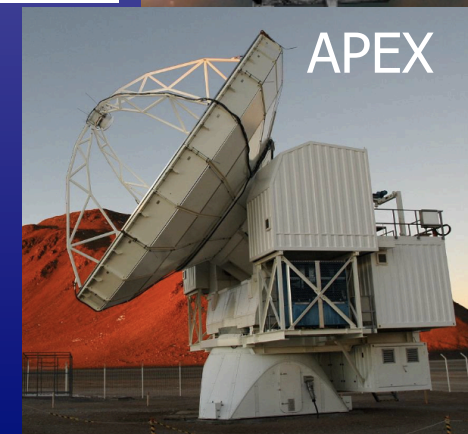
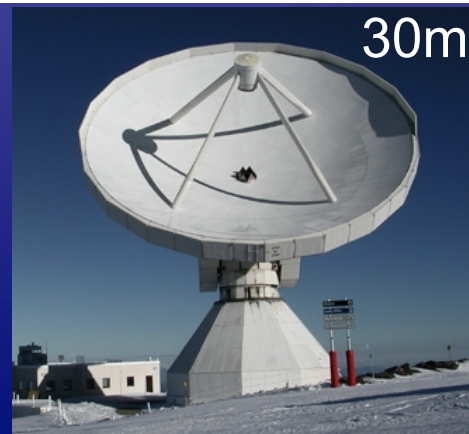
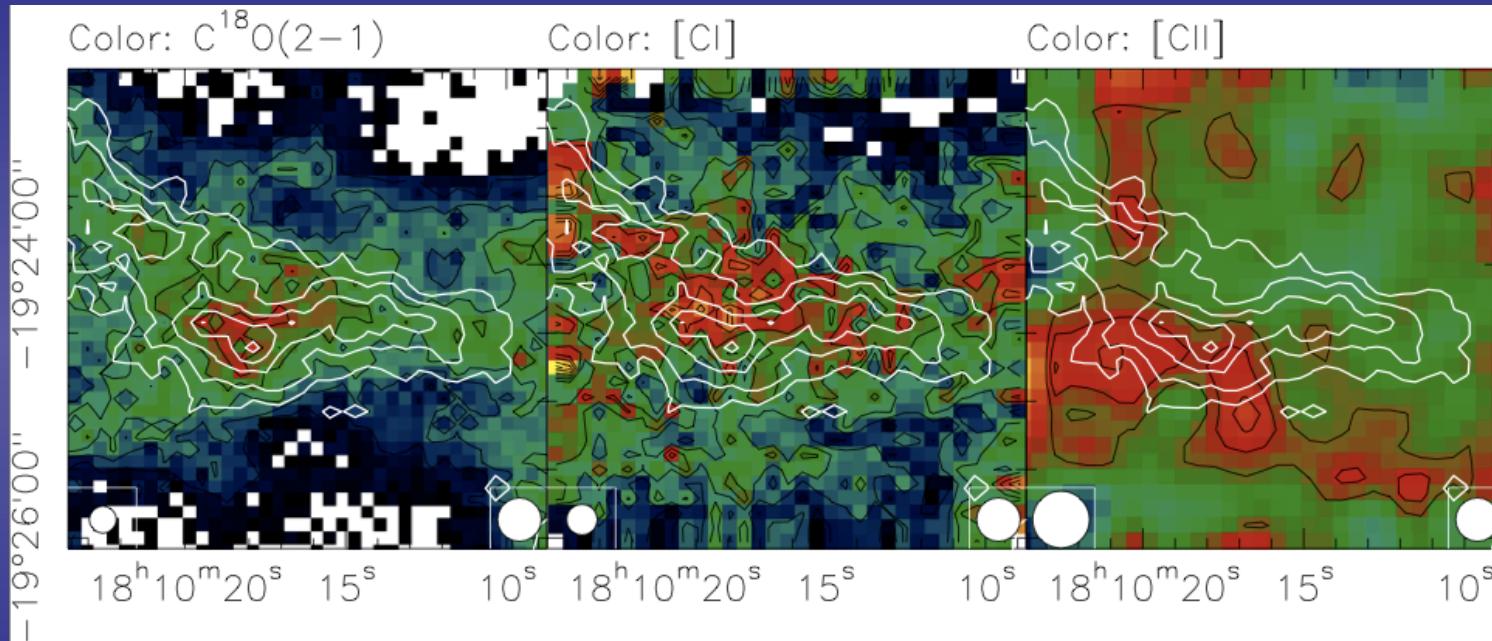


