

Feedback from Supernova Remnants: How shocks may trigger star formation



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**Unveiling
ALMA Band2
Workshop**

25/02/2026

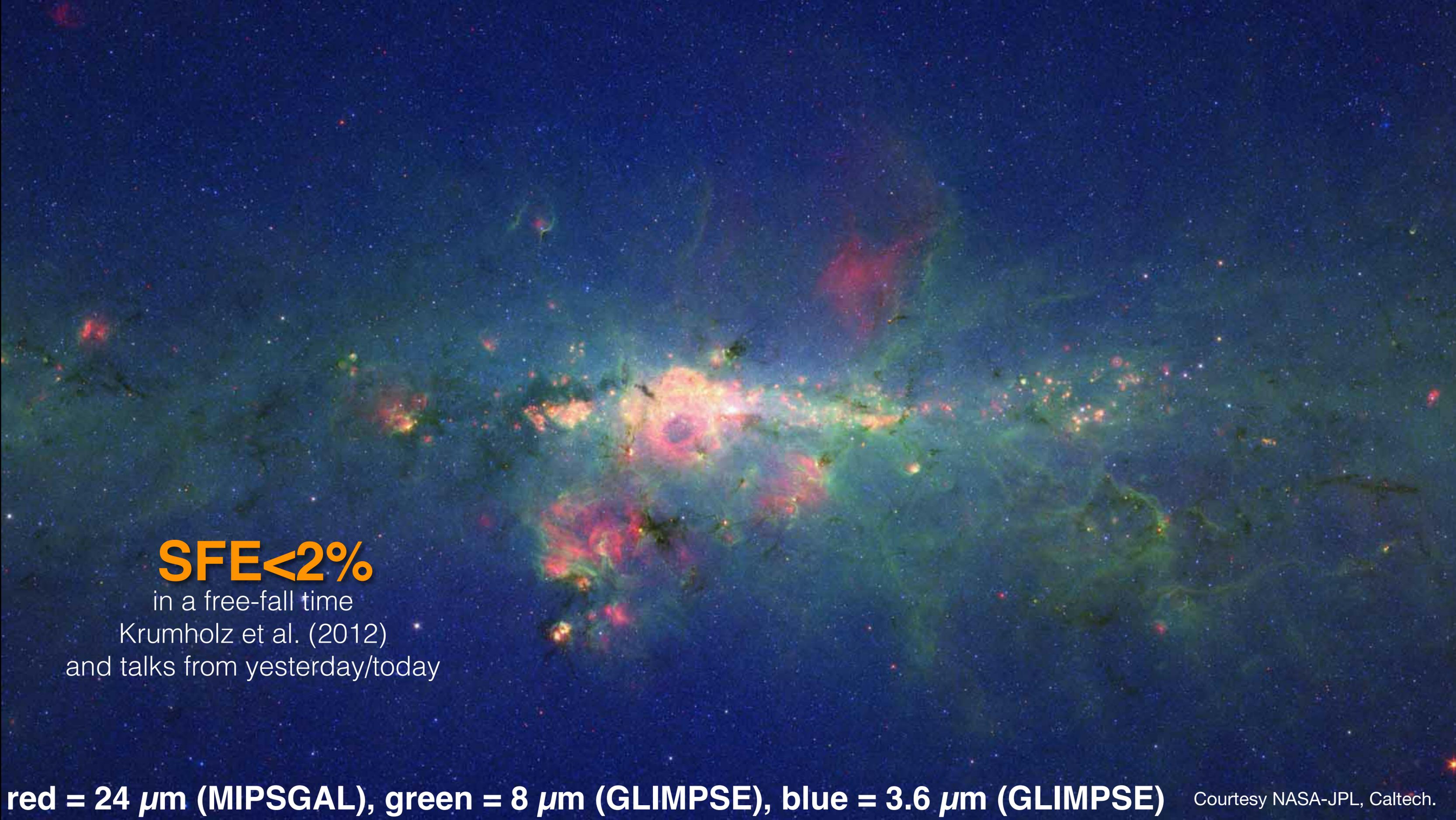


I. Jiménez-Serra (CAB) - J.C. Tan (Chalmers/UvA) -
C. Y. Law (INAF-AAO) - P. Caselli (MPE) - A. T. Barnes (ESO)
F. Fontani (INAF-AAO) - S. Viti (LU) - J.D. Henshaw (JMU)
and the SHREC Collaboration



red = 24 μm (MIPSGAL), green = 8 μm (GLIMPSE), blue = 3.6 μm (GLIMPSE)

Courtesy NASA-JPL, Caltech.



SFE < 2%

in a free-fall time

Krumholz et al. (2012)

and talks from yesterday/today

red = 24 μm (MIPSGAL), green = 8 μm (GLIMPSE), blue = 3.6 μm (GLIMPSE)

Courtesy NASA-JPL, Caltech.

Which mechanisms regulate star formation in galaxies?

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red = 24 μm (MIPSGAL), green = 8 μm (GLIMPSE), blue = 3.6 μm (GLIMPSE)

Courtesy NASA-JPL, Caltech.

**Which mechanisms
regulate star formation
in galaxies?**



**interstellar shocks
may play a role**

SFE < 2%

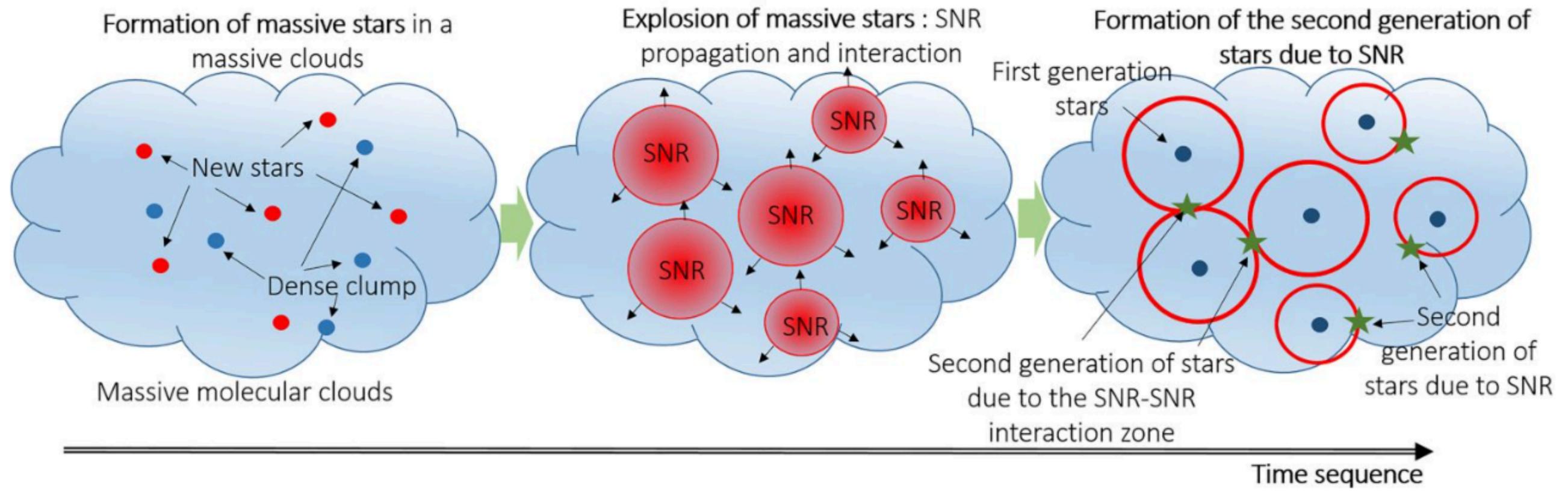
in a free-fall time

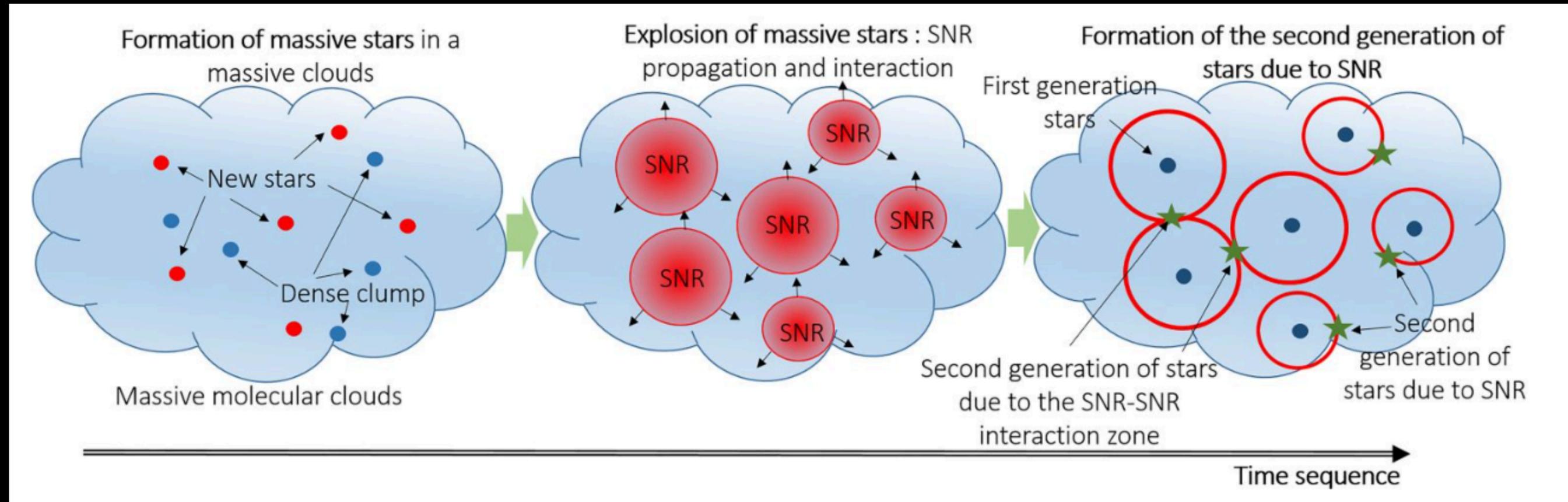
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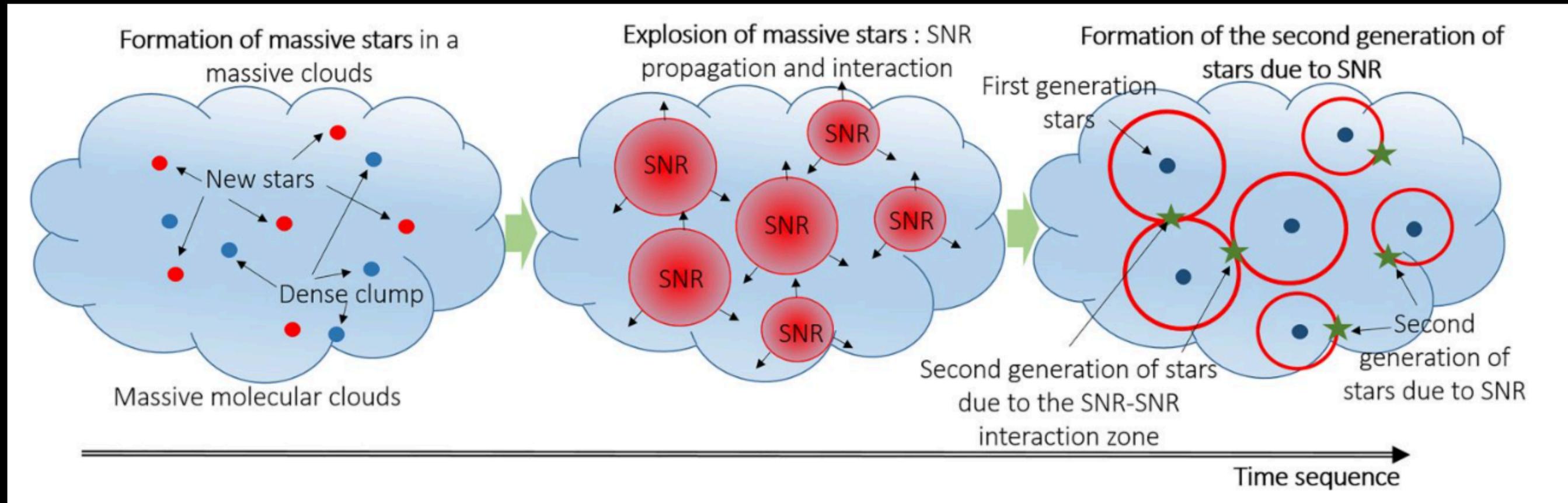
Courtesy NASA-JPL, Caltech.





Negative Feedback

Mass-loaded galactic winds that displace the molecular material, delaying its conversion into stars



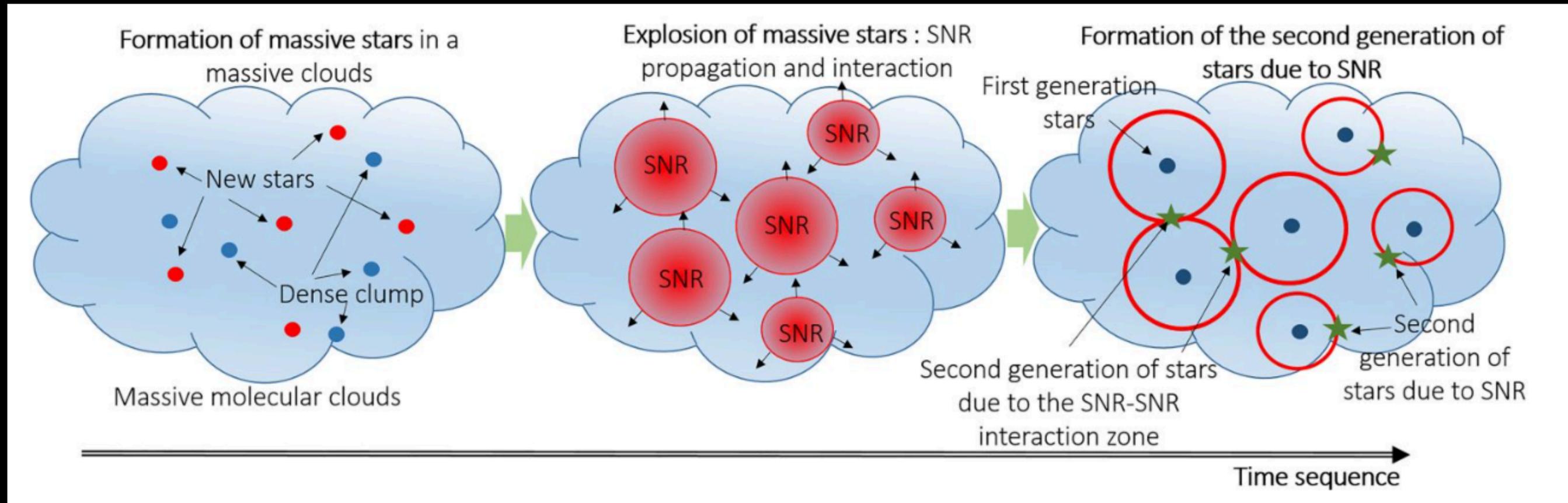
Negative Feedback

Mass-loaded galactic winds that displace the molecular material, delaying its conversion into stars



Positive Feedback

Small scale shock compression locally enhance the gas density, increasing the gas turbulence and hence triggering the formation of new stars.



Negative Feedback

Mass-loaded galactic winds that displace the molecular material, delaying its conversion into stars



Positive Feedback

Small scale shock compression locally enhance the gas density, increasing the gas turbulence and hence triggering the formation of new stars.

The Interplay between compressive and dispersive mechanisms may contribute to regulate star formation in galaxies

