Researchers investigate the brightest cluster galaxy in MACS 1931.8-2635

February 3 2021, by Tomasz Nowakowski

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Using Very Large Telescope (VLT) and Atacama Large Millimeter/submillimeter Array (ALMA), researchers from the University of Vienna, Austria, and elsewhere have investigated the

brightest cluster galaxy (BCG) in a massive galaxy cluster known as MACS 1931.8-2635. Results of the study, published January 28 on arXiv.org, deliver important information about the nature of this BCG.

Galaxy clusters consist of up to thousands of galaxies bound together by gravity. They are the largest gravitationally bound structures, and could therefore be crucial in improving the knowledge about large-scale structure formation and evolution of the universe.

BCGs are generally the brightest galaxies in clusters of galaxies. Observations show that they are mostly massive elliptical galaxies lying close to the geometric and kinematical center of their host galaxy cluster.

At a redshift of approximately 0.35, MACS 1931.8-2635 (M1931 for short) is a massive, X-ray luminous, cool-core galaxy cluster. Its BCG has a stellar mass of about 590 billion solar masses and its star formation rate (SFR) is estimated to be relatively high—some studies point out to a level of some 250 solar masses per year.

Previous studies have found that M1931 BCG harbors one of the most X-ray luminous cool cores yet discovered, with an equivalent mass cooling rate of about 165 solar masses per year. It has also one of the largest known reservoirs of cold gas in a cluster core, with a mass of around 19 billion solar masses, as well as large amounts of dust, with several dust clumps having temperatures less than 10 K.

All in all, M1931 BCG is an example of a cluster with a rapidly cooling core and powerful active galactic nucleus (AGN) feedback and is probably transitioning between two dominant modes of fueling for star formation and feedback. In order to get more insights into the nature and evolution of this BCG, a team of astronomers led by Bianca-Iulia Ciocan of the University of Vienna conducted multiwavelength observations of this galaxy using VLT's Multi Unit Spectroscopic Explorer (MUSE) and

ALMA.

"Based on VLT-MUSE optical integral field spectroscopy, we investigated the BCG of the massive cool-core CLASH cluster MACS 1931.8-2635 at a redshift of z=0.35, concerning its spatially resolved star formation activity, ionisation sources, chemical abundances, gas and stellar kinematics. The optical MUSE IFS data is supplemented by sub-mm ALMA observations, allowing us to link the properties of the warm ionised gas to those of the cold molecular gas component," the researchers wrote in the paper.

The study identified ionizing sources in different regions of M1931 BCG, finding that the ionized and molecular gas components are co-spatial and co-moving. The diffuse gas confined into the galaxy's tail is likely falling inward, providing additional fuel for star formation and AGN feedback, which is in accordance with models of chaotic cold accretion. The main source of ionization in the galaxy appears to be a mix between star formation and other energetic processes.

The star formation rate for M1931 BCG was calculated to be about 97 solar masses per year, with highest values in the galaxy's core. About 80% of the cluster's stellar mass is estimated to have formed more than 6 billion years ago. The intracluster medium (ICM) metallicity of M1931 was found to be consistent with the gas-phase metallicity measured in the BCG's interstellar medium (ISM). This finding suggests that the warm gas observed in the ISM of the galaxy has condensed from the ICM.

"The galaxy is a dispersion-dominated system, typical for massive, elliptical galaxies. The gas and stellar kinematics are decoupled, with the gaseous velocity fields being more closely related to the bulk motions of the intracluster medium," the authors of the paper concluded.

More information: The VLT-MUSE and ALMA view of the MACS 1931.8-2635 brightest cluster galaxy, arXiv:2101.10718 [astro-ph.GA] arxiv.org/abs/2101.10718