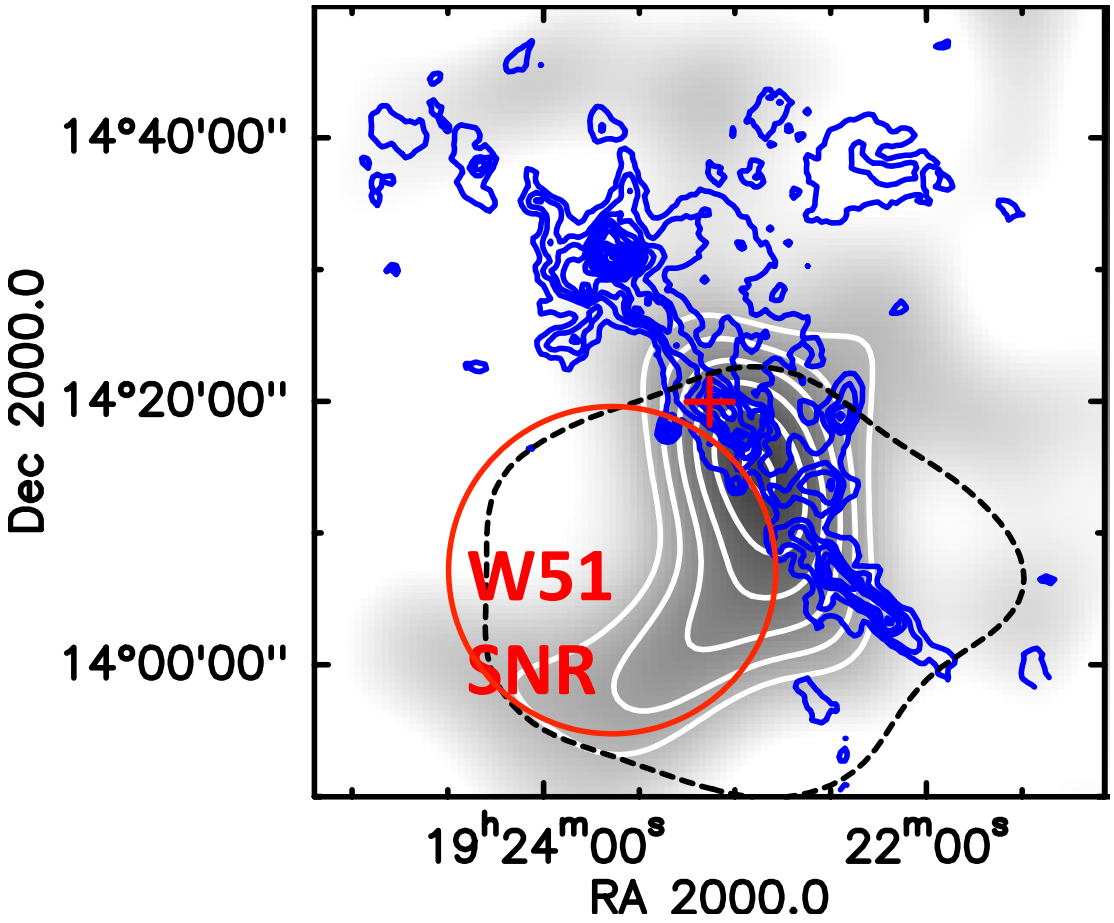
Evidence of the passage of a SNR shock



Gaëlle Dumas

IRAM

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C. Ceccarelli,

P. Hily-Blant,

G. Dubus,

T. Montmerle,

S. Gabici

Outline

1. Introduction: cosmic-rays/ISM interaction
2. The W51C Complex
3. IRAM 30m and PdBI observations
4. Conclusions

Cosmic-ray/ISM

- In dense clumps:
  - UV and X-ray photons cannot penetrate
  - CRs are the major drivers of chemistry

Cosmic-ray/ISM

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- **ionization** of atomic and molecular hydrogen
  - Production of H_3^+
  - ion/neutral chemistry

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- **Ionization**
- **Drive the physical parameters:** T and P

Cosmic-ray/ISM

- In dense clumps:
  - UV and X-ray photons cannot penetrate
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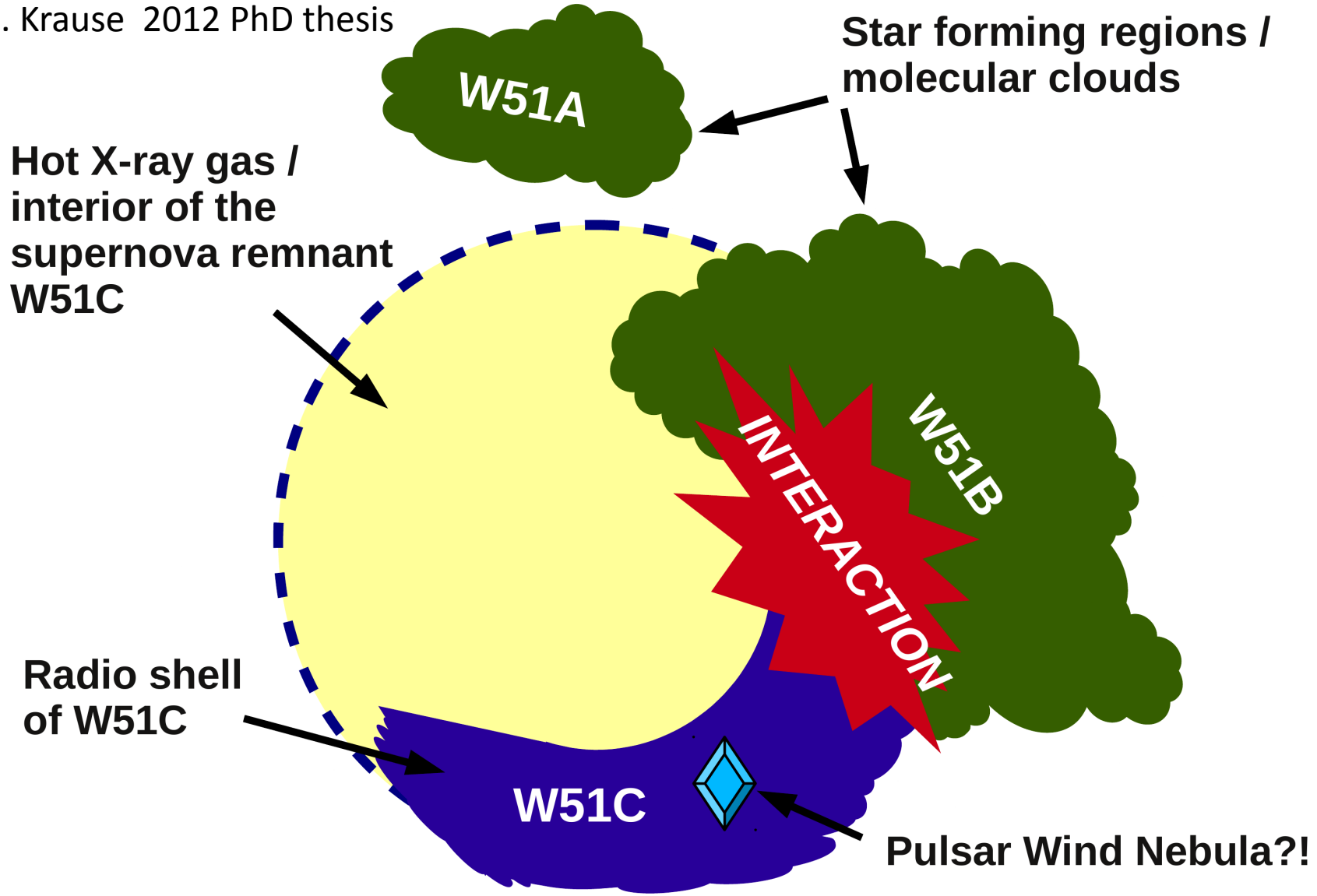
- **Ionization**
- **physical parameters:** T and P
- Destruction of **dust** particles