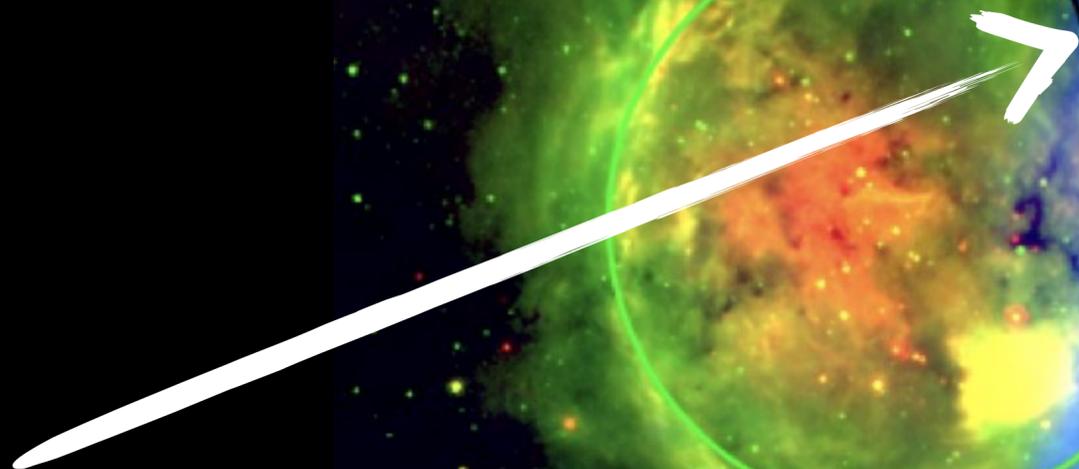
W44



Star Forming
Cloud

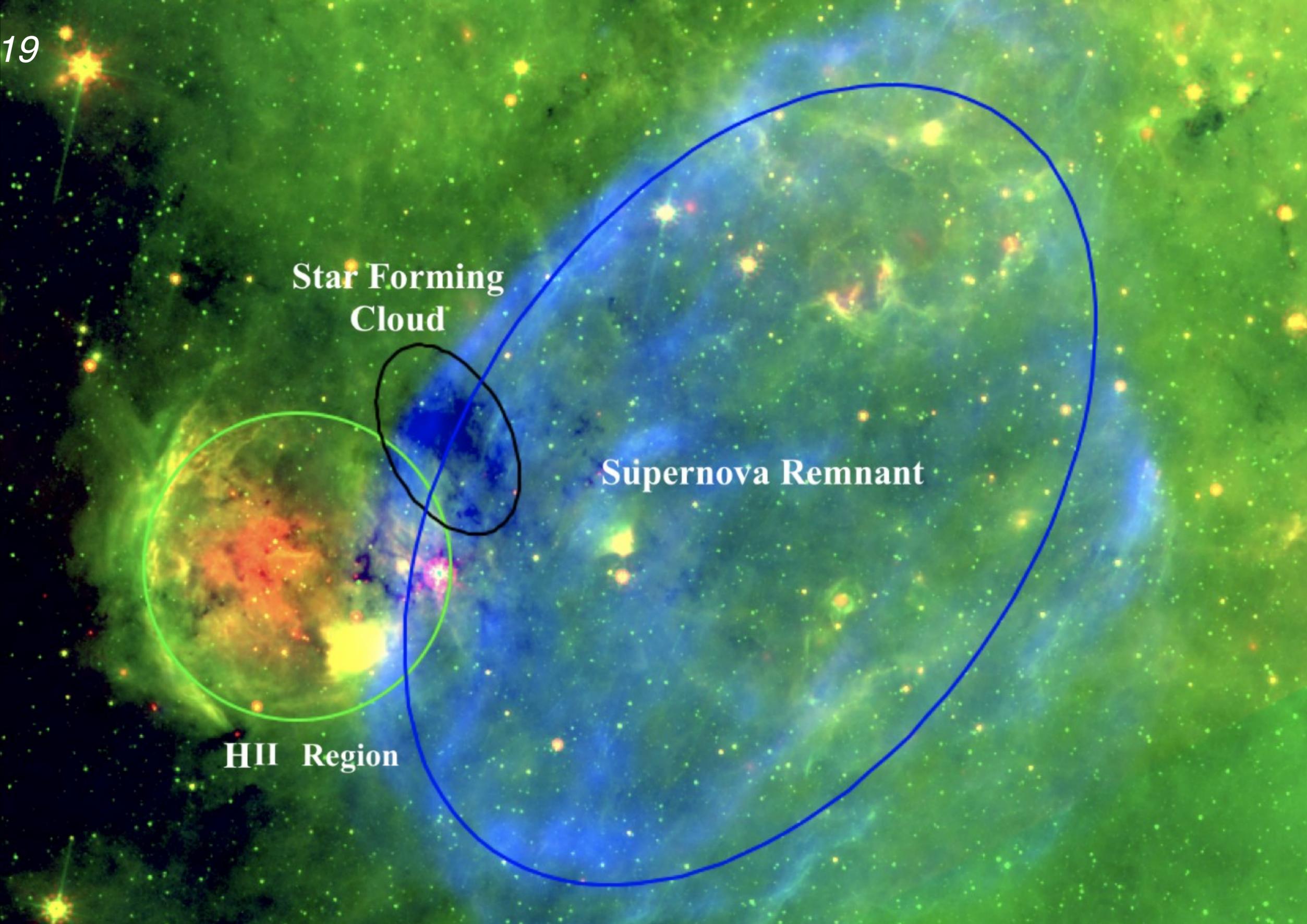


Supernova Remnant



G034.77-00.55

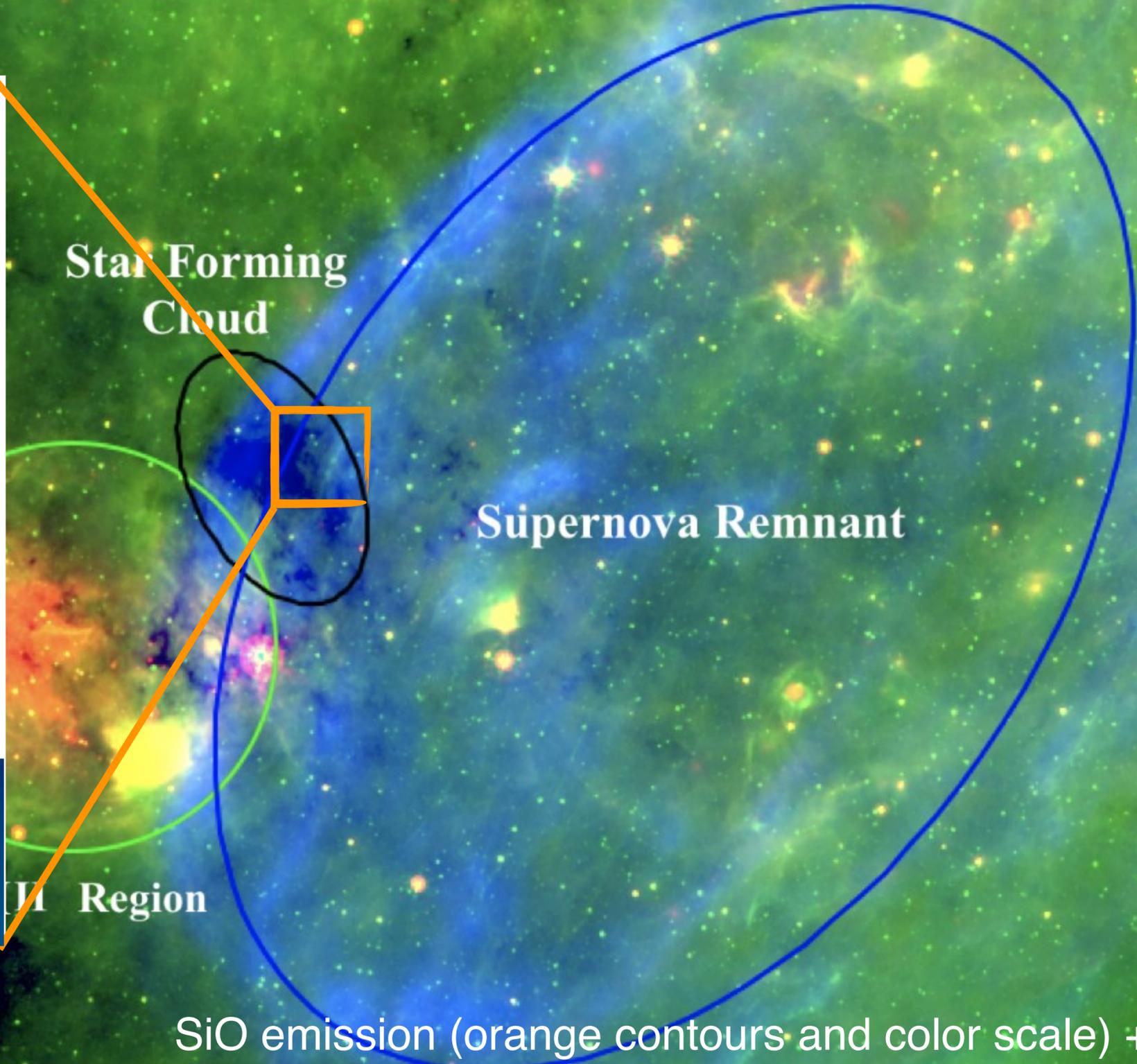
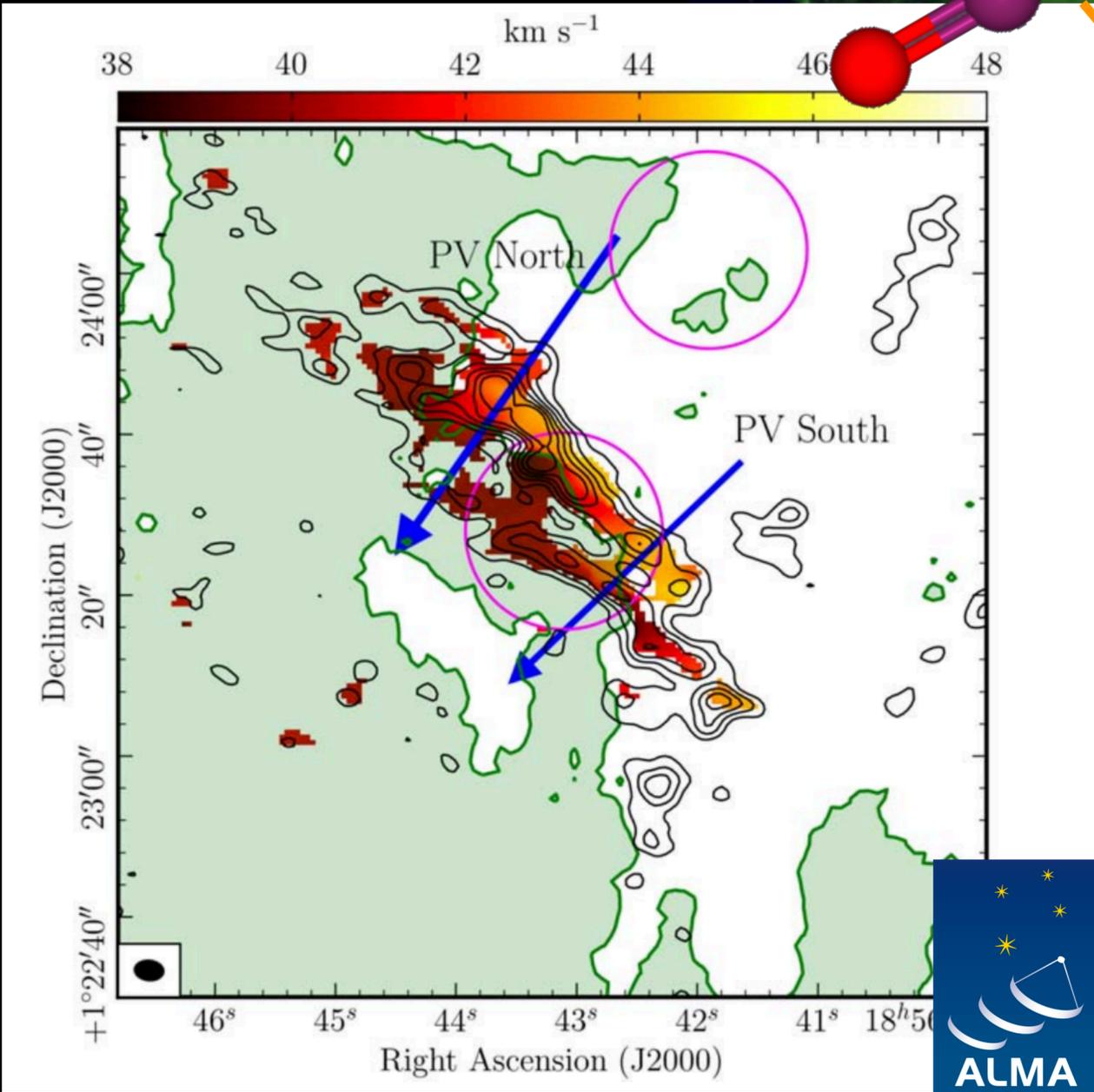
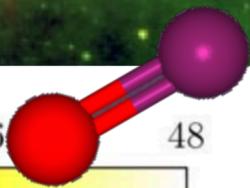
HII Region



**Star Forming
Cloud**

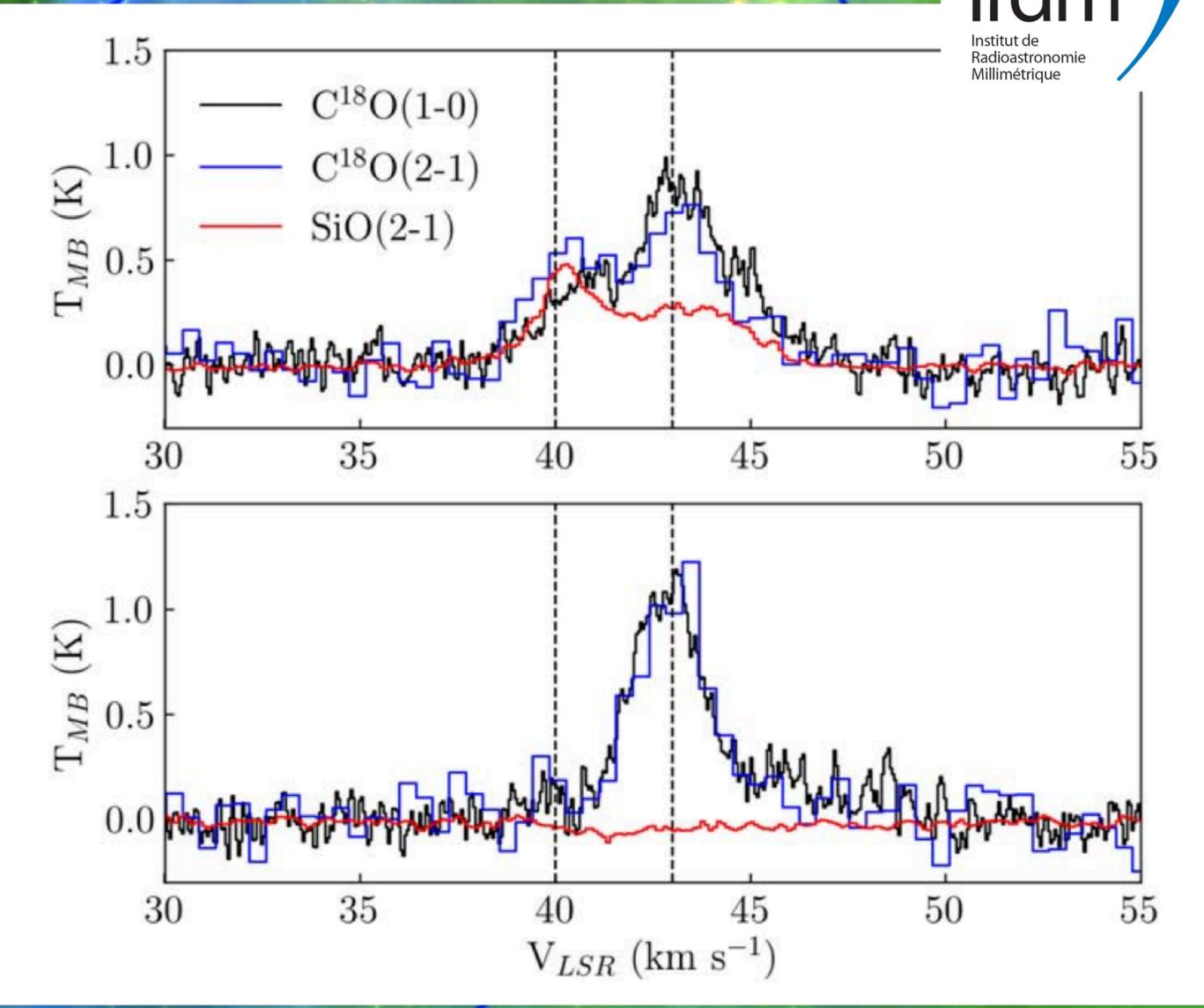
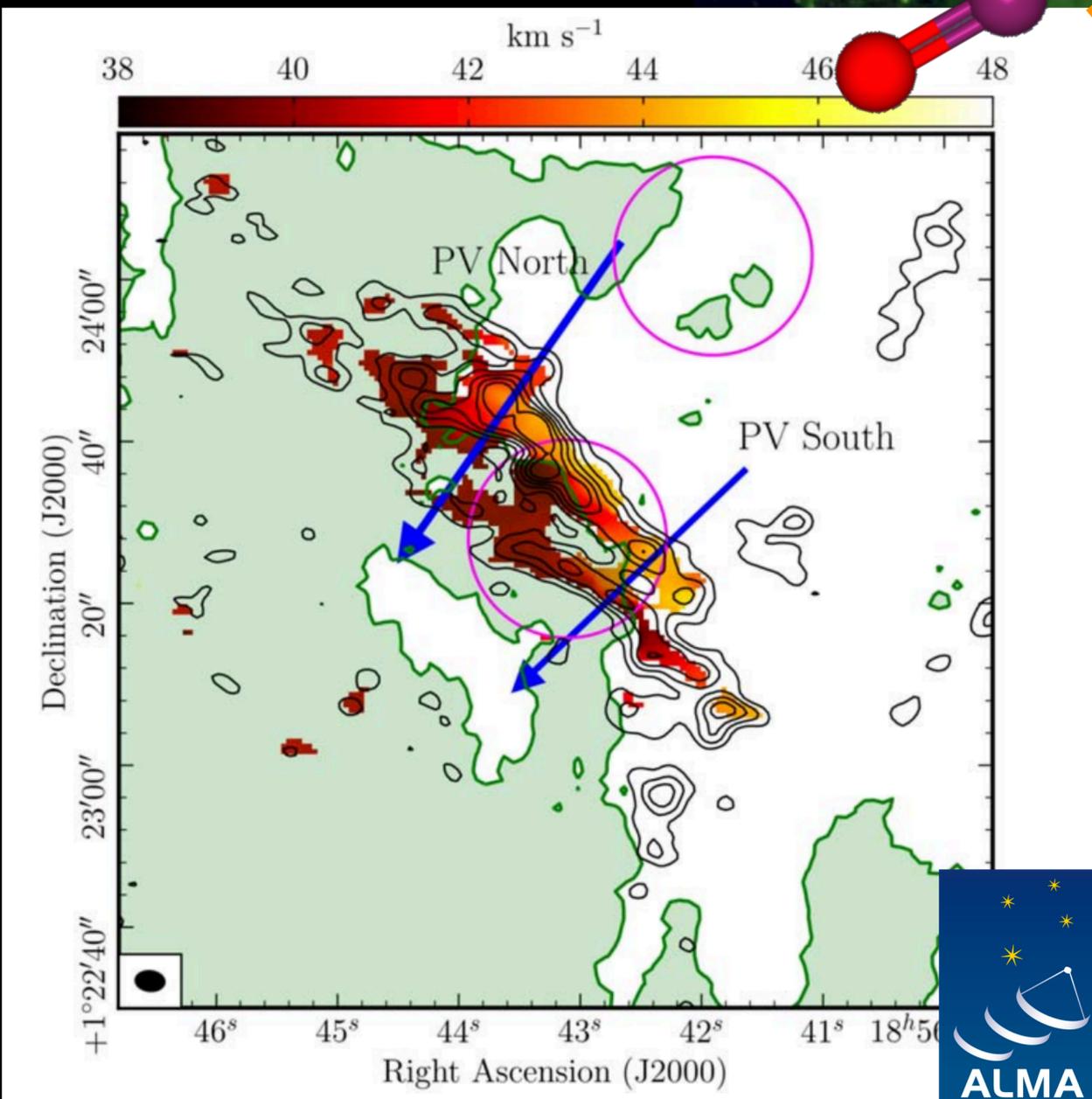
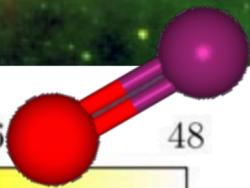
Supernova Remnant

HII Region



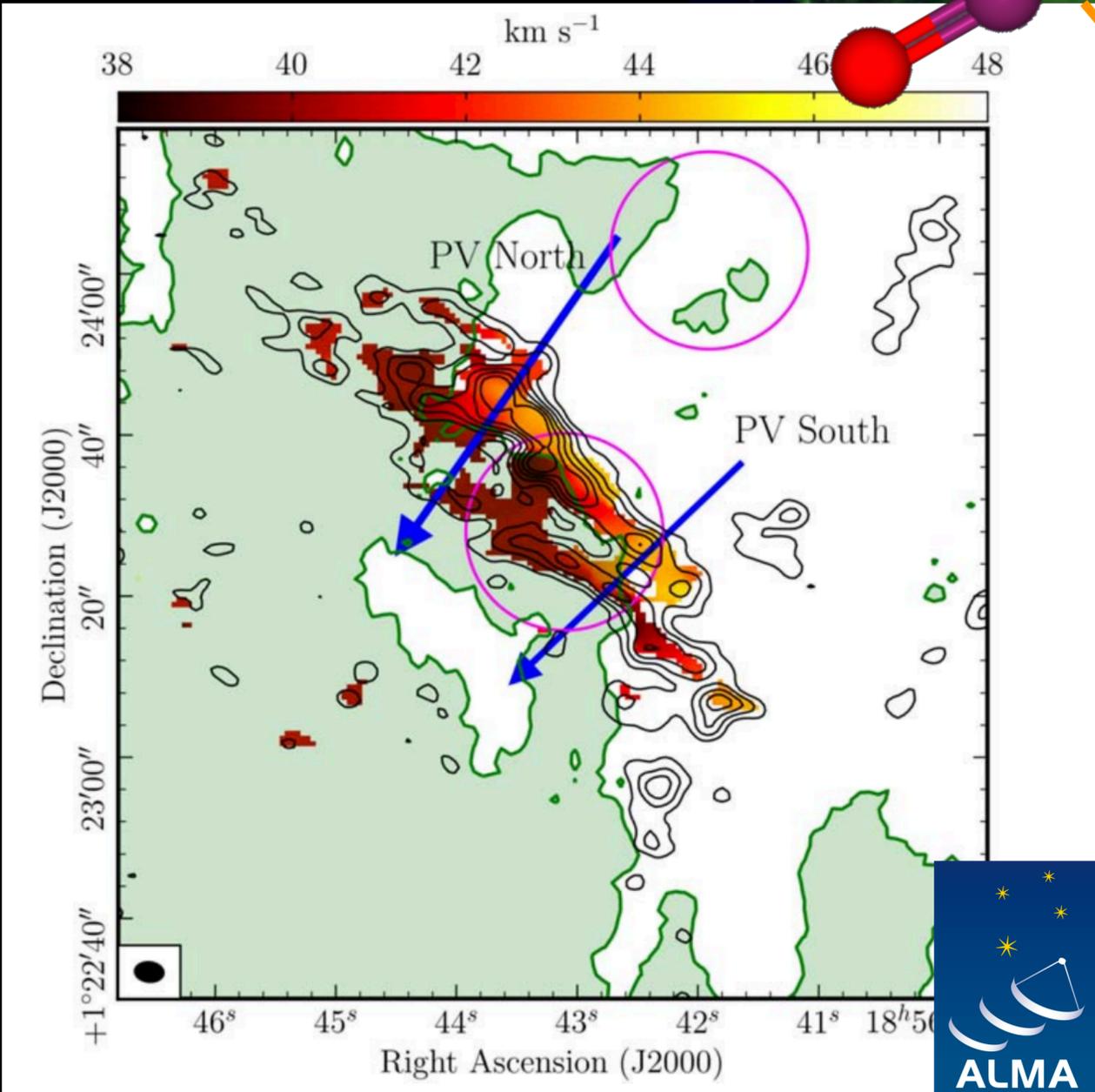
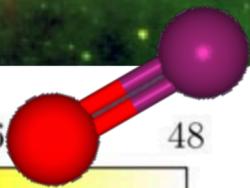
SiO emission (orange contours and color scale) + >20 mag emission (white shadow; Kainulainen & Tan 2013)

red = 24 μm (MIPSGAL), green = 8 μm (GLIMPSE), blue= 1 GHz (THOR)