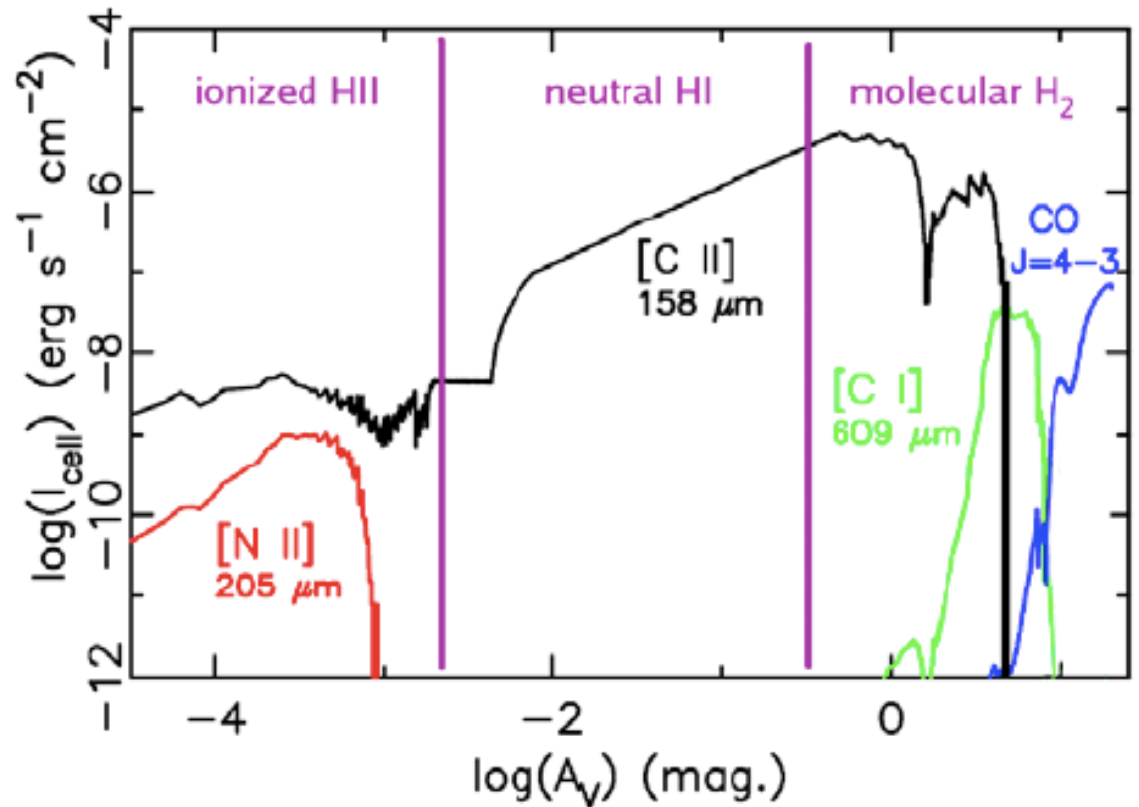
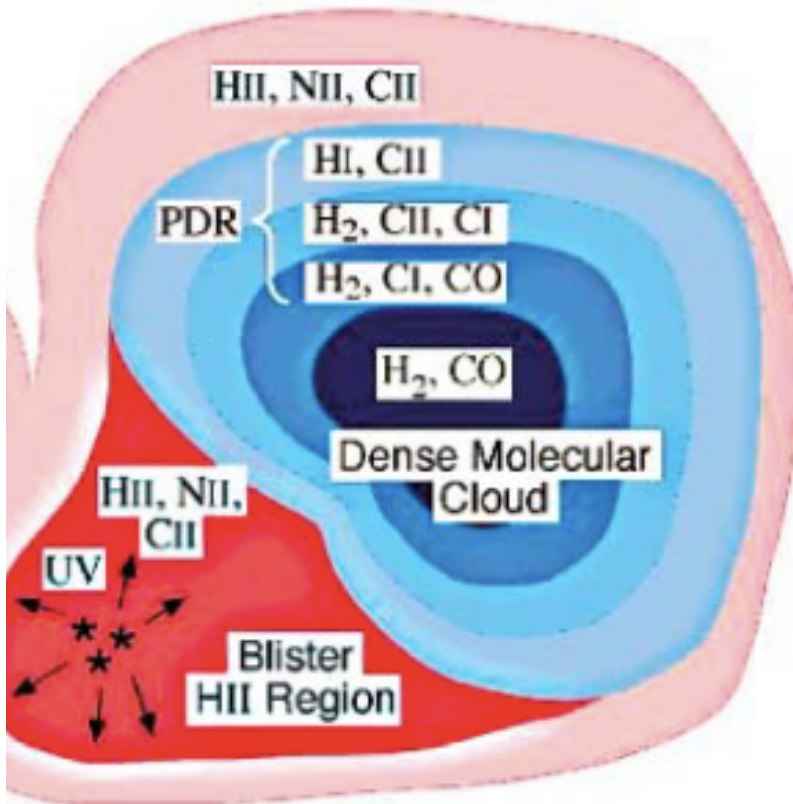
The carbon budget and formation signatures of molecular clouds