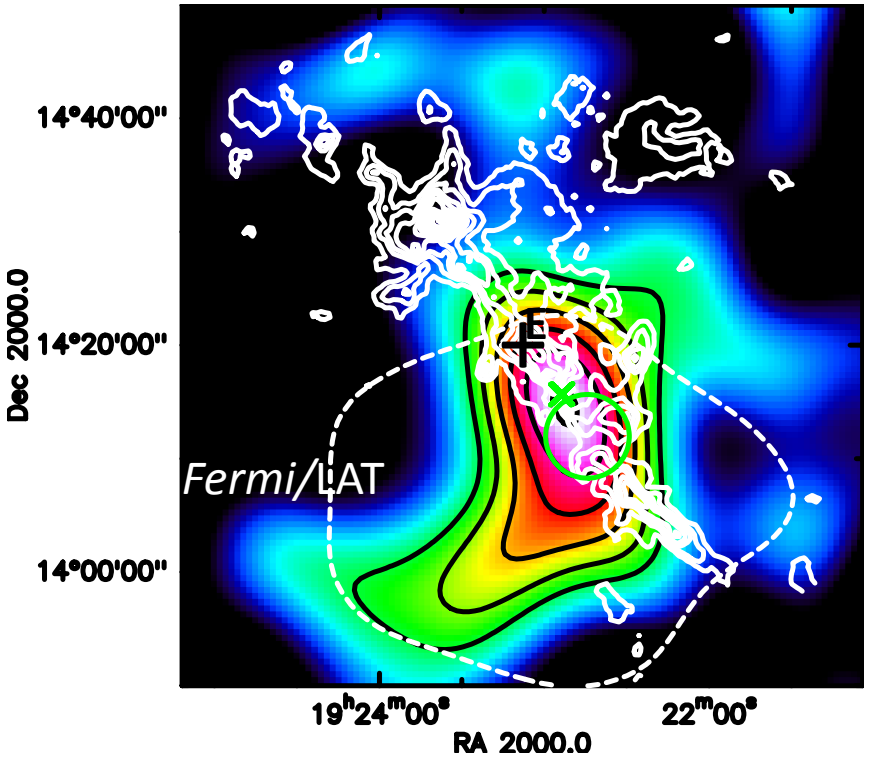
The W51 complex

From J. Krause 2012 PhD thesis

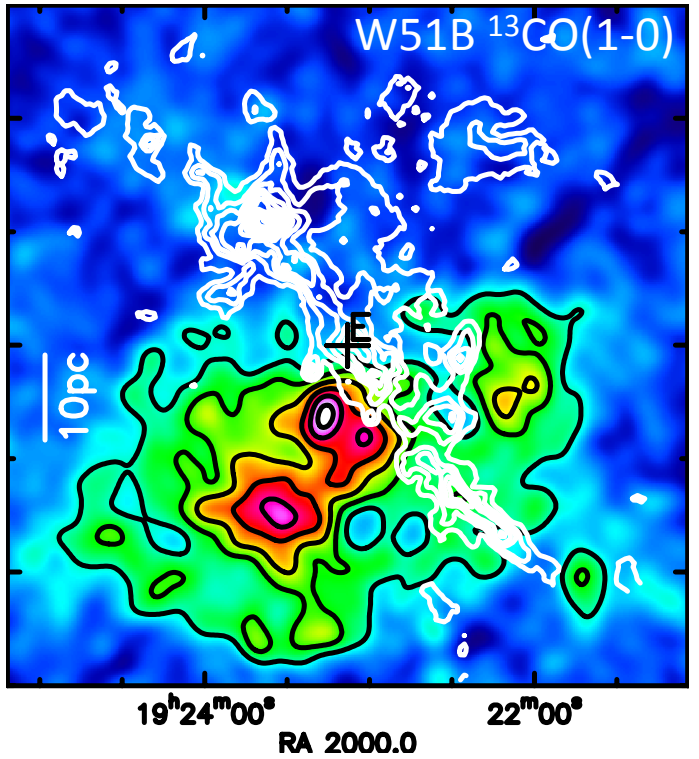


The W51 complex

MAGIC 300-1000 GeV (Aleksic et al. 12)



ROSAT 0.7-2.5 keV (Koo et al. 02)



- W51A &W51B molecular clouds; W51C SNR
- SNR in interaction with W51B (Koo et al. 97, Green et al. 97)
- γ-ray emission (*Fermi*/LAT; MAGIC)

CR ionization rate

Measurement of CR ionization rate ζ:

