Interferometric measurements of *warm* HDO/H_2O

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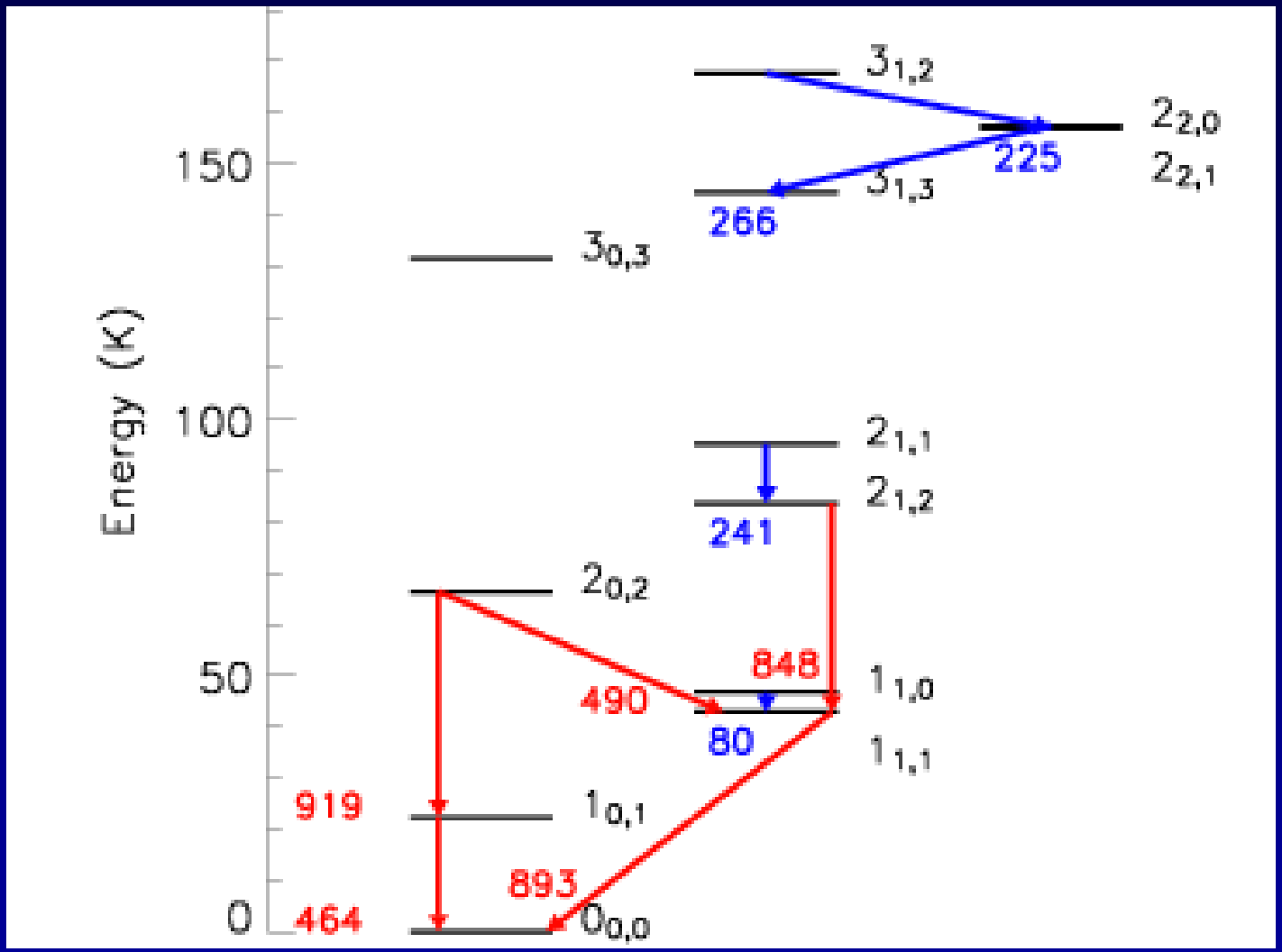
Observations

- $H_2{}^{18}O$ 3_{13}-2_{20} 203 GHz line E_u=204 K
  - PdBI: N1333 I4A, I4B, I2A
  - SMA: IRAS 16293-2422
- $H_2{}^{18}O$ 5_{32}-4_41 692 GHz line E_u=727 K
  - ALMA: IRAS 16293-2422
- HDO 3_{12}-2_{21} 225 GHz line E_u=168 K
  - PdBI: N1333 I2A, I4A, I4B: 225 GHz; I2A: 241 GHz
  - SMA: N1333 I4A, I4B, I2A, IRAS16293-2422

