First Look at Spatially Resolved H2 and AGN Feedback in BCGs with JWST/MRS

C.Riesco, P.Salomé, P.Guillard

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Brightest Cluster Galaxies (BCGs) inhabit the deepest gravitational potential wells in the Universe and host extreme interstellar and circumgalactic environments, making them unique laboratories for studying the interaction between the interstellar medium (ISM) and active galactic nucleus (AGN) feedback. Approximately 15-20% of these systems are classified as cool-core clusters. These are characterized by short cooling times that would suggest enormous star formation rates (SFR); however, such high SFRs are not observed. This implies that an external source, likely the AGN, is responsible for preventing this runaway cooling. In addition to this, cool-core BCGs present extended, multiphase filamentary structures whose molecular component remains poorly understood. These filaments appear largely unique to these systems and are morphologically correlated with radio jets and outflows. Consequently, cool-core BCGs offer a new window into the ways AGN interact with and regulate their host galaxies via winds and radio jets.

Mid-infrared observations with Spitzer revealed exceptionally strong rotational H2 emission in several nearby BCGs—far exceeding that observed in normal star-forming galaxies, but lacked the spatial resolution needed to investigate its origin. JWST now enables these molecular filaments to be directly resolved.

In this talk, I present the first JWST/MIRI Medium Resolution Spectroscopy (MRS) IFU observations of warm molecular hydrogen and Polycyclic Aromatic Hydrocarbons (PAHs) in a sample of cool-core BCGs characterized by radio jets and outflows. These data provide unprecedented spatially resolved maps of H2 emission, allowing the distribution, excitation, and kinematics of the warm molecular gas to be explored for the first time. Combined with PAH analysis, these observations allow us to distinguish between the different ionization mechanisms responsible for the emission in various regions of the BCGs. This work opens a new window onto AGN feedback in extreme environments and reveals filamentary molecular structures that were previously inaccessible to observation.nd provides new insights into the mechanics of AGN feedback in extreme environments.