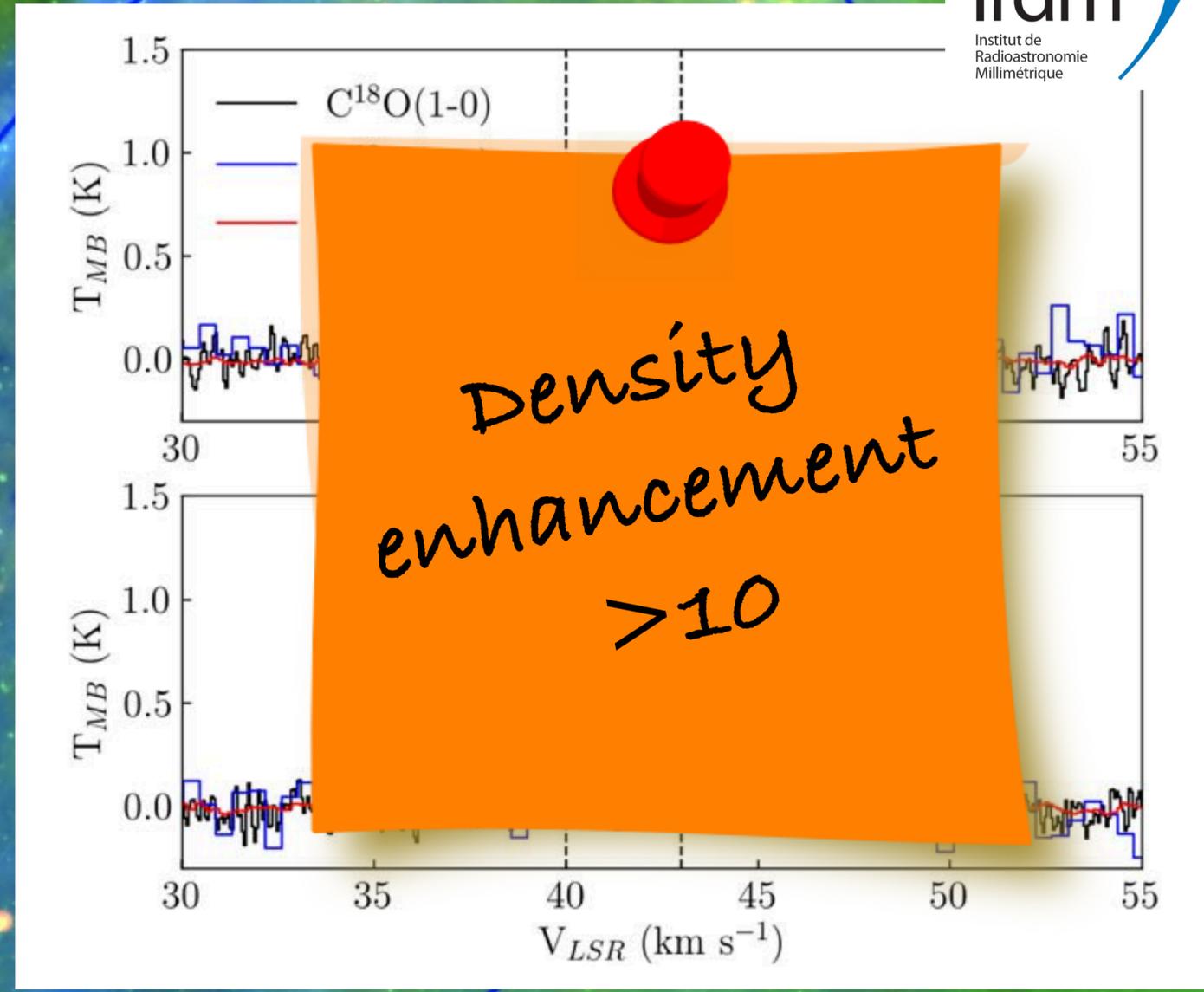
SiO emission (orange contours and color scale) + >20 mag emission (white shadow; Kainulainen & Tan 2013)

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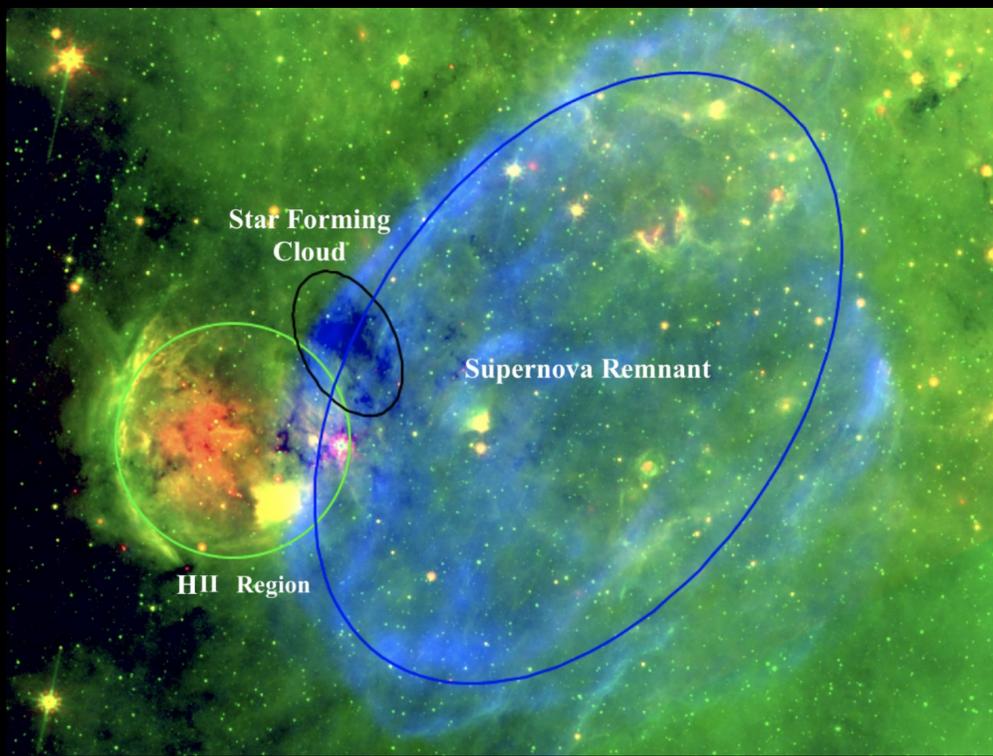
Star Forming Cloud

II Region

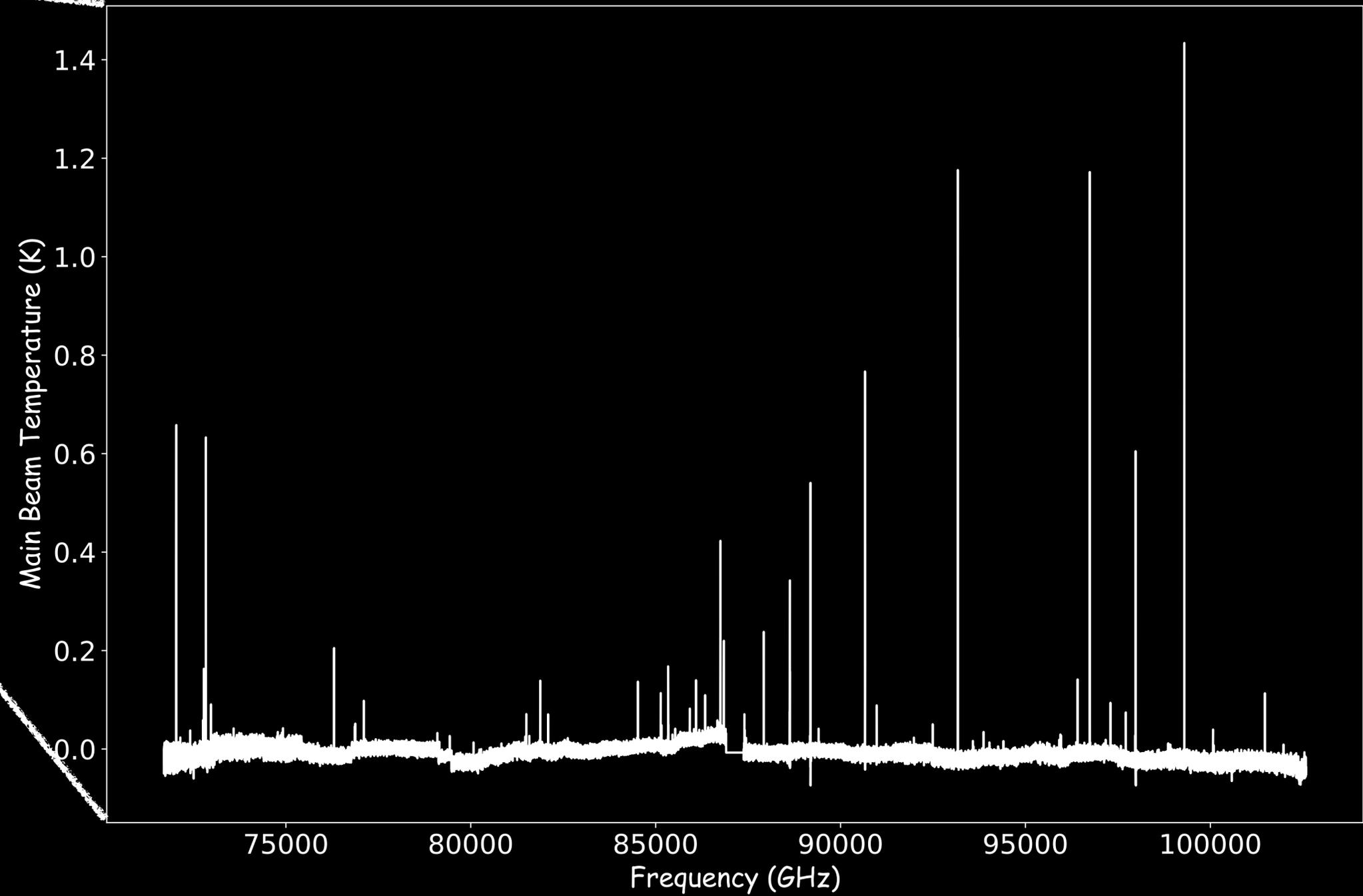
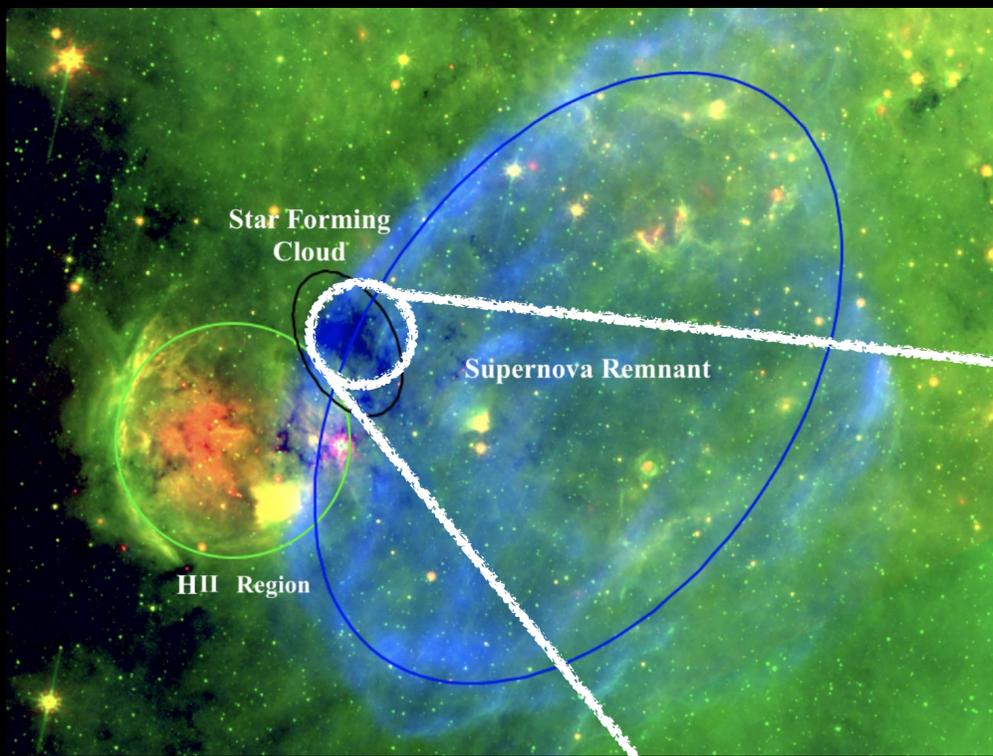


