

First detection of the Methylidyne cation (CH^+) fundamental rotational line with the Herschel/SPIRE FTS

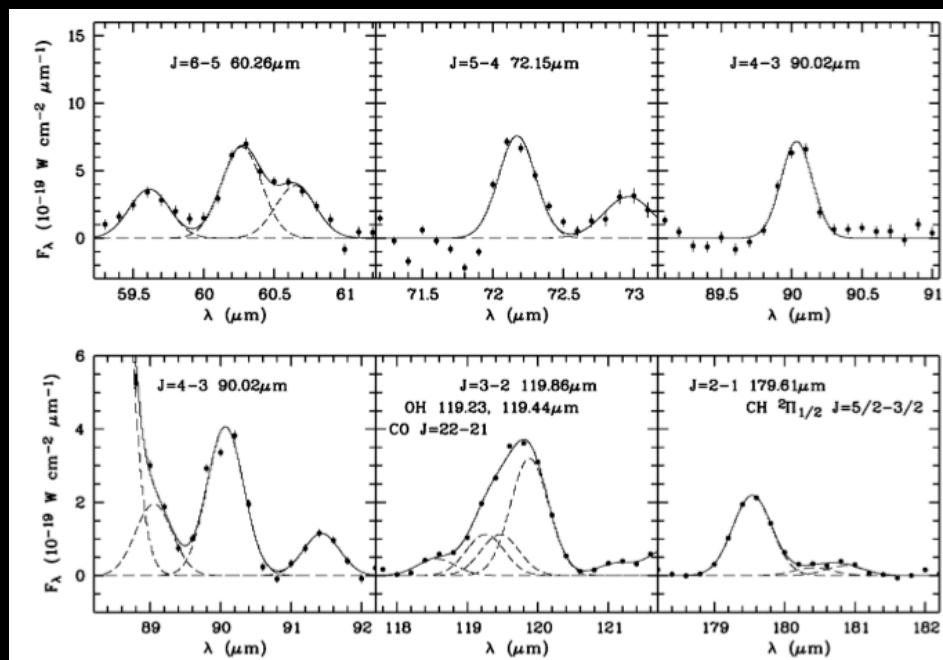
(on behalf of the ISM SPIRE consortium)

D. A. Naylor , E. Dartois[★] , E. Habart , A. Abergel , J.-P. Baluteau , S.C. Jones , E. Polehampton , P. Ade , L. D. Anderson , P. André , H. Arab2 , J.-P. Bernard , K. Blagrove , F. Boulanger , M. Cohen , M. Compiègne , P. Cox , G. Davis , R. Emery , T. Fulton , C. Gry , M. Huang , C. Joblin , J. M. Kirk , G. Lagache , T. Lim , S. Madden , G. Makiwa , P. Martin , M.-A. Miville-Deschênes , S. Molinari , H. Moseley , F. Motte , K. Okumura , D. Pinheiro Gocalvez , J. A. Rodon , D. Russeil , P. Saraceno , S. Sidher , L. Spencer , B. Swinyard , D. Ward-Thompson , G. J. White , A. Zavagno

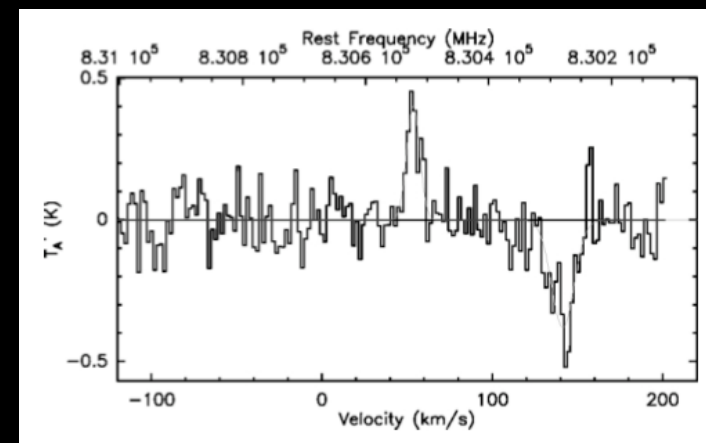
★ emmanuel.dartois@ias.u-psud.fr , naylor@uleth.ca ,
emilie.habart@ias.u-psud.fr , alain.abergel@ias.u-psud.fr

Methyldyne cation CH^+

- One of the first molecules/radicals discovered in the visible 70 years ago (Douglas & Herzberg 1941), shortly after the methyldyne (CH) radical (Swings & Rosenfeld 1937).
- CH^+ far-IR detections reported the J=2-1 to 4-3 transitions in the NGC7027 PDR (ISO-LWS / Cernicharo et al. 1997). $^{13}\text{CH}^+$ (J=1-0) reported from the ground (Falgarone et al. 2005)



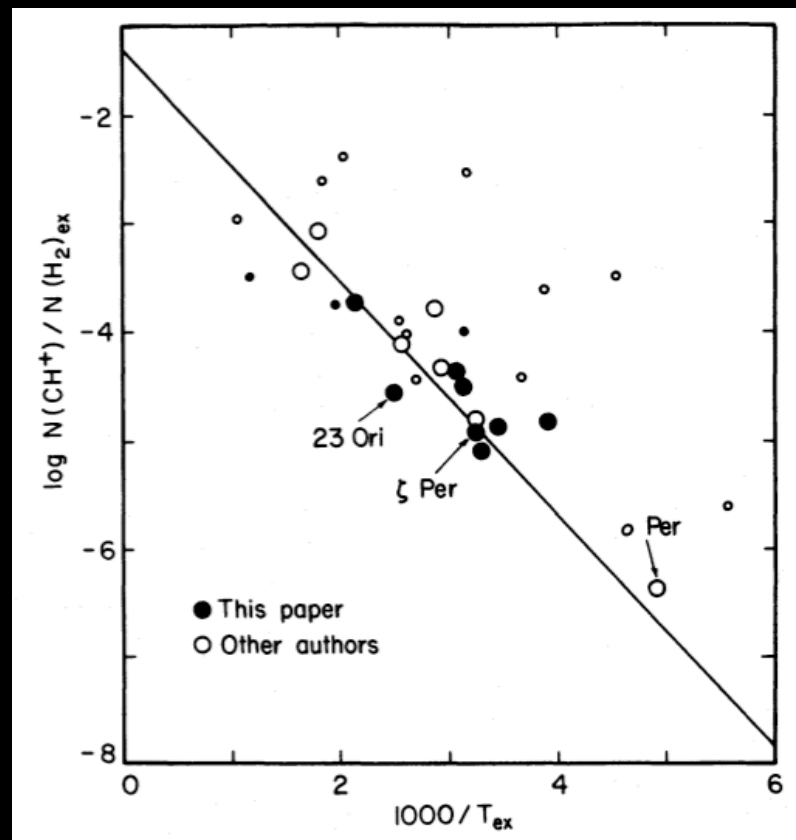
Cernicharo et al., 1997



Falgarone et al., 2005

Production of CH⁺

- CH⁺ is commonly detected in the visible and found to correlate with rotationally excited H₂



Lambert & Danks, 1986



Overcoming barriers for CH⁺

Several routes examined :

