First Results from the Herschel and ALMA Spectroscopic Surveys of the SMC: The Relationship between [C II]-bright Gas and CO-bright Gas at Low Metallicity

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The Small Magellanic Cloud (SMC) provides the only laboratory to study the structure of molecular gas at high resolution and low metallicity. We present results from the Herschel Spectroscopic Survey of the SMC (HS3), which mapped the key far-IR cooling lines [C ii], [O i], [N ii], and [O iii] in five star-forming regions, and new ALMA 7 m array maps of and with coverage overlapping four of the five HS3 regions. We detect [C ii] and [O i] throughout all of the regions mapped. The data allow us to compare the structure of the molecular clouds and surrounding photodissociation regions

using , , [C ii], and [O i] emission at (pc) scales. We estimate using far-IR thermal continuum emission from dust and find that the CO/[C ii] ratios reach the Milky Way value at high in the centers of the clouds and fall to the Milky Way value in the outskirts, indicating the presence of translucent molecular gas not traced by bright emission. We estimate the amount of molecular gas traced by bright [C ii] emission at low and bright emission at high . We find that most of the molecular gas is at low and traced by bright [C ii] emission, but that faint emission appears to extend to where we estimate that the -to-H i transition occurs. By converting our gas estimates to a CO-to- conversion factor (X CO), we show that X CO is primarily a function of , consistent with simulations and models of low-metallicity molecular clouds.