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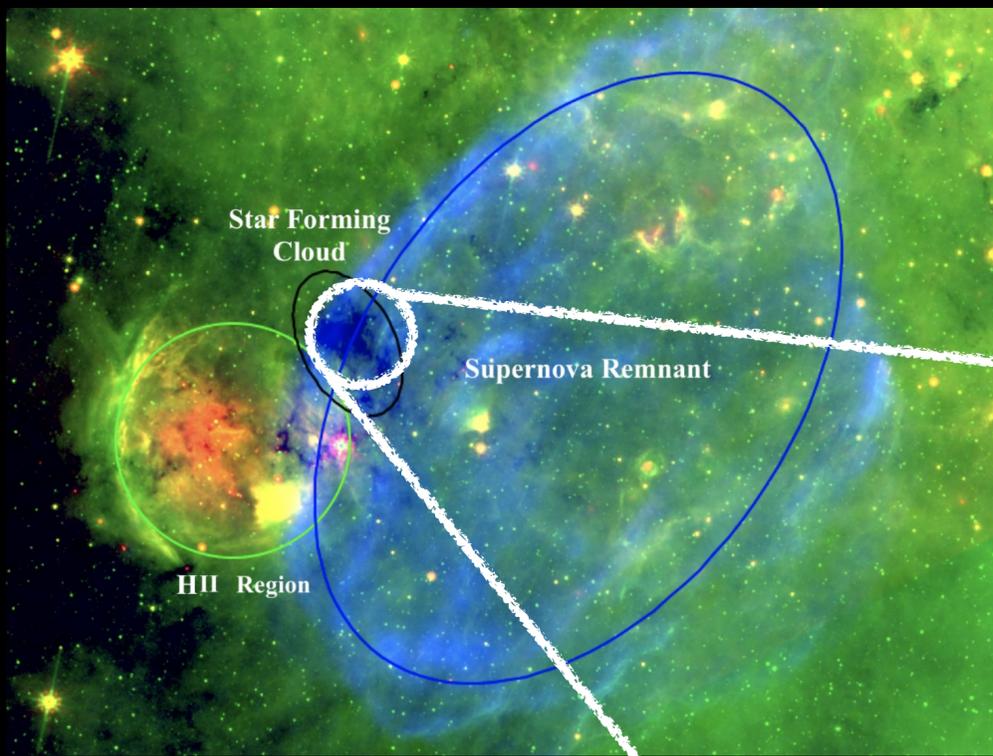
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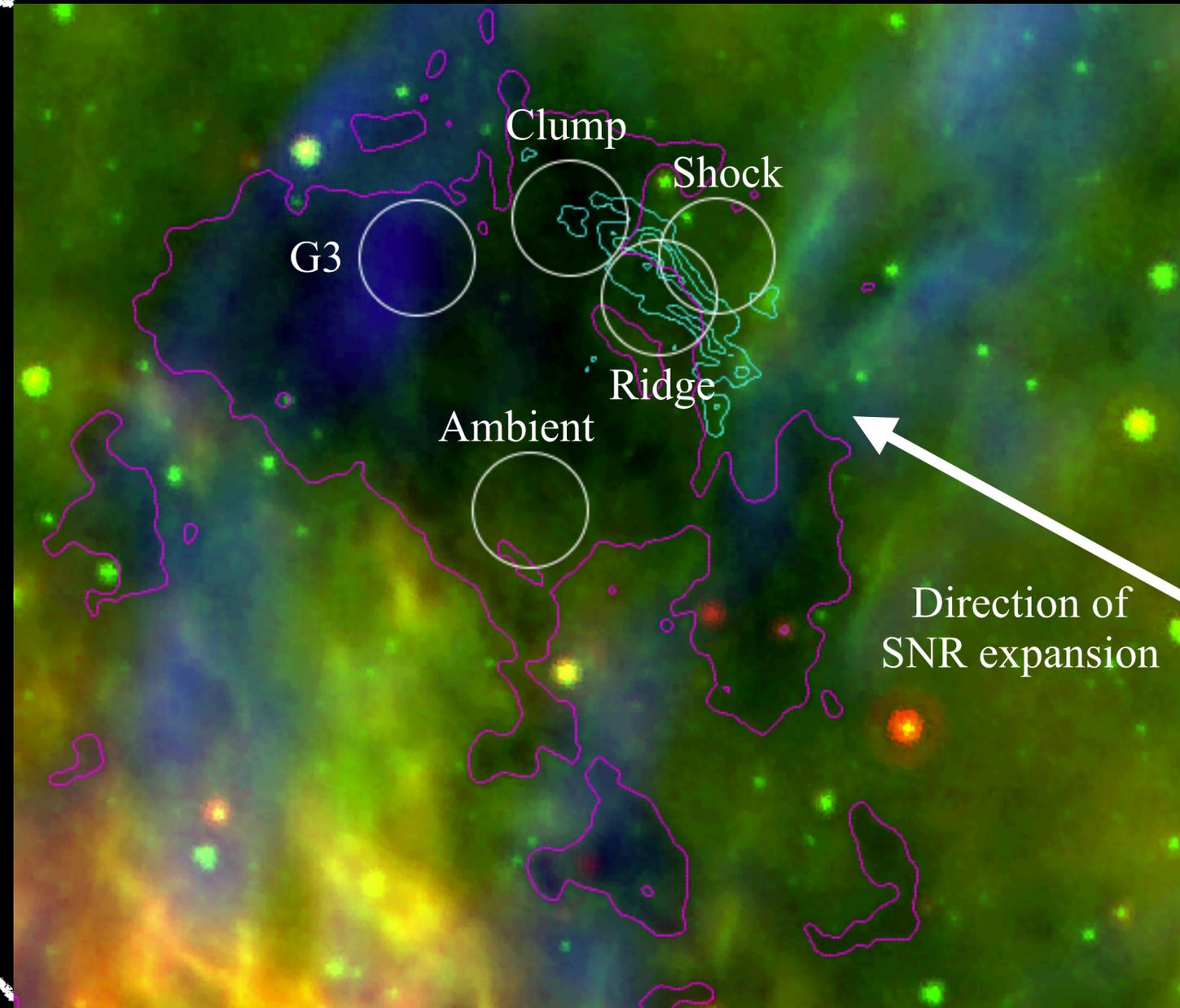
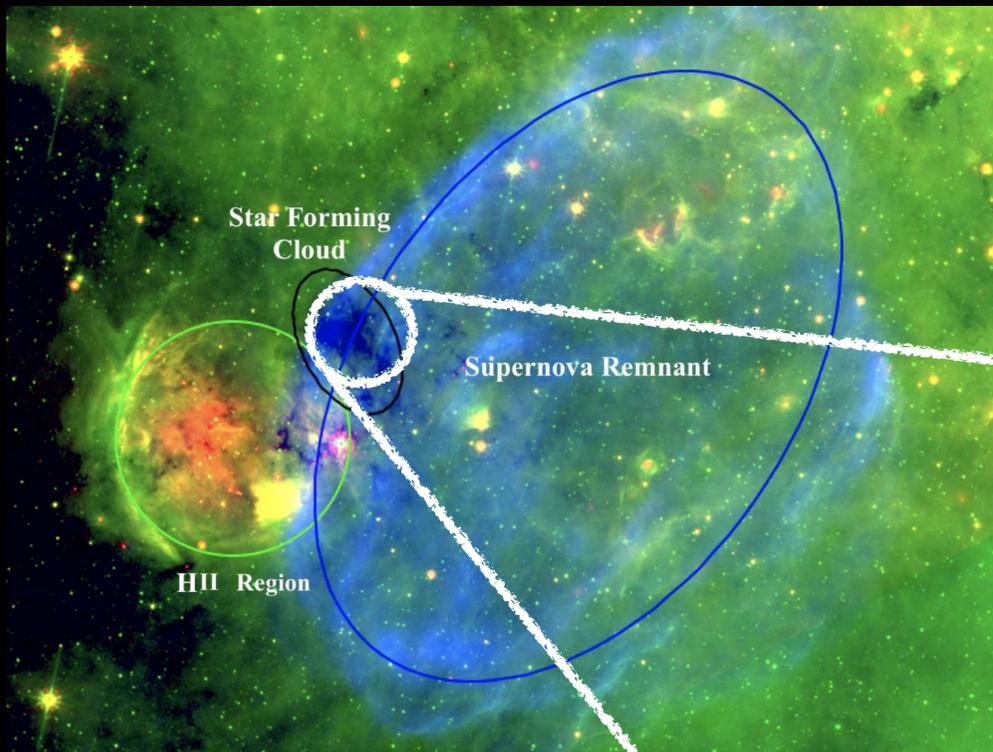
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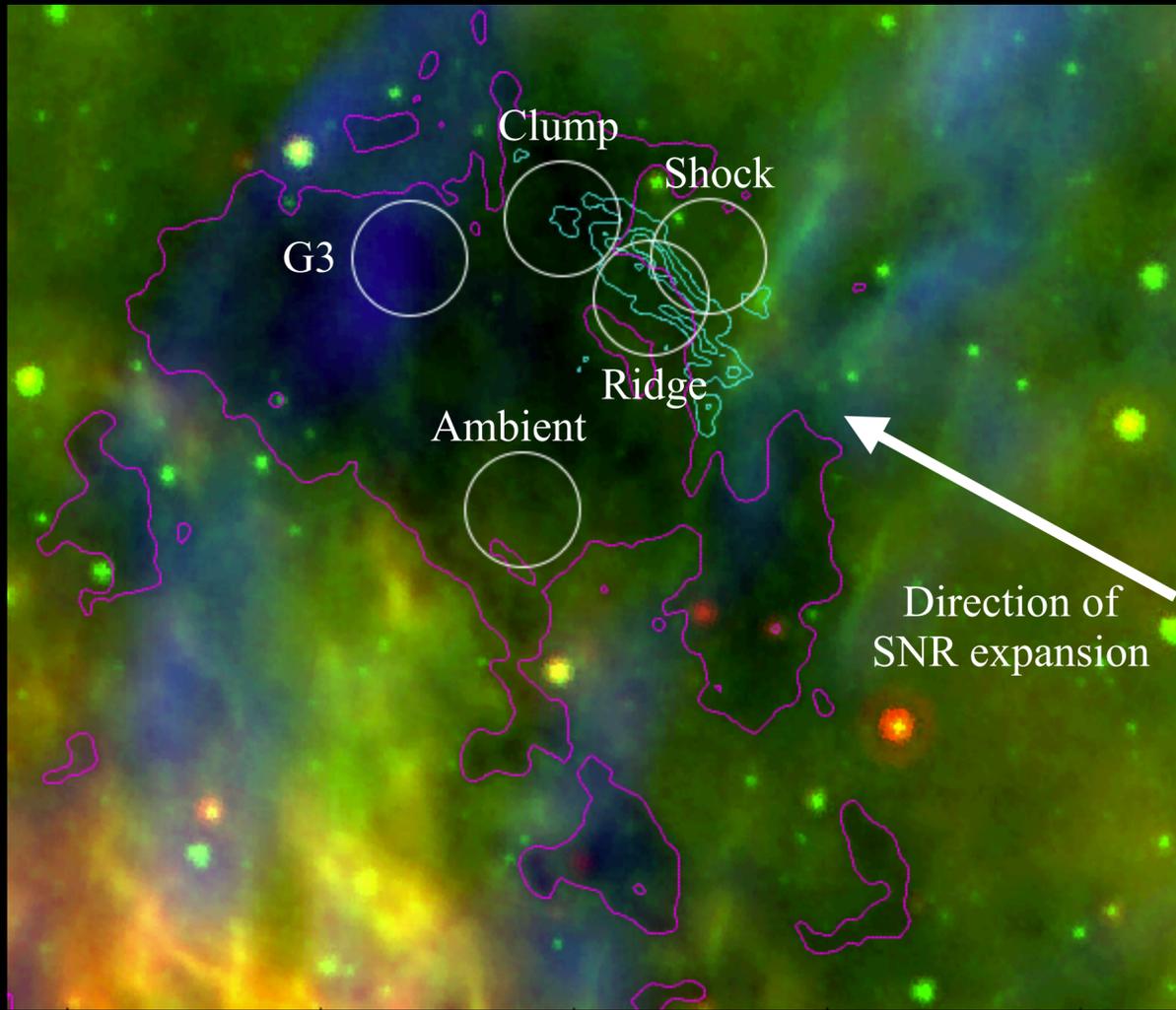
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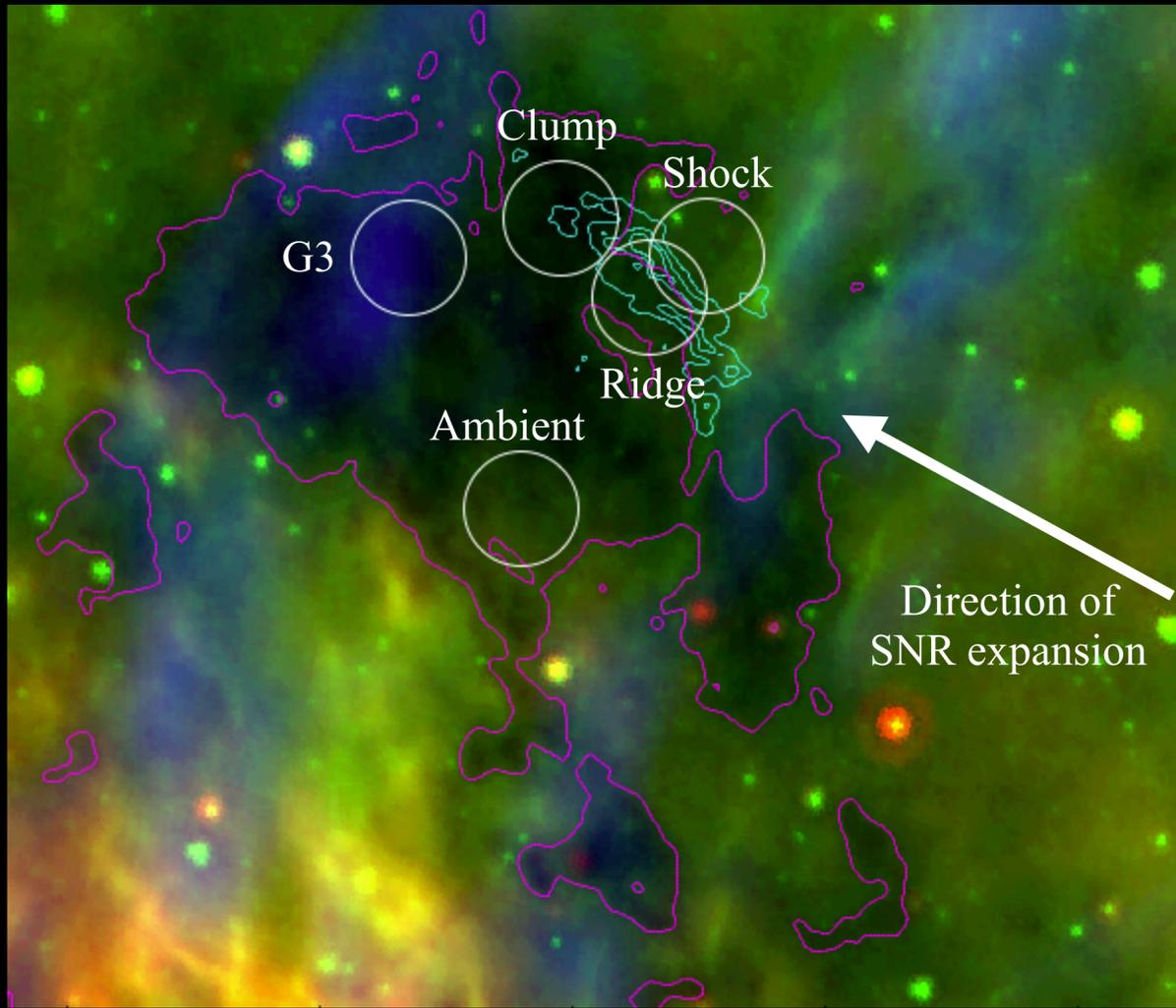


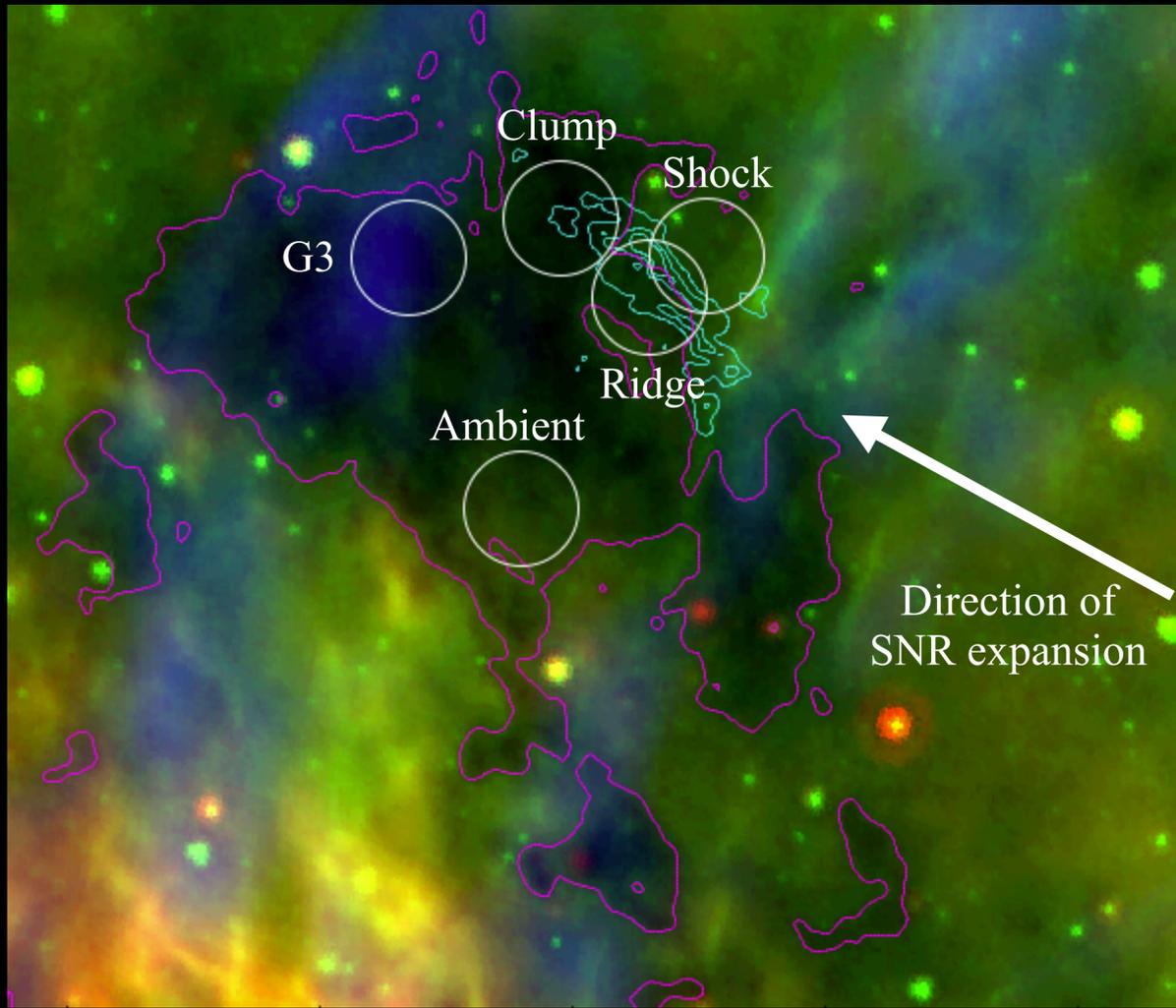
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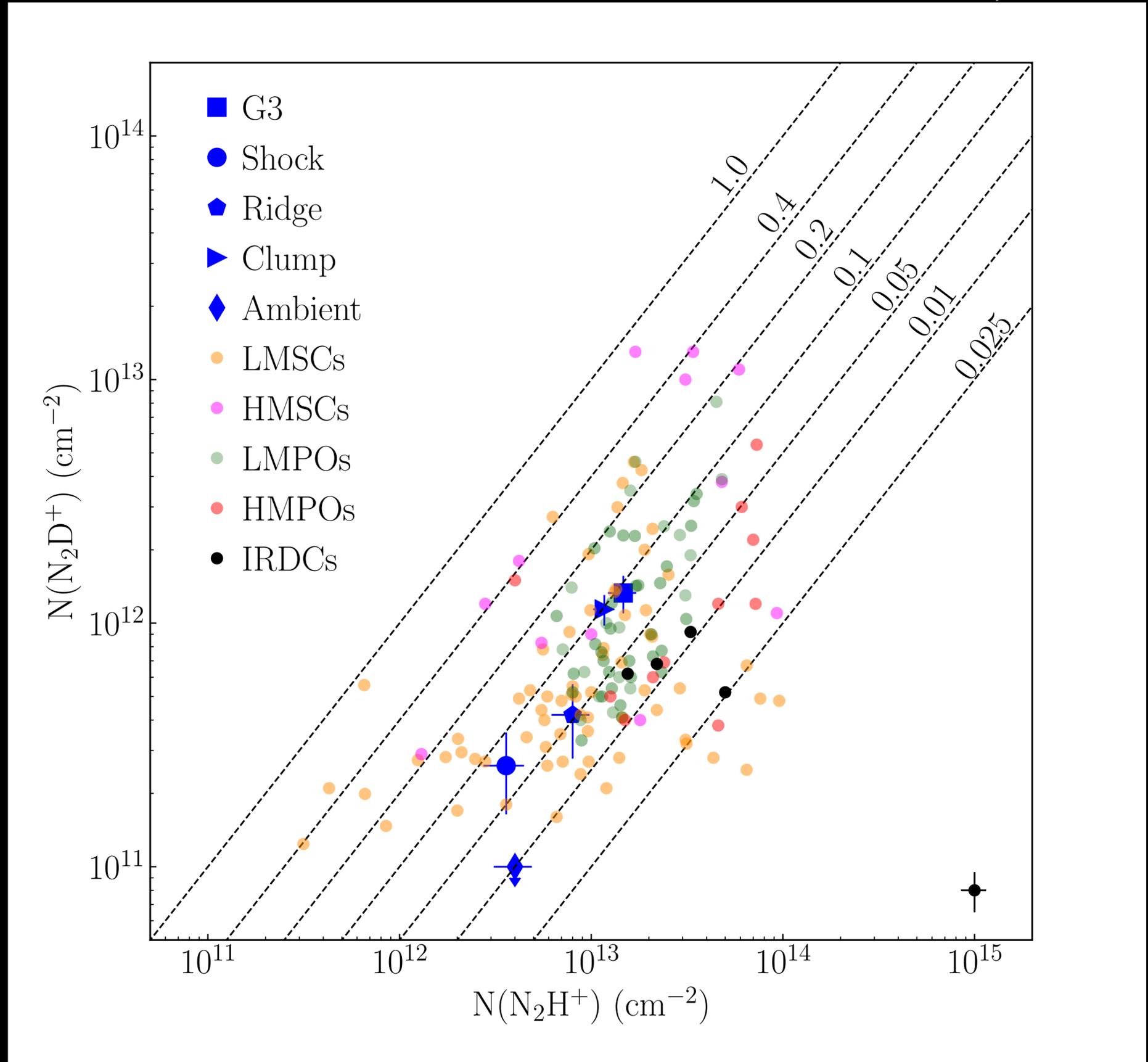
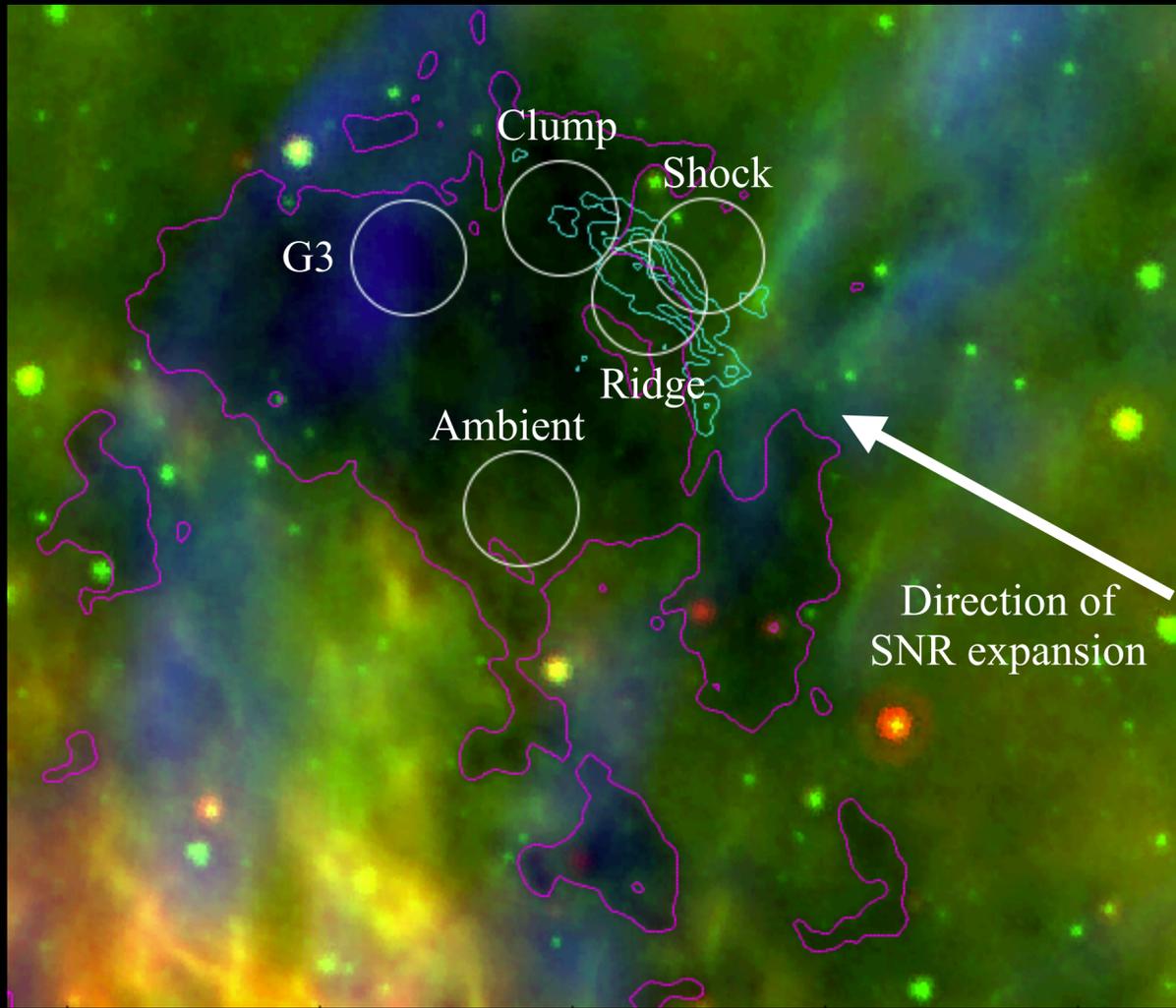






