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Gayathri Gururajan - Probing the gas reservoirs of high-redshift lensed dusty

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The discovery of dust-enshrouded star-forming galaxies in the early Universe has opened new questions in understanding the formation and evolution of galaxies through cosmic times. With the breakthrough in sub millimeter astronomy spearheaded by facilities like Atacama large millimeter/sub-millimeter array, a large diversity in the population of dusty star-forming galaxies (DSFG) has been revealed with some of them hosting prodigious star-formation rates (~500 Msun/yr). Such galaxies play a vital role in understanding the rapid formation and stellar mass assembly of massive galaxies in the early Universe. Characterising the gas reservoir and the interstellar medium (ISM) of these galaxies can give us key insights into their star-forming mechanisms. We present a sample of 29-lensed DSFGs at 1.8<z<4.5, targeted for [CI] observations to estimate the gas content of these DSFGs and present a comparison and cross-calibration between 4 tracers of molecular gas content : CO, [CI], [CII] emission lines and the dust content of a galaxy. The main goal of this work is to check the consistency between the gas mass tracers and cross-calibrate them, but do not provide the absolute values of these tracers which would require us to implicitly assume the value for one of them. We then target 3 such DSFGs with ALMA high-resolution (~0.4") to obtain insights on the resolved gas reservoirs and ISM of the sample. We probe the ISM properties such as density and radiation field intensity using [CI] to mid- or high-J CO lines and [CI] to infrared luminosity ratio. In the case of the large sample, we find that our sample has ISM parameters in comparison to the literature SMG populations. We also find the median excitation temperature of [CI] in the ISM is higher than that of the literature SMGs. We find a good agreement between the various molecular gas mass tracers and provide cross-calibrations for these tracers. With the higher resolution sample, we find a large heterogeneity in the radiation field and density of the ISM in our sample, although their global values are similar to the other SMGs. We model the lensing configuration for our sample and find no strong evidence of differential magnification for our sample. We compute the dynamical mass of these galaxies and find that a ULIRG-like value of the CO-to-H2 conversion factor is more agreeable with the estimated dynamical masses.

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