxies are measured, mostly through the identification of absorption features because the galaxies are mainly early-type galaxies. The redshift accuracy is $\simeq 0.001$, limited by the resolution of the spectrograph and the low S/N spectra. The redshift histogram (Fig 1 – left) shows a distribution ranging from 0.05 to 0.4+ for the most distant clusters and a median value of 0.21. The limiting magnitudes for these galaxies is measured as $V = 21.0$ and $R = 20.0$. This gives robust values for the real performances of MISTRAL and are in close agreement with the expectations.

[1] IRAP, Université de Toulouse, UT3, CNRS, CNES, 14 Av. Edouard Belin, 31400 Toulouse, France
[2] IAP, CNRS, Sorbonne Université, 98 bis boulevard Arago, 75014 Paris, France
[3] ESAC/ESA, Villafranca del Castillo, 28692 Madrid, Spain

3 Galaxies identification and cluster/group redshift validation

A long work of galaxy identification was done because centering images provided by MISTRAL do not contain accurate information on the telescope coordinates and orientation. We used the DESI Legacy Imaging Surveys interface (`https://www.legacysurvey.org/`) to identify the observed galaxies (Fig 1 – right). We also retrieved photometric information when available (g and r photometry, photometric redshifts and SDSS redshifts). For Northern fields or fields that were not observed in DESI, we used PanSTARRS imaging, also available in the ESASky interface (`http://sky.esa.int/`) to get similar information.

The last step is to assess a redshift for each observed X-CLASS source, including a quality flag that depends on the number of measured redshifts in the structure, with or without the Brightest Cluster Galaxy. Redshifts of 48 X-CLASS sources were measured, more than 60% of the sources having a secure redshift coming from 3 or more redshifts. The results of our survey will be ingested in the X-CLASS database (`https://xmm-xclass.in2p3.fr/`).

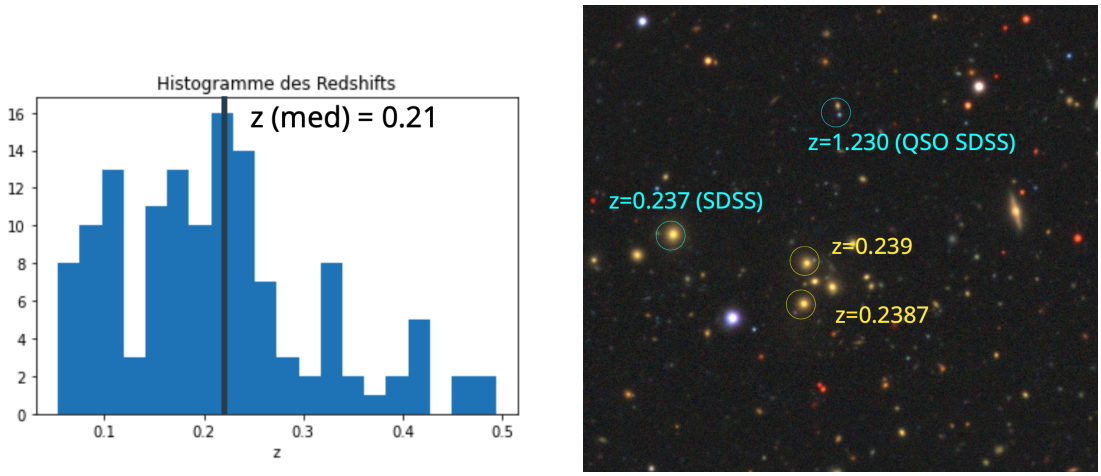

Fig. 1. Left: Redshift histogram of the measured redshifts. **Right:** Galaxy identification for the sources observed with MISTRAL (yellow) as well as existing data in the field (cyan) – X-CLASS 3135, $z = 0.239$.

4 Conclusions and future work

We have performed a successful survey of faint galaxies with the T193 at OHP equipped with MISTRAL. Pushing the instrument to its limits we were able to validate galaxy redshifts up to $z \simeq 0.4$ and $V \simeq 21.0$. The redshift confirmation of about 50 clusters and groups at low redshift will be completed by photometric information for the remaining clusters that could not be observed. This is also the case for more distant clusters for which spectroscopic identification is still pending. With the arrival of new large spectroscopic surveys like DESI we expect to reach a completeness fraction of 80 to 90% for the redshift identification. This allows us to measure accurately some physical parameters such as the X-ray luminosity, the R500 physical radius and also the X-ray temperature that can be properly extracted from the XMM image.

References

Adami, C., Basa, S., Brunel, J. C., et al. 2018, in SF2A-2018: Proceedings of the Annual meeting of the French Society of Astronomy and Astrophysics, ed. P. Di Matteo, F. Billebaud, F. Herpin, N. Lagarde, J. B. Marquette, A. Robin, & O. Venot

Clerc, N., Sadibekova, T., Pierre, M., et al. 2012, MNRAS, 423, 3561

Faccioli, L., Pacaud, F., Sauvageot, J. L., et al. 2018, A&A, 620, A9

Koulouridis, E., Clerc, N., Sadibekova, T., et al. 2021, A&A, 652, A12