$$T_{ex} \sim 4.5 K$$

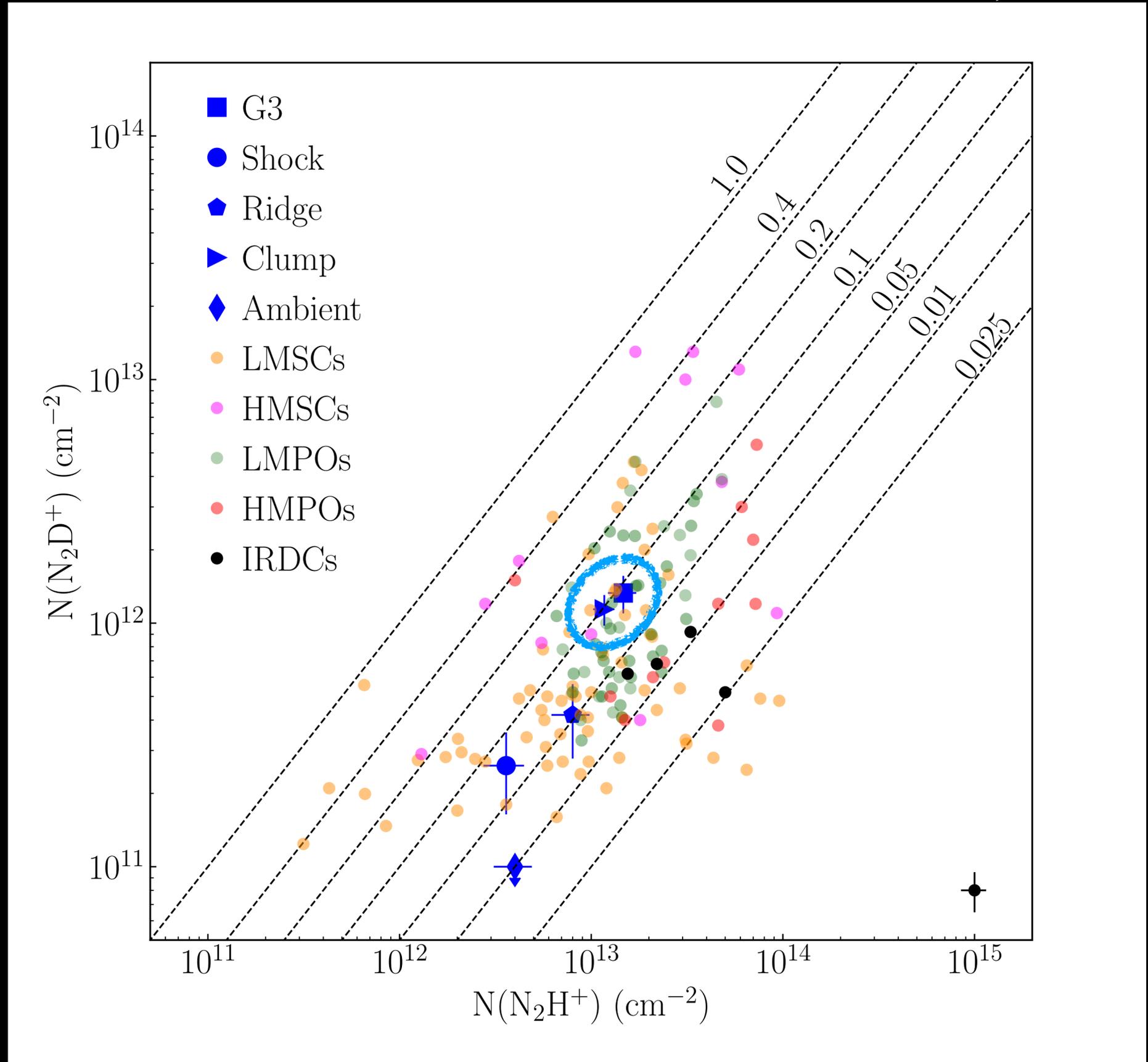
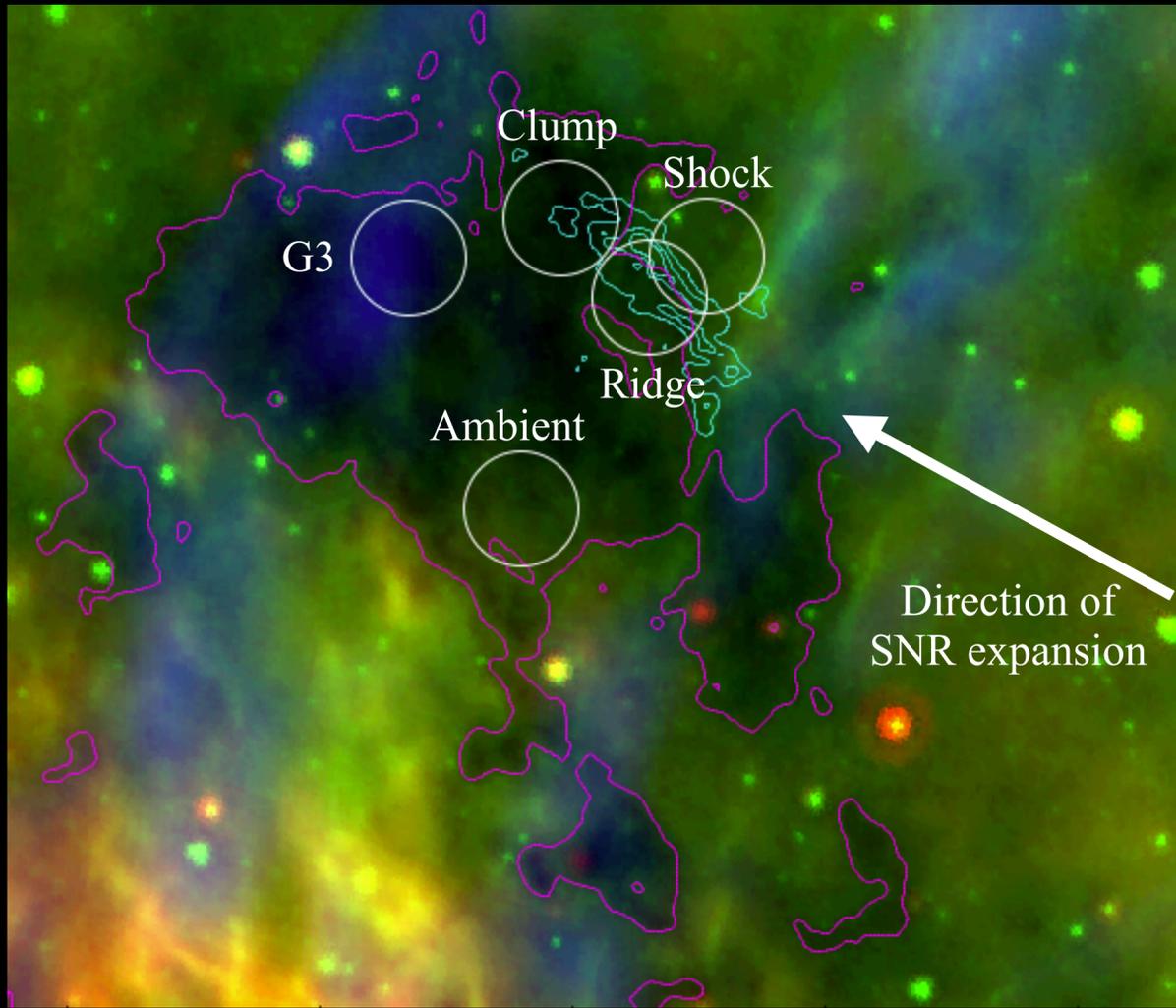
Martin et al. 2019



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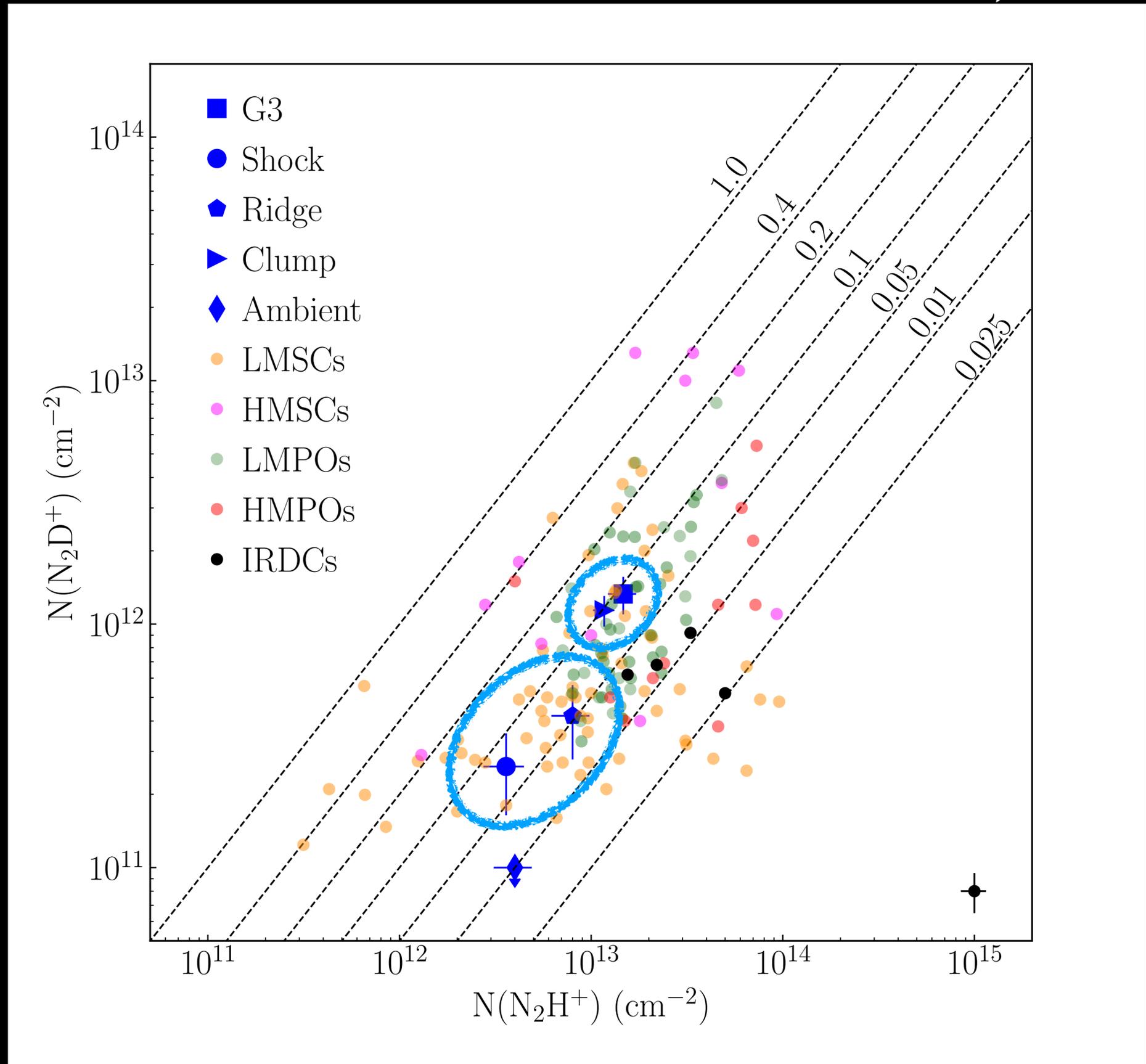
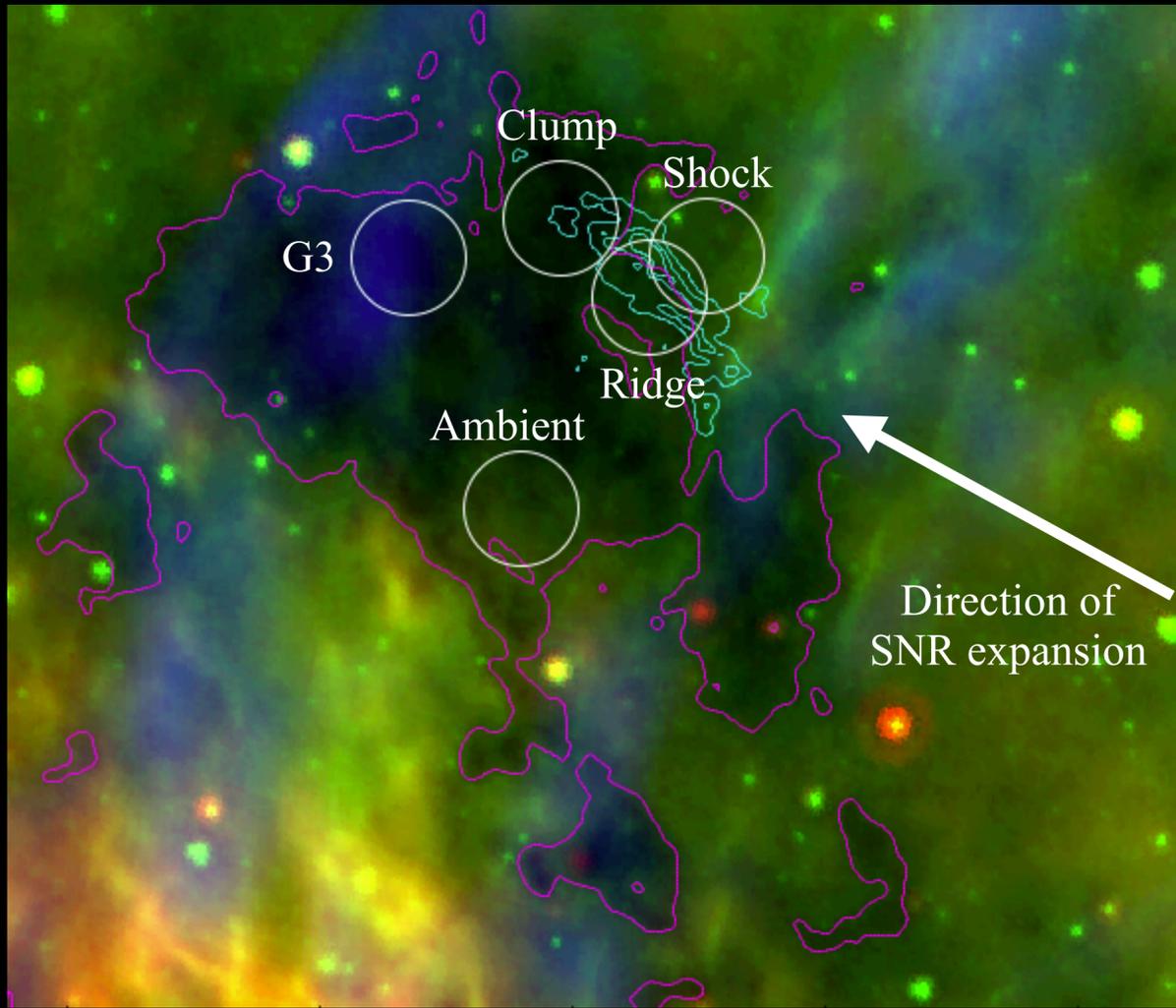


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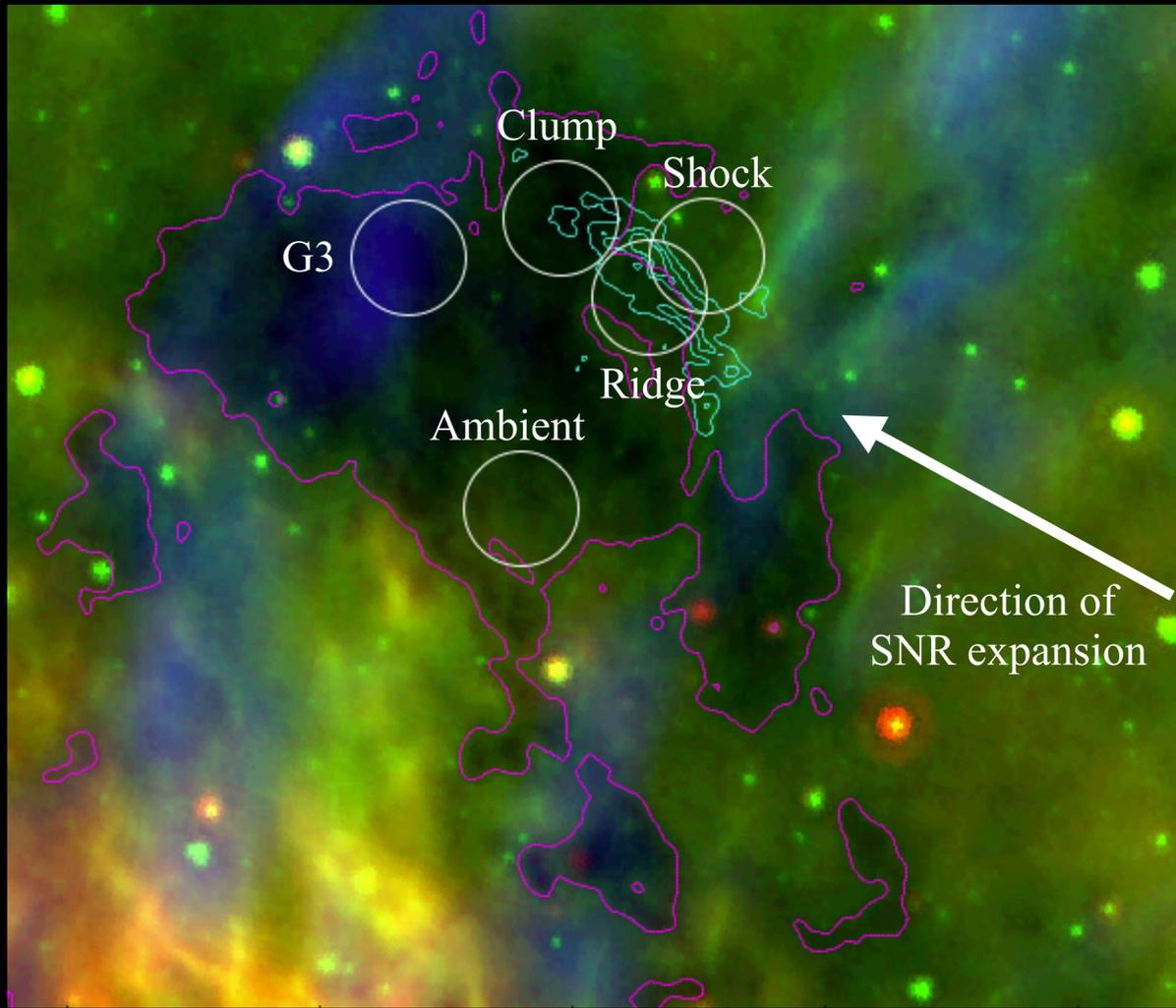