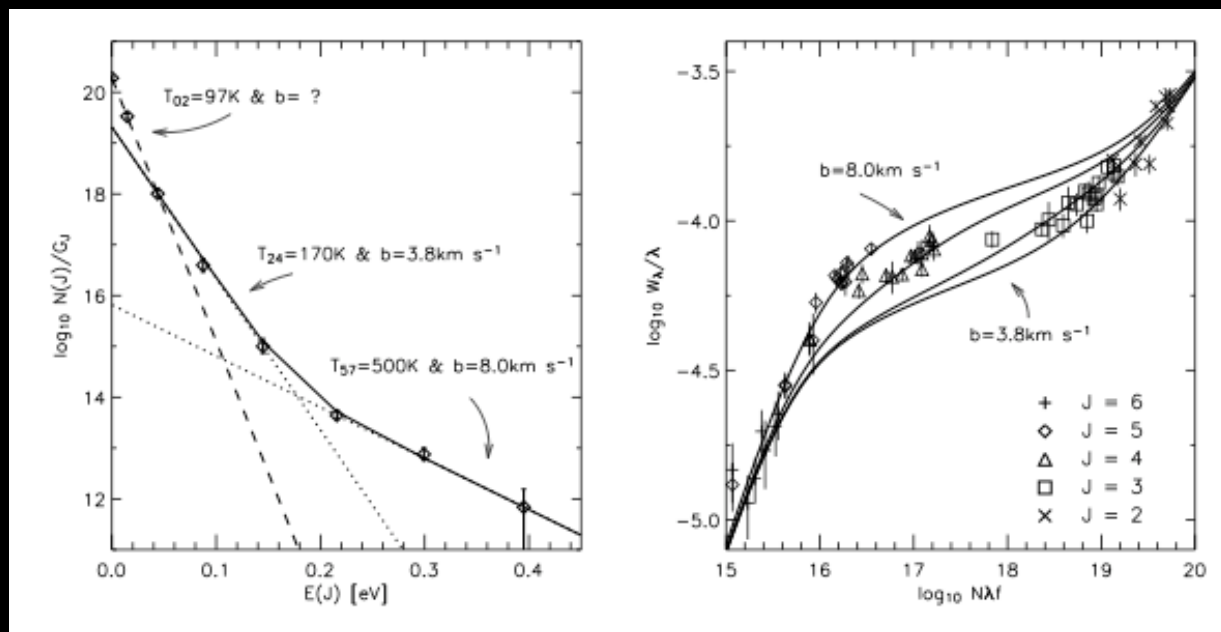
☐ UV pumping

Lambert & Danks, 1986

- The diffuse medium flux seems too weak for that

Gry et al., 2002

- The H₂ profiles widths indicate a warm component



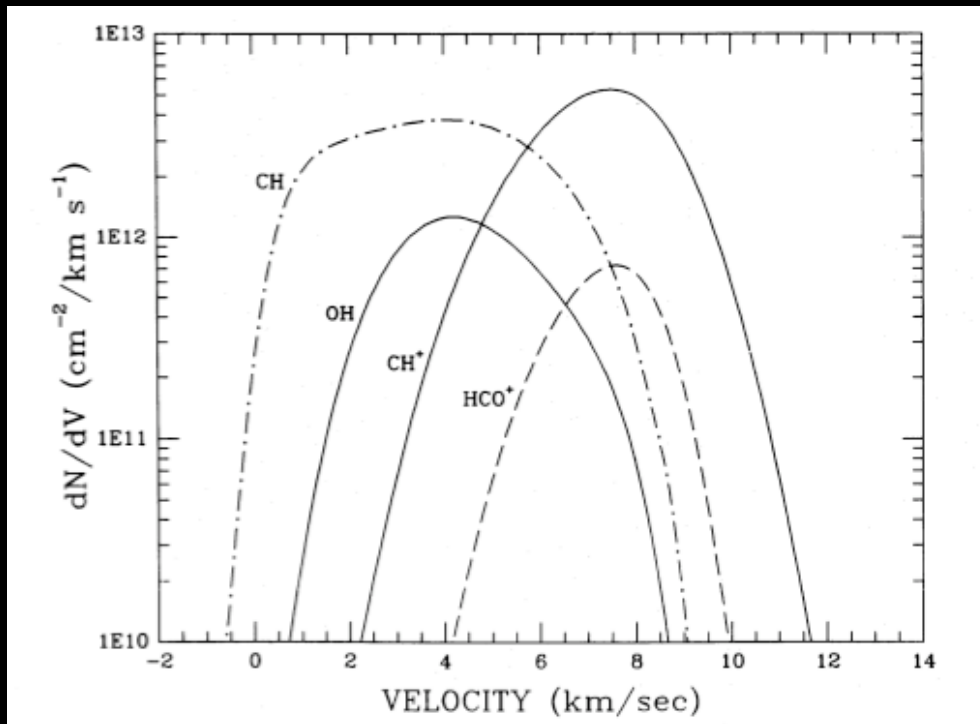
Lacour et al., 2005

Overcoming barriers for CH⁺

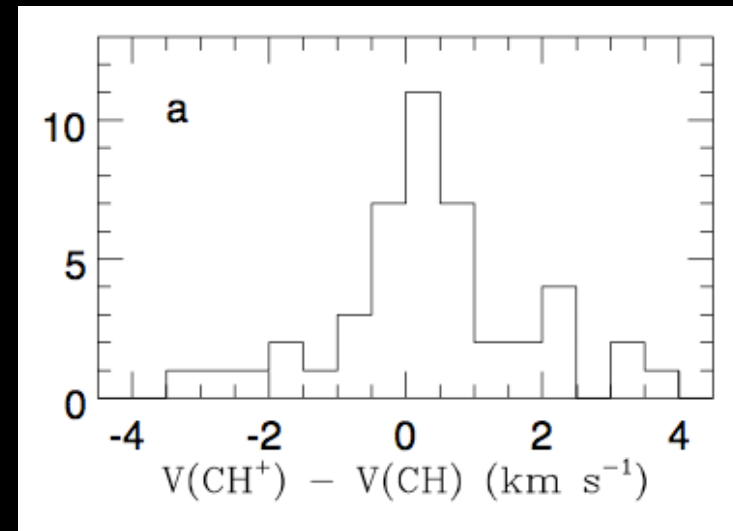
Several routes examined :

☐ Shocks

- expected velocity shifts between different species that are not observed (multiple shocks or intrinsic velocities dispersion among species)



Draine & Katz, 1986



Gredel 1997

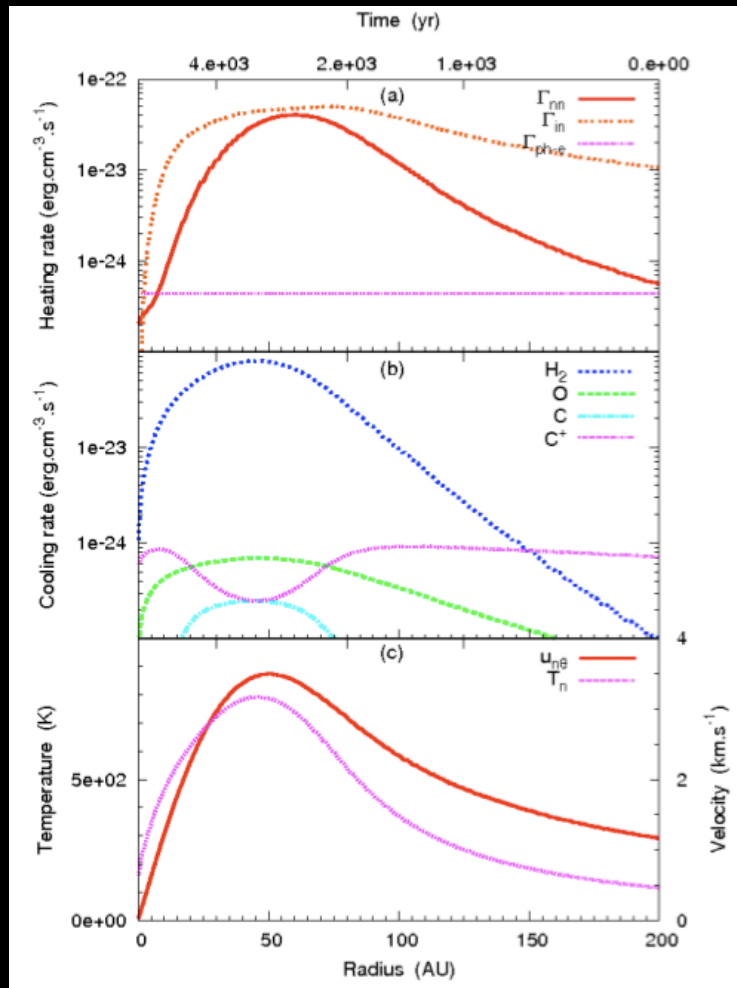
Overcoming barriers for CH⁺

Several routes examined :