Henrik Beuther, MPIA Heidelberg

In collaboration with: Sarah Ragan, Hendrik Linz, Thomas Henning, Markus Nielbock, Oliver Krause, Volker Ossenkopf, Juergen Stutzki, Peter Schilke, Simon Glover, Rolf Guesten



Carbon phases during star formation



During molecular cloud formation: $[CII] \rightarrow [CI] \rightarrow CO$

Courtesy: Juergen Stutzki

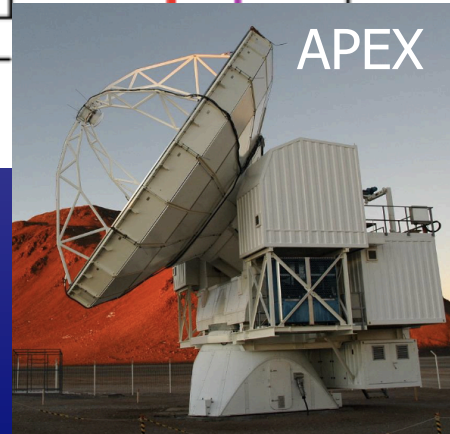
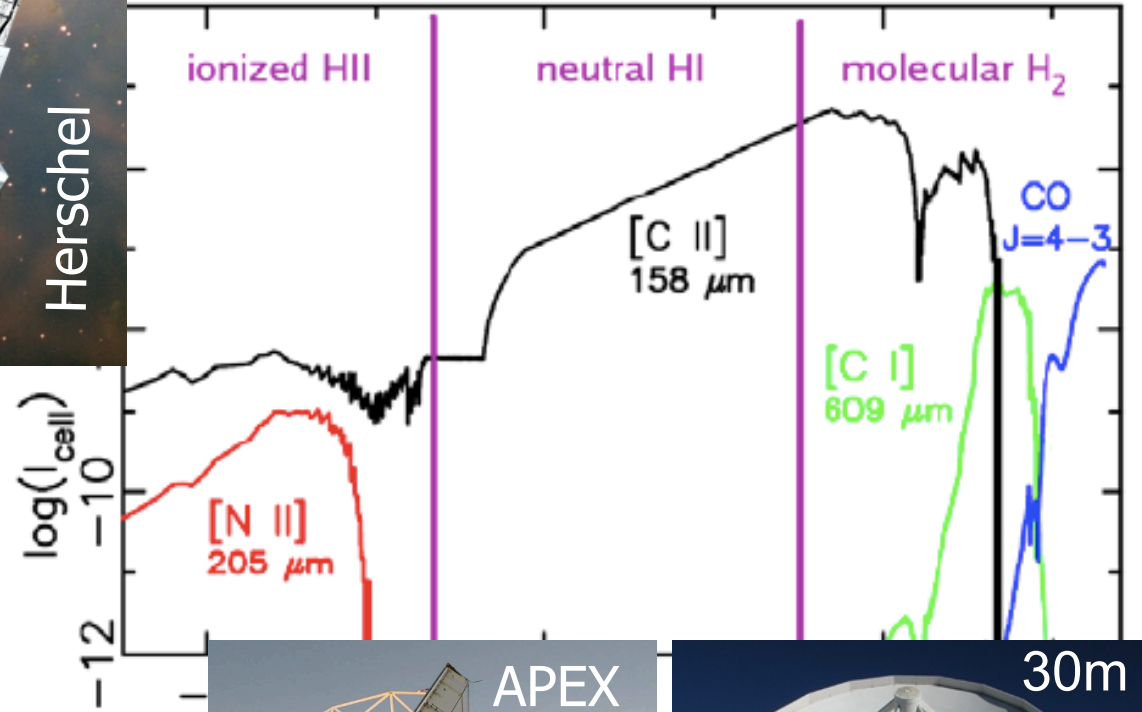
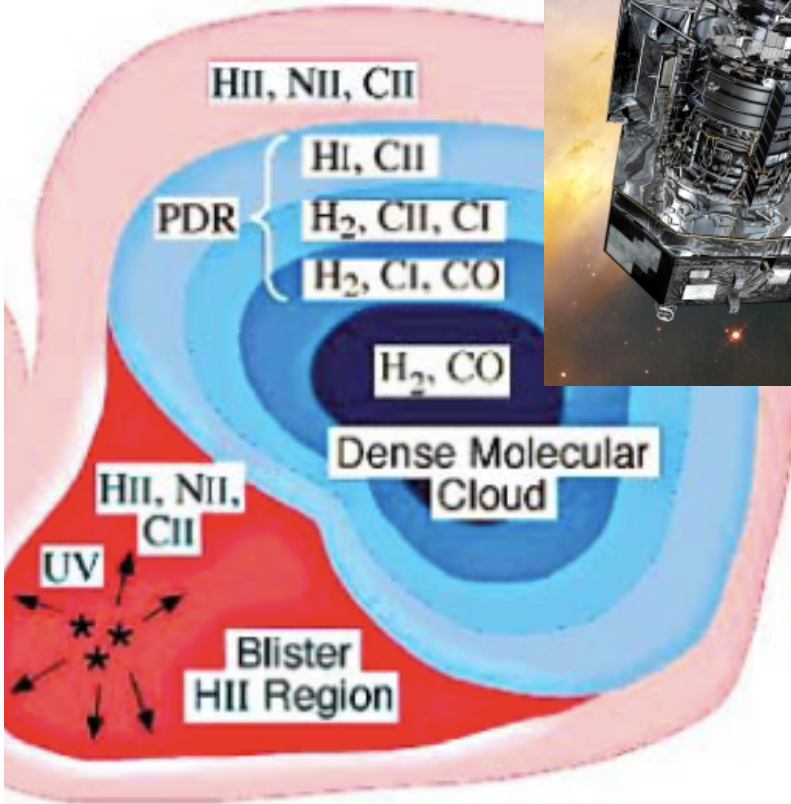
Carbo