HDO level diagram

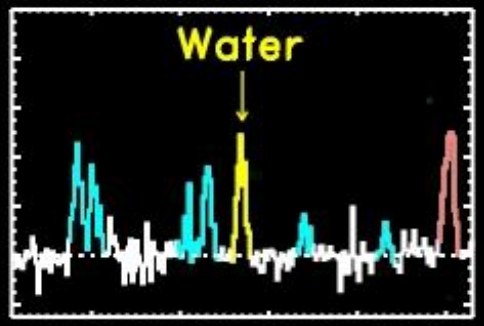


Analysis

- **Simple calculation of number of molecules in beam**
  - **Assumes lines are optically thin**
  - **Assumes LTE at single excitation temperature**
    - **Results not sensitive to T_{ex} in range 70-300 K**
  - **Einstein A coefficients much smaller than at 1 THz => less optically thick**
  - **Dust continuum not optically thick**

Advantage: model independent HDO/H_2O ratio

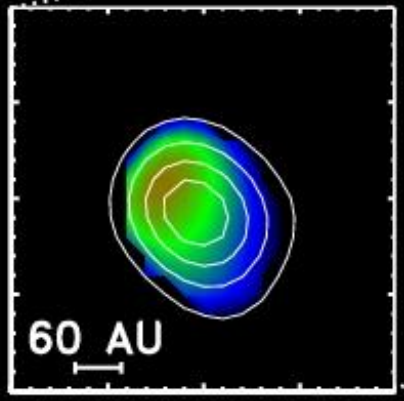
Hot water in a disk in the deeply embedded phase