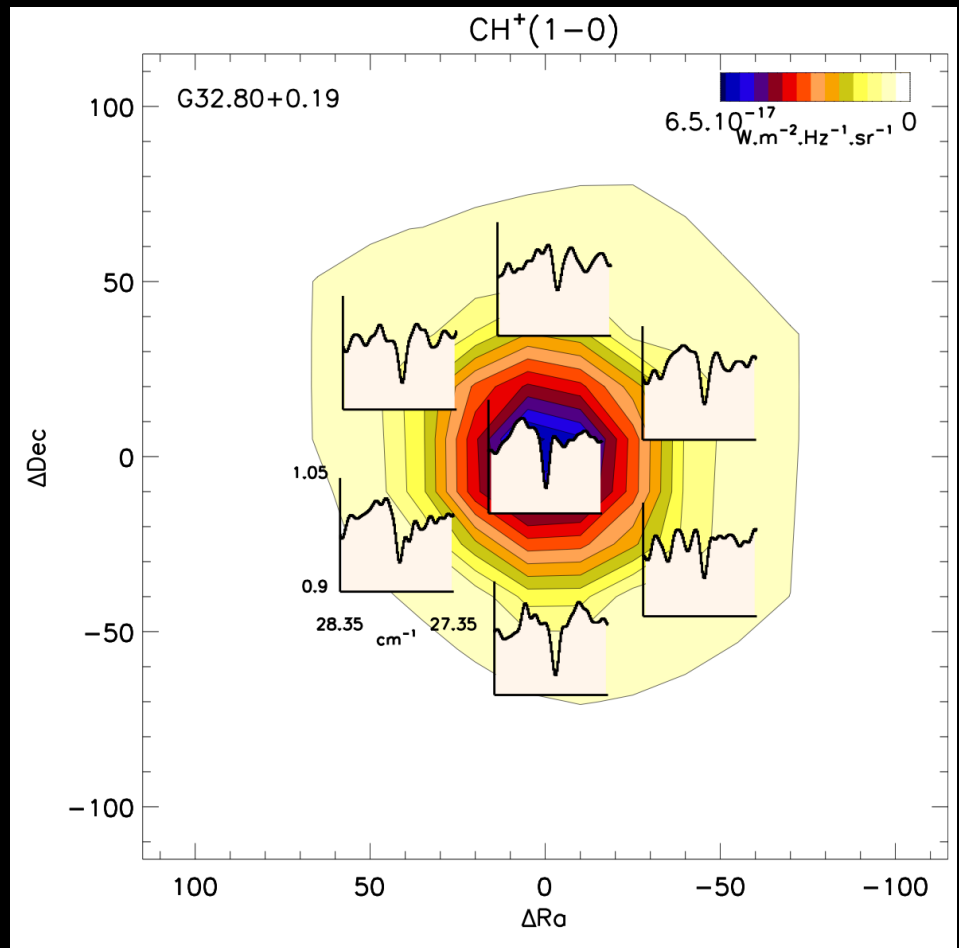
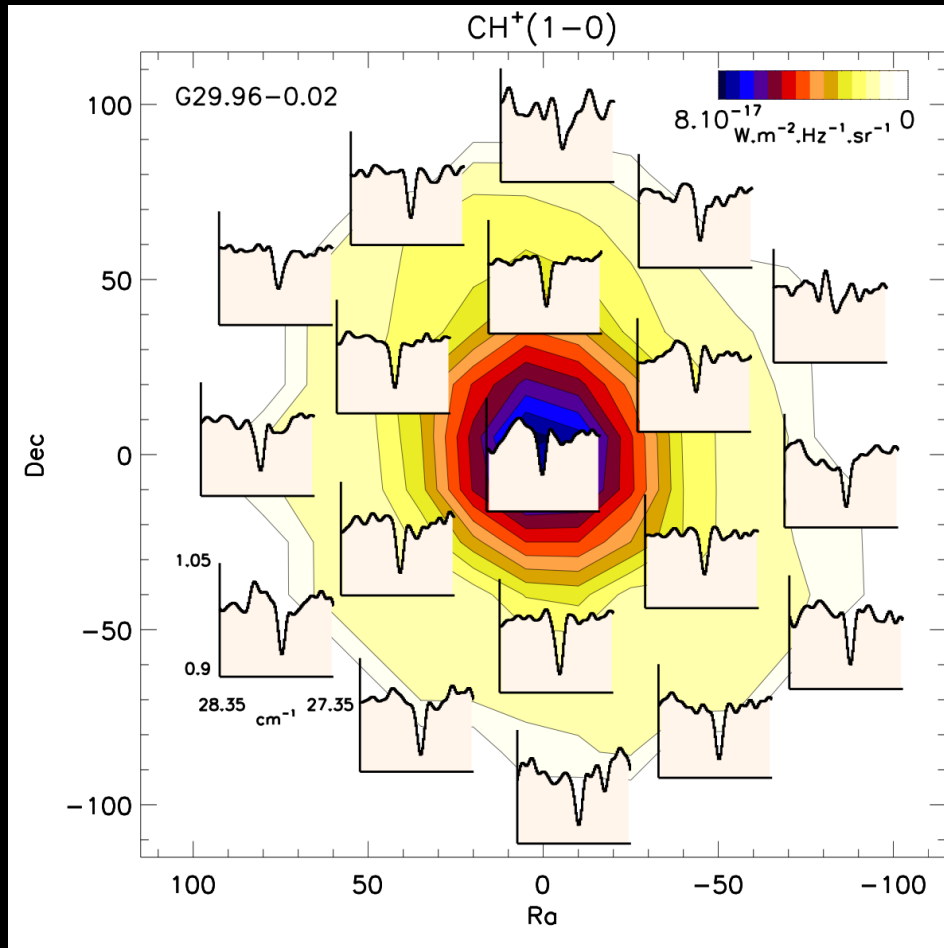
☐ Turbulence

(suggested in articles as a consequence of observed hot H₂ not UV pumped)

TDR

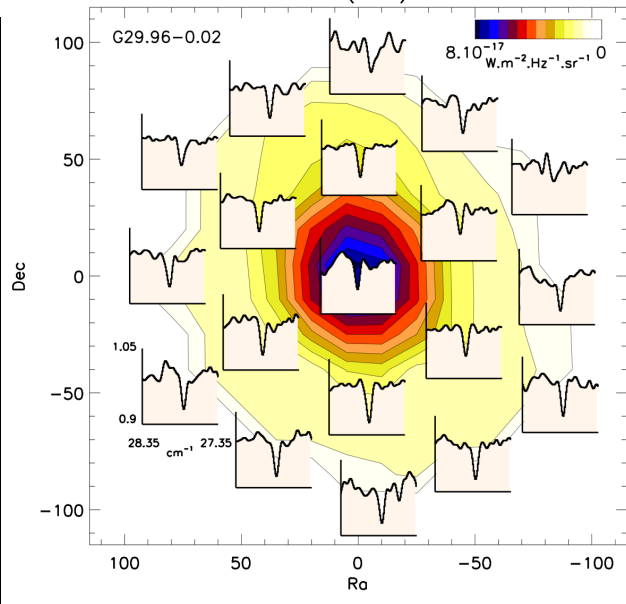
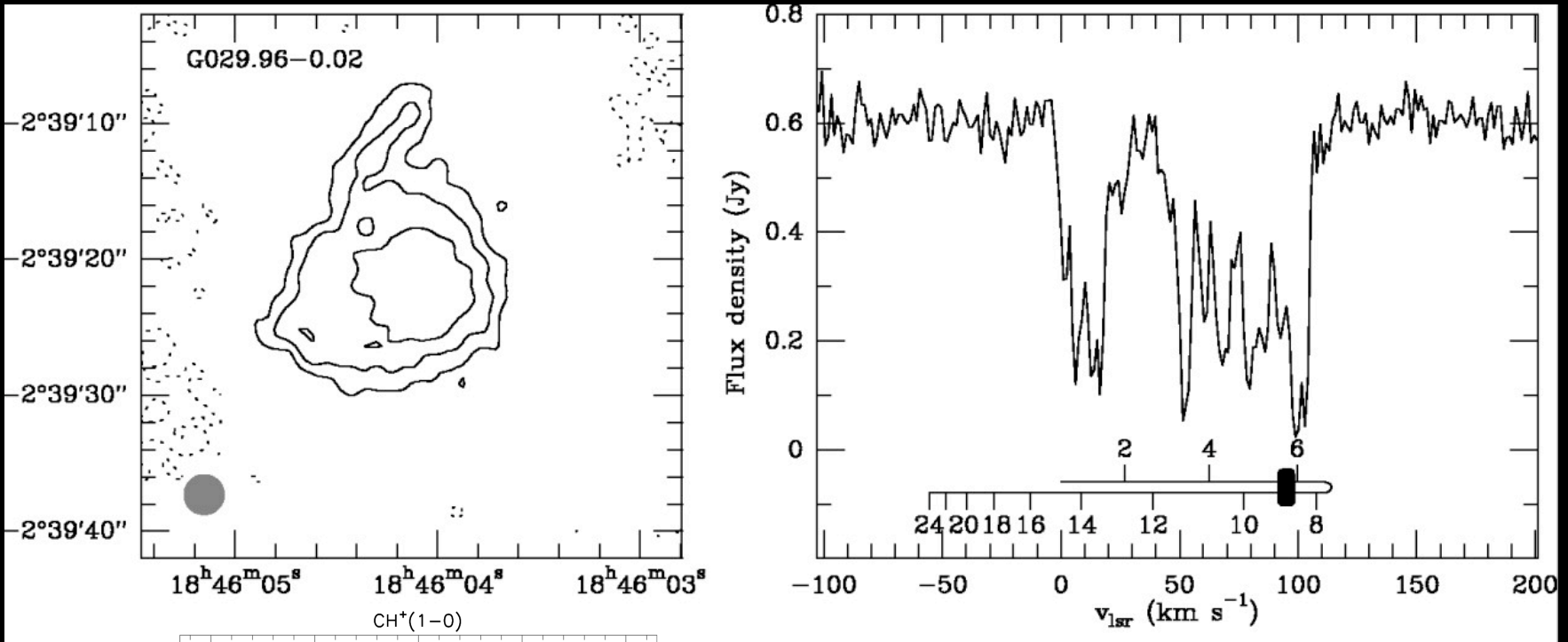