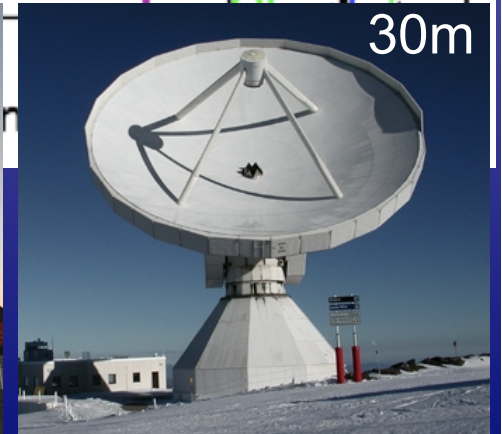
Herschel



Sofia



APEX

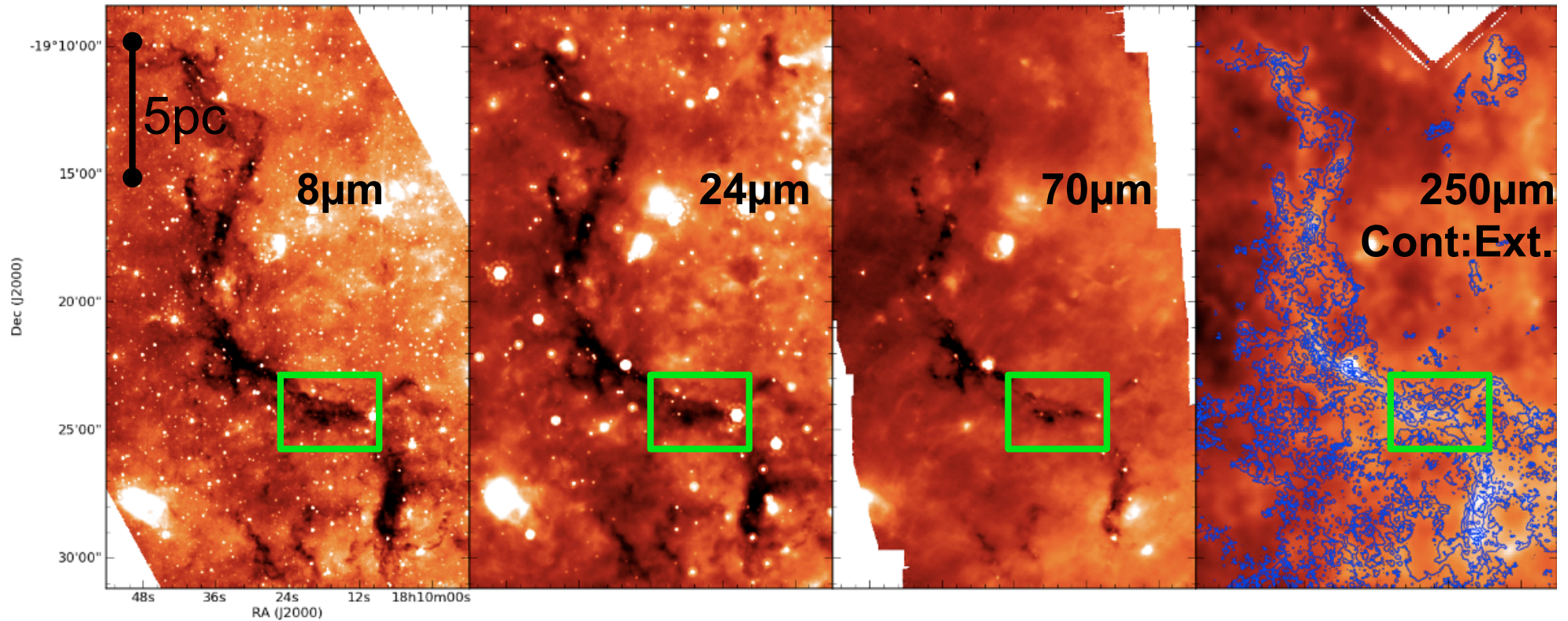


30m

All observable at a spatial resolution between 11" and 13"
→ <0.2pc at 3kpc distance

