

# 30 Years of Photodissociation Regions:

A symposium to honor David Hollenbach's lifetime in science  
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## HI-to-H<sub>2</sub> Transitions in the Perseus Molecular Cloud

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Conversion of hydrogen gas from atomic (HI) to molecular (H<sub>2</sub>) form is of critical importance for the evolution of the interstellar medium (ISM) and for star-formation in galaxies.

Recently, Lee et al. (2012) used the HI data provided by the Galactic Arecibo L-band Feed Array HI Survey, together with far-infrared data from the IRAS Survey and the V-band extinction image provided by the COMPLETE Survey, to derive HI and H<sub>2</sub> surface densities for several hundred sight-lines towards five dark and (low-mass) star-forming regions within the Perseus molecular cloud. These are B1, B1E, B5, IC348, and NGC1333. We use the Sternberg et al. (2014, hereafter S14) theory for interstellar atomic to molecular conversion to analyze and fit the HI-to-H<sub>2</sub> transitions in Perseus.

Our basic results (Bialy et al. 2015 in prep.) are shown in Figure 1 below. The points are the Lee et al. data, and the red curves are our model fits. The observations indicate complete HI-to-H<sub>2</sub> transitions. The measured HI mass surface densities of 5.8 to 8.2 M<sub>⊙</sub> pc<sup>-2</sup> in combination with S14 theory imply that the transitions are dominated by "HI-dust" shielding in outer atomic envelopes.

The implied ratios  $I_{UV}/n$  of the FUV intensity to hydrogen volume density range from 0.13 to 0.08 cm<sup>3</sup> in the Perseus clouds. For an FUV radiation field strength  $I_{UV} \approx 0.8$  in Perseus, the effective gas densities in the atomic envelopes range from 6.2 to 10.5 cm<sup>-3</sup>. The inferred densities are a bit lower than expected for pure CNM. For dust-photoelectric heating by the ambient radiation (Wolfire et al. 2003) the HI gas densities are consistent with a multiphase WNM/CNM mixture in which the WNM contributes significantly to the shielding of the H<sub>2</sub> cores.

Our analysis has important implications for the interpretation of global HI-to-H<sub>2</sub> in galaxies and star-formation thresholds in the Kennicutt-Schmidt relation.

## REFERENCES

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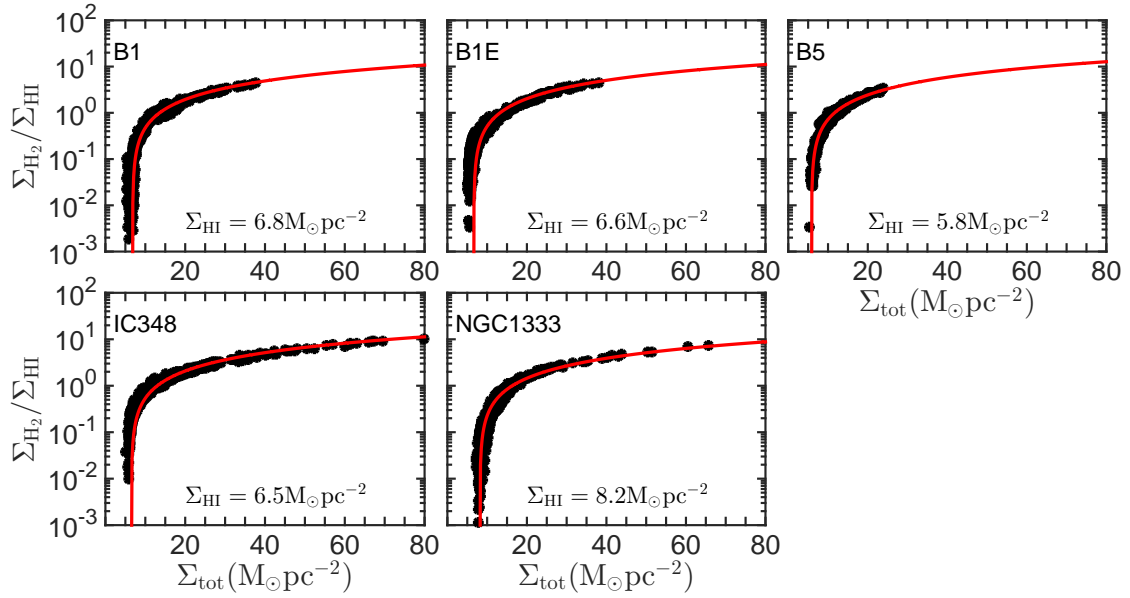


Figure 1: : The molecular to atomic mass surface density ratio  $\Sigma_{\text{H}_2}/\Sigma_{\text{HI}}$ , as a function of the total mass surface density  $\Sigma_{\text{tot}} \equiv \Sigma_{\text{HI}} + \Sigma_{\text{H}_2}$ , for B1, B1E, B5, IC348 and NGC1333. The points are the Lee et al. data, and the red curves are our “best-fits” to the data. The best-fitting values of  $\Sigma_{\text{HI}}$  are also indicated.