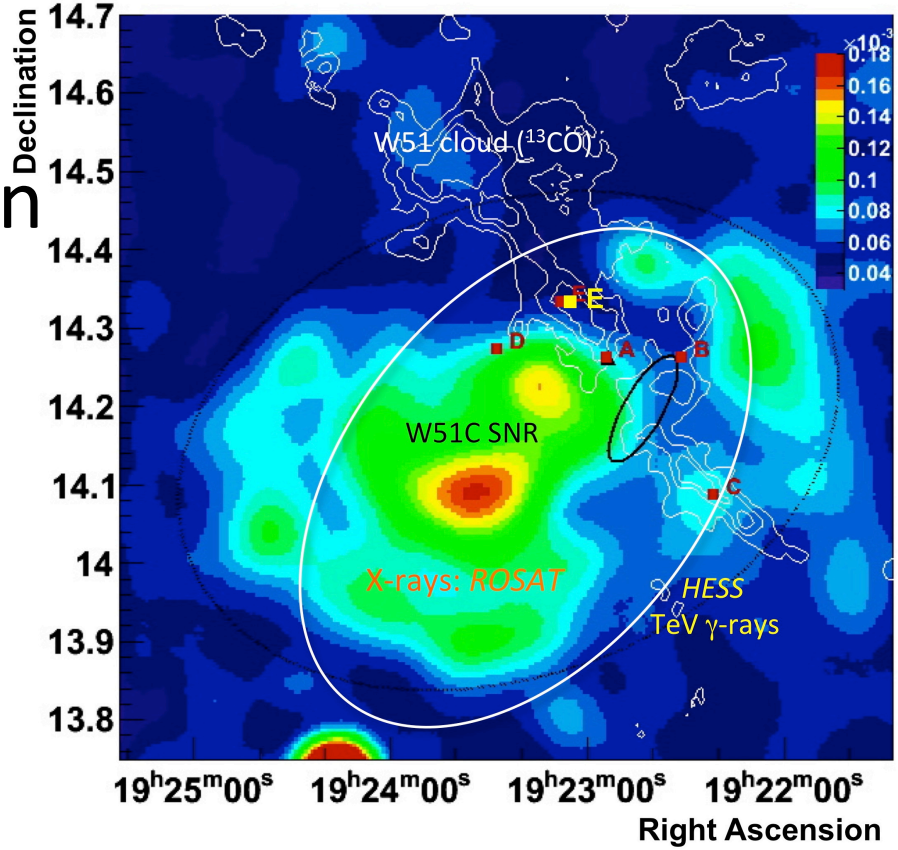
- Abundance of H_3^+:
- Direct measurement in diffuse cloud
- In dense cloud: observations of DCO+/HCO+ ratio *(Guelin et al 97)*

CR ionisation rate

Ceccarelli et al. 2011 ApJL 740

- IRAM 30m observations
- 5 positions in the interaction region of W51C and W51B
- Abundance ratios:

DCO^+ / HCO^+ in all 5 regions



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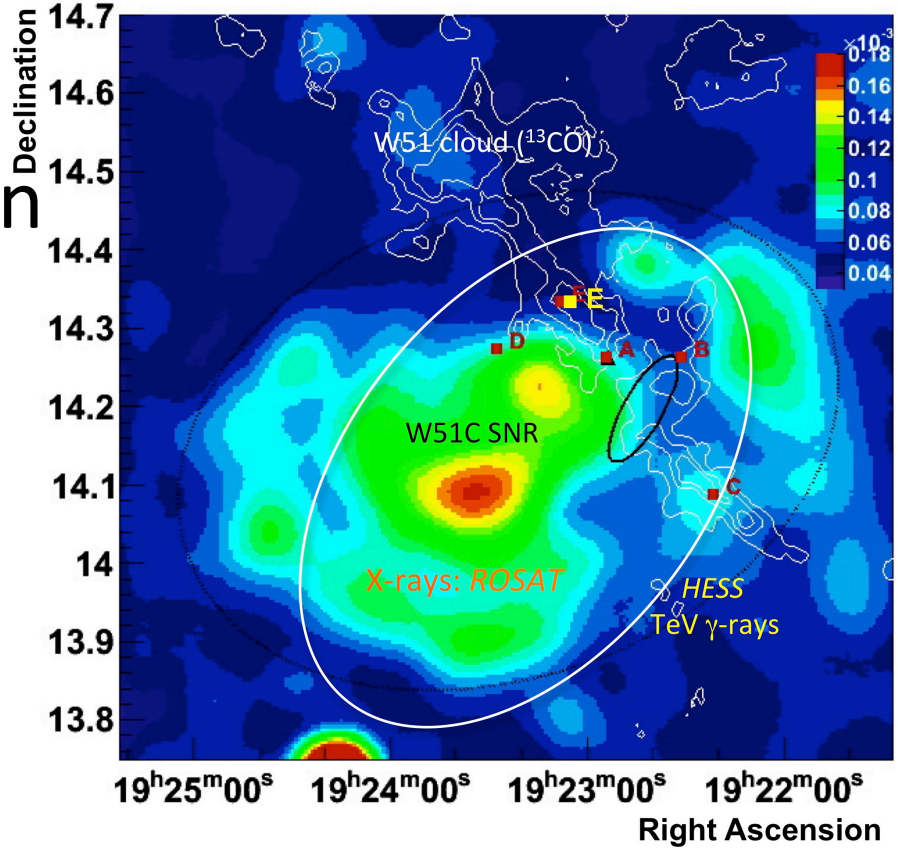

- **W51C-E**
  - $\zeta = 10^{-15}$ s^{-1} = 100 times larger than standard value
  - Presence of freshly accelerated CR

CR ionisation rate

- *Ceccarelli et al. 11*
  - IRAM 30m observations
  - high ionization rate in the W51C-E region due to CR

- *Cyganowski et al. 11*
  - IR and cm observations
  - Discovery of a protostar in close vicinity of W51C-E

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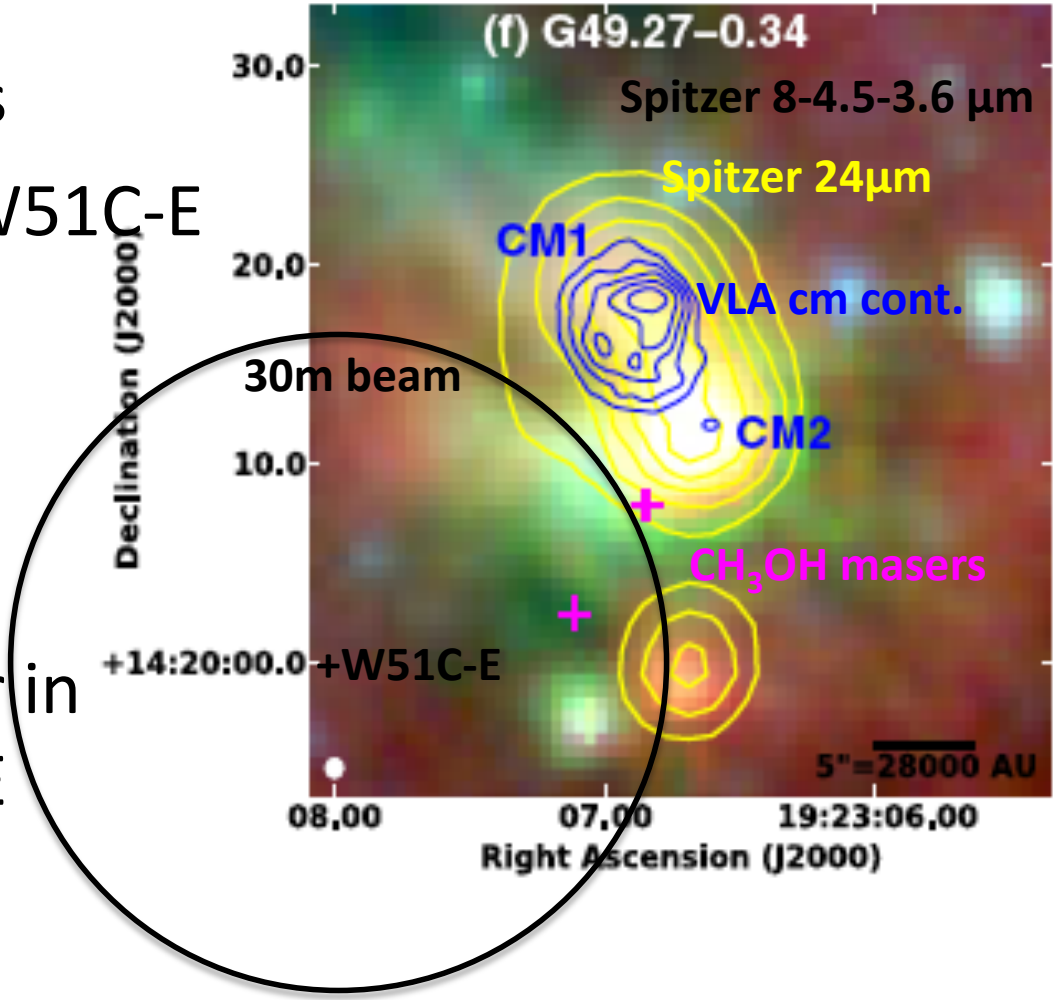

