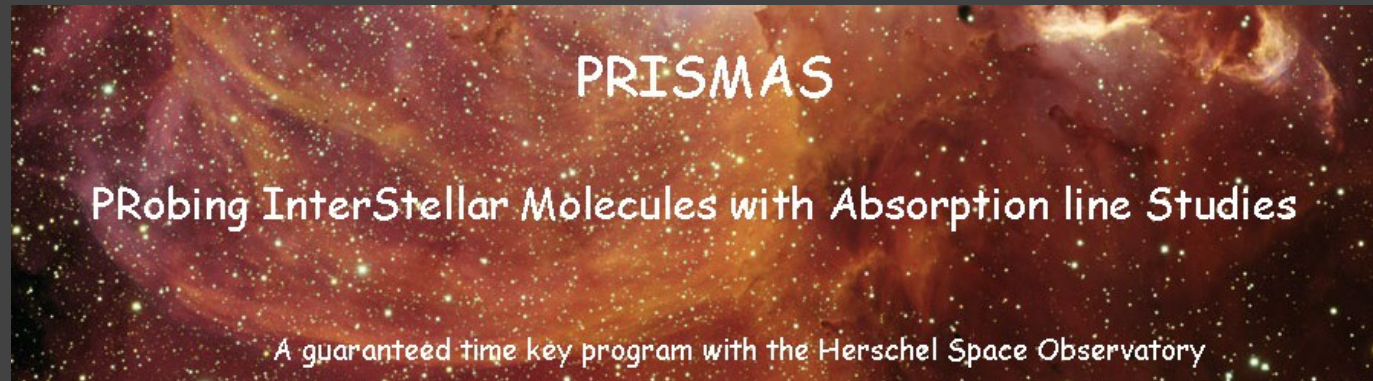


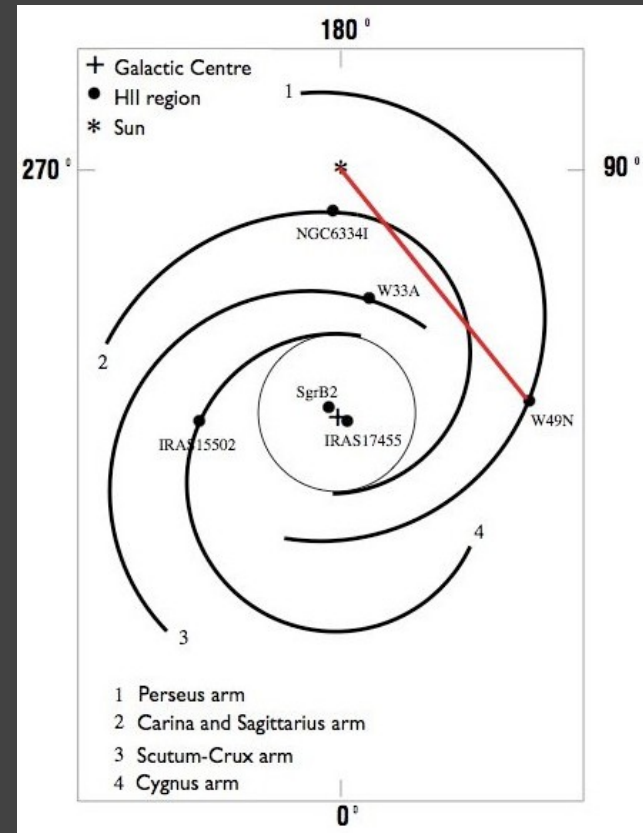
Deuterated water in W33A

Floris van der Tak, Fabrice Herpin, **Charlotte Vastel**, Yunhee Choi
Groningen, Bordeaux, Toulouse



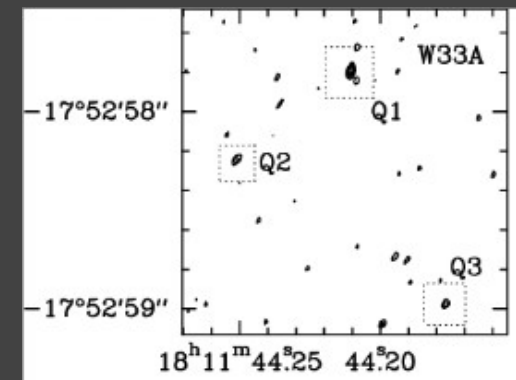
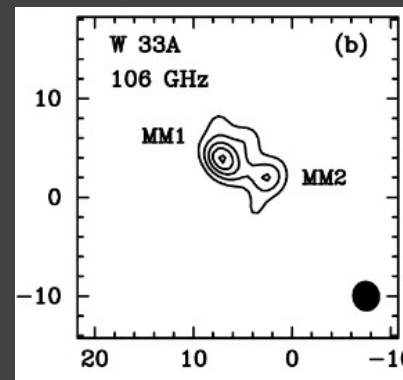
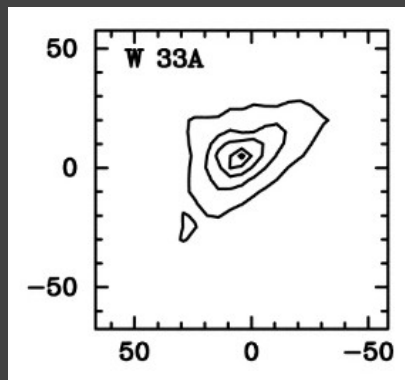
Some source basics

