FEEDING, FEEDBACK AND THE GROWTH OF GALAXIES – MOLECULES AS TOOLS FOR PROBING GALAXY EVOLUTION

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Cold gas plays a central role in feeding and regulating star formation and growth of supermassive black holes (SMBH) in galaxy nuclei. Particularly powerful activity occurs when interactions of gas-rich galaxies funnel large amounts of gas and dust into nuclei of luminous and ultra luminous infrared galaxies (LIRGs/ULIRGs). These dusty objects are of key importance to galaxy mass assembly over cosmic time. Some (U)LIRGS have deeply embedded galaxy nuclei that harbour a very active evolutionary stage of AGNs and/or starbursts. The nuclear activity will often drive mechanical feedback in the form of molecular winds, jets and outflows. This feedback can for example remove baryons from low-mass galaxies, prevent overgrowth of galaxies, be linked to the M_{BH}-σ relation, and explain "red-and dead" properties of local ellipticals.

With the ALMA and NOEMA telescopes we can use molecules as diagnostic tools to probe the properties of dust-enshrouded galaxy nuclei and their associated cold winds and outflows. Their morphology, velocity structure, physical conditions and even chemistry can be studied at unprecedented sensitivity and resolution, opening new avenues to further our understanding of the growth of galaxies.

I will give a brief review of the ALMA/NOEMA view of AGN and starburst radiative and mechanical feedback, and how it is linked to the properties of the nuclear power source. I will discuss the use of molecules (e.g. H_2O, H_3O^+, HCN, HCO^+, H_2S) for studying dusty nuclei and the nature of the embedded activity. We can, for example, investigate ionization rates and the impact of cosmic ray-, X-ray- and PDR-chemistry and the onset of outflows and winds. Interestingly, in some deeply obscured nuclei the chemistry shows strong similarities to that of Galactic hot cores. Finally I will show peculiar molecular jets and very recent ALMA observations at resolutions of tens of milli-arcseconds (few pc) of vibrationally excited HCN in opaque nuclei. These regions offer both challenges and opportunities for IR and submm studies of the nature of the buried activity – which we suggest is a deeply dust-enshrouded SMBH in a high-accretion state, or an extreme, high-temperature, burst of star formation.