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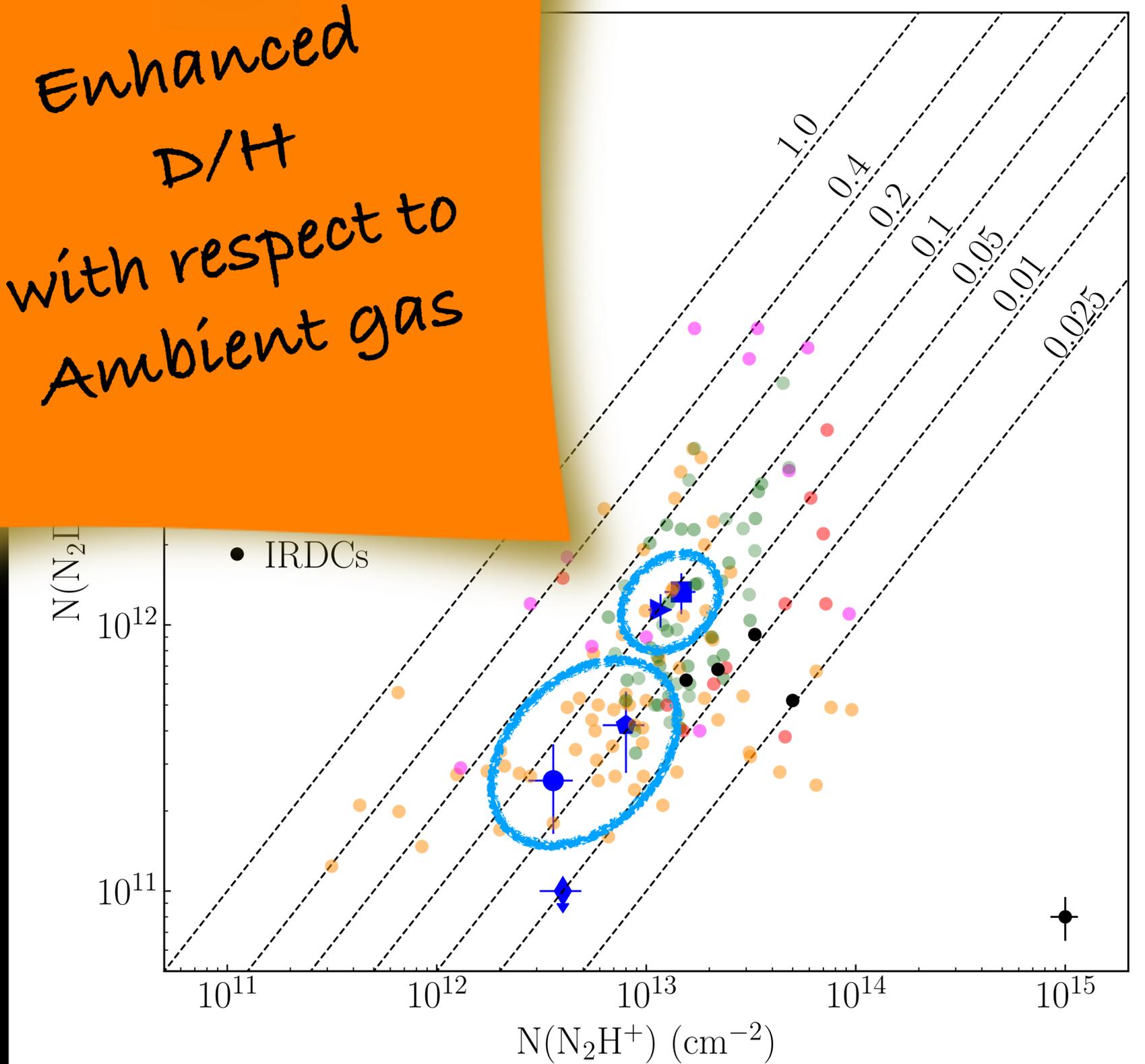
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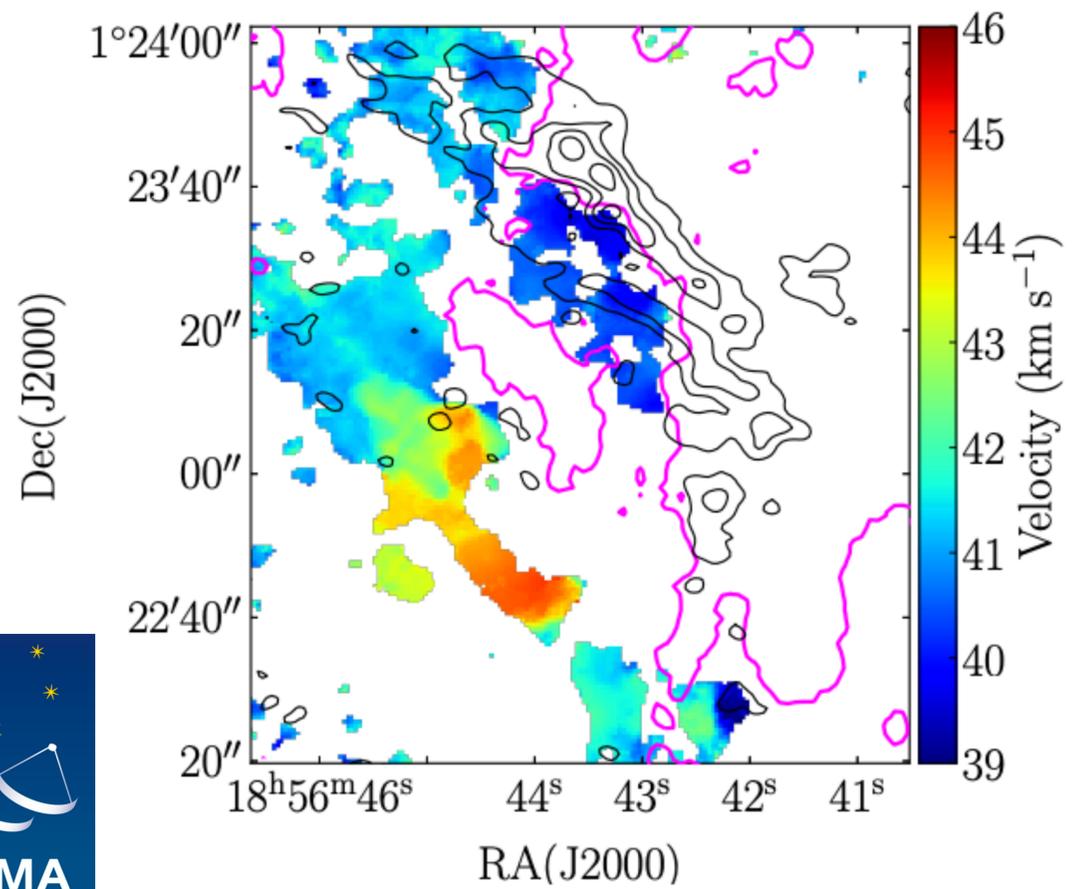
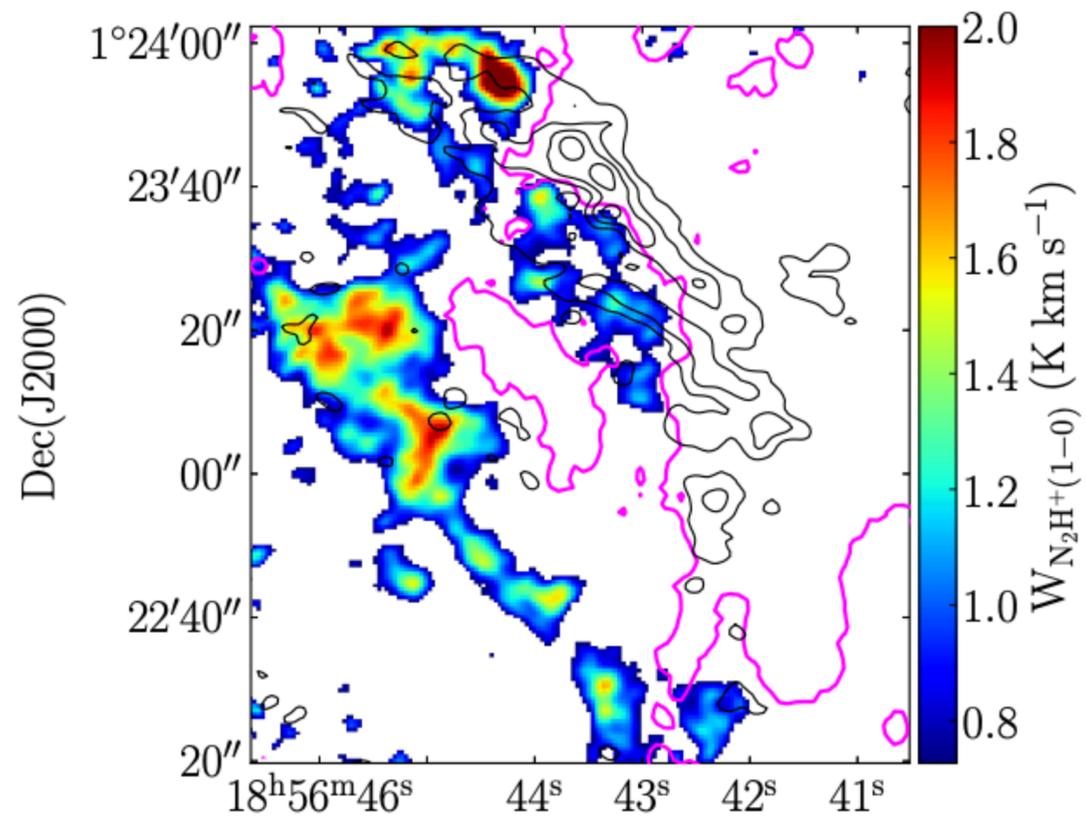


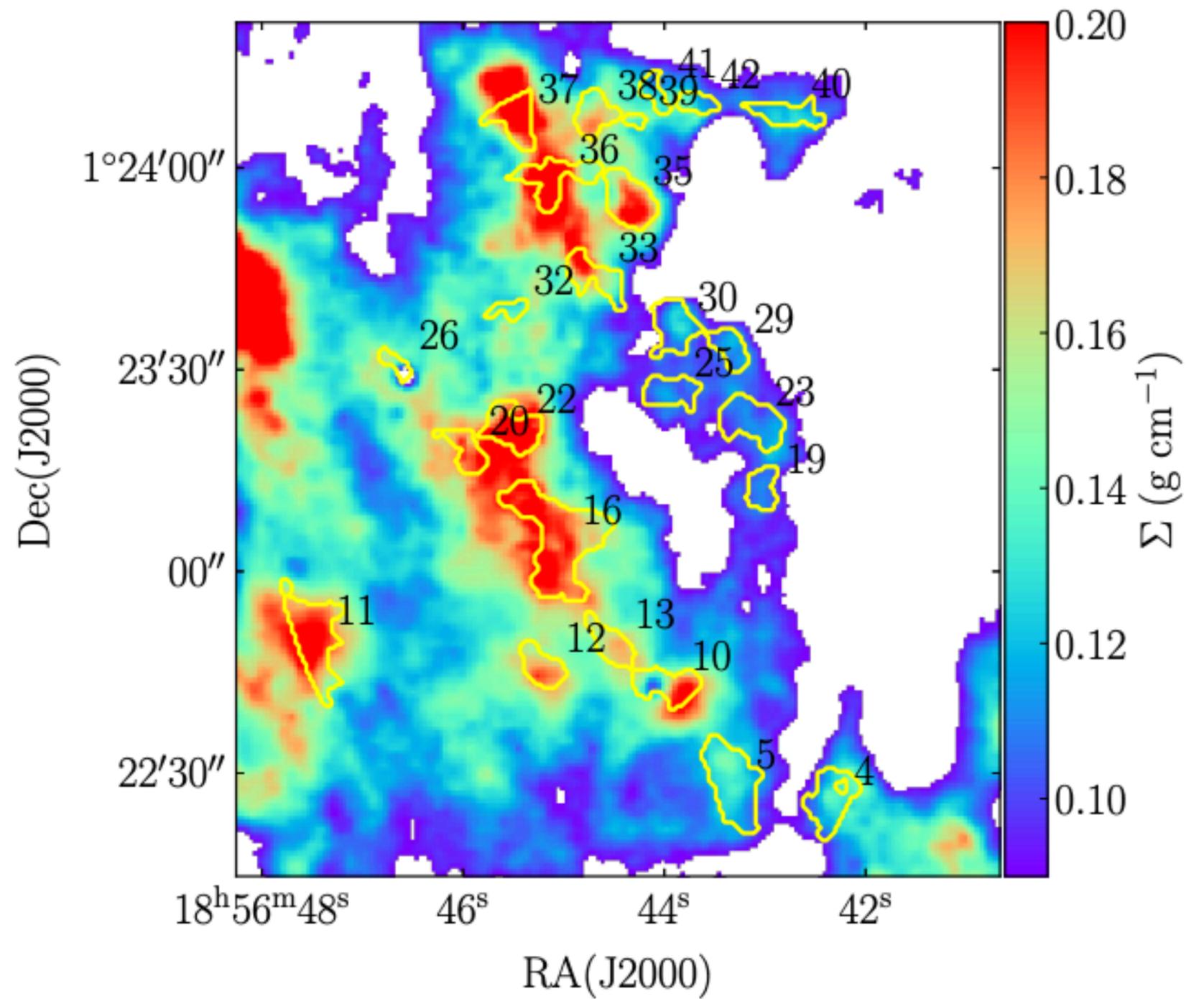
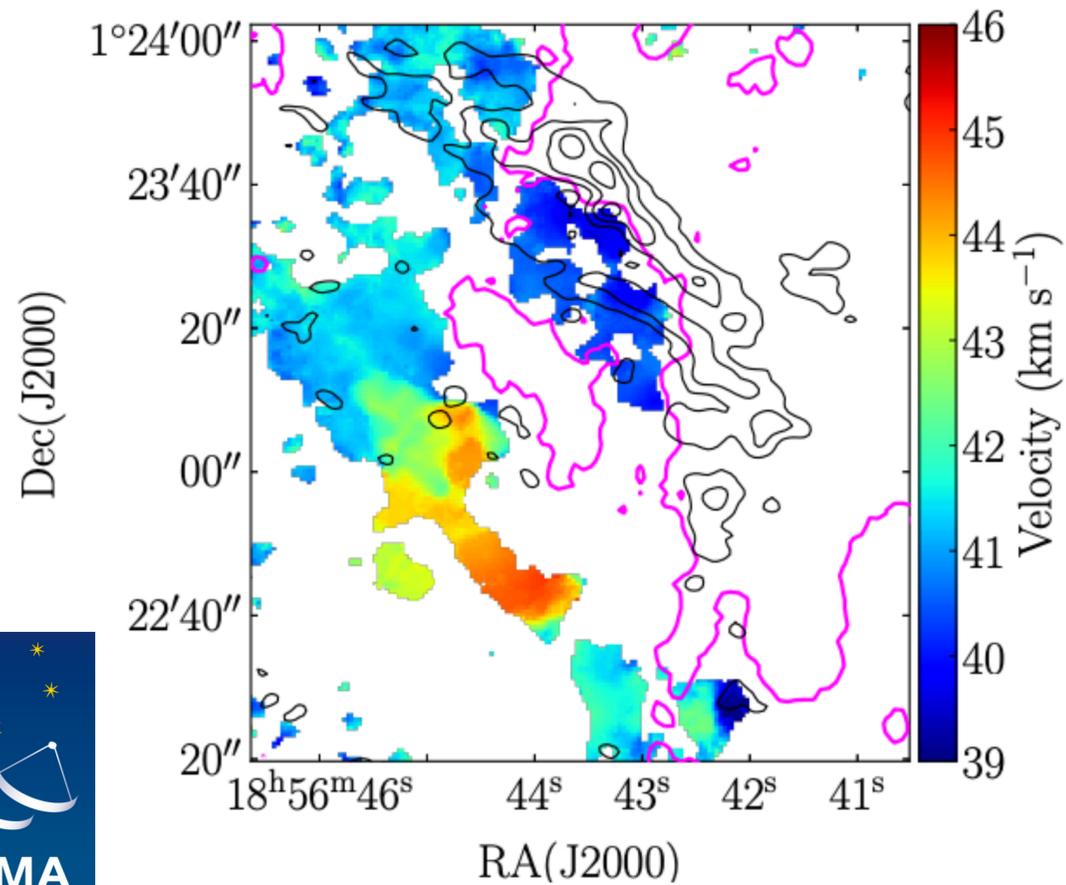
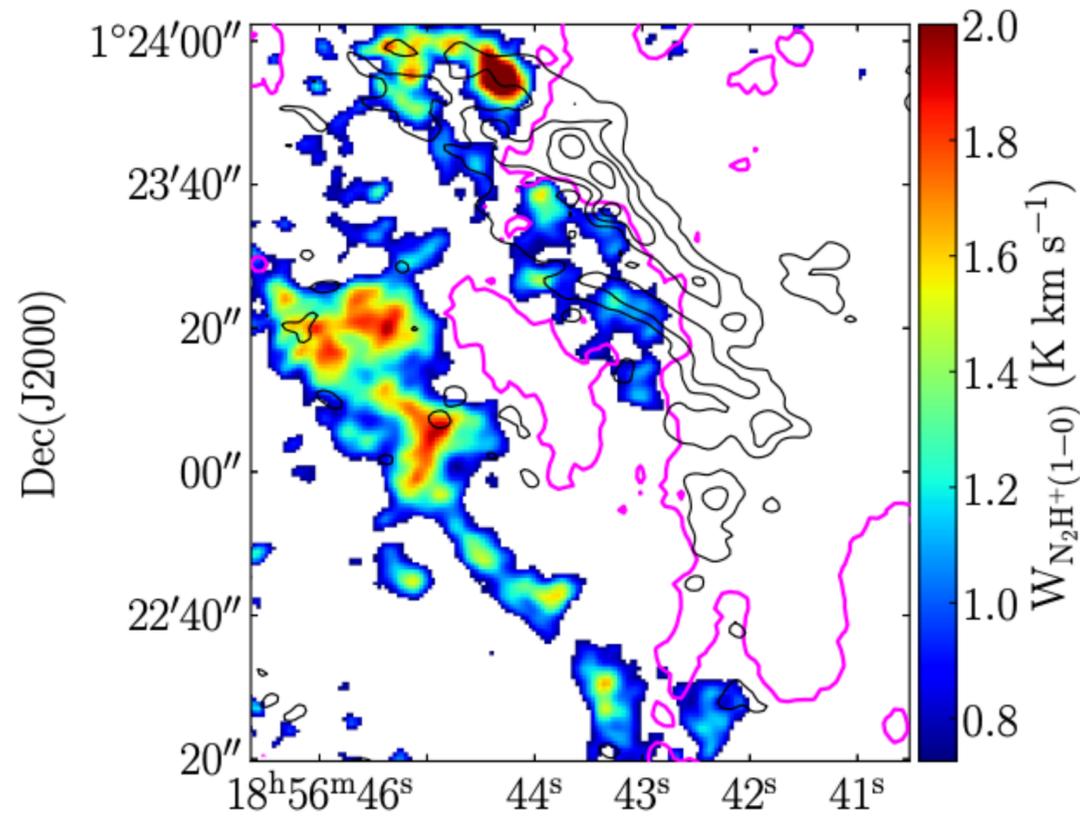
Enhanced
D/H
with respect to
Ambient gas

