Spatially Resolved Water Emission from Gravitationally Lensed Dusty Star-forming Galaxies at $z \sim 3$ - DTU Orbit (29/10/2019)

Spatially Resolved Water Emission from Gravitationally Lensed Dusty Star-forming Galaxies at $z \sim 3$

Water ($H_2O$), one of the most ubiquitous molecules in the universe, has bright millimeter-wave emission lines that are easily observed at high redshift with the current generation of instruments. The low-excitation transition of $H_2O$, ($\nu_{\text{rest}} = 987.927$ GHz), is known to trace the far-infrared (FIR) radiation field independent of the presence of active galactic nuclei (AGNs) over many orders of magnitude in FIR luminosity ($L_{\text{FIR}}$). This indicates that this transition arises mainly due to star formation. In this paper, we present spatially ($\sim0.5$ corresponding to $\sim1$ kiloparsec) and spectrally resolved ($\sim100$ km $s^{-1}$) observations of in a sample of four strong gravitationally lensed high-redshift galaxies with the Atacama Large Millimeter/submillimeter Array. In addition to increasing the sample of luminous ($>10^{12} L_\odot$) galaxies observed with $H_2O$, this paper examines the relation on resolved scales for the first time at high redshift. We find that is correlated with on both global and resolved kiloparsec scales within the galaxy in starbursts and AGN with average . We find that the scatter in the observed relation does not obviously correlate with the effective temperature of the dust spectral energy distribution or the molecular gas surface density. This is a first step in developing as a resolved star formation rate calibrator.

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