Cometary Studies with the Atacama Submm Telescope

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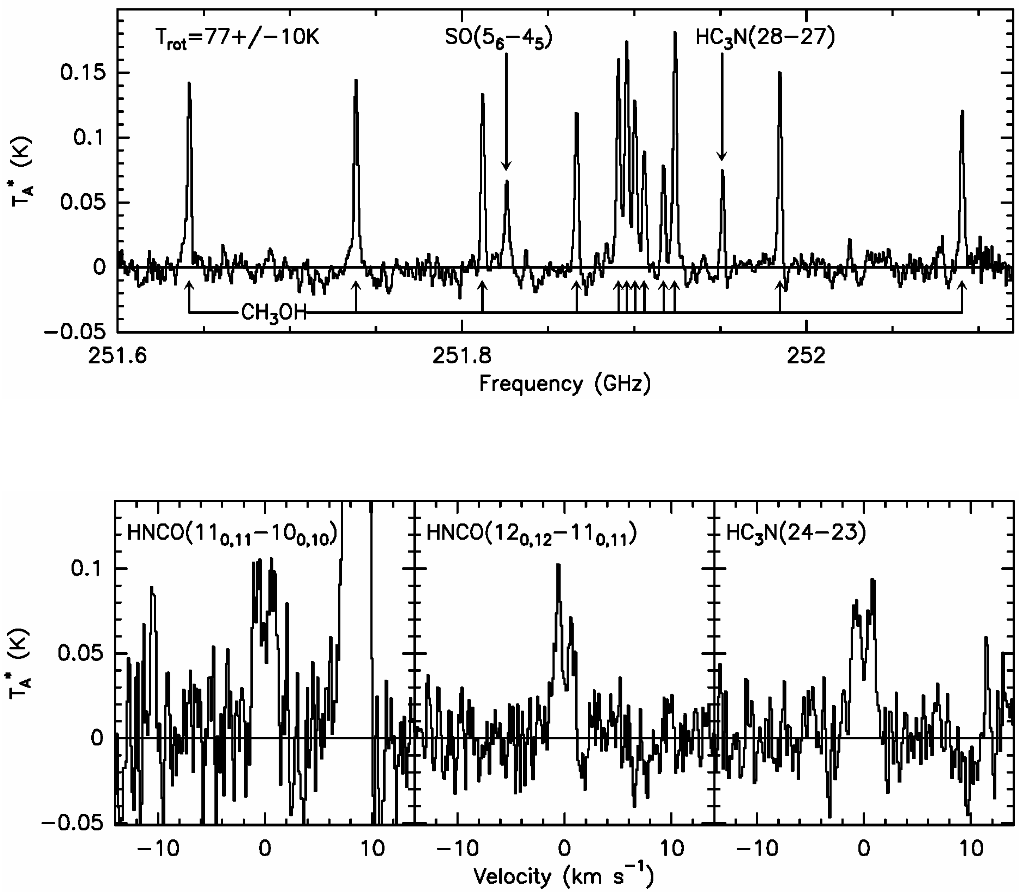
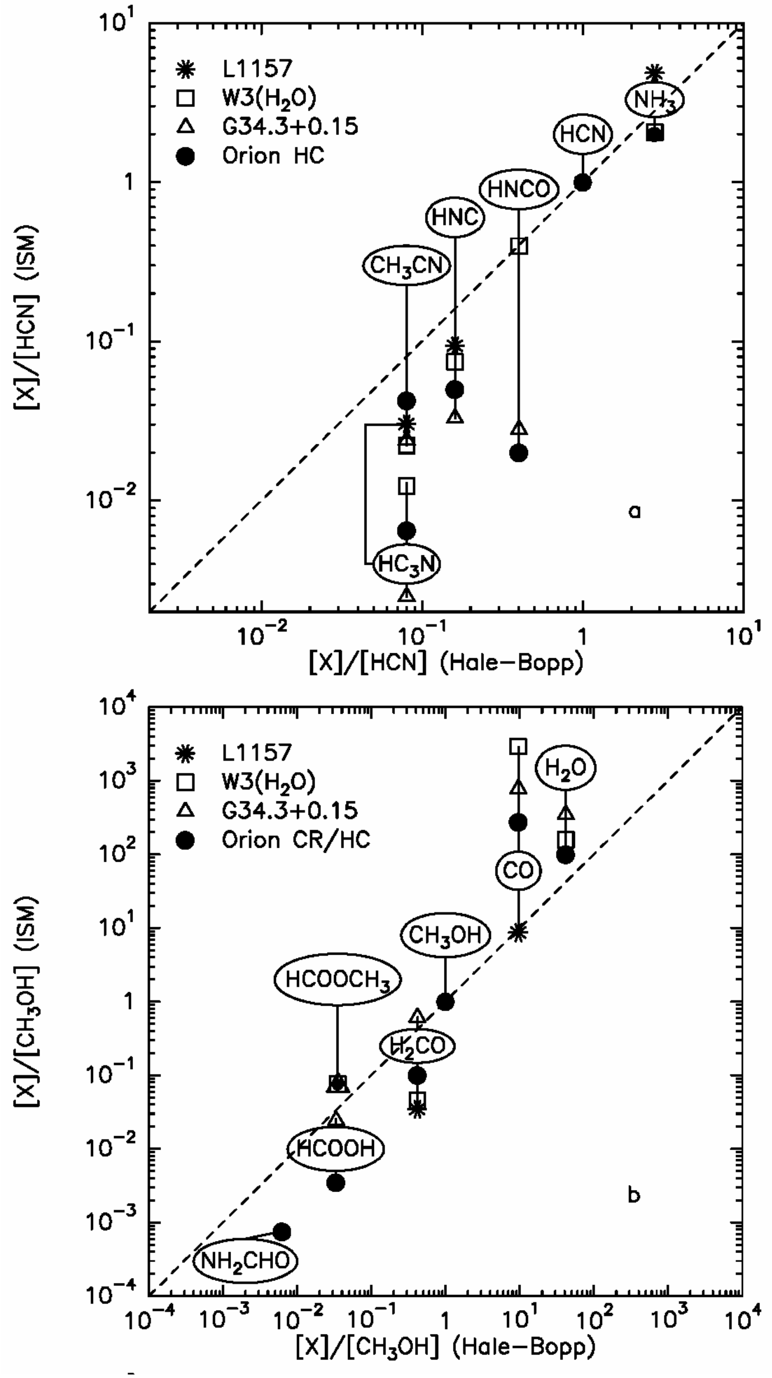
- Comets formed at large distances from the primordial Sun and have remained for most of their lifetime outside of the orbit of Pluto
- They have undergone very little thermal processing
- Their size is small so that internal heating is negligible
- Therefore comets have largely retained and preserved pristine material from the early Solar Nebula
- Studies of their chemical composition provide unique clues to the history and evolution of the Solar System
- Allow to assess the link between the ISM and Solar System bodies and their formation

