

The EMPIRE Survey : Dense Gas and Star Formation across Nearby Galaxy Disks

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While stars are formed in the cold, dense parts of molecular clouds, extragalactic studies have mainly focused on ¹²CO emission to study star formation in galaxies. To make a significant step forward, with the EMPIRE survey, an IRAM 30m large program (~500h; [1,2]), we have obtained sensitive observations of dense gas tracers such as HCN, HCO⁺, HNC, ¹³CO, C¹⁸O, across the entire disks of 9 nearby spiral galaxies. The key goals of the survey are to characterize the emission properties of the dense gas, the ISM physical conditions that they trace (densities, opacities, etc.), and how those relate to the star-formation activity and environment within galaxies.

I will present the first results from the survey. 1/ We find that, contrary to galaxy-integrated studies, dense gas fractions (HCN/CO) and star formation efficiencies (HCN/IR) vary within galaxies. Dense gas is abundant but particularly inefficient at forming stars in the galaxy centers, which are high-pressure environments ([2]). 2/ Analysis of the isotopologues of CO and the dense gas provide important new constraints on the optical depths, filling factors, and evidence for abundance variations in our sample of galaxies ([3,4,5], figure). In particular, we find that, ¹³CO does not appear to be a better predictor of the bulk molecular gas mass than ¹²CO because it does not measure diffuse molecular gas that seems to be important (though less so in the galaxy centers).

References

- [1] Bigiel et al., ApJ, 822, 26 (2016)
- [2] Jiménez-Donaire et al. in prep
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- [4] Jiménez-Donaire et al., MNRAS, 466, 49 (2017)
- [5] Cormier et al., MNRAS in press (2018)