NGC 1333 IRAS4B
Plateau de Bure

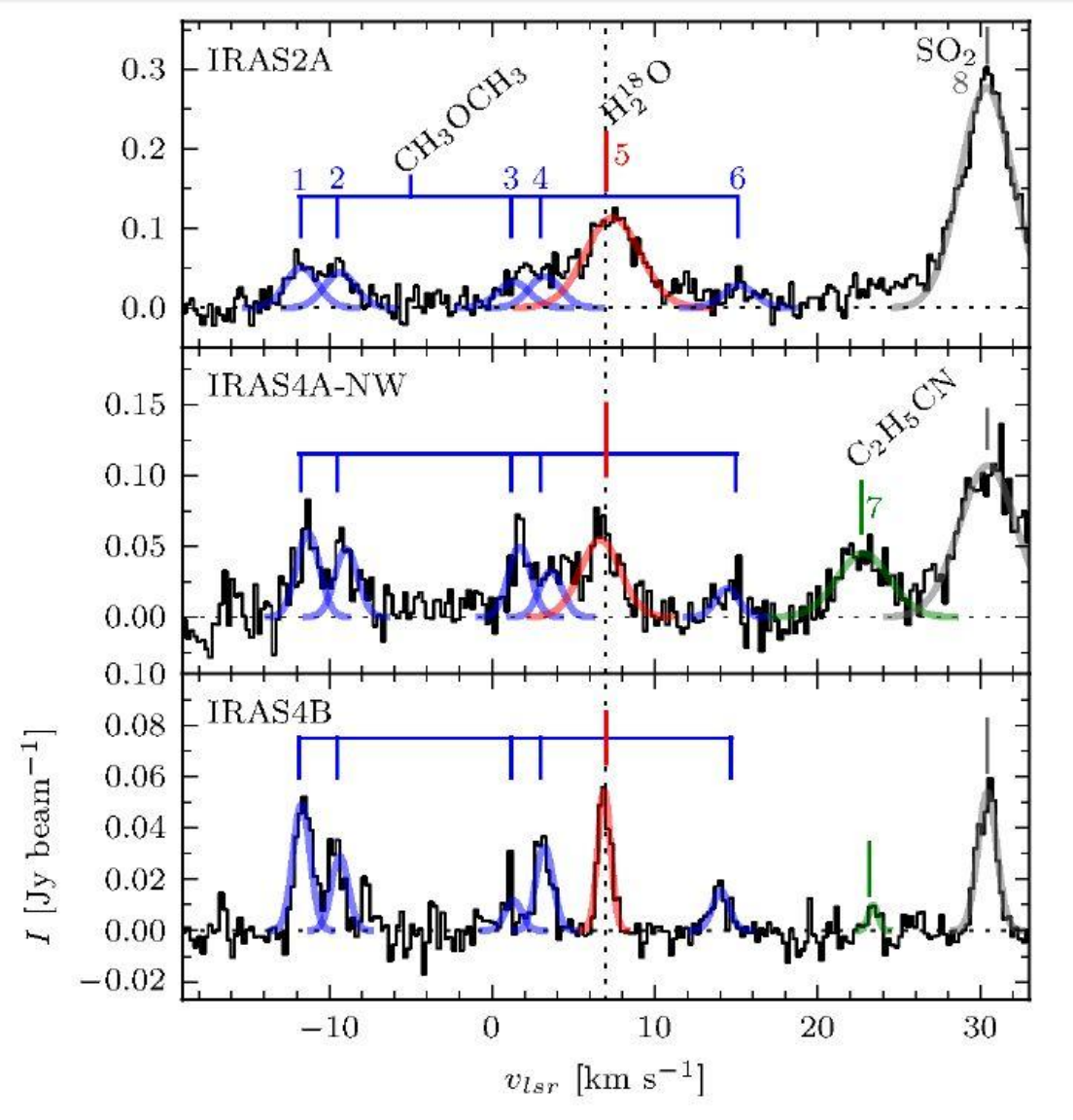
$H_2{}^{18}O$ 3_{13}-2_{20} 203 GHz

Jørgensen & vD 2010a



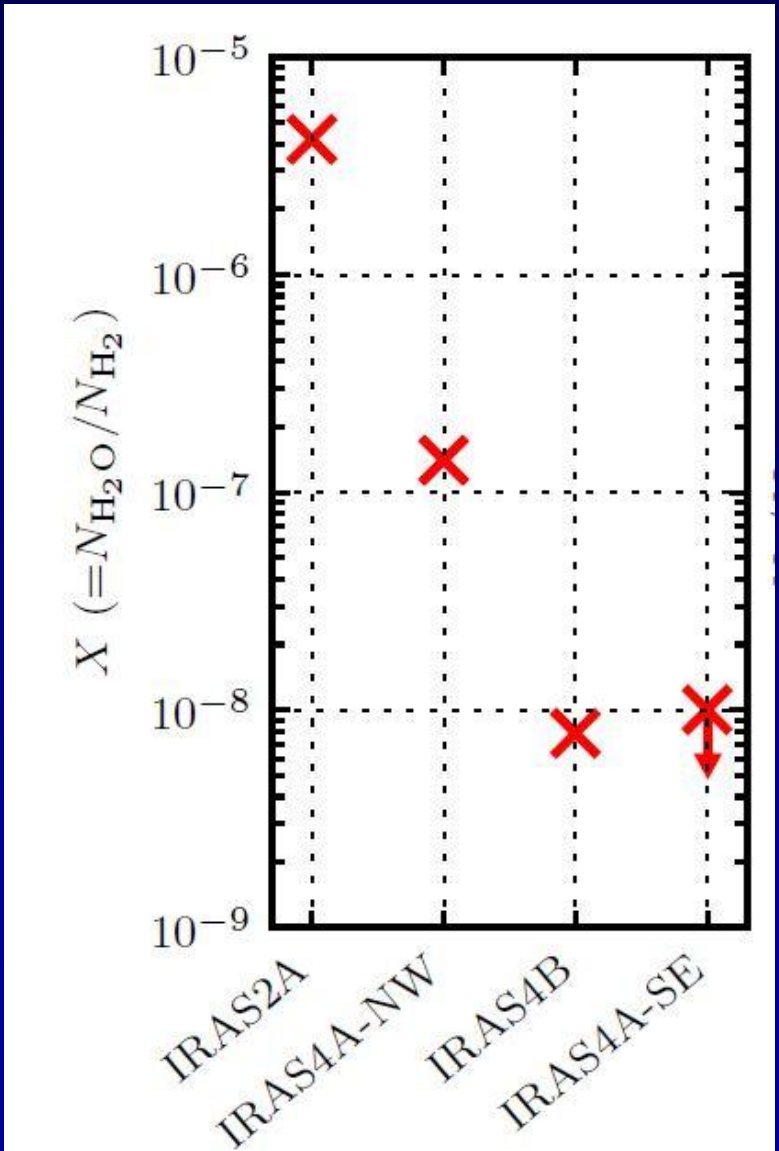
HDO/H_2O<6x10^{-4} in hot gas from interferometer data: Jorgensen & vD 2010b.

