THE RELATIONSHIP OF MOLECULAR HYDROGEN, ATOMIC HYDROGEN, AND SELECTED DIFFUSE INTERSTELLAR BANDS[a]

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We have conducted an exhaustive astronomical observing campaign aimed at developing a high-quality, uniform set of spectra of the diffuse interstellar bands (DIBs), with the goal of refining physical and chemical constraints that may ultimately help in the identification of the specific carriers of the DIBs. In the present study we have analyzed the correlations between molecular and atomic hydrogen and five selected DIBs, which include the strongest DIB (at 4428Å); three prominent DIBs that have been included in many previous surveys ($\lambda\lambda$5780, 5797, and 6284); and one DIB (4963Å) that represents a new class identified by our survey as being closely associated with diatomic carbon (Thorburn *et al.* 2003, ApJ, 584, 339; see also the Thorburn *et al.* paper in this symposium, presented by T. Oka). We find that the 5780 and 6284Å DIBs correlate very strongly with atomic hydrogen but extremely weakly with molecular hydrogen, suggesting that the carriers of these two DIBs do not co-exist with H_2. The correlations between the DIBs at 4428, 5797, and 4963Å and atomic and molecular hydrogen are more complex, but also suggest that there is no strong connection with molecular hydrogen. We discuss an empirical picture in which most of the DIB carriers form in low-density atomic gas while H_2 and possibly the "C_2 DIBs" arise in denser regions. One possible chemical interpretation is that the carriers of the traditional DIBs may be primary ions, which would be efficiently converted to protonated ions by hydrogen abstraction reactions in the presence of H_2, whereas the carriers of the "C_2 DIBs" do not react with H_2.

[a]Based on observations from the APO 3.5-meter telescope, owned and operated by the Astrophysical Research Consortium.