Comets Hyakutake and Hale-Bopp



- Submillimeter and far-infrared wavelengths offer unique opportunities for studying the composition of cometary ices
- Number of know parent molecules tripled; primarily thanks to (sub)mm spectroscopy
- Most comprehensive view of the volatile composition of a cometary coma ever obtained

Lis et al. (1999) and Bockelée-Morvan et al. (2000)

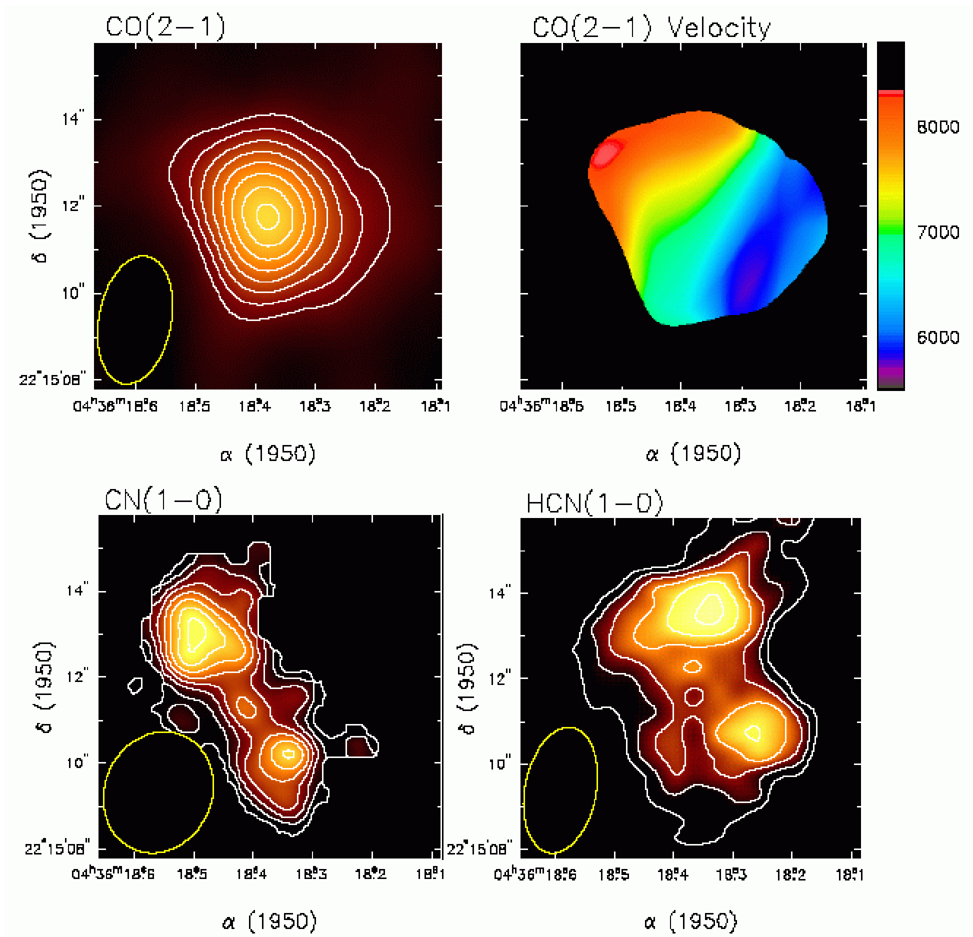


Link with the ISM

- New cometary species predominantly found in molecular hot cores and outflows in the ISM (grain mantle evaporation)
- Interesting similarities between the composition of comets and hot cores for N- and CHO-bearing species
- Direct link between cometary and interstellar ices suggested

Bockelée-Morvan et al. (2000)