SPIRE/FTS : CH⁺ towards HII regions

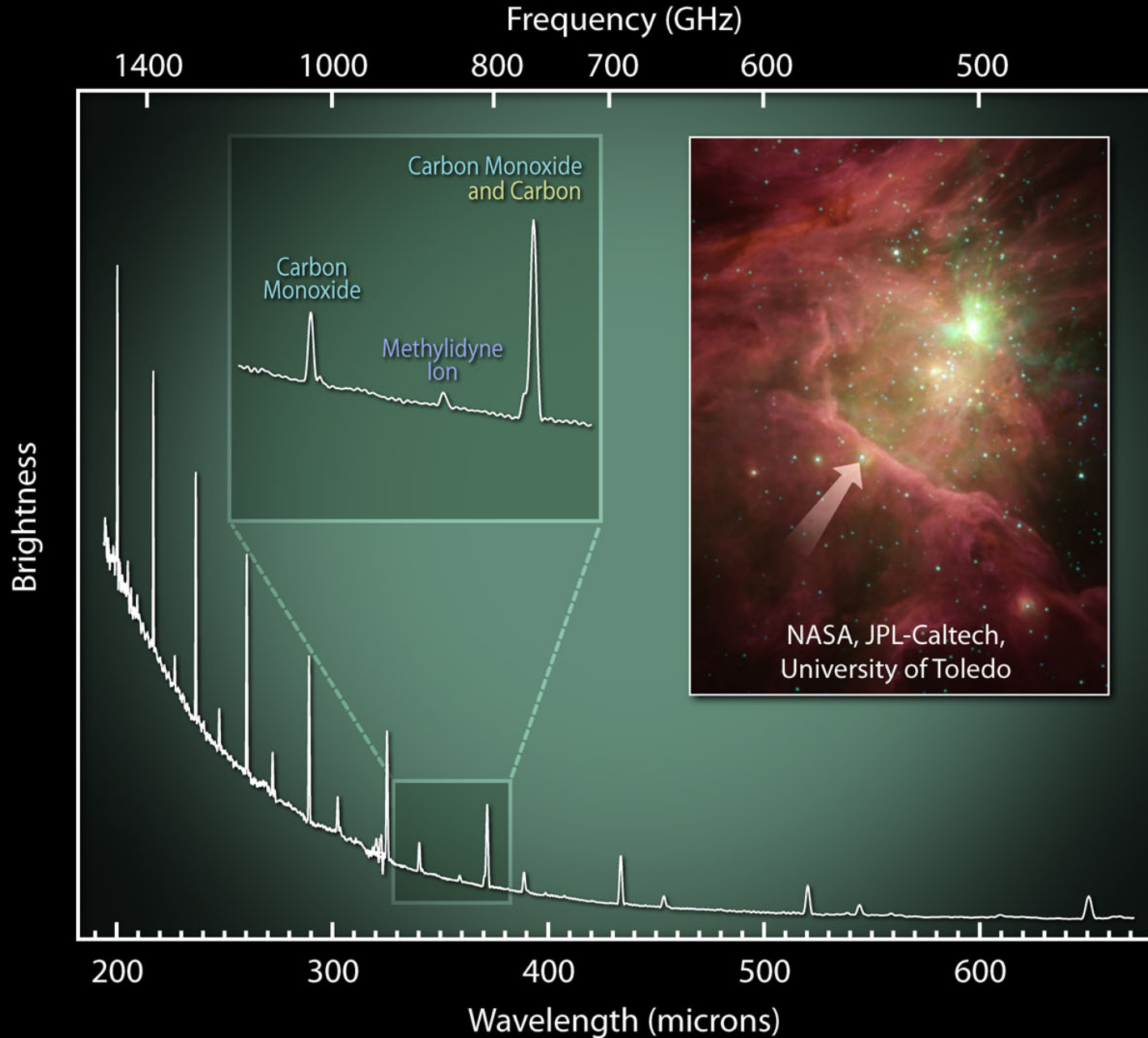


Res ~ 780 km/s, $\Delta\tau$ obs. = 0.05 \Rightarrow Δv ~ 40 km/s

CH⁺ towards HII regions



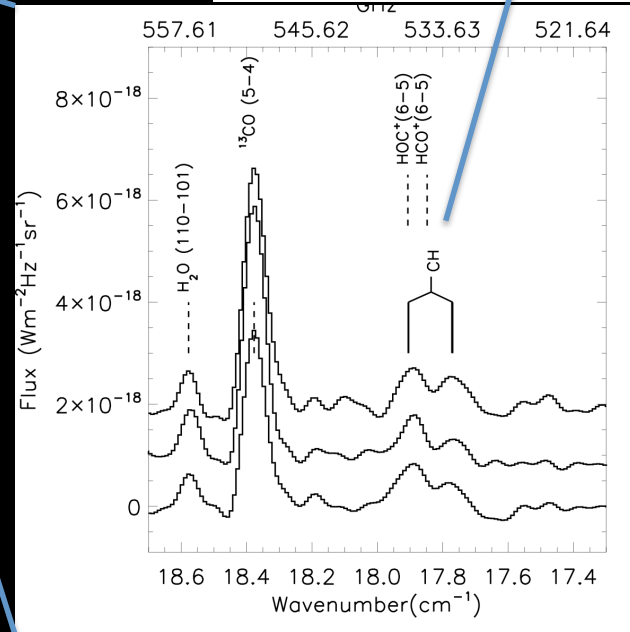
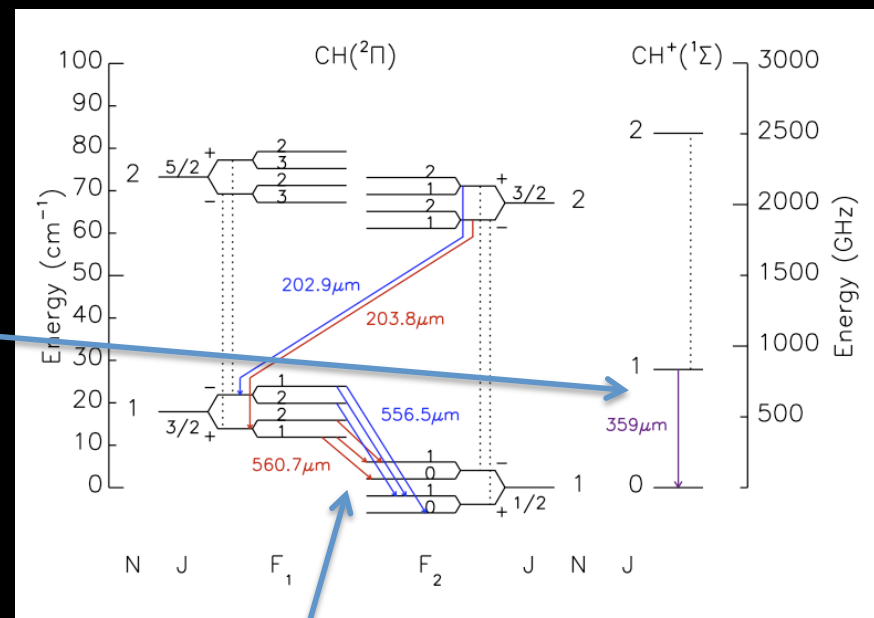
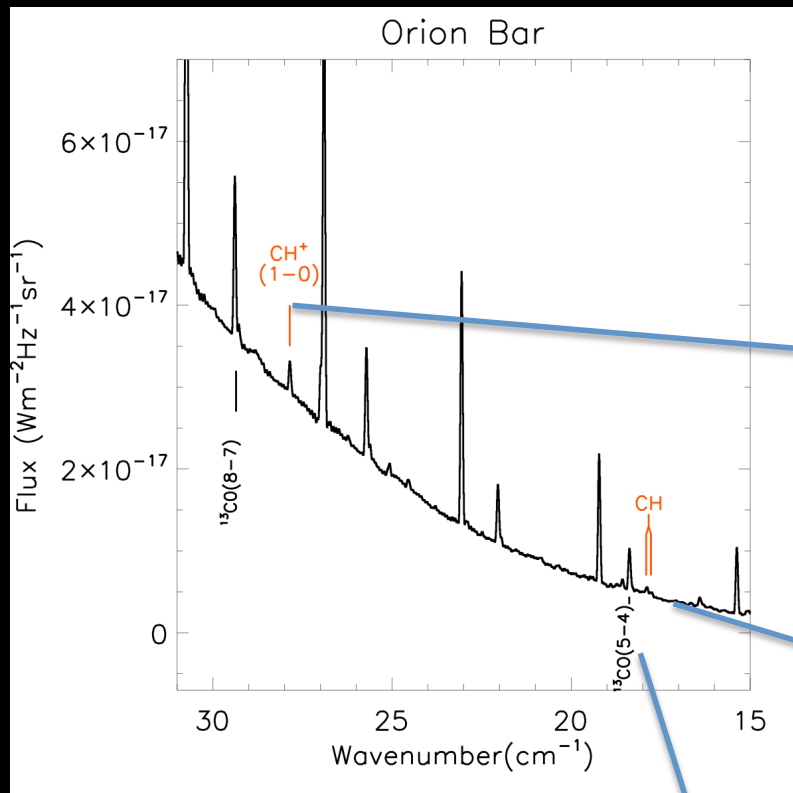
CH⁺ with SPIRE FTS in Orion Bar



