Molecular fraction limits in damped Lyman-α absorption systems – supplement

In this supplement we show the reduced data of Curran et al. 2004, MNRAS 352, 563 together with the derived $\text{H}_2$ molecular fraction limits for various $N_{\text{CO}}/N_{\text{H}_2}$ conversion ratios.

THE SPECTRA

For the BIMA array observations (Figs. 1 to 3), the upper panel shows the passband at the full 0.78 MHz spectral resolution. The grey region shows the r.m.s of each 100 MHz correlator section (the regions without spectral information correspond to useless section edges and are a feature of the correlator). The lower panel shows the same data divided by the r.m.s. of each section, with the central window hanning-smoothed to 1.56 MHz resolution. The frequencies corresponding to the redshift of the candidate molecular (Curran et al. 2002, A&A 394, 763) and the HI absorption are indicated.

![Graph showing CO (0−1) emission](image)

Figure 1: The reduced BIMA array observations of CO $0 \rightarrow 1$ at $z_{\text{abs}} = 0.3939$ towards 0248+430.

For the GBT observations (Figs. 4 to 7) we show the data taken with the digital spectral processor at the full spectral resolution of 39 kHz (the 1402+044 data are from February 2003 observations using the wide band spectrometer of 6.1 kHz resolution). Note that the flux densities are determined from these observations for 0201+113, 0405−331, 0537−286, 1402+044 and 1418−0064 only, with the remainder being obtained either from VLA observations or the literature.
Figure 2: The reduced BIMA array observations of CO $2 \rightarrow 3$ at $z_{\text{abs}} = 2.0398$ towards 0458–020.

Figure 3: The reduced BIMA array observations of CO $0 \rightarrow 1$ at $z_{\text{abs}} = 0.2212$ towards 0738+313.
Figure 4: The reduced GBT observations of HCO$^+$ $0 \rightarrow 1$ towards 0201+113 ($z_{\text{abs}} = 3.38639$), 0201+365 ($z_{\text{abs}} = 2.4614$), 0335–122 ($z_{\text{abs}} = 3.178$), 0336–017 ($z_{\text{abs}} = 3.0619$), 0405–331 ($z_{\text{abs}} = 2.570$) and 0528–250 ($z_{\text{abs}} = 2.8110$).
Figure 5: The reduced GBT observations of HCO$^+$ $0 \rightarrow 1$ towards 0537–286 ($z_{\text{abs}} = 2.974$), 0913+003 ($z_{\text{abs}} = 2.774$), 1021–006 ($z_{\text{abs}} = 2.398$), 1251–407 ($z_{\text{abs}} = 3.752$), 1354–107 ($z_{\text{abs}} = 2.501$), 1354–107 ($z_{\text{abs}} = 2.996$) and 1402+044 ($z_{\text{abs}} = 2.713$).
Figure 6: The reduced GBT observations of $\text{HCO}^+\ 0 \rightarrow 1$ towards 1418-064 ($z_{\text{abs}} = 3.449$) and 1614+051 ($z_{\text{abs}} = 2.52$), over the 5 pass-bands.
Figure 7: The reduced GBT observations of HCO$^+$ $0 \rightarrow 1$ towards 2131–045 ($z_{\text{abs}} = 3.27$, over the 3 pass-bands, and) 2342+342 ($z_{\text{abs}} = 2.908$).
MOLECULAR FRACTION LIMITS

Figure 8: H$_2$ molecular fractions measured in redshifted absorbers. In this and Figs. 9 to 12 the unfilled squares represent the upper limits derived from the millimetre CO searches, the unfilled circles the limits derived from optical CO ($N_{\text{H}_2} = 10^4 N_{\text{CO}}$ and $T_x = 10$ K at $z_{\text{abs}} = 0$), the inverted triangles the HCO$^+$ limits ($N_{\text{H}_2} \approx 10^{9.34} N_{\text{HCO}^+}$ and $T_x = 10$ K at $z_{\text{abs}} = 0$), the filled circles the H$_2$-bearing DLAs and the stars 4 known millimetre absorption systems ($N_{\text{H}_2} = 10^4 N_{\text{CO}}$ and $T_x = 10$ K, $\forall z_{\text{abs}}$).
Figure 9: Molecular fractions measured in redshifted absorbers for $N_{\text{H}_2} = 10^{4.75} N_{\text{CO}}$ and $T_x = 10$ K at $z_{\text{abs}} = 0$, i.e. as in Fig. 4 of the paper but showing the optical CO limits.
Figure 10: Molecular fractions measured in redshifted absorbers for $N_{\text{H}_2} = 10^{5.25} N_{\text{CO}}$ and $T_x = 10 \text{ K}$ at $z_{\text{abs}} = 0$. 
Figure 11: Molecular fractions measured in redshifted absorbers for $N_{\mathrm{H}_2} = 10^6 N_{\mathrm{CO}}$ and $T_x = 10 \text{ K}$ at $z_{\text{abs}} = 0$. 
Figure 12: Molecular fractions measured in redshifted absorbers for $N_{\text{H}_2} = 10^6 N_{\text{CO}}$ and $T_x = 2.73$ K at $z_{\text{abs}} = 0$. 