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Deuterium Fractionation and Ionization Degree in Massive Protostellar/cluster Cores

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Abstract. We have conducted a survey of deuterium fractionation of N_2H^+, $R_D(N_2H^+) \equiv N(N_2D^+)/N(N_2H^+)$, with the Arizona Radio Observatory (ARO) Submillimeter Telescope (SMT) to assess the use of $R_D(N_2H^+)$ as an evolutionary tracer among massive protostellar/cluster cores in early stages. Our sample includes 32 dense cores in various evolutionary stages, from high-mass starless cores (HMSCs), high-mass protostellar objects (HMPOs), to ultra-compact (UC) HII regions, in infrared dark clouds (IRDCs) and high infrared extinction clouds. The results show a decreasing trend in deuterium fractionation with evolutionary stage traced by gas temperature and line width (Fig. 1). A moderate increasing trend of deuterium fractionation with the CO depletion factor is also found among cores in IRDCs and HMSCs. These suggest a general chemical behavior of deuterated species in low- and high-mass protostellar candidates. Upper limits to the ionization degree are also estimated to be in the range of $4 \times 10^{-8} - 5 \times 10^{-6}$.

Keywords. ISM: molecules — stars: formation

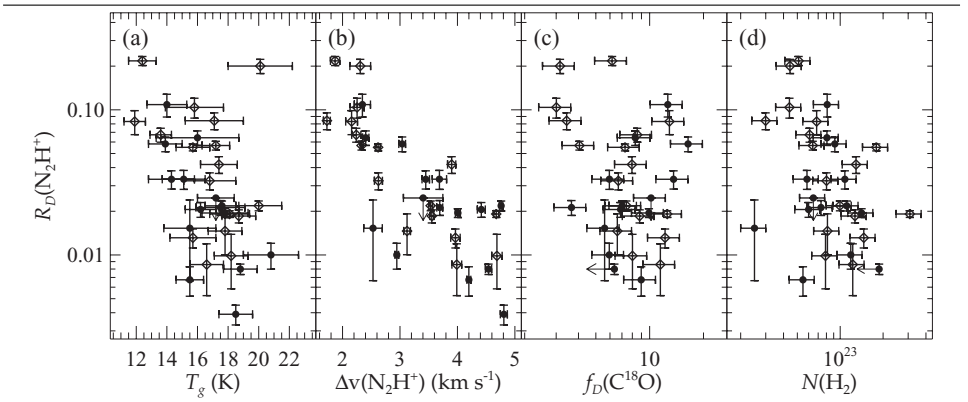

Figure 1. (a) Deuterium fractionation of N_2H^+, $R_D(N_2H^+)$, vs. gas temperature, T_g, shows a decreasing trend. Cores that have been reported in Chen *et al.* (2011) are marked by filled circles. Recent measurements for cores in high infrared extinction clouds (Rygl *et al.* 2010) are marked by open diamonds. (b) $R_D(N_2H^+)$ vs. line width, $\Delta v(N_2H^+)$, also shows a decreasing trend. (c) $R_D(N_2H^+)$ vs. the CO depletion factor, $f_D(C^{18}O)$, shows a moderate increasing trend, particularly among cores in IRDCs and HMSCs (filled circles). (d) $R_D(N_2H^+)$ vs. beam averaged column density, $N(H_2)$, derived from the 1.2 mm dust continuum emission.

References

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