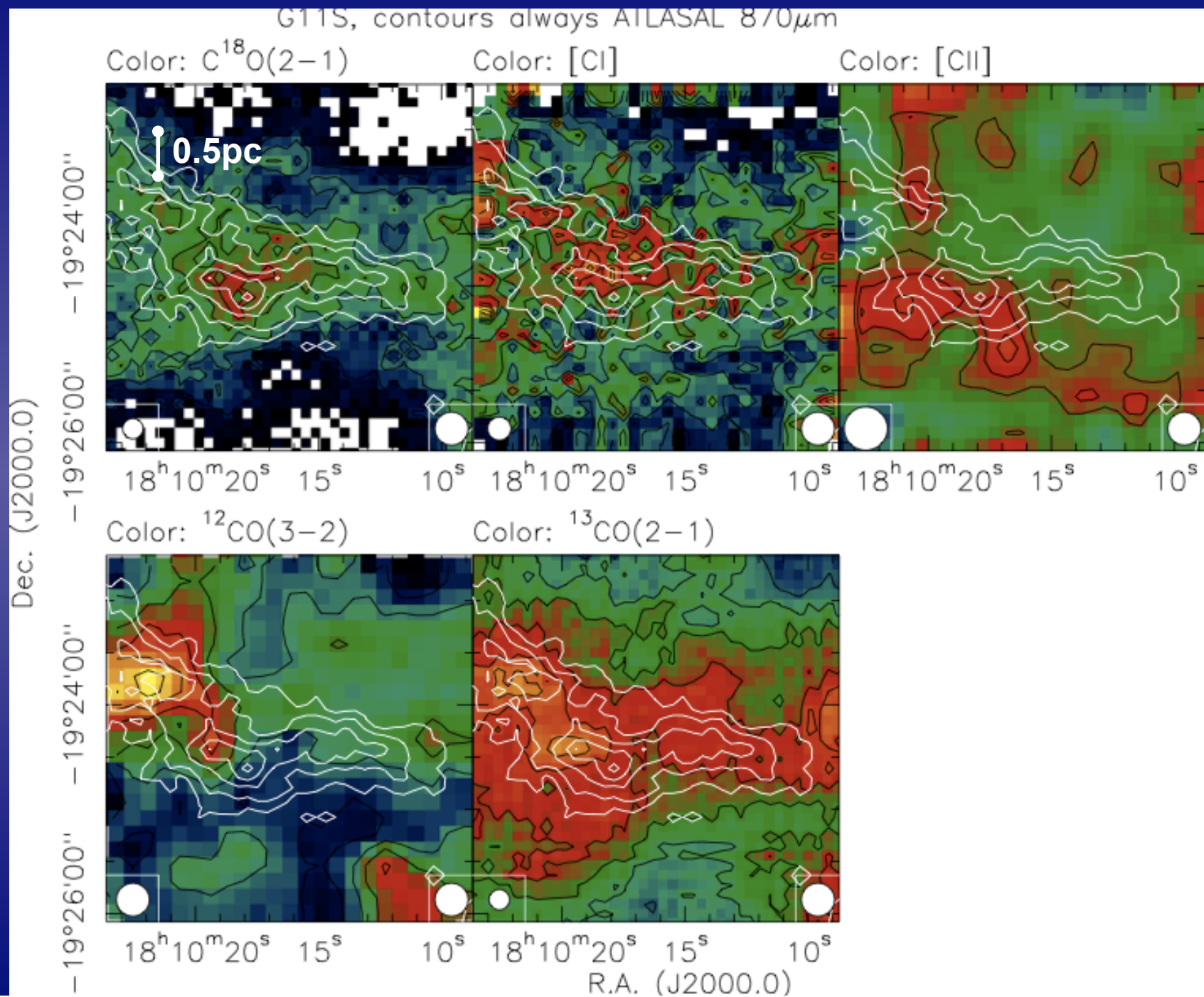
Courtesy: Juergen Stutzki

The G11.11 complex – a.k.a. The Snake