- **High-mass star-forming region**
 - prominent binary
- **Luminosity $10^5 L_0$**
 - Gürtler et al 1991
- **distance 4 kpc**
 - Rengarajan & Ho 1996
- **Bright in mid & far IR**
 - Willner et al 1982, de Wit et al 2007
- **Weak radio source**
 - van der Tak & Menten 2005

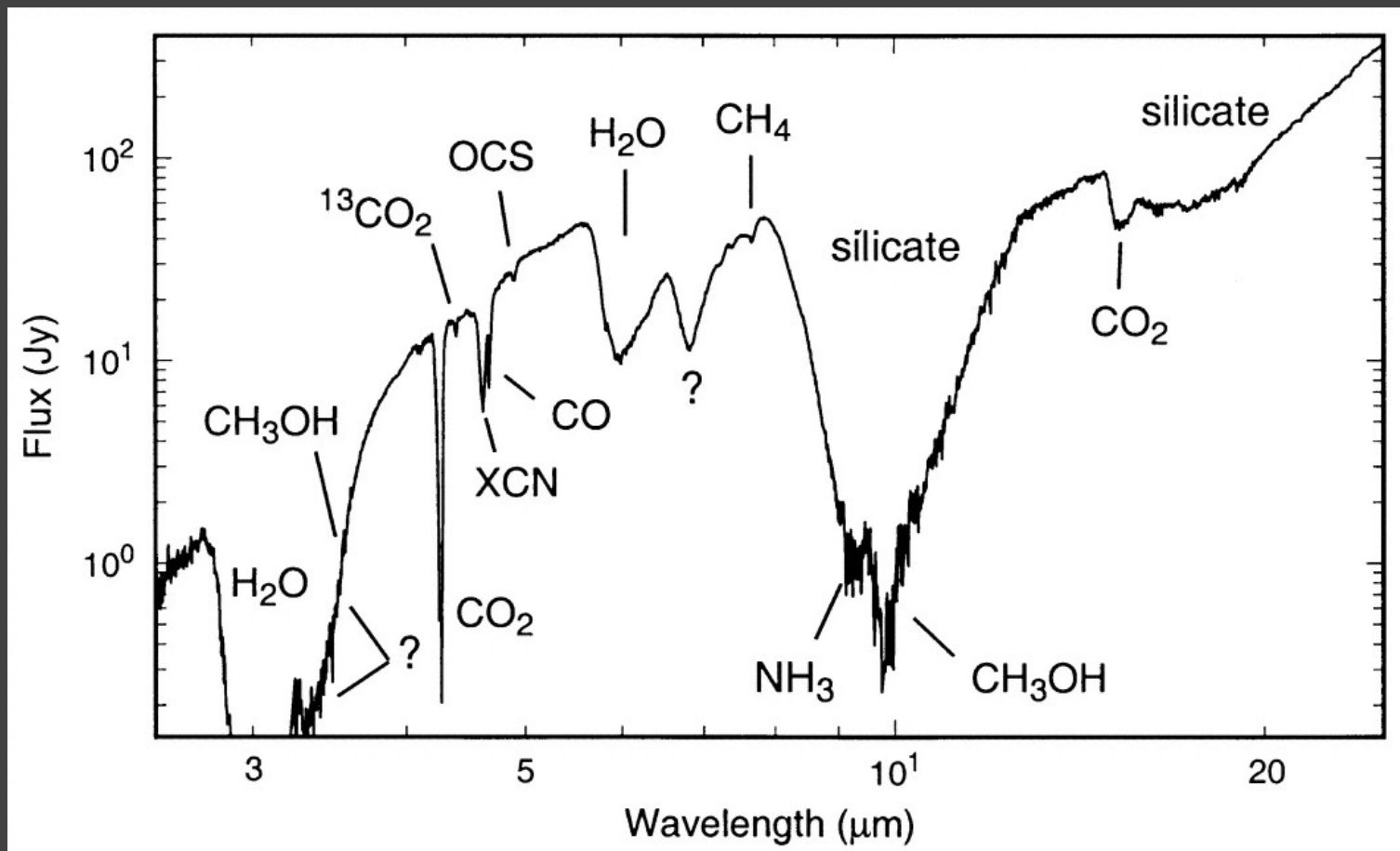


Vastel 2002

*FvdT et al
2000, 2005*



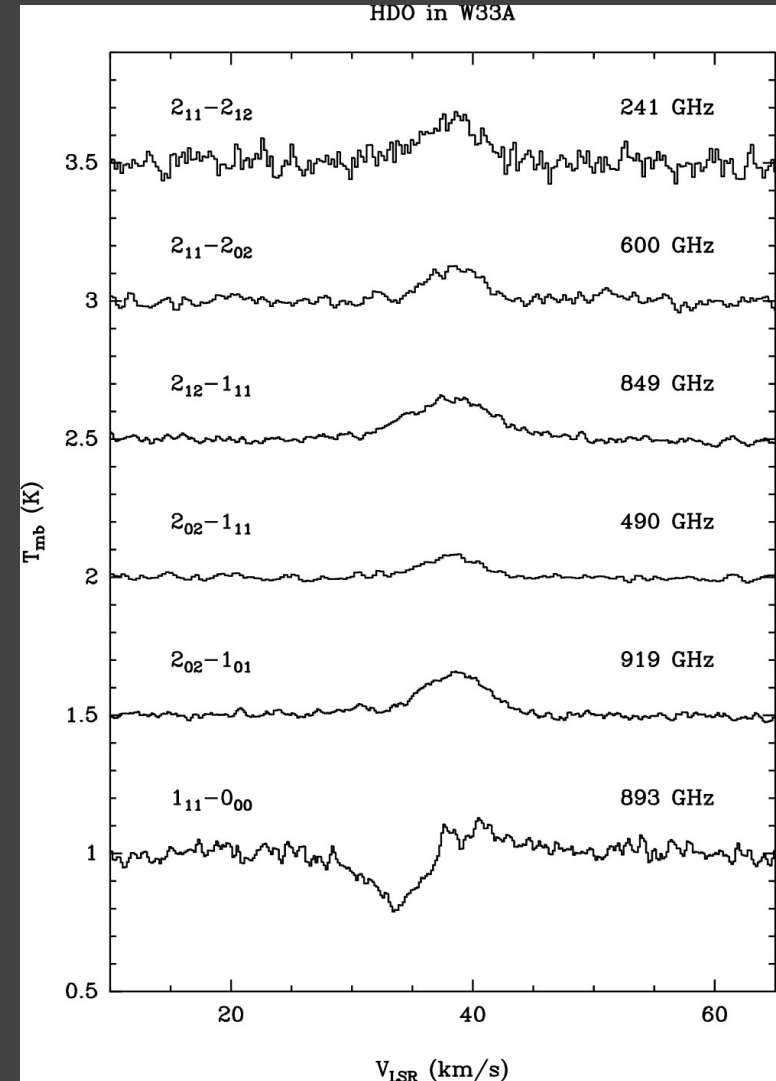
A classic ice source



- ISO-SWS spectrum: Gibb et al (2000)