CR ionisation rate

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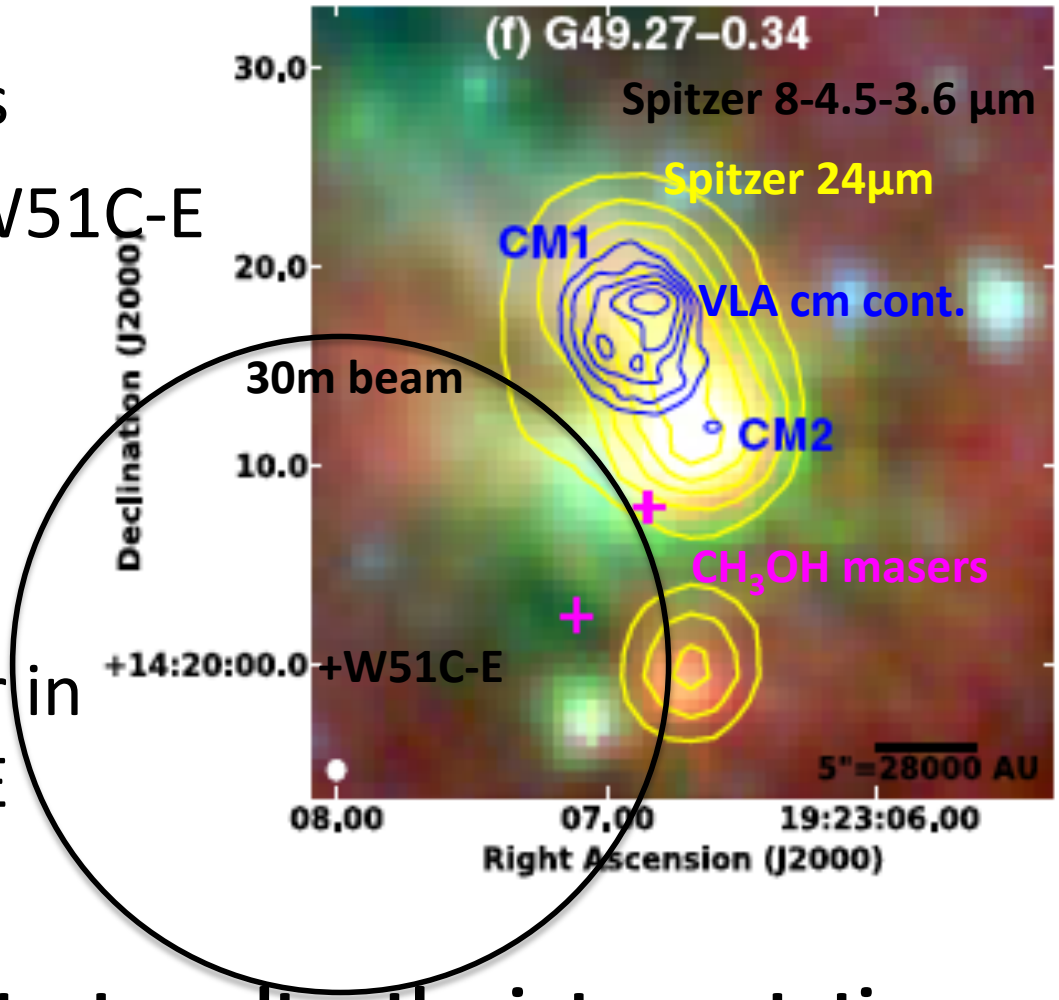
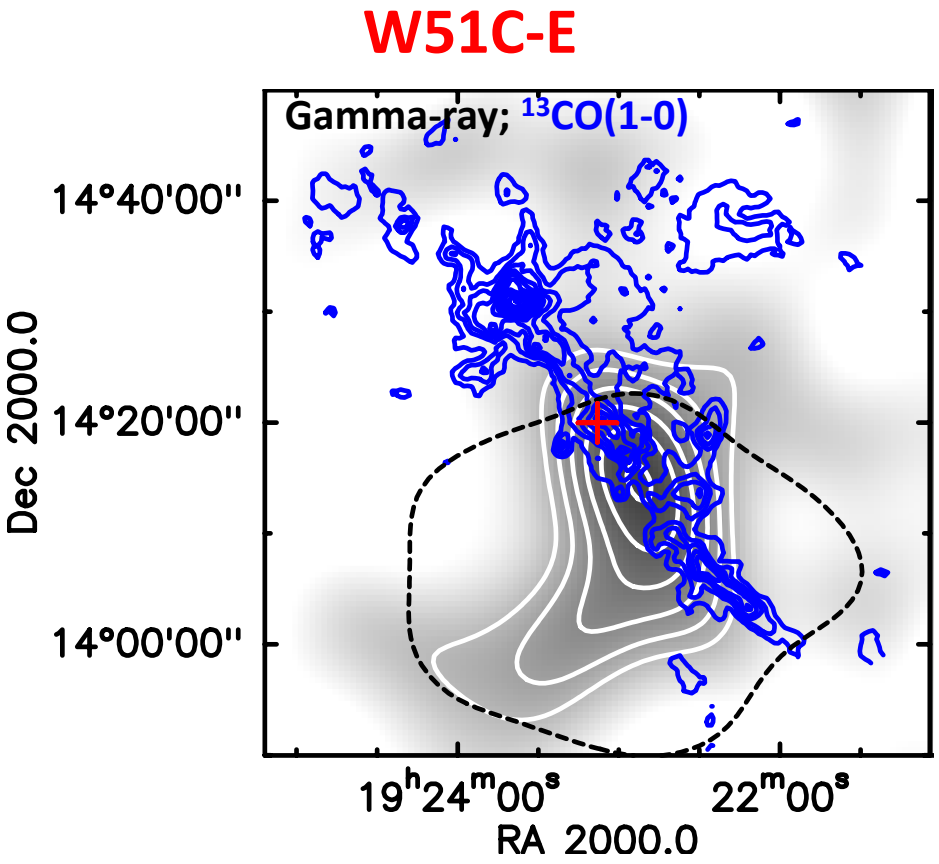


Could emission of this protostar alter the interpretation of the 30m observations?

