Variations in the X-Factor within Molecular Clouds

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**Introduction**

Observations of galactic molecular clouds have suggested a linear relationship between the molecular column density $N_{\text{H}_2}$ and CO intensity $W_{\text{CO}}$. The ratio of $N_{\text{H}_2} / W_{\text{CO}}$, known as the X factor, is thus assumed to be constant. Hydrodynamic simulations, including a treatment of molecule formation, by Glover et al. 2009 have found that $\text{H}_2$ is more effective than CO for self-shielding to prevent UV photodissociation. In order to investigate how the observationally derived X factors varies with molecular cloud properties, we apply radiative transfer calculations to these hydrodynamic simulations.

**Results**

Figure 1 shows the $\text{H}_2$ and CO column densities, along with the observed velocity integrated intensities, from a model molecular cloud with solar metallicity. The synthetic CO observation of the cloud was performed with the radiative transfer code RADMC (Dullemond et al. In prep.), using the Sobolev Large Velocity Gradient method to solve for the CO the level populations. As discussed by Glover et al. 2009 and Glover & Mac Low 2010, though there is generally good correlation between the CO and $\text{H}_2$ column densities, the low density regions show larger CO voids, or underdensities (e.g. region A). Additionally, due to projection effects, long continuous filaments in the observed CO map are segmented, shorter filaments in the $\text{H}_2$ or CO column densities (region B). Similarly, observed structures in the highest density regions do not clearly correspond to structures found in the $\text{H}_2$ or CO column densities (region C).

In high density regions, the X factor is found to vary by about only 1 order of magnitude, with values similar to those found from observations of Galactic GMCs, as shown in Fig. 2. Most of the X factor variations occur near the low density regions. However, in a simulation with low metallicity, the X factor varies by over 4 orders of magnitude (Figure 3). These variations occur throughout the cloud, suggesting that employing a constant X factor to analyze CO observations may lead to inaccurate cloud masses estimates.

**Primary References**

Glover, Federrath, Mac Low, & Klessen, 2010, MNRAS Accepted, arXiv 0907.4081