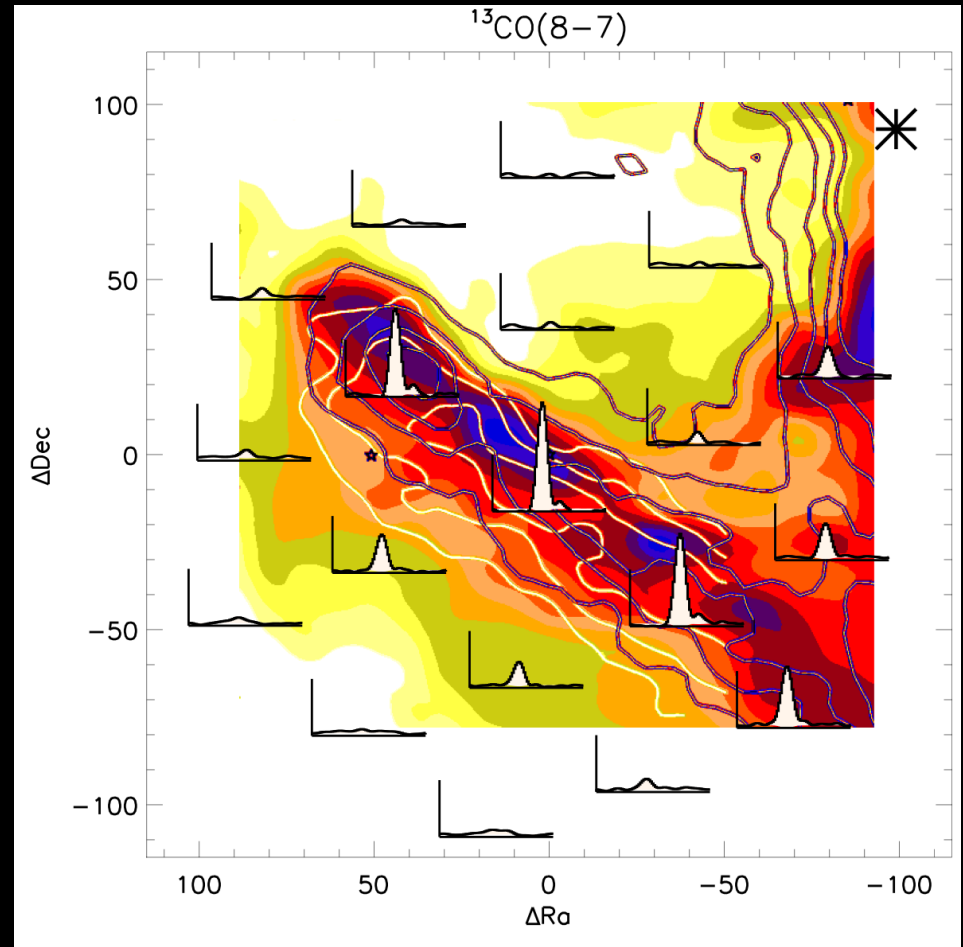
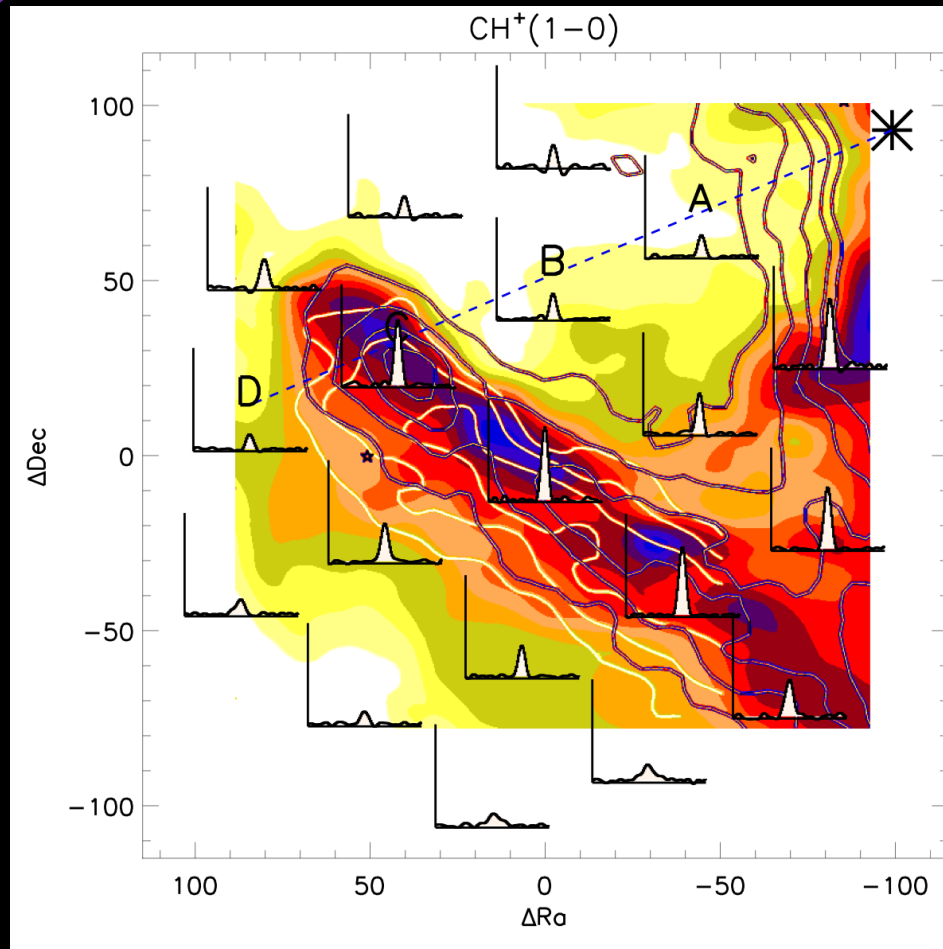
Orion Bar