PdBI Observations



- Compact emission in the 30m beam?
- Structure of the molecular gas?

- 144GHz: DCO^{+}, 4”x3”
- 87GHz: $H^{13}CO^{+}$, 7”x4”

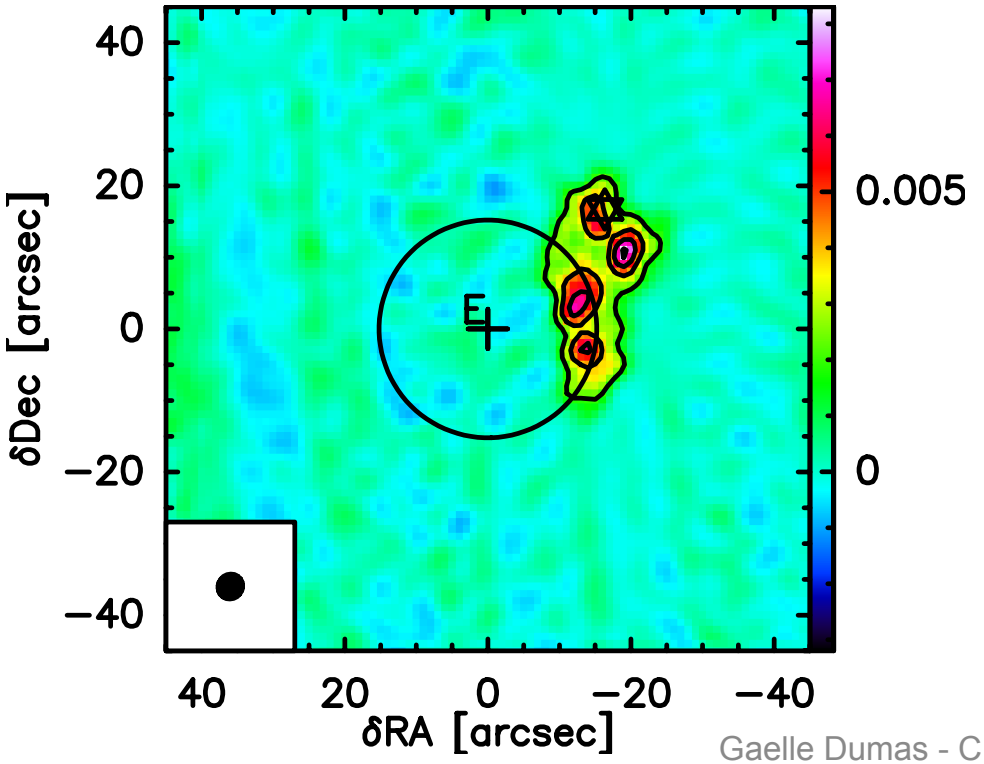
- rms ≈ 5mJy/beam

Continuum

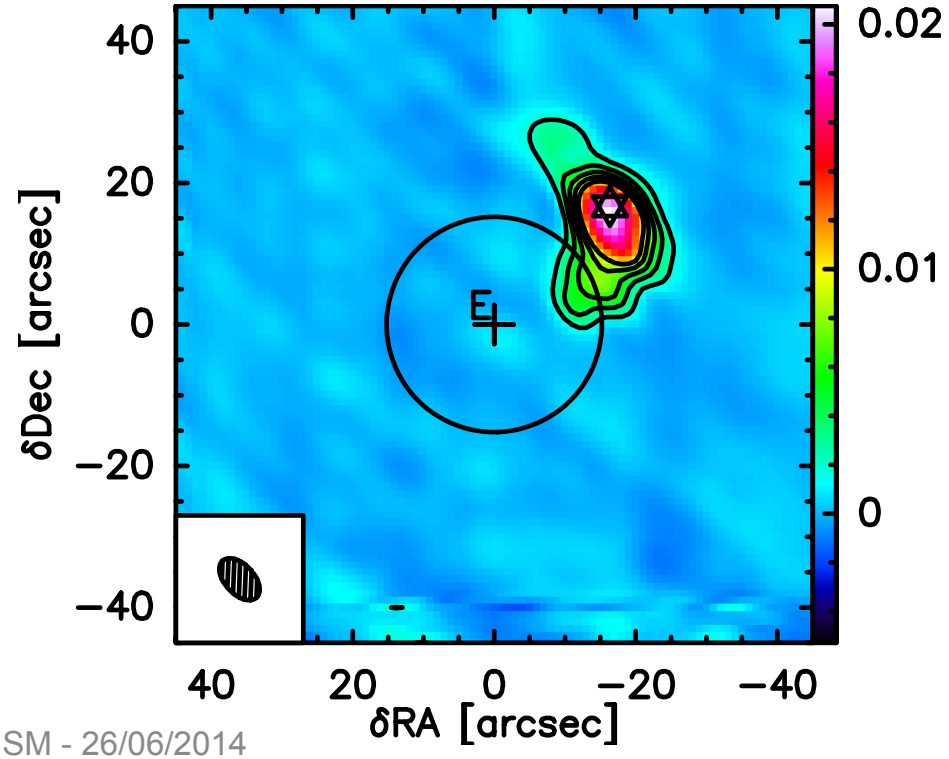