$H_2{}^{18}O$ NGC 1333 detections



Persson et al. 2012

Hot water abundance
w.r.t. *total* compact (warm + cold) H_2



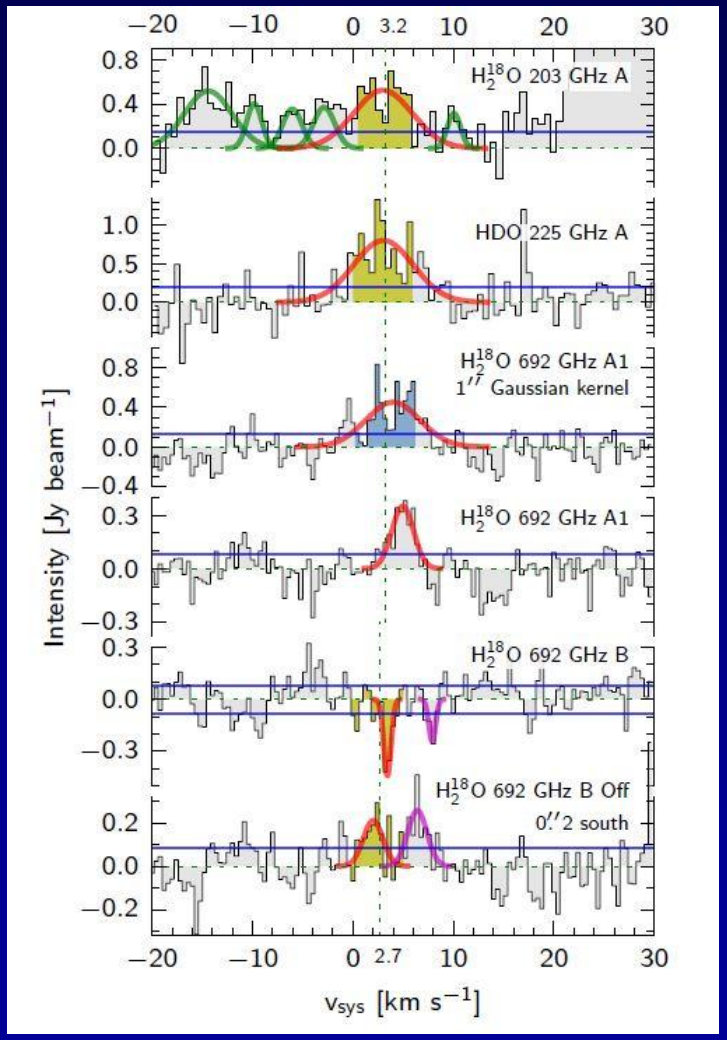
This is *not* the hot core water abundance

Total column from dust continuum; Only a few% of gas >100 K

Persson et al. 2012

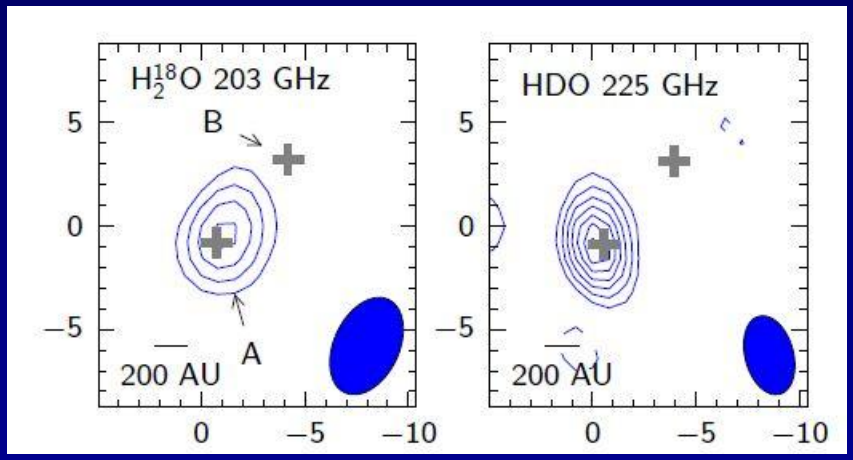
HDO/H_2O IRAS16293 A

ALMA 692 GHz



IRAS 16293 -2422 CSV data

SMA 203 GHz



Persson et al. 2012b

Warm HDO/H_2O=9.2±2.6×10^{-4}
vs. 3.4×10^{-2} Coutens et al. 2012

T_{ex}=124 K

Conclusion

- **All warm HDO/H_2O ratios ~0.001 within factor of 2**
- **Persson et al. 2013 summary in prep.**