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CH⁺ and CH with SPIRE FTS in Orion Bar



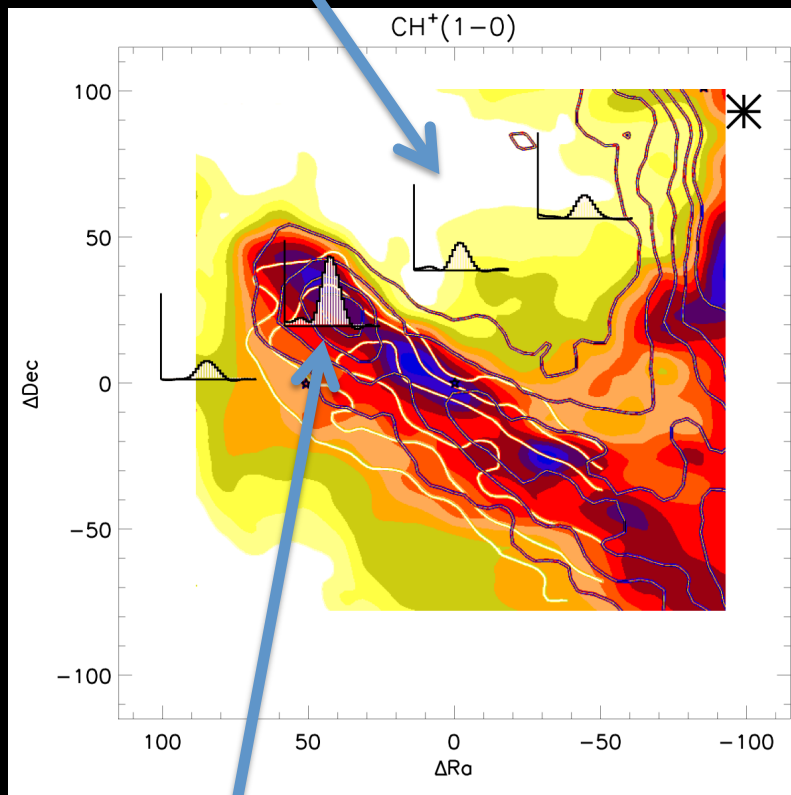
CH⁺ in Orion



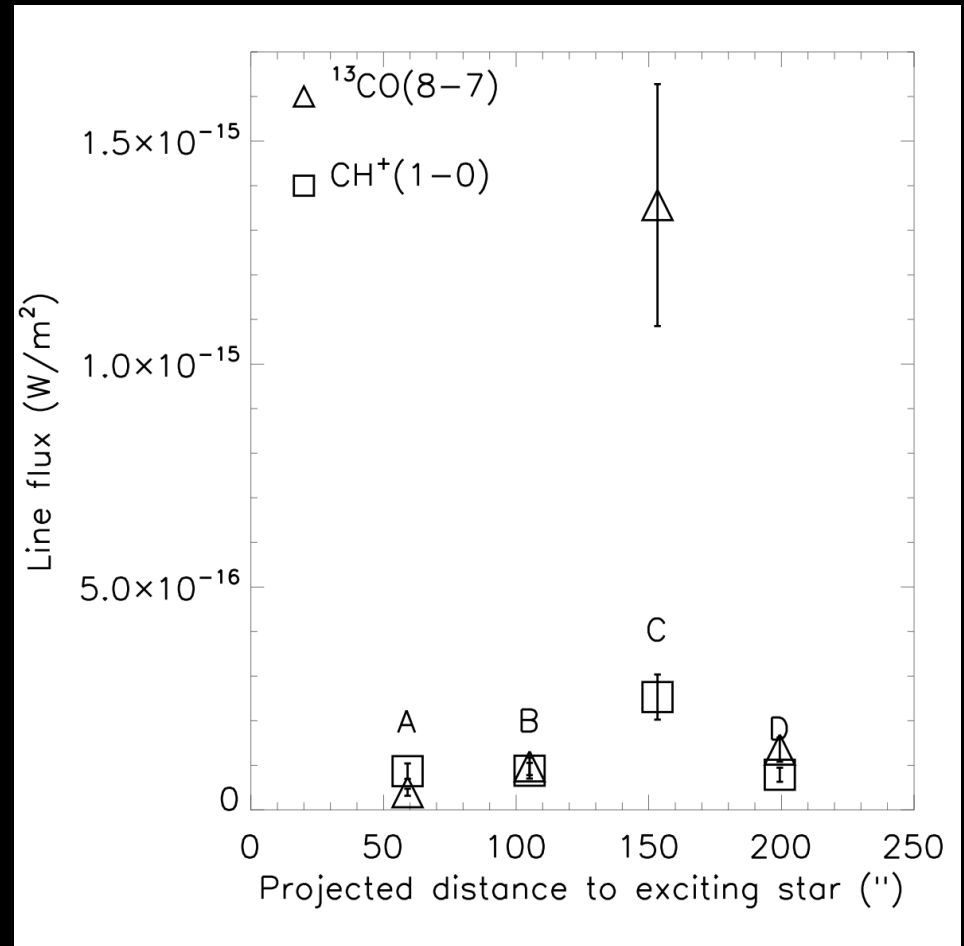
Lis et al, 1998

CH⁺ in Orion Bar

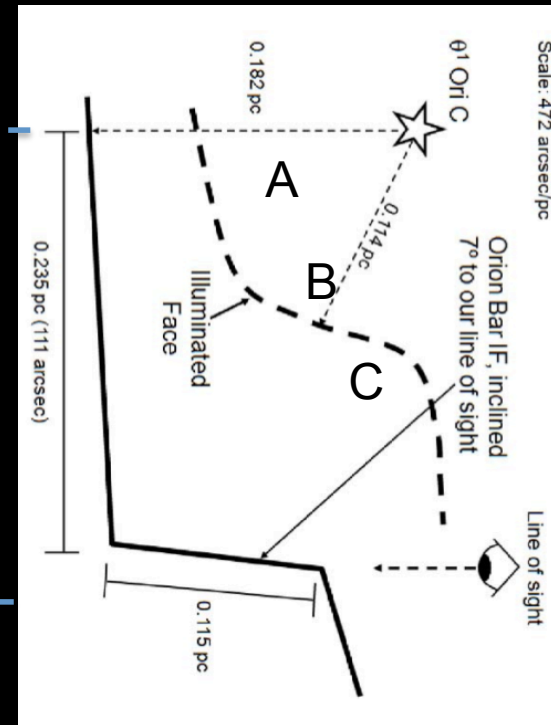
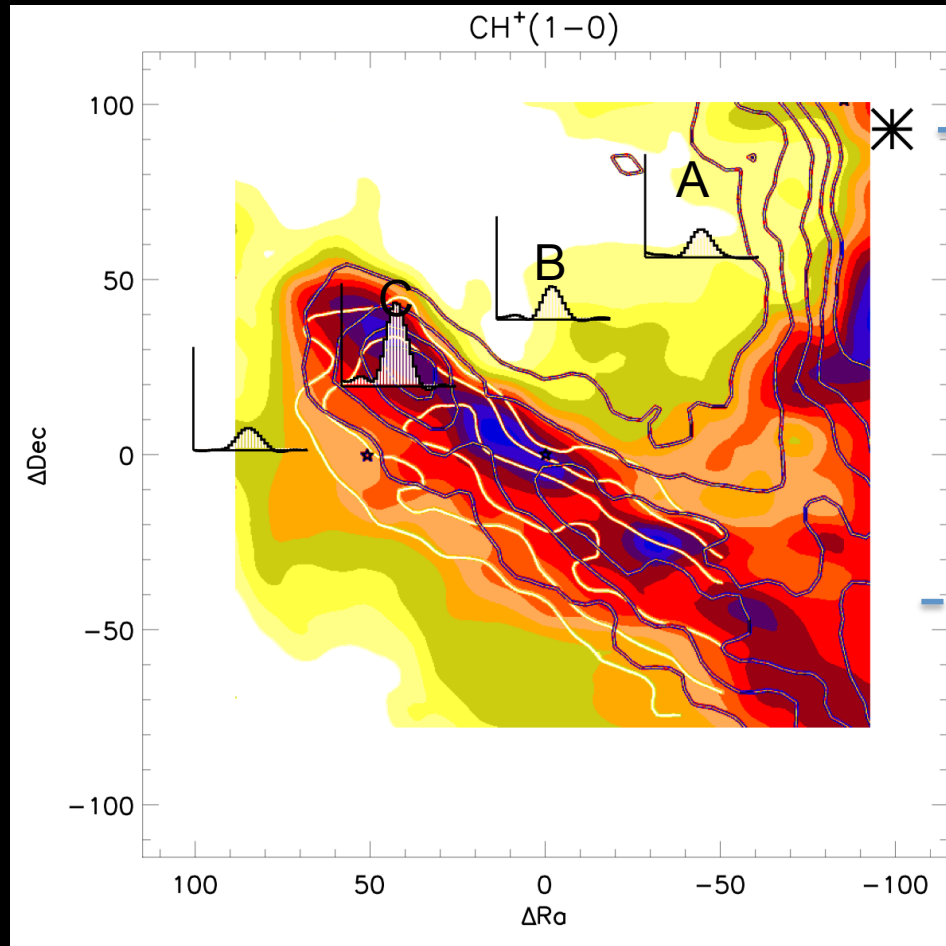
$1.9 - 3.8 \times 10^{12} \text{ cm}^{-2}$ (50-200K)