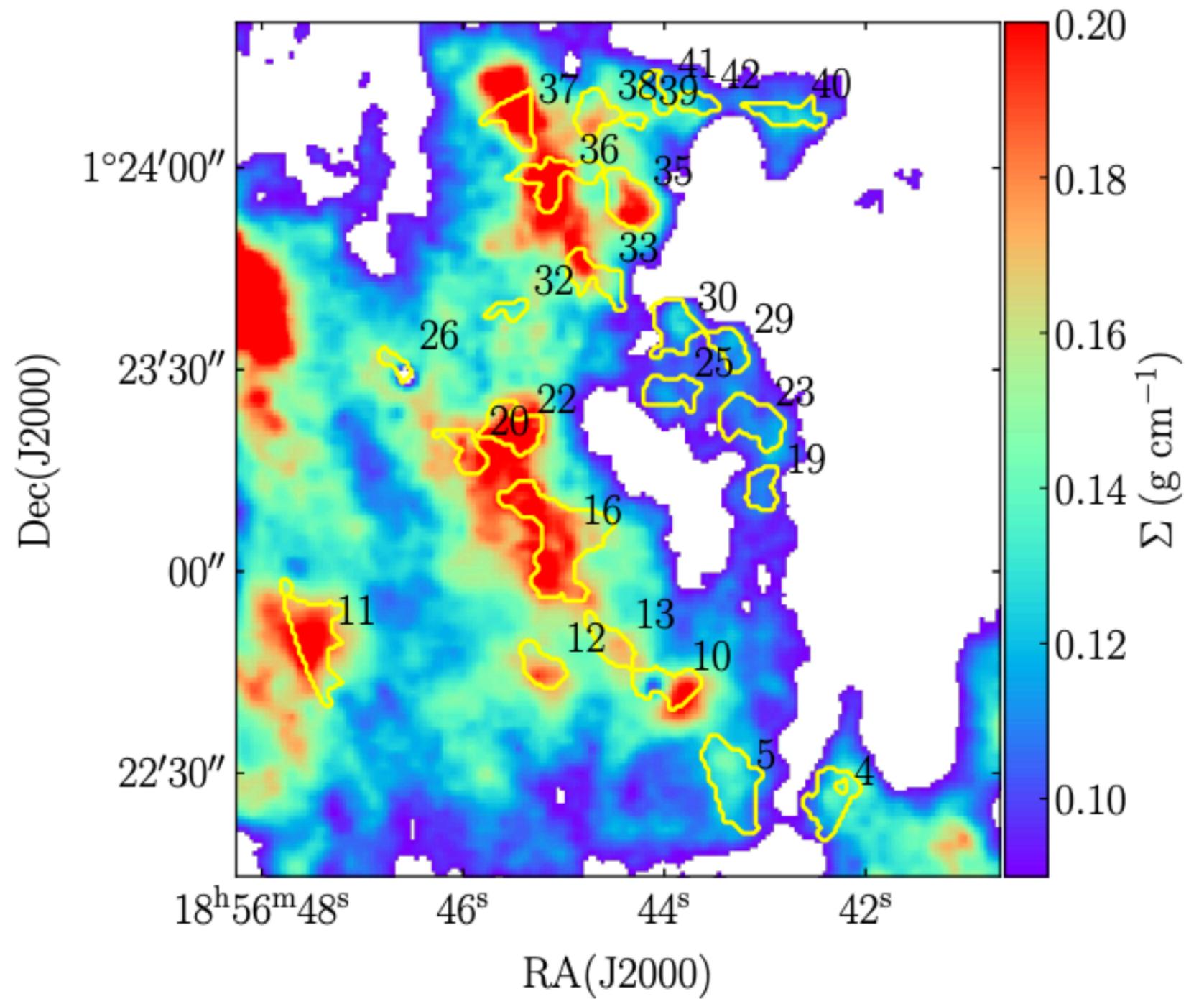
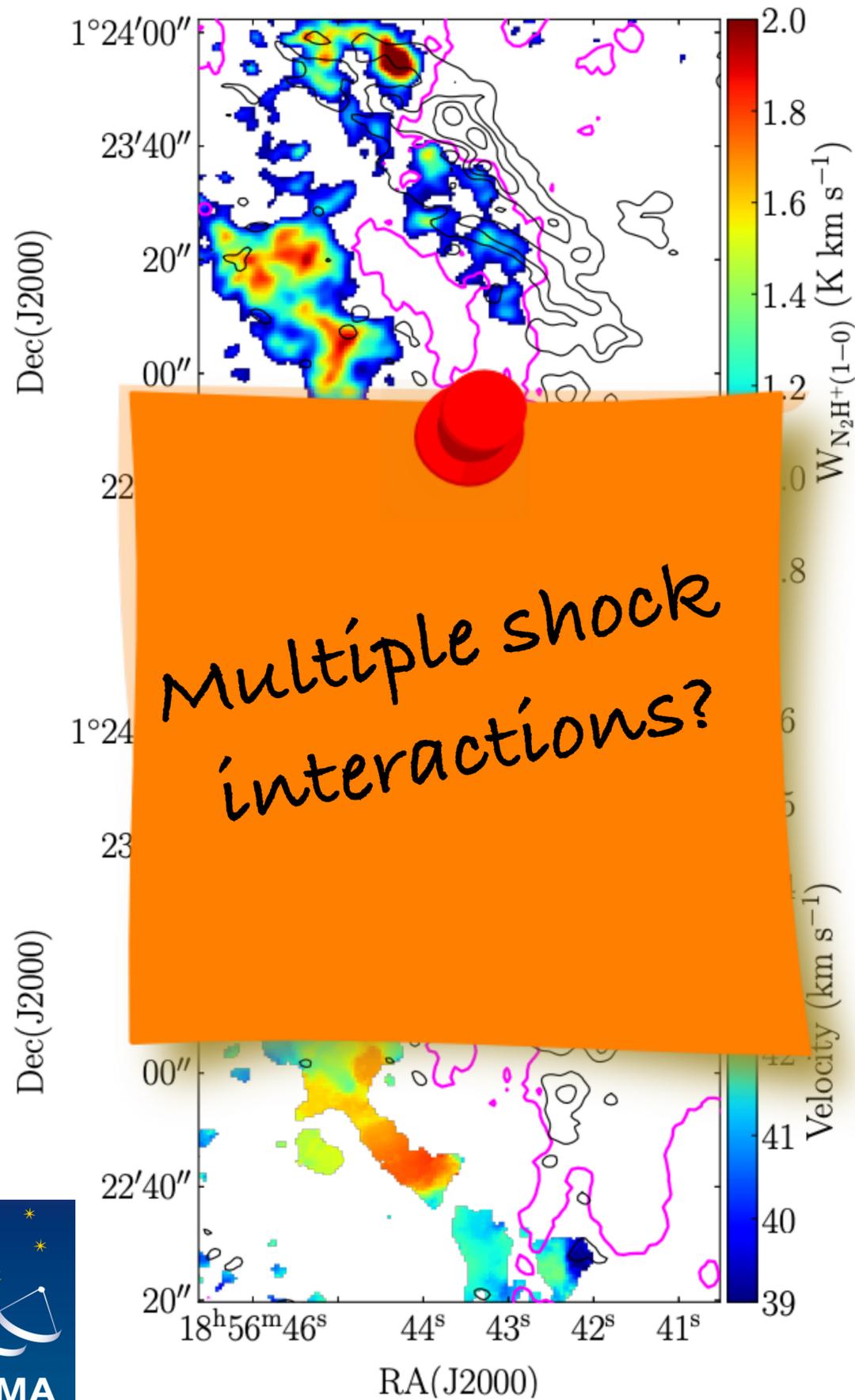


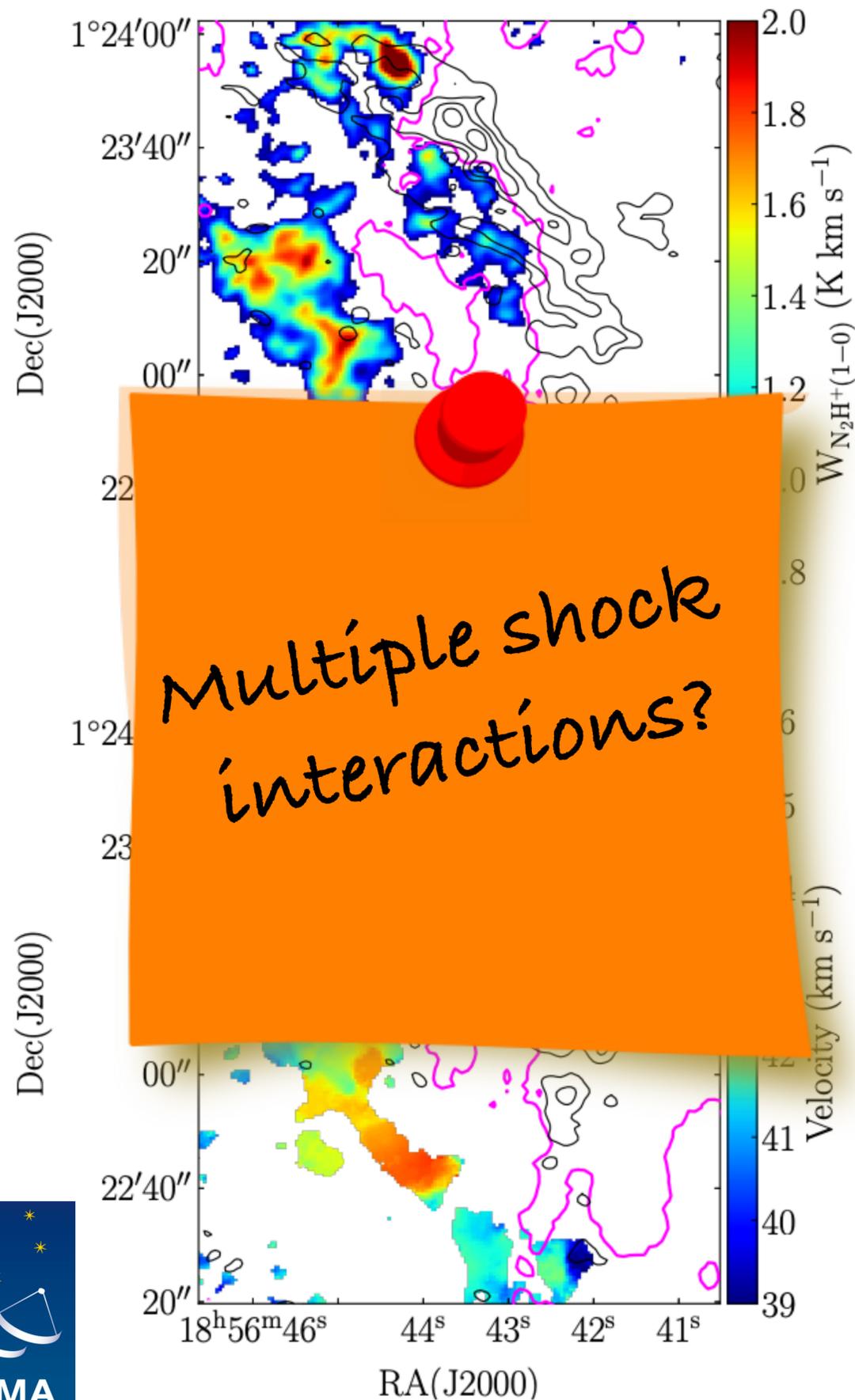
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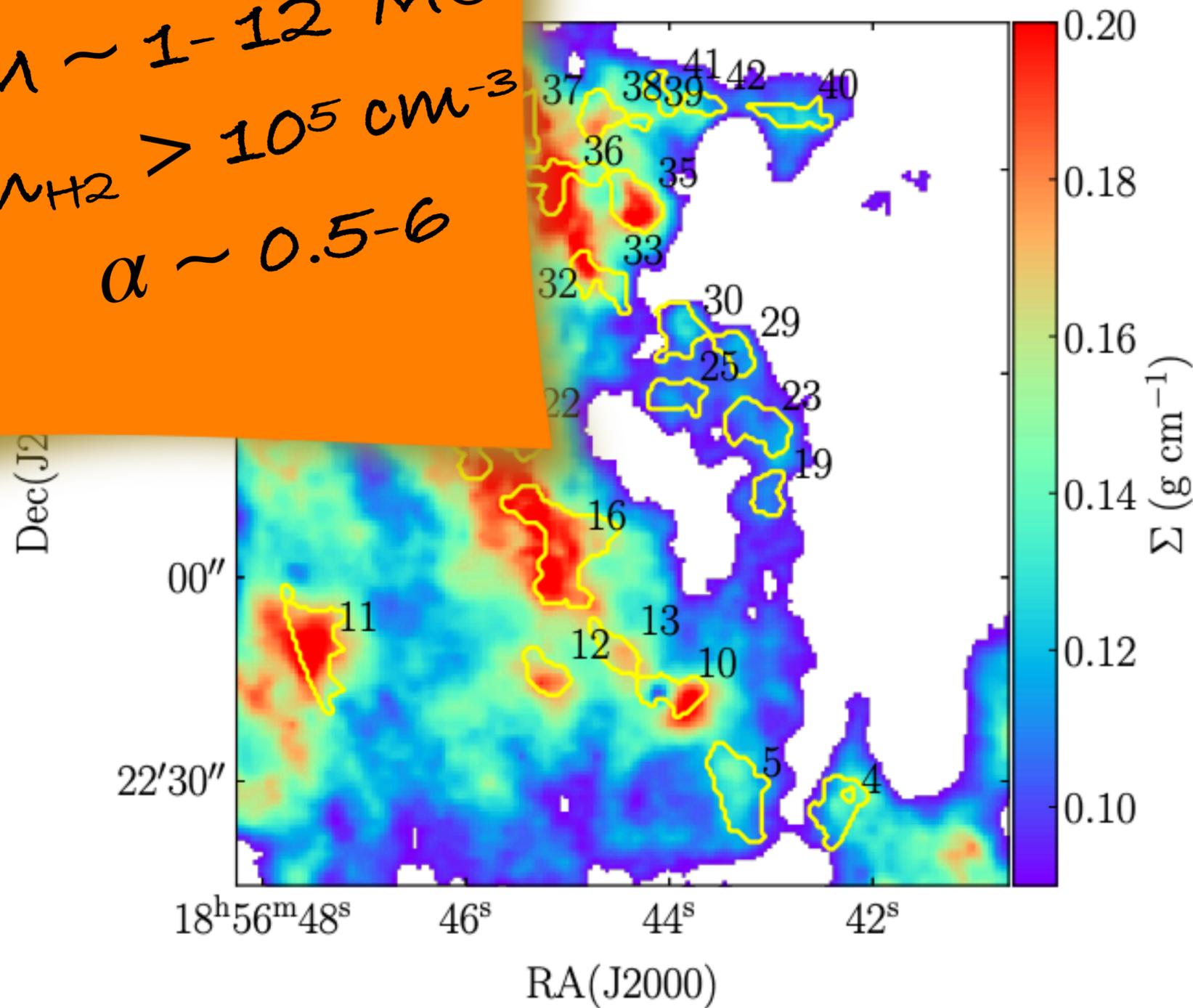


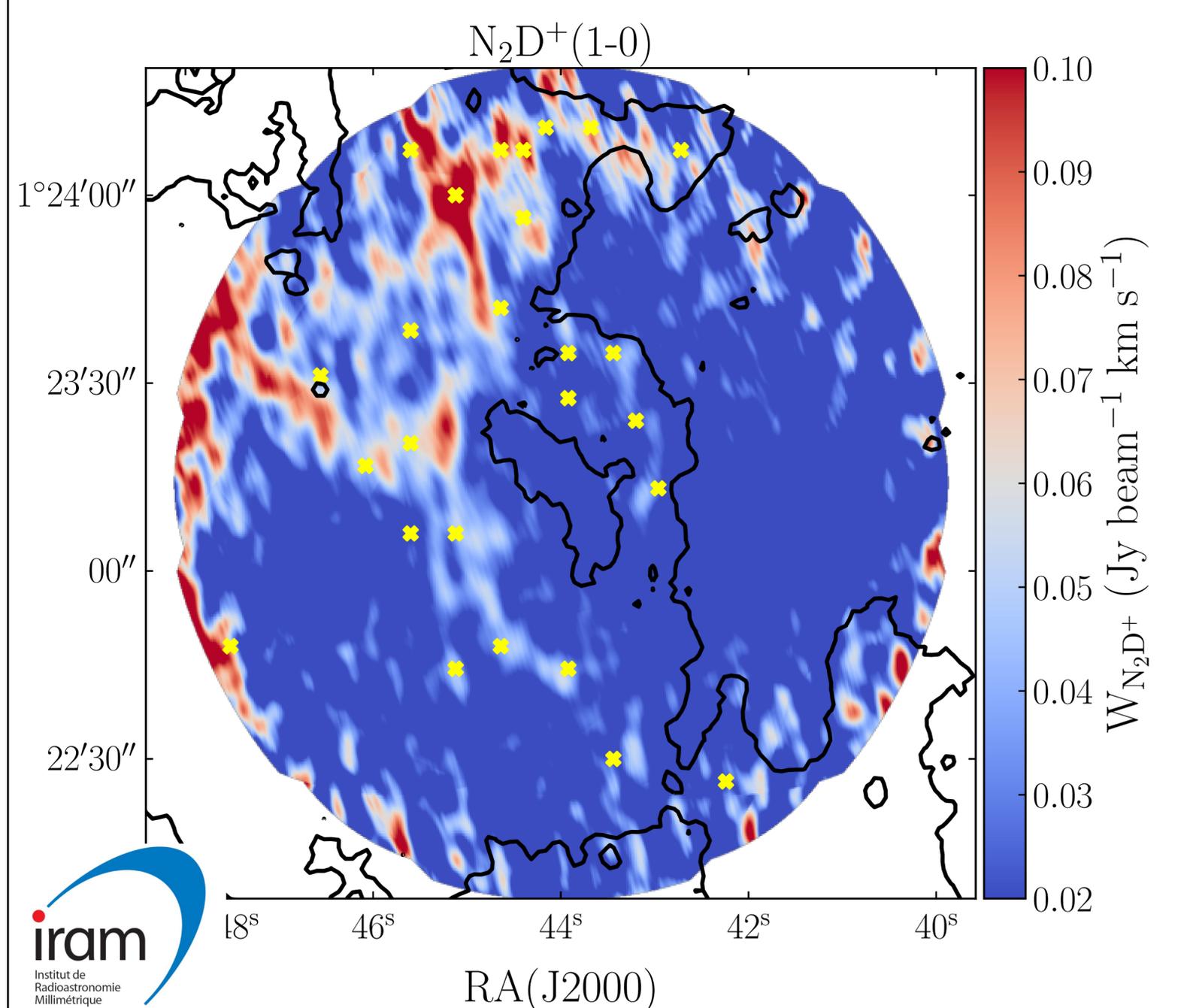
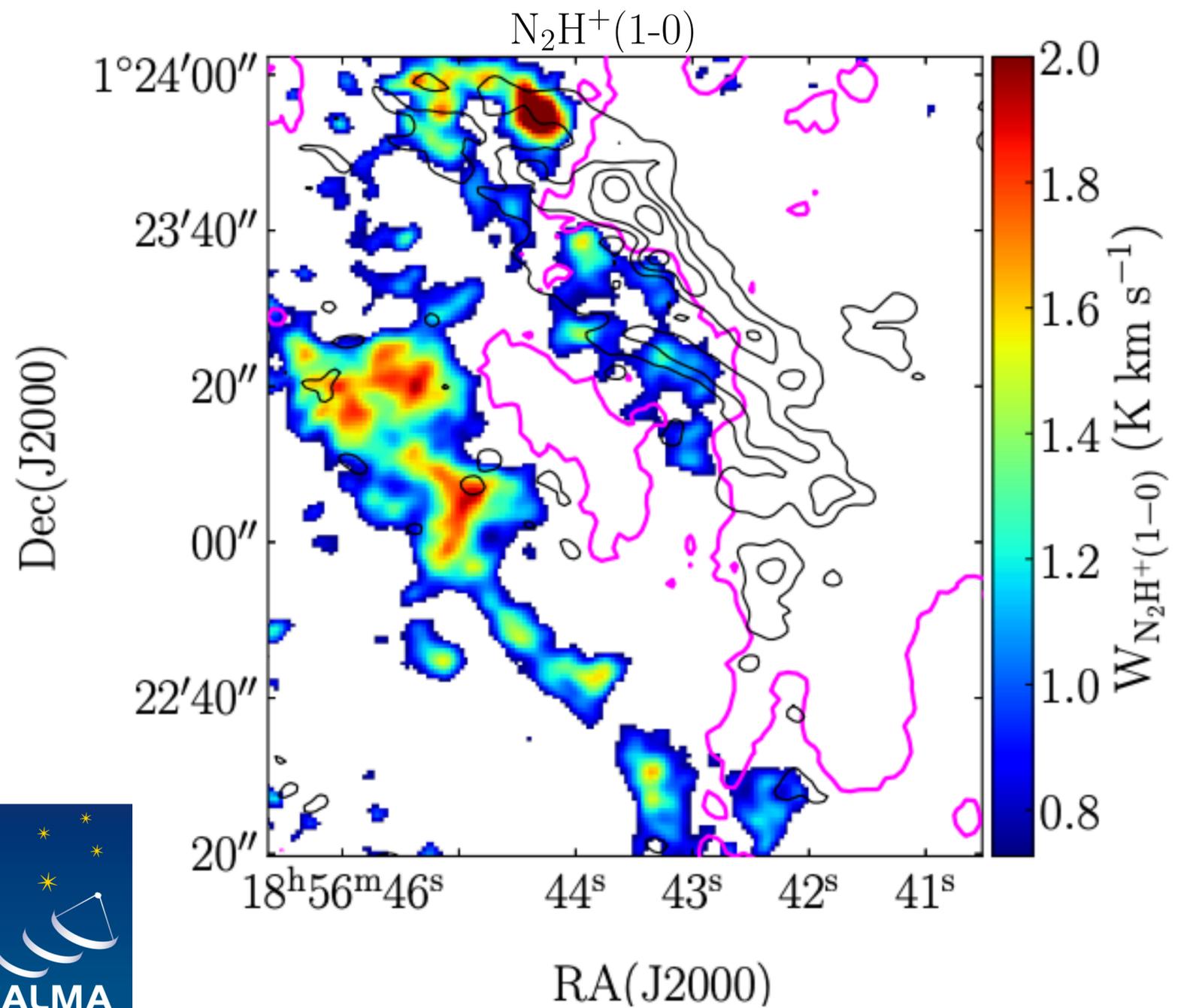