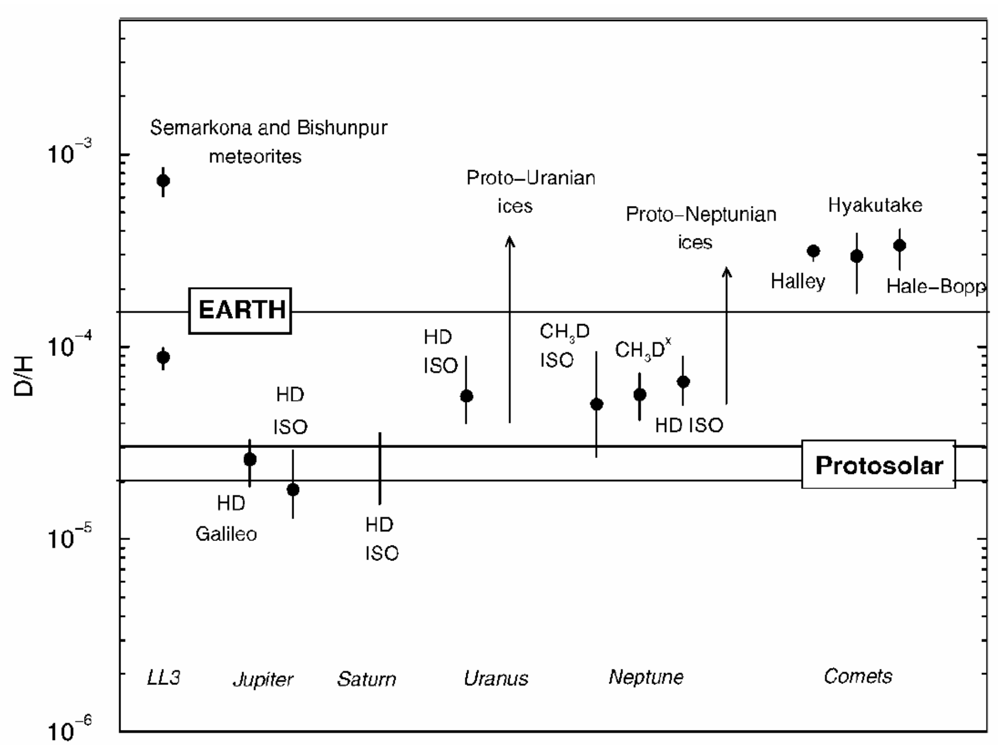
Chemistry of Pre-Planetary Disks



LkCa 15: Blake et al.

- Disks around 1–5 Myr old T-Tauri stars
- Sizes ~100AU, comparable to that inferred for the primitive Solar Nebula
- Molecular spectroscopy allows the assessment of the initial conditions in the planet-forming zones
- Clues for the origin and evolution of primitive bodies
- Angular sizes typically only ~1–2" (sensitivity advantage for ALMA)

D/H Ratio in Cometary Water



Altwegg & Bockelée-Morvan (2002)

- Deuterium in cometary water enriched by a factor of 10 compared to the protosolar value
- Cometary water largely preserved the high D/H ratio acquired in the protosolar cloud
- Only partial mixing occurred in the Solar Nebula
- High cometary D/H values (twice terrestrial) make it difficult to defend a major cometary origin of terrestrial water
- D/H measured only in 3 long-period comets (from Oort cloud); observations of a large sample of comets, including short-period comets (from Kuiper Belt) form an integral part of the HIFI Solar System key program