- Solid HDO claimed (Teixeira et al 1999)
 - but rejected by Dartois et al (2003)

Our HDO data: HIFI / IRAM

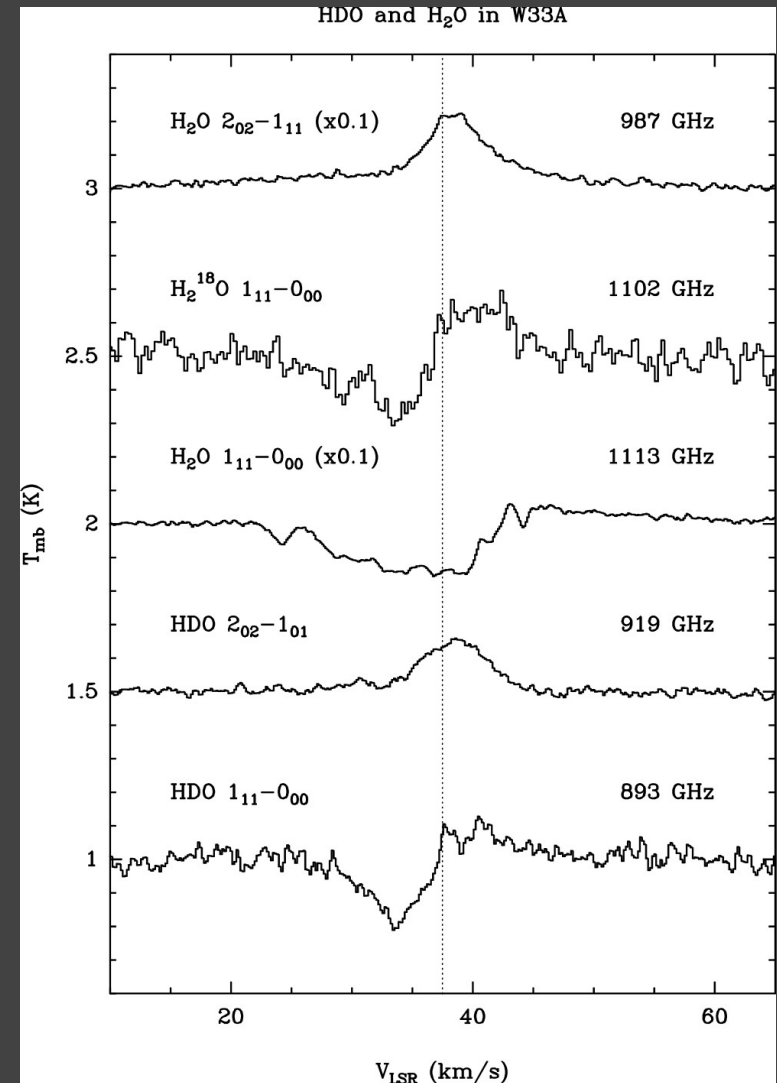
- **Ground state: absorption**
 - $V_0 \sim 33$ km/s
 - $\Delta V \sim 5$ km/s
 - does not look saturated
- **Excited states: emission**
 - $V_0 \sim 38$ km/s = systemic
 - $\Delta V \sim 5$ km/s = as from ground
 - $T_{\text{mb}} \sim 0.1\text{--}0.2$ K
- **Wing on blue side**
 - envelope + outflow
 - or inverse P Cygni?



