Warm molecular gas and mechanically coupled feedback in low-power radio ellipticals

Shaunak Mishra, Pierre Guillard, Philippe Salomé, Mathieu Langer

Institut d'Astrophysique de Paris, Sorbonne Université, CNRS, 98 bis boulevard Arago, 75014 Paris, France

Observatoire de Paris, PSL University, 61 avenue de l'Observatoire, 75014 Paris, France

shaunak.mishra@obspm.fr

Context. Low-power radio AGNs in early-type galaxies provide an important laboratory for testing how mechanical feedback couples to the interstellar medium outside the regime of classical powerful radio galaxies. The dusty ellipticals identified by Kaneda et al. (2008), which show bright rotational H_2 emission and little evidence for recent star formation, are particularly well suited to this question.

Aims. We investigated whether the warm molecular gas observed in two representative Kaneda galaxies, NGC 708 and NGC 4589, can be powered by turbulence alone or instead requires additional AGN-related heating channels, and whether their low star-formation activity remains robust once AGN contamination is accounted for.

Methods. We combined NOEMA CO(2–1) cubes with IRAM 30m/APEX spectra to derive cold-gas masses and CO kinematics. Using the Spitzer H_2 rotational-line measurements from Kaneda et al. (2008), we estimated warm-H_2 luminosities and cooling rates. We compared the warm-H_2 cooling budget with turbulent dissipation inferred from the CO line widths, estimated the available AGN mechanical power from LOFAR DR3 144 MHz data, assessed the plausibility of cosmic-ray heating, and used X-CIGALE to refine the star-formation rates and AGN contribution.

Results. We found that the warm-H_2 cooling times are short, implying the need for continuous heating. The turbulence inferred from the observed CO kinematics does not robustly account for the full warm-H_2 budget, while cosmic-ray heating requires extreme ionization rates. By contrast, the AGN mechanical power inferred from the radio data could supply the observed warm-H_2 luminosity at only a few per cent coupling, favouring a picture of mechanically coupled feedback through shocks and unresolved dissipation. Preliminary X-CIGALE constraints on the SFR and AGN contribution will also be presented.

Conclusions. These systems suggest that even low-power AGNs can couple efficiently to the ISM and maintain luminous warm molecular gas without requiring strong ongoing star formation. They therefore provide a useful bridge between local low-power feedback and the broader question of how AGN-driven winds regulate galaxy evolution.