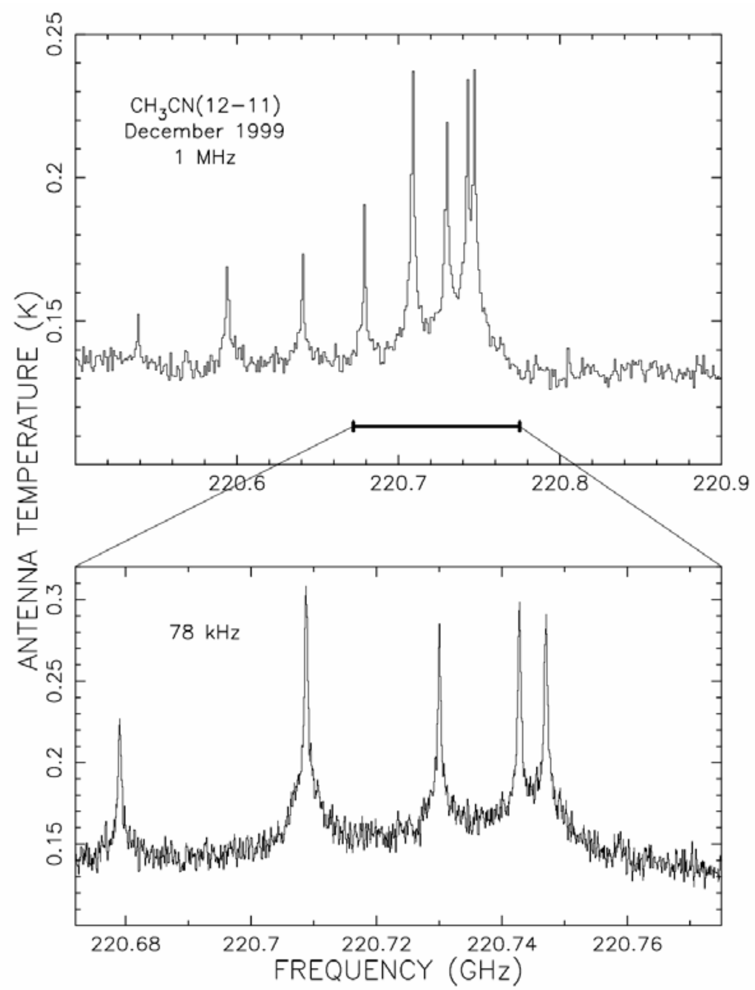
Sensitivity vs. Herschel

- Strongest cometary HDO line (1_{11}–0_{00}) at 893.6 GHz
- ALMA Rx specs (ALMA Memo 276), *PWV*=0.35mm, *A*=1.3 → *Tsys*=750K in the 850 GHz window
- FSW, 1 hr (ON+OFF), 0.1 kms^{-1} resolution → 32 mK rms → 16 mK kms^{-1} rms for integrated line intensity
- $Q=5\times10^{28}$ s^{-1}, $r_h=\Delta=1$AU, $v_{exp}=0.8$ kms^{-1}, $T=30$K, D/H=3×10^{-4} → Integrated intensity=$0.54\times\eta_A$ Kkms^{-1}; SNR=$35\times\eta_A$
- For comparison, Herschel: SNR=8.8 in 1 hr, FSW
- Observations very complementary to Herschel, assuming both instruments operational at the same time

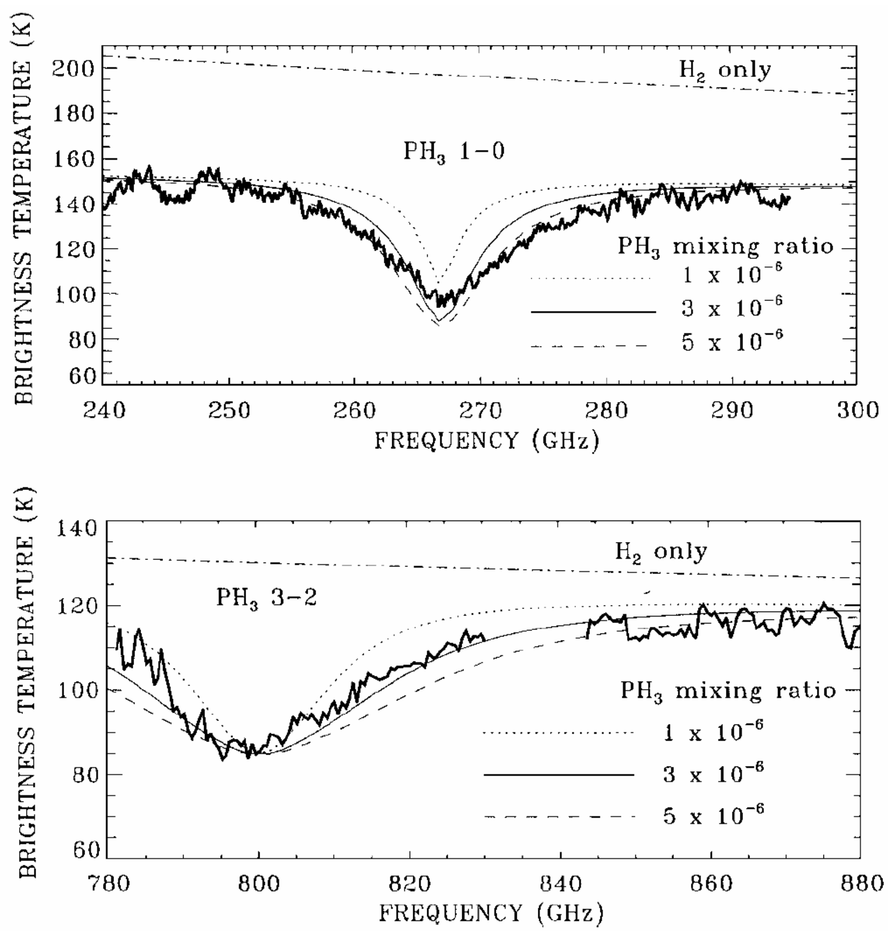
Sensitivity vs. ALMA

- Compact configuration (ALMA Memo 276; B_{max}=0.2 km): → 0.24 K rms in 1 hr, 0.1 kms^{-1} resolution (~7.5 times higher than single dish)
- But synthesized beam ~0.5" at 893 GHz (~7 times smaller) → same SNR, but you get a map with ALMA!
- 850 GHz array Rx with Nyquist sampling?
- ALMA sensitivity may be higher, depending on the final configuration (e.g. ACA, ACA+4 etc.)

Planets and Satellites



Titan: Marten et al. (2002)



Saturn: Orton et al. (2000)