- Continuum emission at

  2mm: 144.1GHz and 3mm: 86.8GHz

2mm



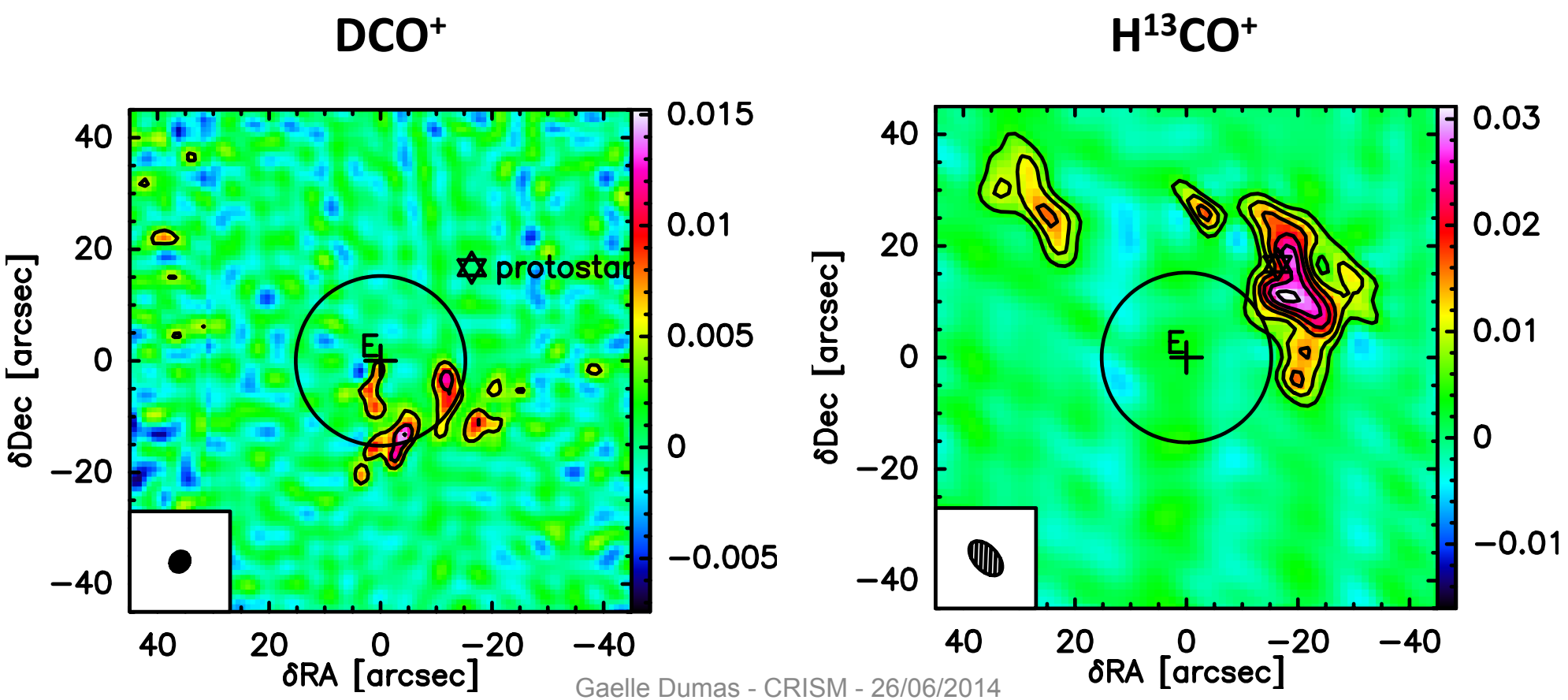
3mm



DCO^+ and $H^{13}CO^+$

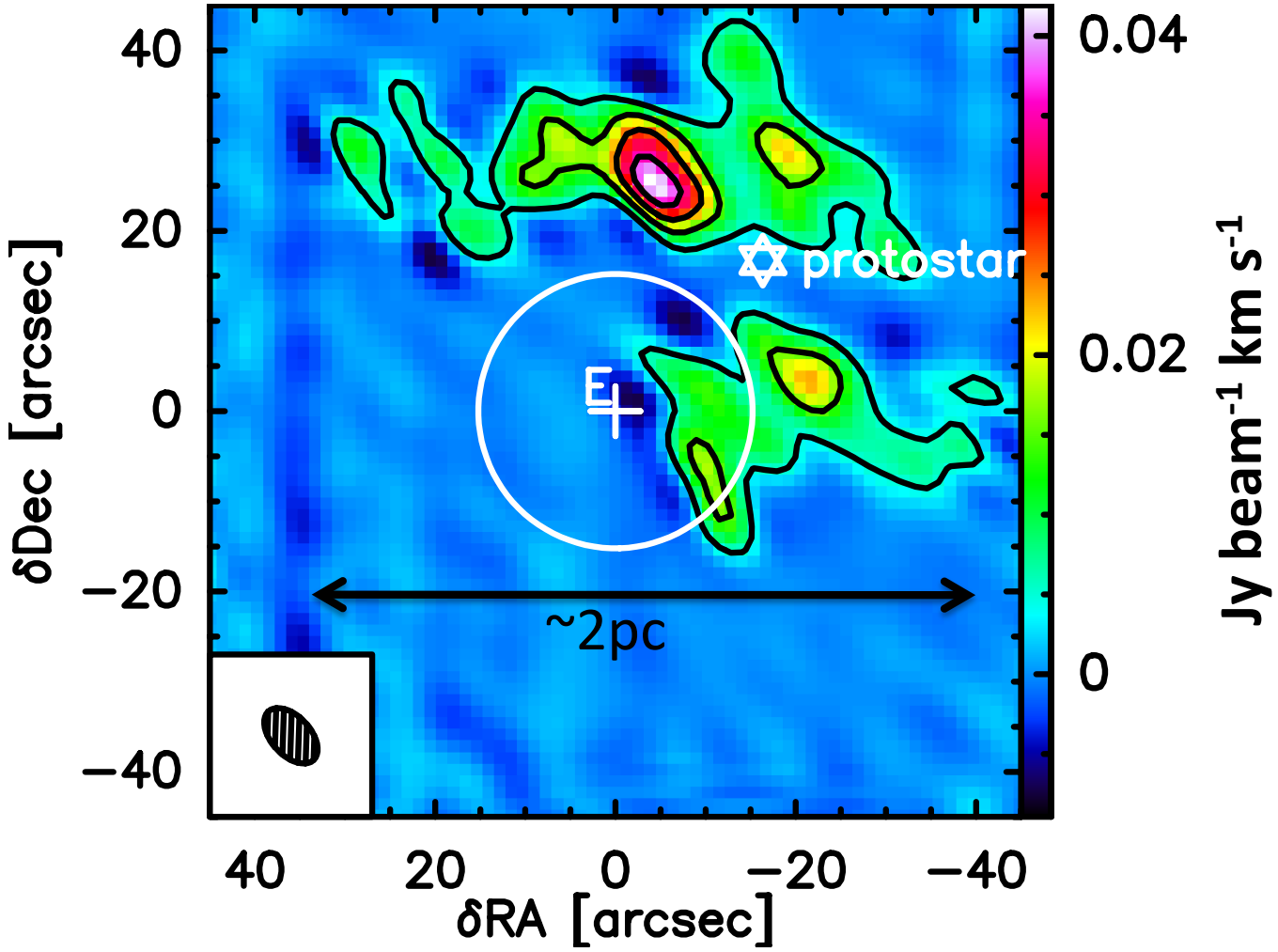
Dumas et al. 2014 ApJL

- No contamination from the protostar
- W51C-E has an enhanced CR ionization flux