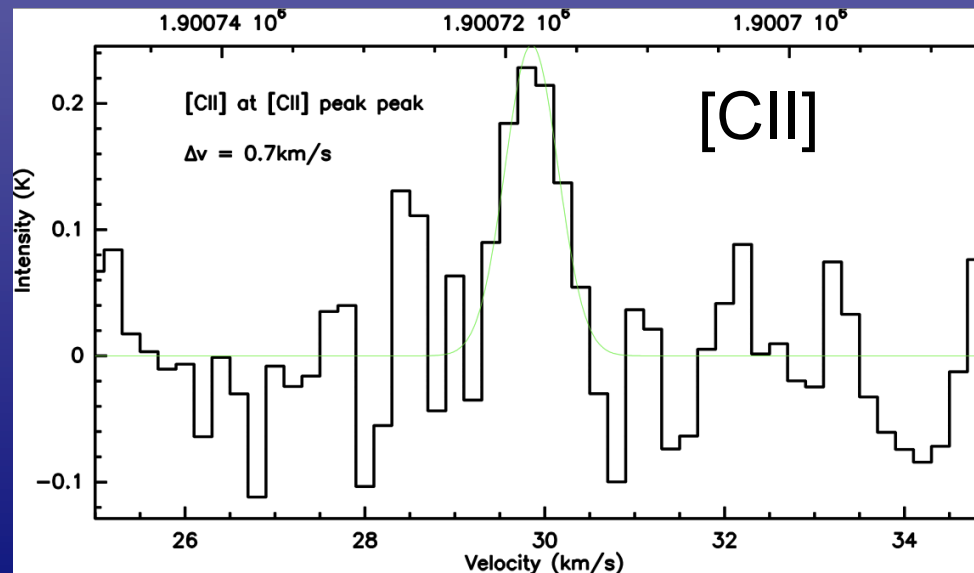
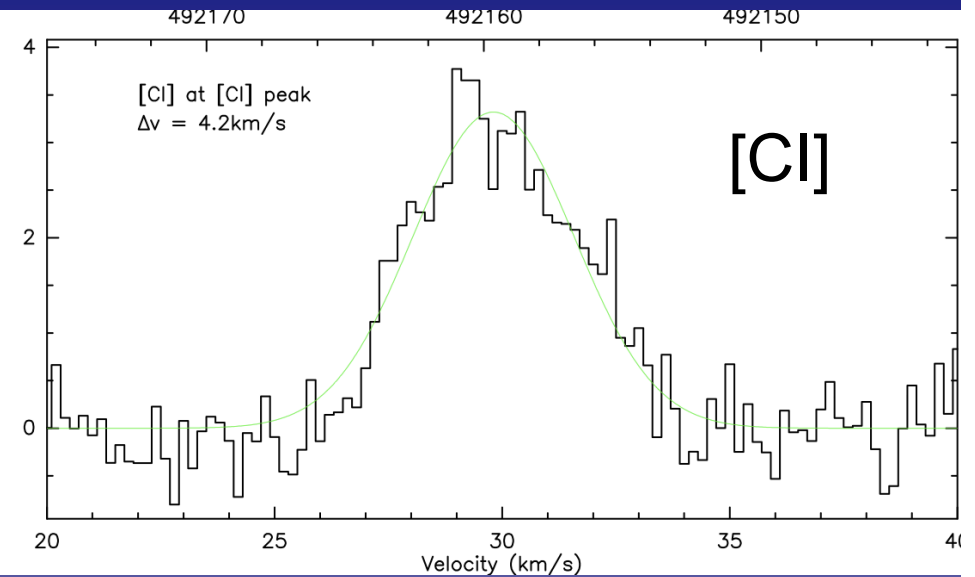
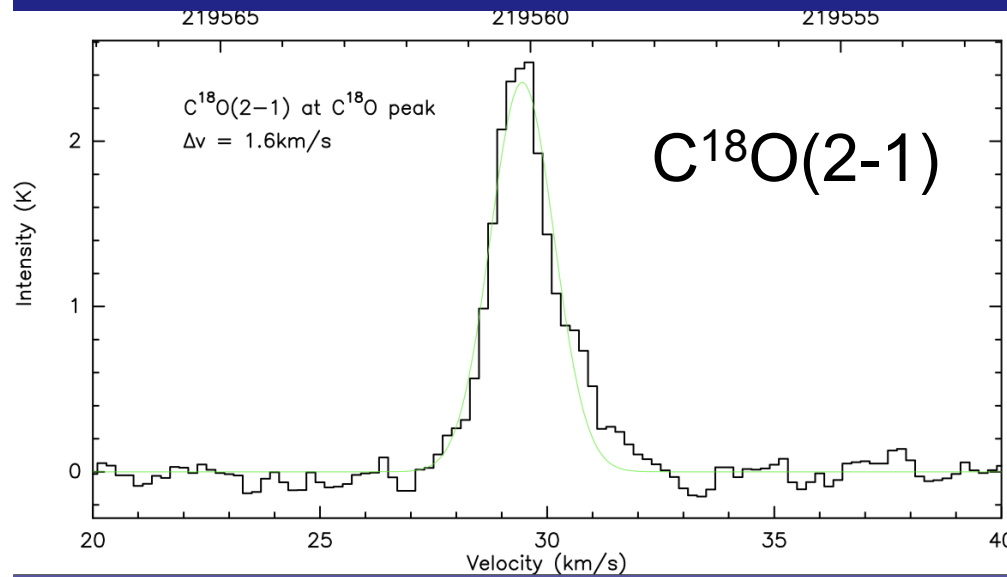


