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The CO-H2 conversion factor of diffuse ISM: Bright 12CO emission also traces diffuse gas

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Summarizing 20 years of efforts, we will quantify the CO luminosity and CO-H2 conversion factor applicable to diffuse but partially molecular ISM when H2 and CO are present but C+ is the dominant form of gas-phase carbon. To do this, we will discuss galactic lines of sight observed in HI, HCO+ and CO where CO emission is present but the intervening clouds are diffuse (locally Av ~ 1 mag) with relatively small CO column densities N(CO) ~ 2.10^16 cm-2. We will separate the atomic and molecular fractions statistically using Ebv as a gauge of the total gas column density and compare N(H2) to the observed CO brightness.

Although there are H2-bearing regions where CO emission is too faint to be detected, we will show that the mean ratio of integrated CO brightness to N(H2) for diffuse ISM does not differ from the usual value of 1 K.km/s of integrated CO brightness per 2.10^20 H2.cm-2. Moreover, the luminosity of diffuse CO viewed perpendicular to the galactic plane is 2/3 that seen at the Solar galactic radius in surveys of CO emission near the galactic plane.

Commonality of the CO-H2 conversion factors in diffuse and dark clouds
can be understood from considerations of radiative transfer and CO
chemistry. There is unavoidable confusion between CO emission from diffuse and dark gas and misattribution of CO emission from diffuse to dark or giant molecular clouds. The character of the ISM is different from what has been believed if CO and H2 that have been attributed to molecular clouds on the verge of star formation are actually in more tenuous, gravitationally-unbound diffuse gas.

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