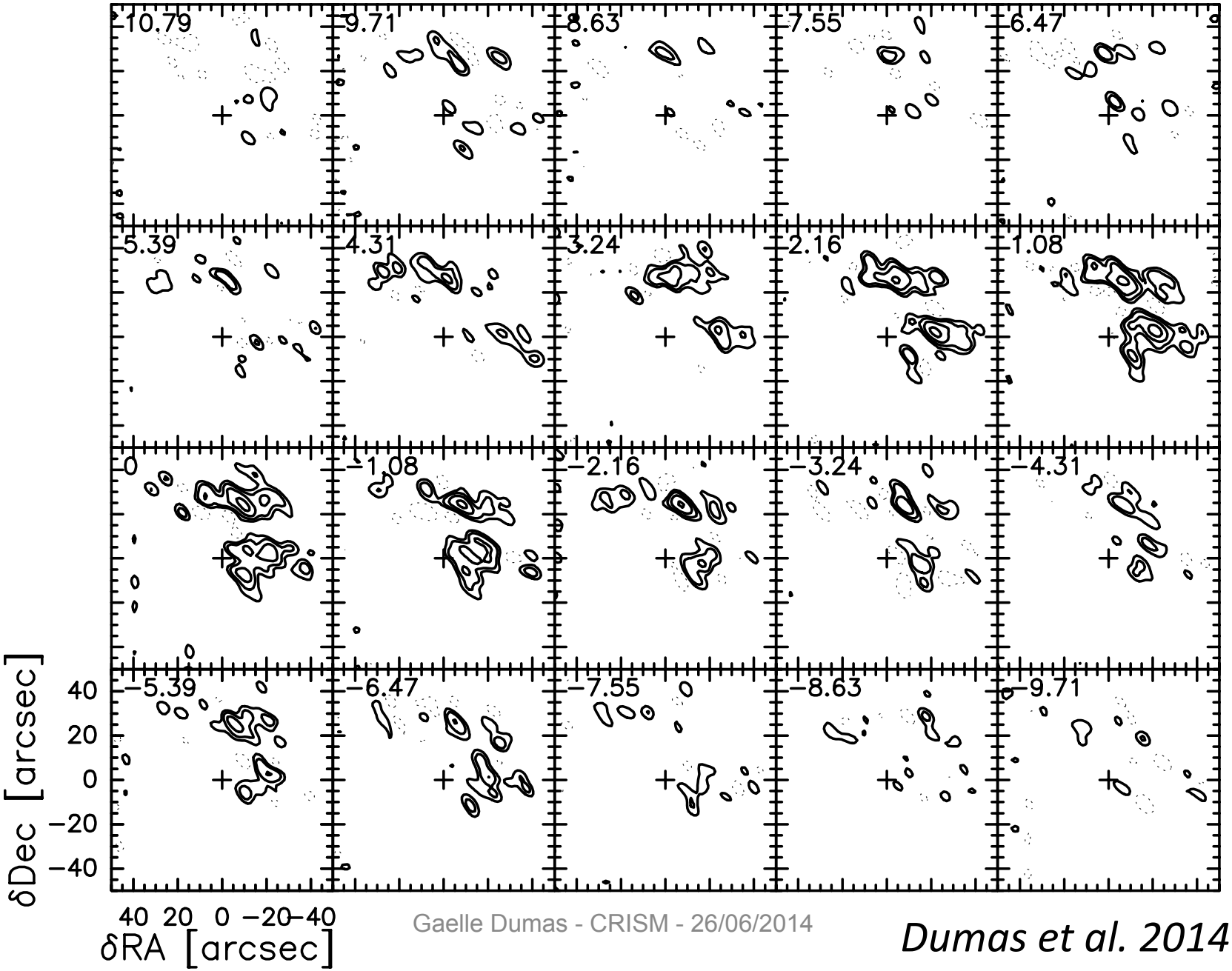


SiO(2-1) emission

Dumas et al. 2014 ApJL



SiO(2-1) – Channel maps



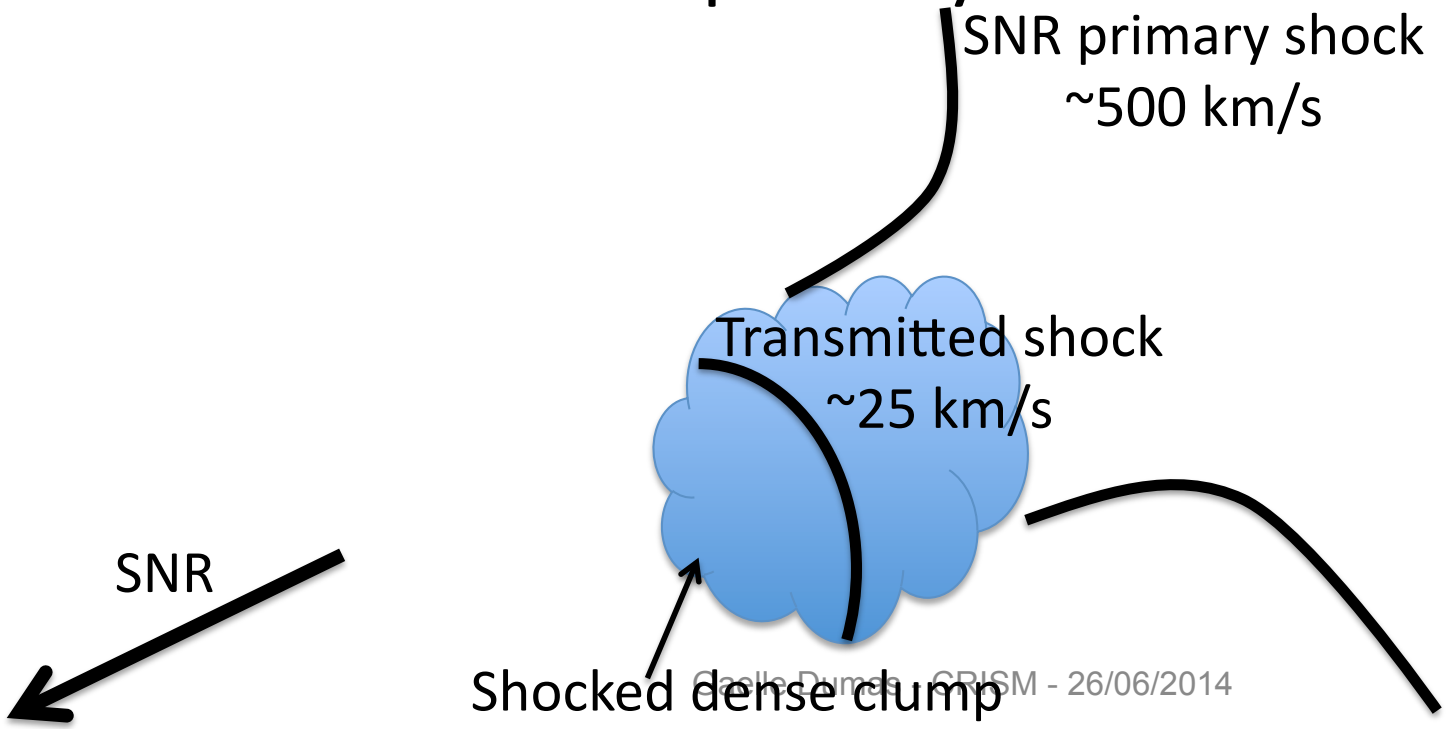
Dumas et al. 2014 ApJL

SiO(2-1) emission

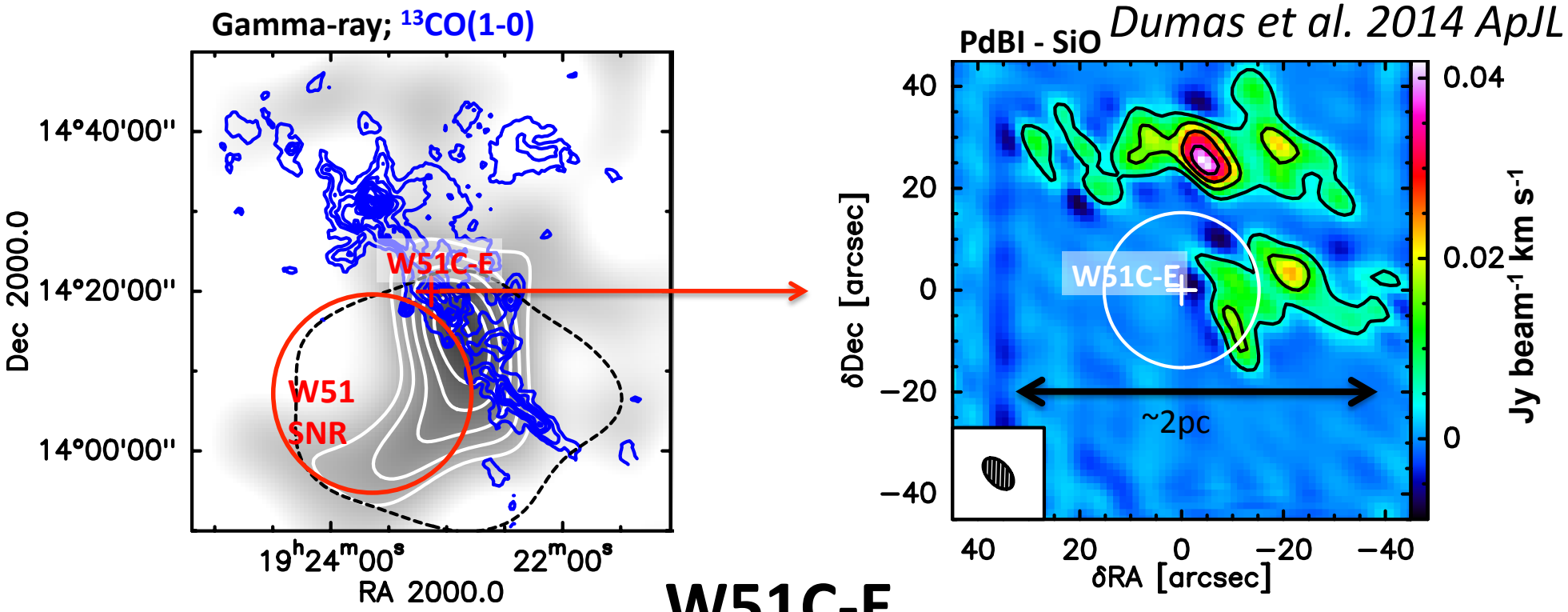
Dumas et al. 2014 ApJL

Interpretation of the SiO emission

- Region of shock
- No outflow from the protostar
