Water D/H Ratio In Low-Mass Protostars

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What?

- HDO/H_2O ratio used to infer the amount of processing between different evolutionary stages [e.g. 14].
- Measurement in protostars so far inconsistent [9-14].
- We measured the warm HDO/H_2O ratio in several Class 0 low-mass protostars using high resolution and sensitivity interferometric observations on scales comparable to our solar system [15-18].

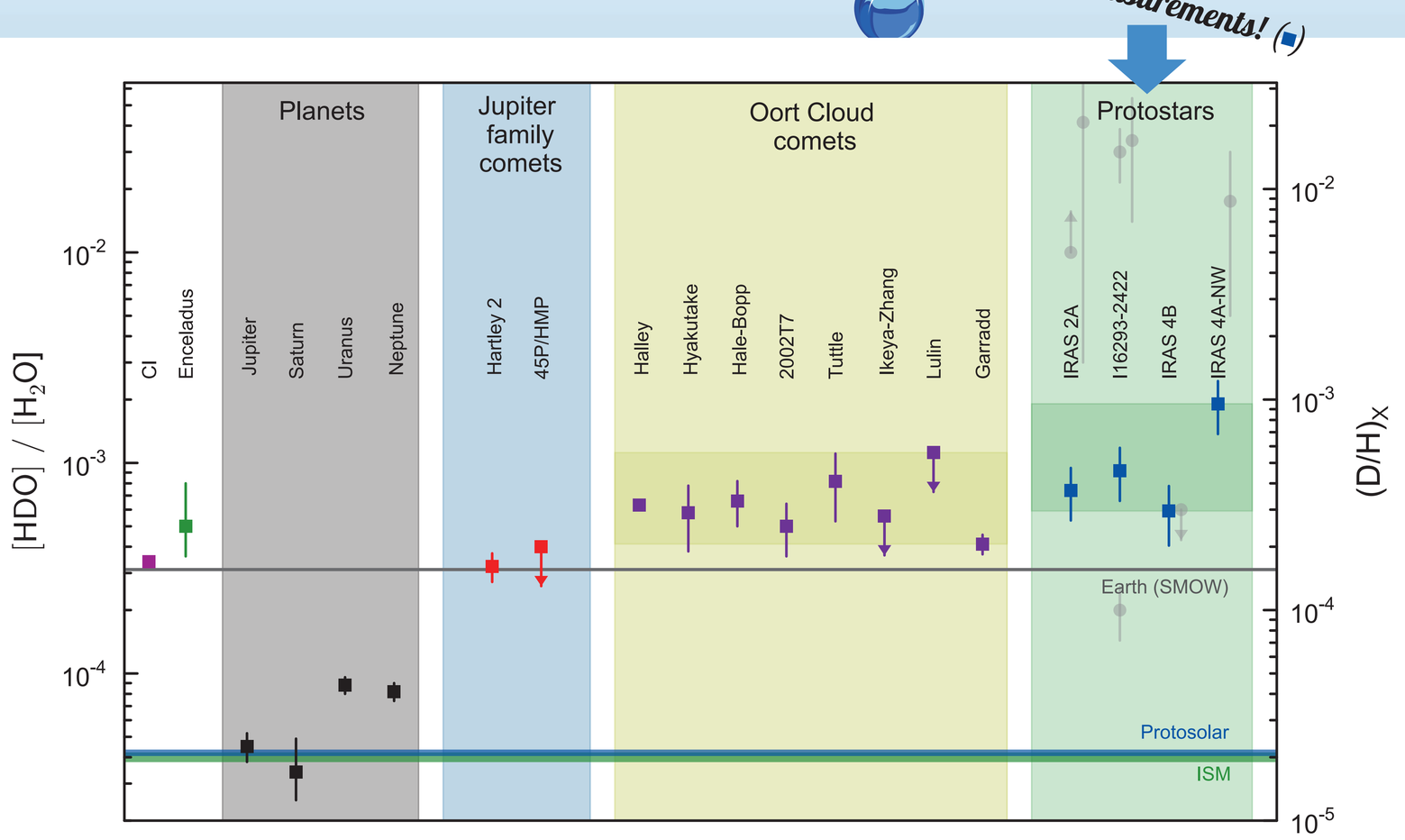
Conclusions

- Comparable values of warm HDO/H_2O ratios for all observed sources.
- Confirms low HDO/H_2O ratios compared with other determinations.
- Similar HDO/H_2O ratios as some solar system comets.