Comparison to H₂O

- H₂O ground state: absorption
 - cold outer envelope
 - outflow wing
- excited H₂O line: emission
 - inner envelope
 - outflow
- H₂¹⁸O line: P Cygni profile
 - just like HDO
 - use this to compare

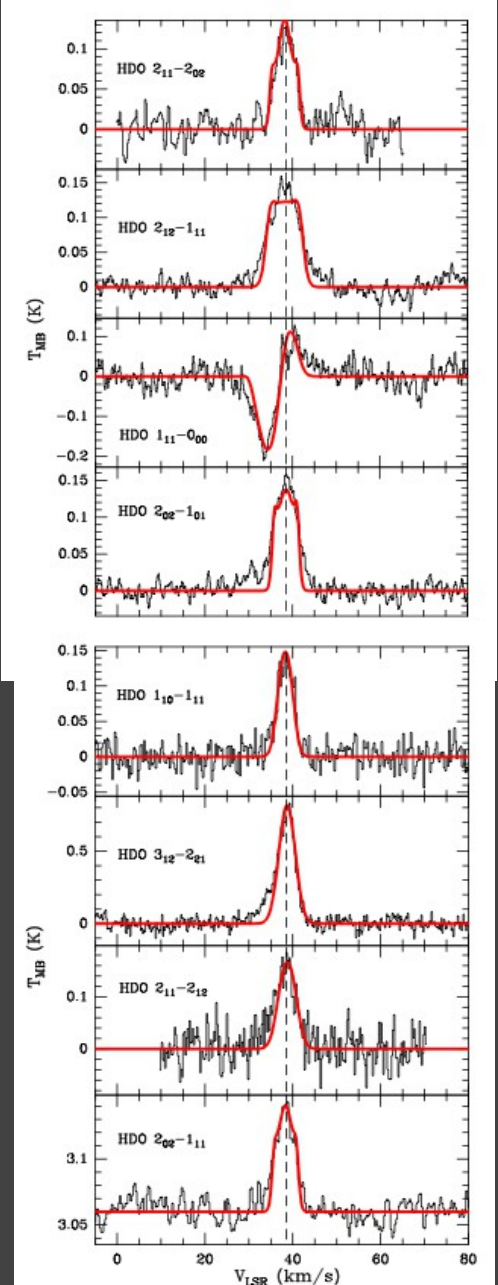
FvdT et al 2013 (submitted)



Model of the HDO line profiles

- **Model tool: Ratran 1D**
 - $n(r)$, $T(r)$ from continuum (L. Chavarria)
 - CRC: Faure, Wiesenfeld et al 2012
- **Kinematics:**
 - turbulence 1.5–3.0 km/s
 - expansion 1.2 km/s ...
 - ...only in 226 & 893 GHz lines ?!
- **Abundances**
 - 4(-10) in outer envelope
 - 4(-7) in inner envelope
- **2006 model: abundances 1(-8) & 2(-7)**
 - ground-state: more precise outer value
 - inner value: structure has minor effect

80, 225 GHz lines: FvdT et al 2006



Next steps

- **Ratran model for H₂O (Yunhee)**
 - kinematics: similar turbulence / expansion velocities?
 - chemistry: HDO/H₂O ratio as a function of radius
- **put results in context**
 - other sources
 - chemical models
 - trends of HDO/H₂O ratio with source parameters (L , M , ...)