Henning et al. 2010, courtesy: Sarah Ragan

Carbon structure in G11S



Linewidths of carbon components

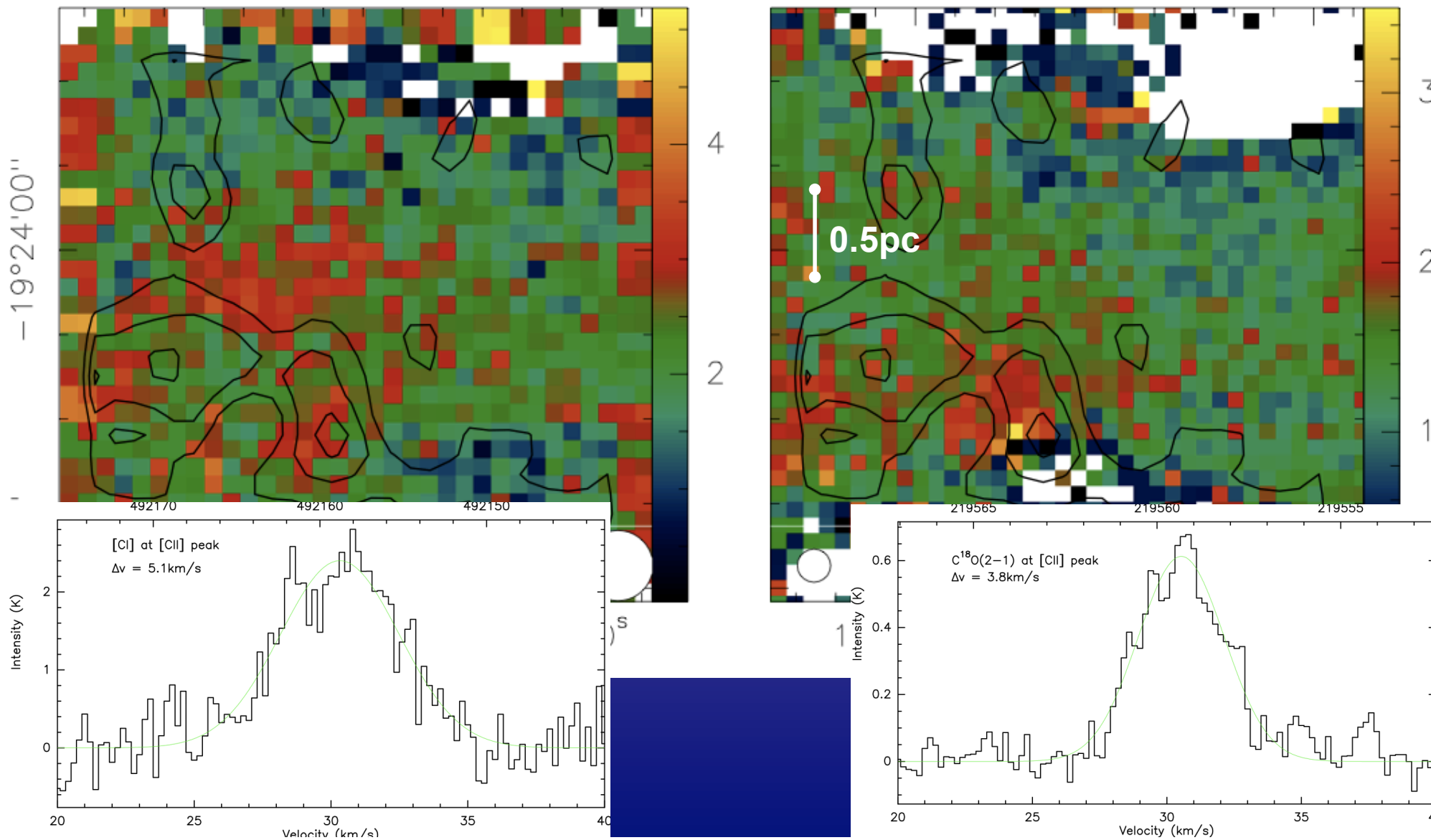


2nd moment maps of C¹⁸O and [CI]

Contours: Integrated [CII] emission

Color: [CI] 2nd moment

Color: C¹⁸O(2-1) 2nd moment



Parameters of carbon constituents

Cloud mass $\sim 8000 M_{\text{sun}}$

Mass molecular carbon $\sim 0.81 M_{\text{sun}}$

Mass atomic carbon $\sim 0.056 M_{\text{sun}}$

Mass ionized carbon: @20K $\sim 0.18 M_{\text{sun}}$

@50K $\sim 0.011 M_{\text{sun}}$

@100K $\sim 0.005 M_{\text{sun}}$

→ [CII] / [CI] / CO @20K $\sim 3 / 1 / 14$

[CII] / [CI] / CO @50K $\sim 1 / 5 / 70$

[CII] / [CI] / CO @100K $\sim 1 / 11 / 154$

Summary

- Carbon in ionized, atomic and molecular form observable at high spatial resolution.
- [CI], C¹⁸O correlate with dust emission
- [CII] only at cloud edge
- Relative abundances can be constrained
- Kinematics still a puzzle
- More to come with SOFIA