- Link with the SNR primary shock



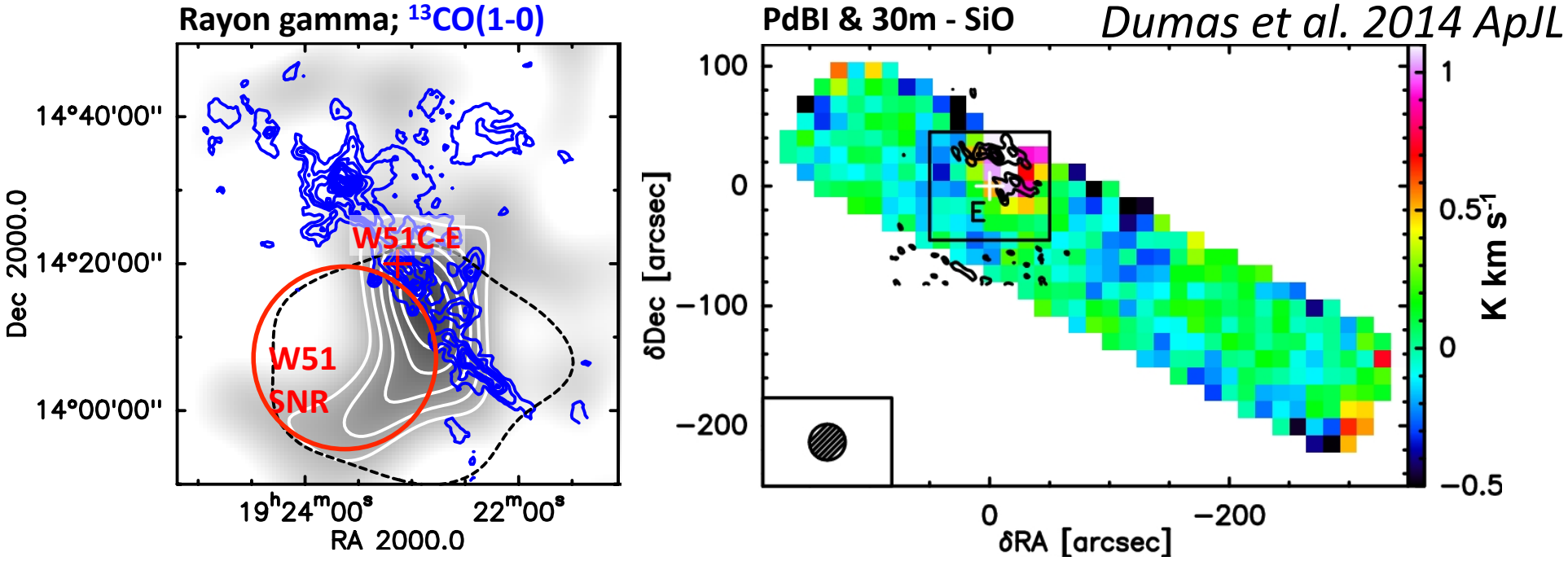
Take home messages



W51C-E

- **CR Ionization of dense gas**
- **Shocked regions caused by the passage of the SNR shock**
- **W51C-E is downstream of the SNR primary shock**

What's next?



- **Spatial variations of the ionization**
- **Properties of the reverse shock**
- **CR acceleration sites**