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The AGN fueling/feedback cycle in LERGs: a multi-phase study of a sample of local early-type radio galaxies

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Galaxy formation theories struggle to explain the role of Black Hole accretion in shaping galaxies over cosmic time. Radio feedback, associated to radio jets, is accepted as a fundamental component of the lifecycle of the most massive radio loud early-type galaxies (Radio Loud ETGs, i.e. Radio Galaxies, RGs), at least in the late stages of cosmic evolution ($z < 1$). The many details of such process, however, still remain poorly understood. It is generally accepted that High Excitation Radio Galaxies (HERGs) are triggered by cold gas transported to the center through merging or collisions with gas-rich galaxies, while accretion in Low Excitation Radio Galaxies (LERGs) may occur directly from the hot phase of the IGM. The most compelling evidence that cold gas can play a role in fueling LERGs as well, is that in such systems dust and molecular gas are detected in larger quantities than in radio-quiet ETGs. The origin of this gas (external or secular) remains still unclear. Systematic high-resolution CO imaging of radio galaxies (in which radio jets are currently active) together with kinematic information on the stellar and ionized gas components, is fundamental to isolate the role played by radio-mode feedback in the overall formation and evolution of ETGs, allowing also to do a crucial comparison with existing studies of radio-quiet ETGs (e.g. ATLAS3D sample). For this purpose, we have selected a complete volume-limited sample of eleven nearby ($z < 0.03$) RGs associated with elliptical galaxies, selected from the Ekers et al. (1989) parent sample of 90 radio galaxies in the Southern sky. All the selected galaxies have low-power ($P_{1.4GHz} \leq 1025$ W Hz-1), low accretion rate, and FRI type or (arcsec-scale) compact radio morphology. For all the sources, we have already acquired a set of multi-wavelength data, spanning from the radio to the mm regime. Here we present the results obtained so far by analyzing ALMA Cycle 3 CO(2-1) observations of 9 targets, with resolutions of few hundreds of parsecs at the source redshifts. The CO(2-1) line emission was detected in 6 out of 9 targets (detection significance from 8 to 45 sigma; 66% detection rate). CO(2-1) maps show rotating disc structures in all the sources, with some peculiar cases in which the gas disk shows a disturbed morphology that seems to suggest an interaction with the radio jets. The detected CO discs are mostly located in the inner kpc-sub-kpc scales of the host galaxy. Available optical images were used to investigate the relative distribution of gas and dust: they result mostly co-spatial, with dust extending on larger scales in some cases. The study of the CO kinematics is still ongoing, but preliminary results show hints of the presence of of non-circular motions (i.e. inflow/outflow) in at least one of the detected CO discs.

Affiliation

INAF-IRA/University of Bologna

Author: RUFFA , Ilaria (INAF - IRA, Univ. Bologna)

Co-author: PRANDONI, Isabella (Istituto Nazionale di Astrofisica (INAF))

Presenter: RUFFA , Ilaria (INAF - IRA, Univ. Bologna)

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