Gas and Star Formation from HD and Dust Emission in a z~5.7 Strongly Lensed Starburst Galaxy

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The molecular gas content of high-redshift galaxies is a highly sought-after property. However, H_2 is not directly observable in most environments, so its mass is probed through other emission lines (e.g. CO, [CI], [CII]), or through a gas-to-dust ratio. Each of these methods depends on several assumptions and are best used in parallel. In this work, we extend an additional molecular gas tracer to high-redshift studies by observing hydrogen deuteride (HD) emission in the strongly lensed z = 5.656 galaxy SPT0346−52 with ALMA. While no HD(1–0) emission is detected, we are able to place an upper limit on the gas mass of $M_{H2}<6.4\times10^{11}$ M_{solar}. This is used to find a limit on the L_{CO} conversion factor of $\alpha_{CO} < 5.8$ M_{solar} (K km s^{-1} $pc^2)^{-1}$. In addition, we construct the most complete spectral energy distribution of this source to date and fit it with a single-temperature modified blackbody using the nested sampling code MULTINEST, yielding a best-fitting dust mass $M_{dust} = 10^{8.92 \pm 0.02}M_{solar}$, dust temperature 78.6 ± 0.5 K, dust emissivity spectral index β = 1.81 ± 0.03, and star formation rate SFR = 3800 ± 100 M yr^{-1}. Using the continuum flux densities to estimate the total gas mass of the source, we find $M_{H2} < 2.4\times10^{11}$ M_{solar}, assuming subsolar metallicity. This implies a CO conversion factor of $\alpha_{CO} < 2.2$, which is between the standard values for MW-like galaxies and starbursts. These properties confirm that SPT0346−52 is a heavily starbursting, gas-rich galaxy.

References

[1] Jones G. C., Maiolino R., Caselli P., Carniani S., MNRAS 498, 4109 (2020)