$5.5 - 11 \times 10^{12} \text{ cm}^{-2}$ (50-200K)

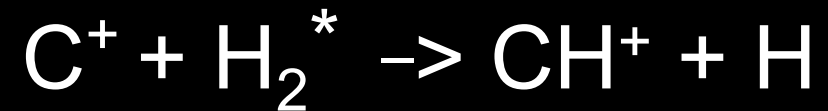
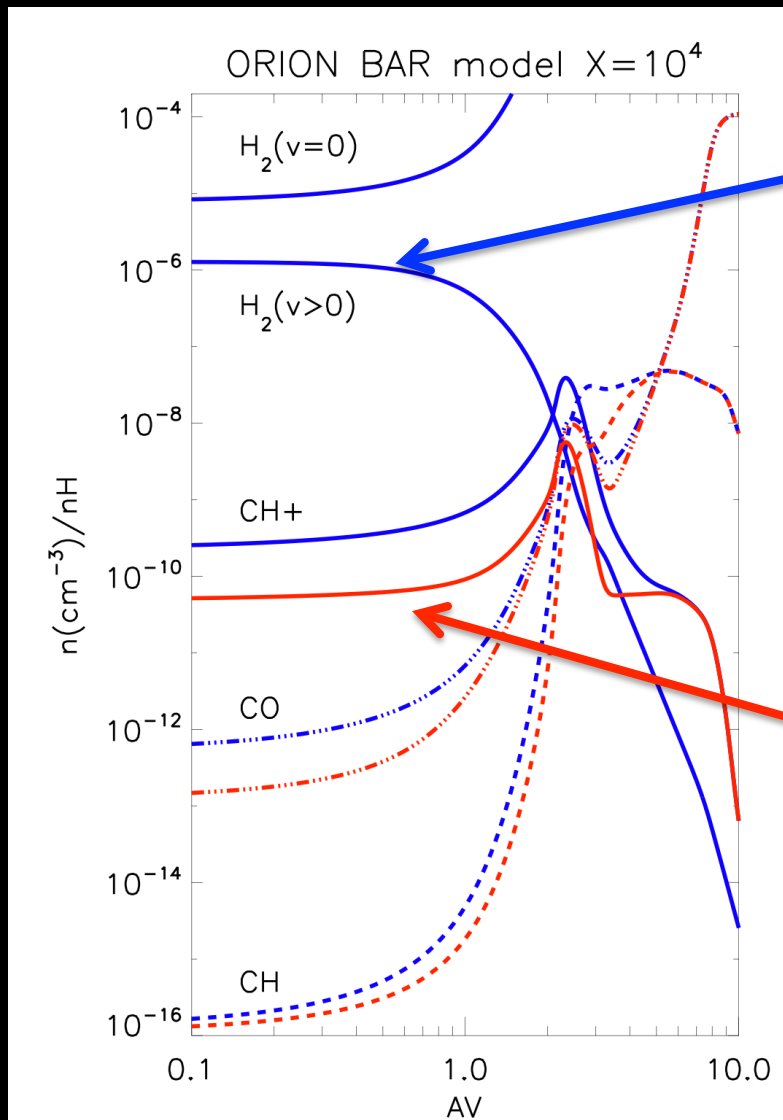


CH⁺ in Orion Bar

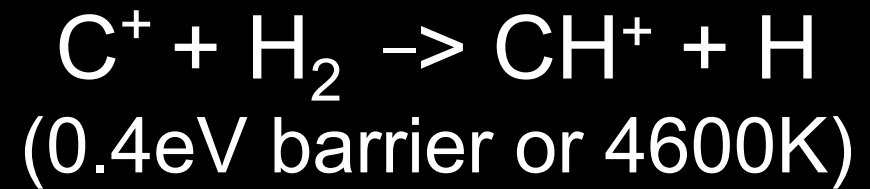


Pellegrini et al, 2009

Orion PDR modelling



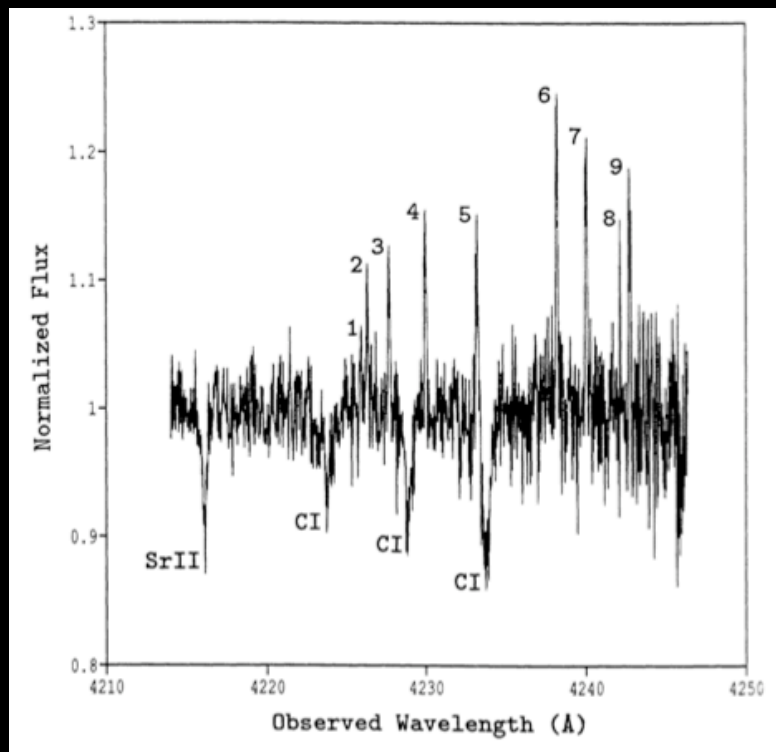
Hierl et al. 1997



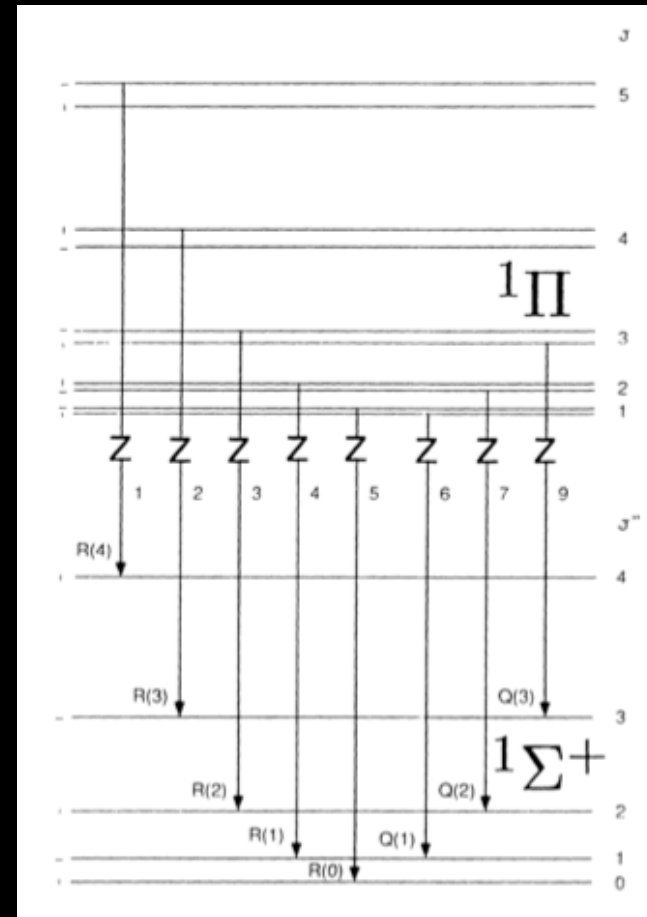
Meudon PDR Code : LePetit et al. 2006,
Agundez et al. 2010, Habart et al. 2010

Work in progress...

