The VLT-MUSE and ALMA view of the MACS 1931.8-2635 brightest cluster galaxy

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We reveal the importance of ongoing in situ star formation in the brightest cluster galaxy (BCG) in the massive cool-core CLASH cluster MACS 1931.8-2635 at a redshift of z = 0.35. Using a multi-wavelength approach, we assessed the stellar and warm ionised medium components, which were spatially resolved by the VLT-MUSE spectroscopy, and linked them to the molecular gas by incorporating sub-mm ALMA observations. We measured the fluxes of strong emission lines, which allowed us to determine the physical conditions of the warm ionised gas. Our analysis reveals the ionising sources in different regions of the galaxy. The ionised gas flux brightness peak corresponds to the location of the supermassive black hole in the BCG and the system shows a diffuse warm ionised gas tail extending 30 kpc in the north-east direction. The ionised and molecular gas are co-spatial and co-moving, with the gaseous component in the tail likely falling inward, providing fuel for star formation and accretion-powered nuclear activity. The gas is ionised by a mix of star formation and other energetic processes which give rise to LINER-like emission, with active galactic nuclei emission dominant only in the BCG core. We measured a star formation rate of ~97 $M_\odot$/yr, with its peak at the BCG core. However, star formation accounts for only 50–60% of the energetics needed to ionise the warm gas. The stellar mass growth of the BCG at $z < 0.5$ is dominated either by in situ star formation generated by thermally unstable intracluster medium cooling or by dry mergers, with these mechanisms accounting for the build-up of 20% of the stellar mass of the system. Our measurements reveal that the most central regions of the BCG contain the lowest gas-phase oxygen abundance, whereas the Hα arm exhibits slightly more elevated values, suggesting the transport of gas out to large distances from the centre as a

result of active galactic nuclei outbursts. The galaxy is a dispersion-dominated system that is 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.