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Overview

Gas in galactic disks, including our own, exists in a wide range of temperatures and densities, most of which are unsuitable for star formation. Nonetheless, diffuse atomic clouds are collected into colder, denser molecular clouds that can collapse under their own gravity. Molecular condensation is not directly observable, and the gas itself is often "dark" to standard probes like optically thin H i 21 cm emission or the CO 2.6 mm line. However, the presence of dark gas can be inferred from infrared dust emission in excess of what is expected for the observed H i and CO content. We have mapped apparent H i column densities in the Inner-Galaxy Arecibo H i survey, which covers a 1600 square degree area of the Galactic plane. We compare these "Naive" H i columns to others derived from Planck first-release CO and dust maps and NE2001 model dispersion measures to identify a number of areas with potentially significant dark gas. We discuss whether optically thick H i or CO-free HI is more likely to dominate the dark column, and we consider the effects of possible biases on our results.

Results, Caveats, and Future Work

- If standard conversion factors are used with the NE2001 HI, I-GALFA optically thin H i, and Planck CO and dust data, up to 50% of the total column in some regions near the Galactic plane is implied to be dark gas.

- The Strasser & Taylor (2004) correction is only applicable to reduce the dust-gas discrepancy near the plane significantly, so much of the dark column is probably optically thick H i but the implied dark H i and CO components vary considerably with position. Although dark H i appears spatially smoother than the dark HI, it is scaled off the relatively smooth integrated H i emission, and the actual dark H i may be more structured. The NE2001 model has little small-scale structure but is consistent with only a negligible dark H i column.

- The total column vs. position implied by the dust varies significantly between the Planck data releases 1.1 and 1.2 (March and December 2013), so individual dark gas features shown here should be treated with caution and revaluated for future data releases. However, both available versions show more dark gas at lower Galactic longitudes, consistent with prior, lower-resolution results further from the plane (Fig. 4).

- Many positions show "excess" gas, implying the dust column is underestimated. The Planck dust columns are fitted to the dust thermal emission spectral energy distribution (SED) assuming a single temperature population, but if other temperatures are present, the SED fit can underemphasize the dust optical depth, e.g., with a small warm grain component (Fig. 5), or with cold grains shielded deep within HI clouds (Wangle et al. 2014).

- We are experimenting with least-squares fits of the column difference between gas and dust tracers to see if the standard column conversion parameter values are the best choice (e.g., see Liszt 2014). But these may further underestimate the dark component, since it is not constrained unless conversion values are assumed.

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