- PDR Modeling including detailed physical param for CH⁺ to examine the excitation (in the rotational levels)



Waelkens et al., 1992



Balms et al., 1993

Work in progress...

❑ These data represent only few min int time, a fully sampled map will be investigated

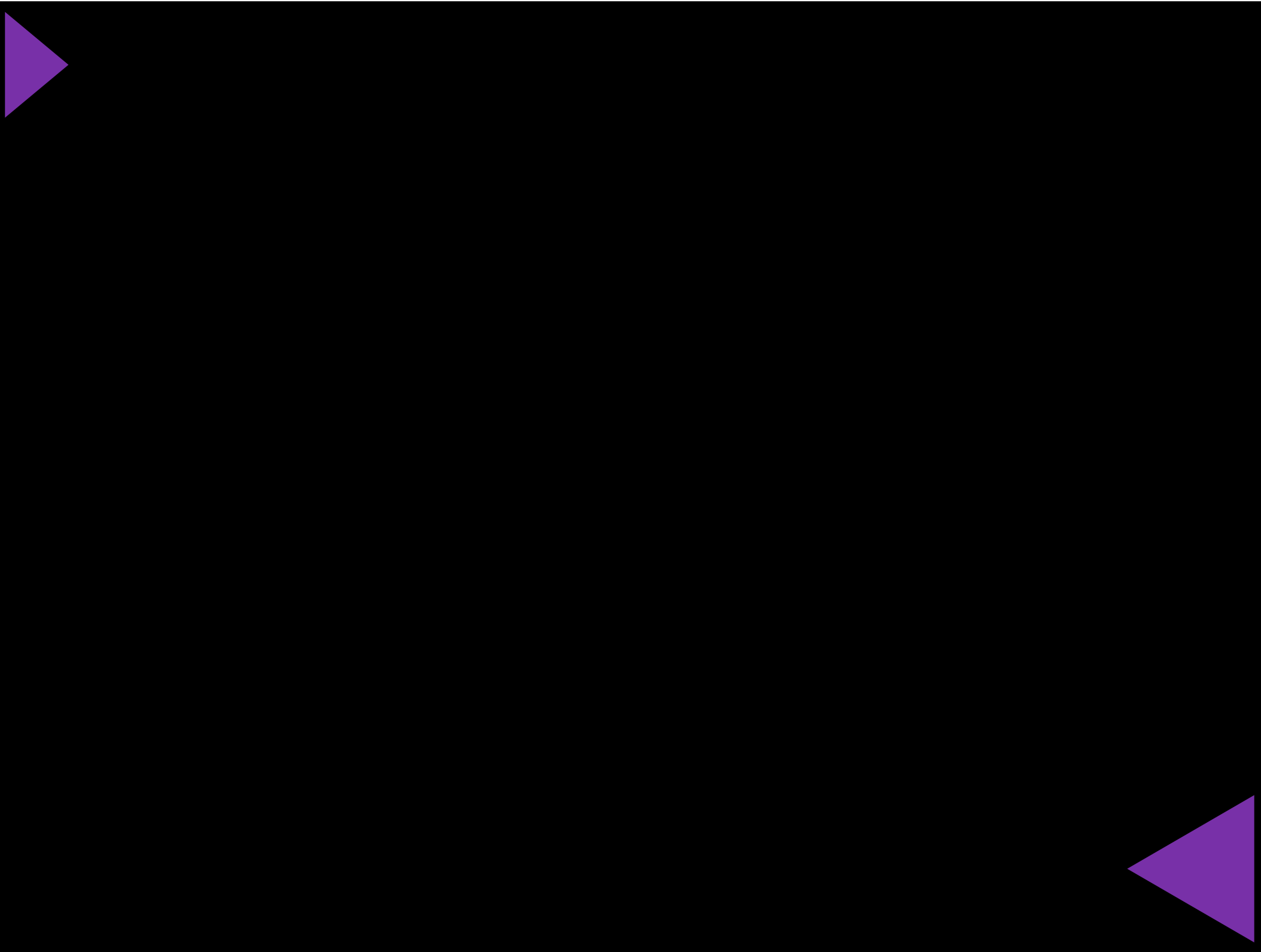
❑ Should be associated to HIFI data

➡ P1.03 PRISMAS Observations of the Methylidyne Ion (CH⁺):
coupling Turbulence and Chemistry *Falgarone, E.; et al.*

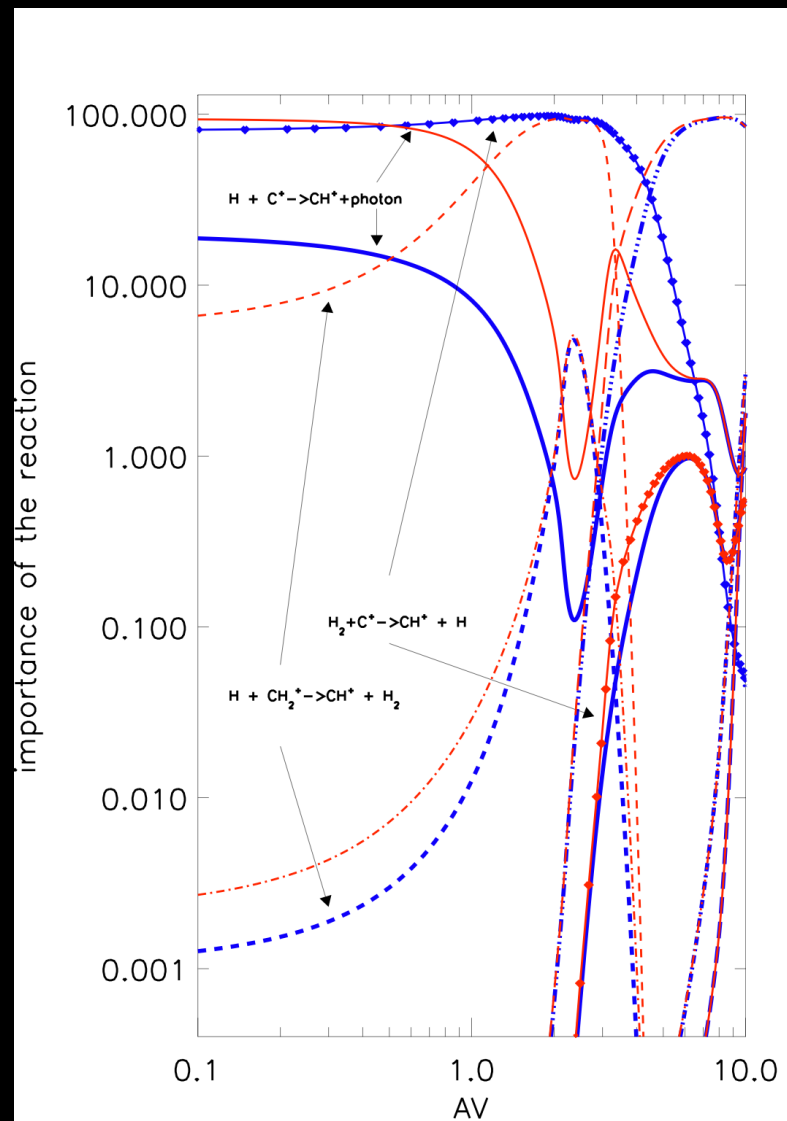
P1.05 Herschel/HIFI Observations of the Methylidyne Ion CH⁺ in
DR21 *Gerin, M.; et al.*

❑ SPIRE FTS and HIFI complementary (wavelength coverage, mapping, HR obs.)

❑ ➡ [Naylor et al., 2010, A&A special issue](#)



Orion PDR modeling



Meudon PDR Code : LePetit et al. 2006,
Habart et al. 2010

Orion : CH on the Bar