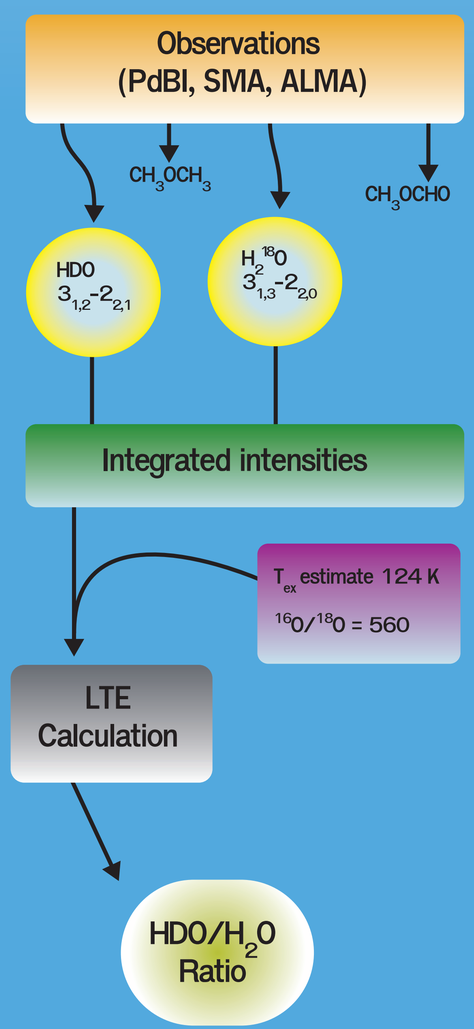
Comparison

This plot shows our measurements of the water deuterium fractionation in the warm gas of the sources in this study [15-16,18] and IRAS 16293-2422 [17]. The previous estimates are shown as grey circles [9-14]. The main issue with previous observations is the low resolution, sensitive to the extended emission and that certain transitions of water can be optically thick at different radii in the protostar [19].

Values for the water deuterium fractionation measured in other objects are also included [1-8] such as solar system comets, planets [e.g. 2], moons and meteoritic inclusions [8]. The values measured for these protostars are similar to that of the Oort Cloud Comets in our Solar System, indicating little processing of water before incorporation into ices of smaller bodies in the early protoplanetary evolution.



How?

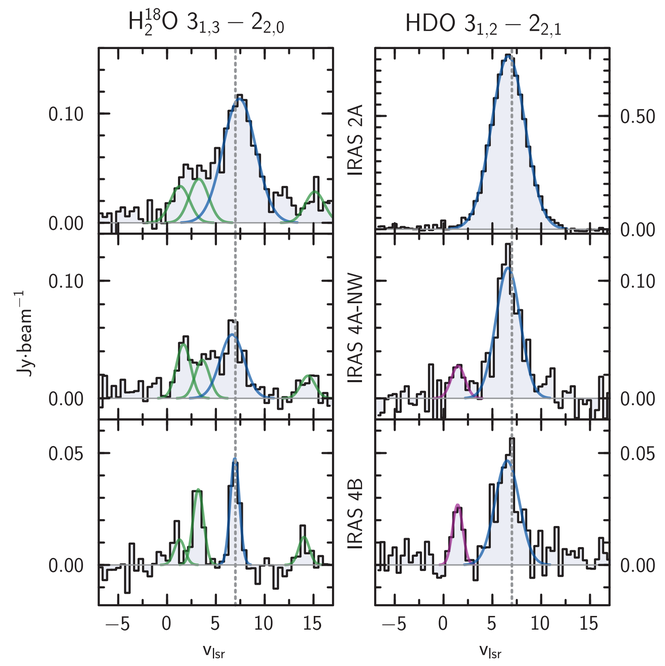


Sources

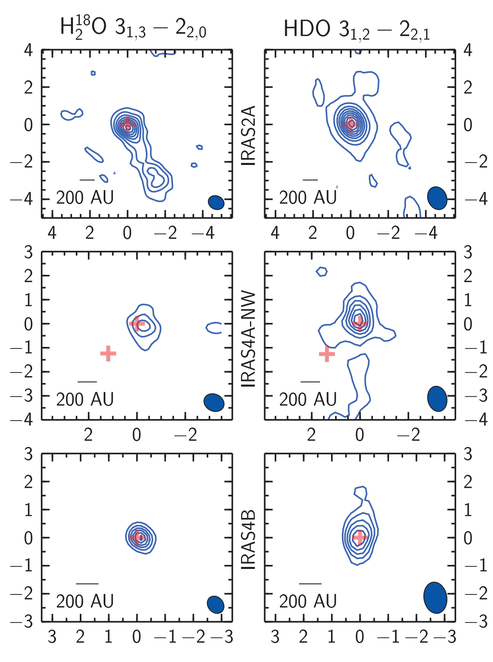
For this study the sources IRAS 2A, IRAS 4A and IRAS 4B in the NGC 1333 cloud in Perseus were observed with the Plateau de Bure Interferometer [15-16,18]. In [17] IRAS 16293-2422 in Rho Ophiuchus was observed with both the SubMillimeter Array (SMA) and the Atacama Large sub/Millimeter Array (ALMA). All of the sources are Class 0 objects, with large envelopes and collimated bipolar outflows.

Data

The figure to the right shows the spectra and the integrated intensity maps for the two water lines for the NGC 1333 sources. Water is detected toward all sources, except one of the binary components in IRAS 4A. In the maps it is clear that high-resolution observations are needed due to the extended emission that is present.



Spectra binned to four times the resolution, i.e. about 0.5 km/s. Molecules : CH_3OCH_3, Water, CH_3OCHO



Contours start at 4σ, steps 3σ for HDO (33σ for IRAS2A) and 4σ for $H_2{}^{18}O$. RA and Dec offset in arcseconds.

References

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