Herschel-HIFI Detections of Hydrides in Star Forming Regions : Envelope, Outflow or Foreground?

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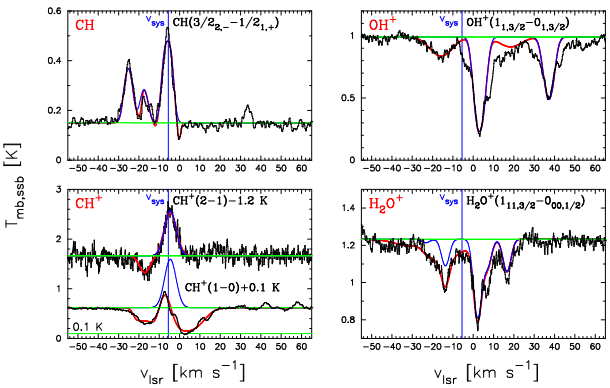
... and the WISH Herschel GT key program-team

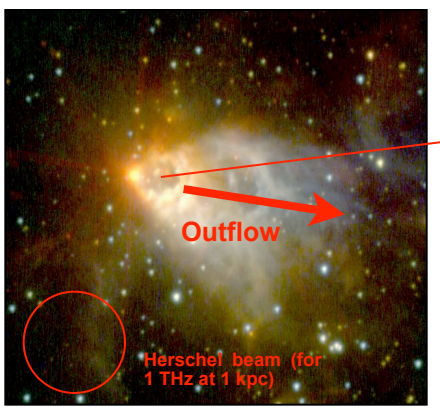
I. HIFI-detections towards AFGL 2591



- **Light diatomic hydrides** (XH, XH⁺, X=C, O, N, S) hard to observe from ground, with frequency in the range of 1 THz
- Detection of CH, CH⁺, OH, and NH towards the **massive star forming region AFGL 2591**. Also H_2O^+ detected (Bruderer et al. 2010b)
- CH and CH⁺ in **emission**, but OH⁺, H_2O^+ and NH in **absorption**
- Velocity of absorption agrees to **foreground clouds**

II. A scenario : FUV irradiated outflow walls

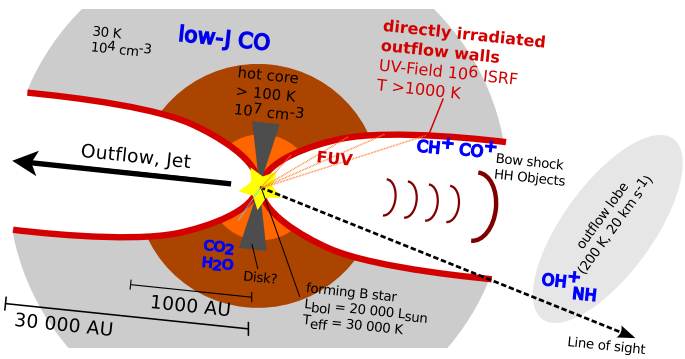
- AFGL 2591 has a **large scale cavity** along the outflow (several 1000 AU) (e.g. Preibisch et al 2003, van der Tak et al. 2000)



AFGL 2591 seen in JHK-band (Aspin et al., NIRI on Gemini North)

Outflow Cavity

- Tracers for **warm and FUV irradiated gas** detected towards AFGL 2591 (e.g. CO⁺)
- **Directly irradiated outflow walls** (Bruderer et al. 2009b)



III. Physical/chemical models e.g. CH⁺

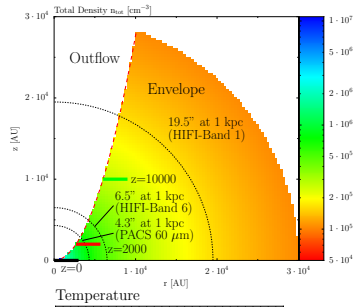
- CH⁺ Formation mechanism **requires high temperature and FUV radiation**

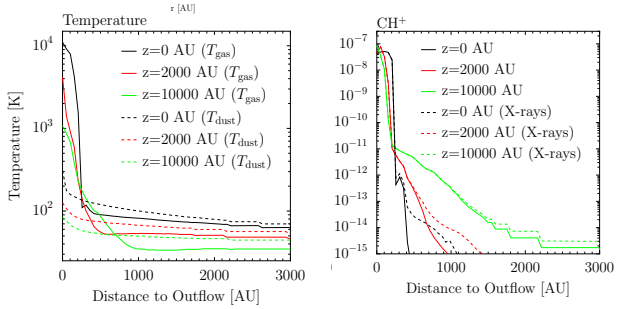
$$C^+ + H_2 + 4640\ K \rightarrow CH^+ + H$$

- **Detailed 2d physical/chemical** model (Bruderer et al. 2009a,b & 2010a)

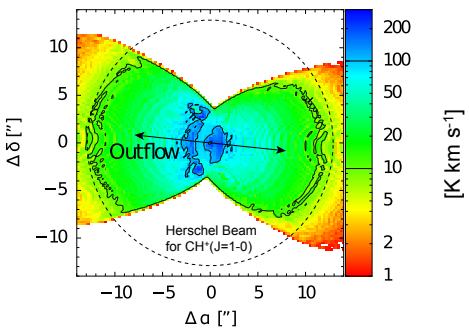
1. Physical structure → Density
2. Transfer of the FUV radiation → FUV radiation
3. Dust radiative transfer → Dust temperature
4. Calculation of the gas temperature together with chemistry → Gas temperature
5. Chemistry → Abundances
6. Radiative transfer → Molecular lines

- Calculated Density and Temperature structure and abundance profile (rel. to H_2)





- **Thin and hot layer** (a few 100 AU with 1000 K) with strong enhancement of CH⁺
- **Modeled line map:** Velocity integrated emission of CH⁺(J=1-0)



- **Comparison** between model and observations

CH⁺(J=2-1) : **Measured** 3.8 K km s⁻¹,
Model: **Hot Core only** < 10^{-4} K km s⁻¹
Model: **Outflow wall** 8.9 - 30.8 K km s⁻¹ (depending on distance, inclination, ...)

CH⁺(J=1-0) : Comparison difficult, due to fore-ground absorption

→ Outflow walls directly irradiated by the young protostar lead to warm and extended gas
→ Outflow walls can explain CH⁺ observations

References
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- Bruderer, S.; Benz, A. O.; van Dishoeck, E. F.; Melchior, M.; Doty, S. D.; van der Tak, F.; Stäuber, P.; Wampfler, S. F.; Dedes, C.; Yıldız 2010b, A&A HIFI special issue