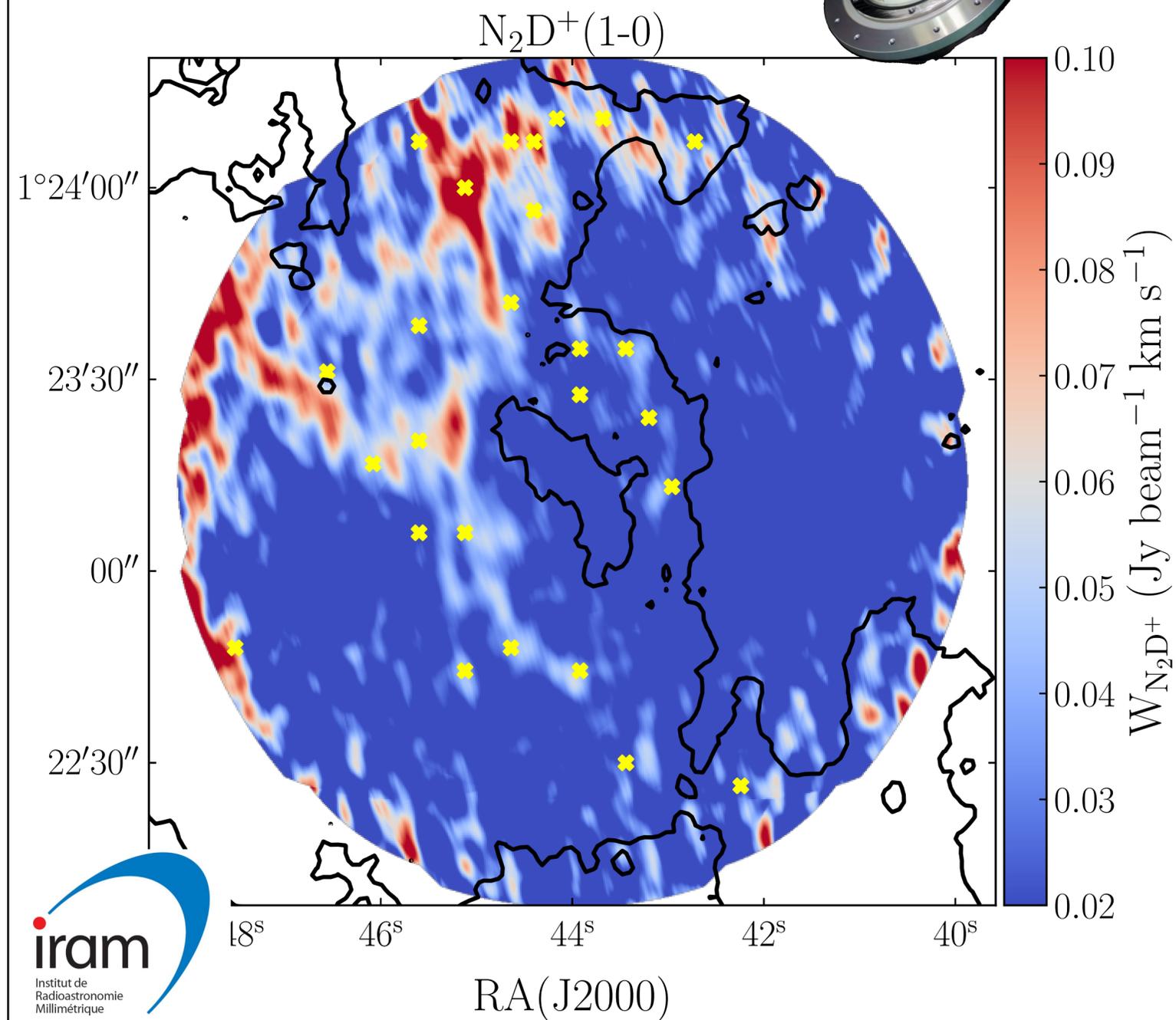
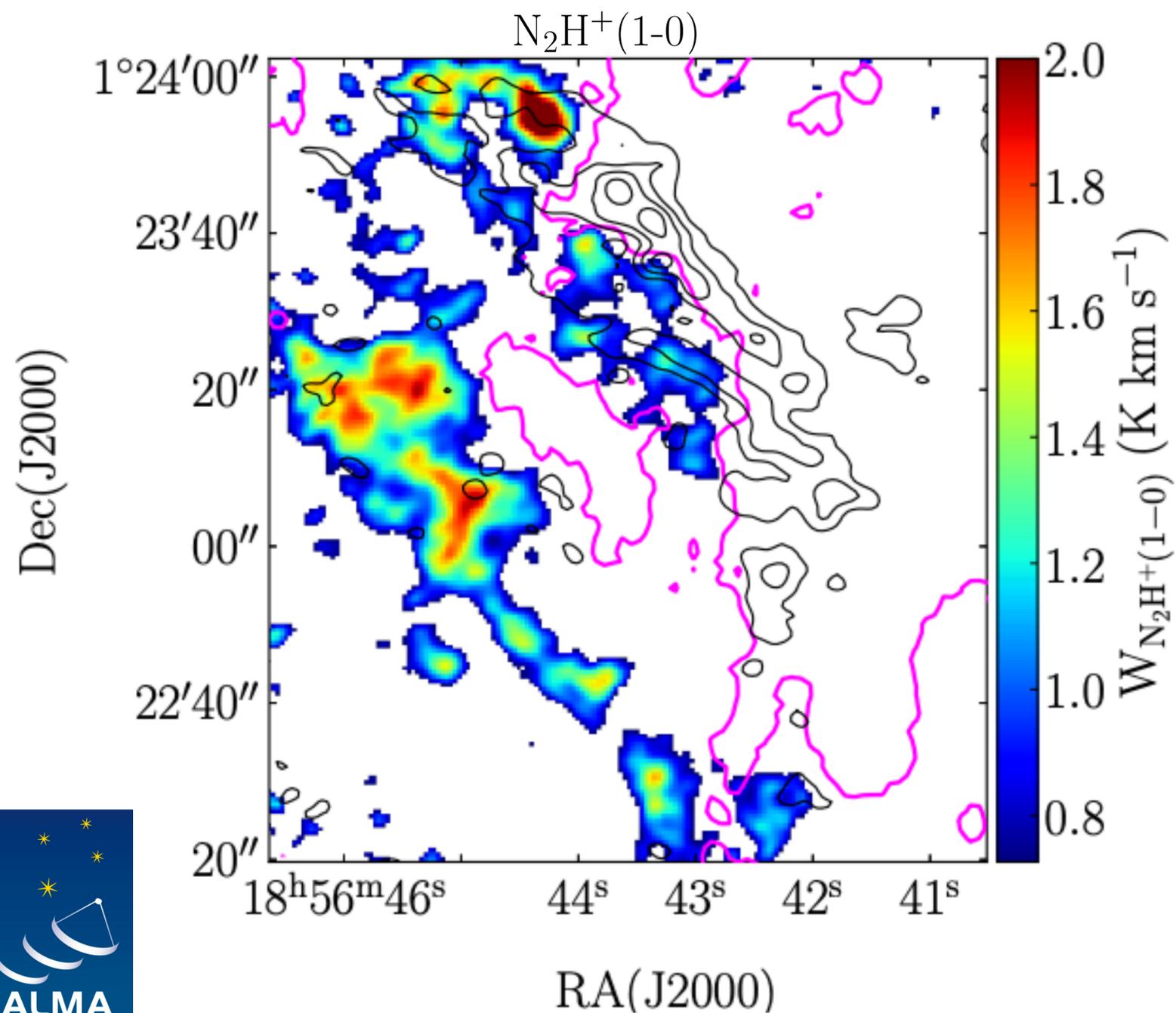
Multiple shock interactions?

$M \sim 1-12 M_{\odot}$
 $n_{H_2} > 10^5 \text{ cm}^{-3}$
 $\alpha \sim 0.5-6$





ALMA
Band 2



**Do SNR shocks impact MCs often enough
to affect star formation in galaxies?**

Shock Interaction

S

Remnants and

H

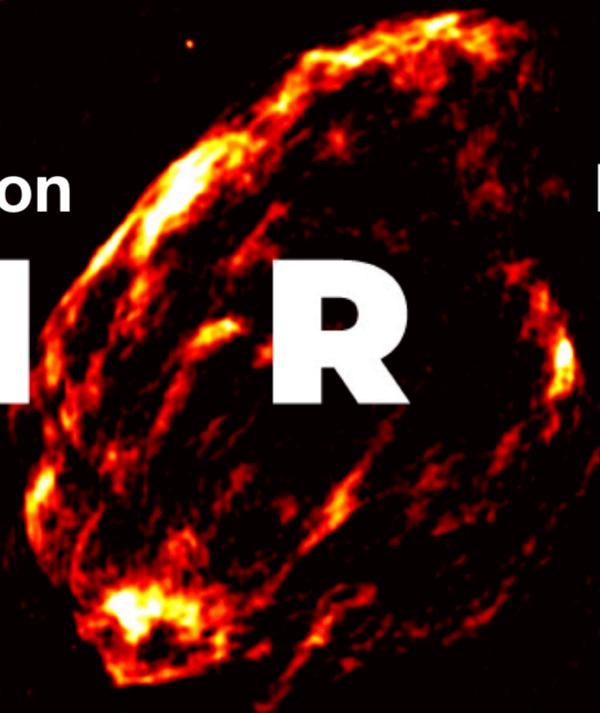
R

Between Supernova

E

C

Molecular Clouds



Shock Interaction

S

Remnants and

H

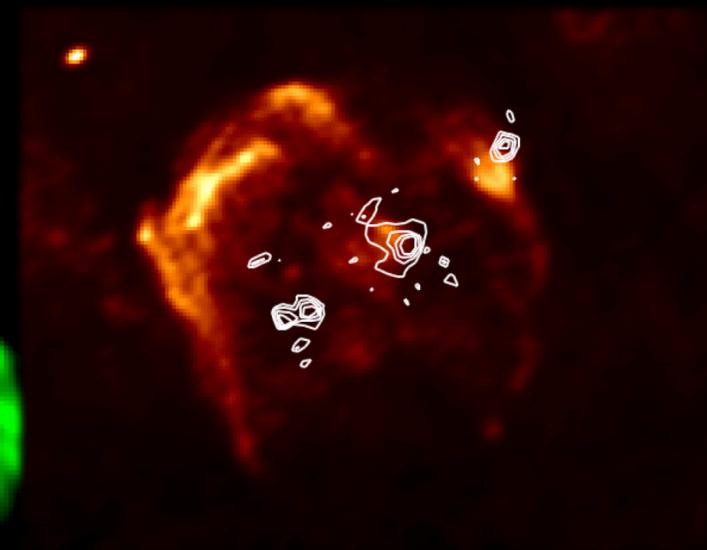
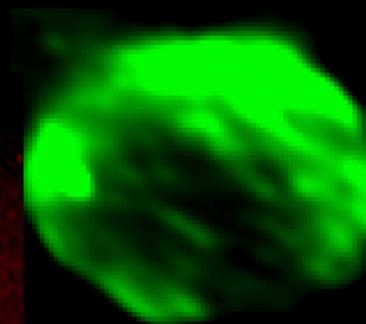
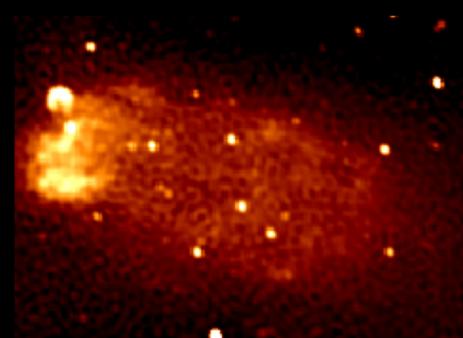
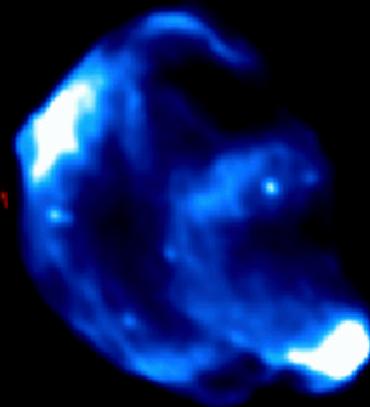
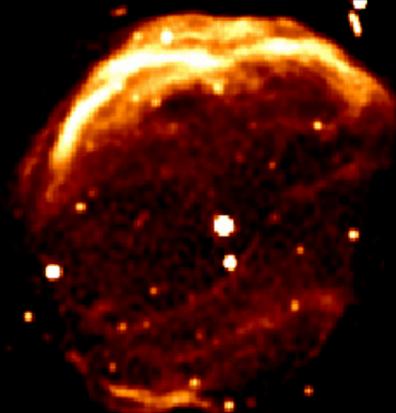
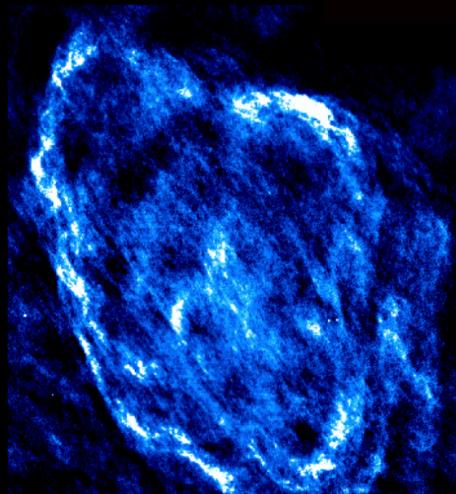
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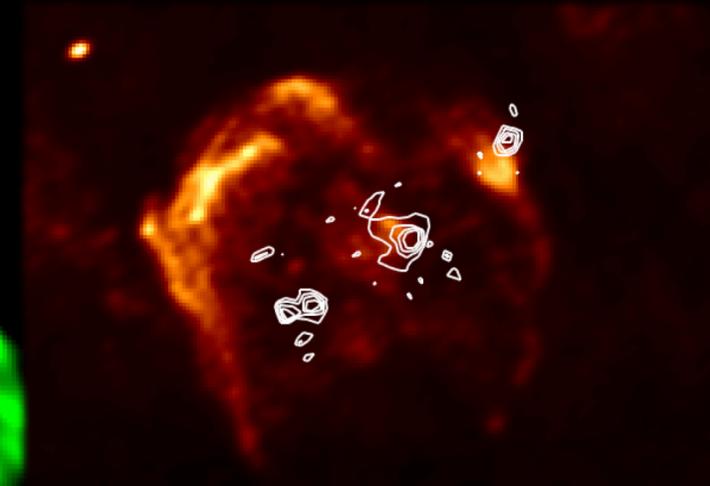
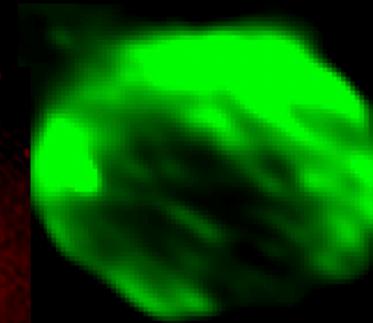
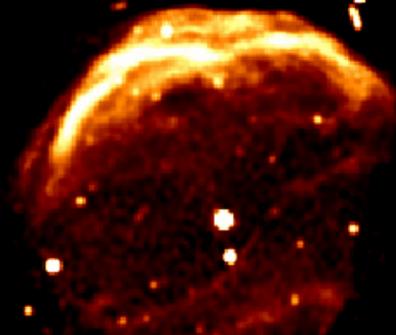
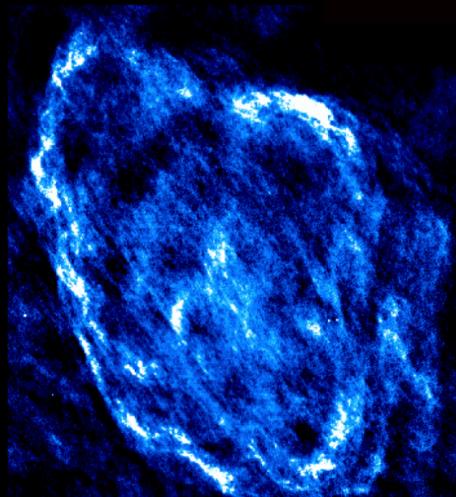
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Giuliana Cosentino (IRAM) - Izaskun Jimenez-Serra (CAB) - Serena Viti (UL) Leonardo Testi (UniBo) - Jonathan Henshaw (JMU) - Ashley Barnes (ESO) - Paola Caselli (MPE) Jonathan Tan (Chalmers/UVa) - Francesco Fontani (INAF-OAA) - Sandy Zeng (Riken) - Sarolta Zahorecz (OPU/NAOJ) - Marco Miceli (UniPA/INAF) - Giovanni Peres (UniPa/INAF) - Emanuele Greco (INAF) - Salvatore Orlando (INAF) - Fabrizio Bocchino (INAF)- Sabina Ustamujic (INAF) Fernando Rico-Villas (CAB) - Jesus Martin-Pintado (CAB) - Chi Yan Law (INAF-OAA) Ruben Fedriani (IAA) - Prasanta Gorai (UO) - Andres Megias (CAB)

Shock Interaction

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Remnants and

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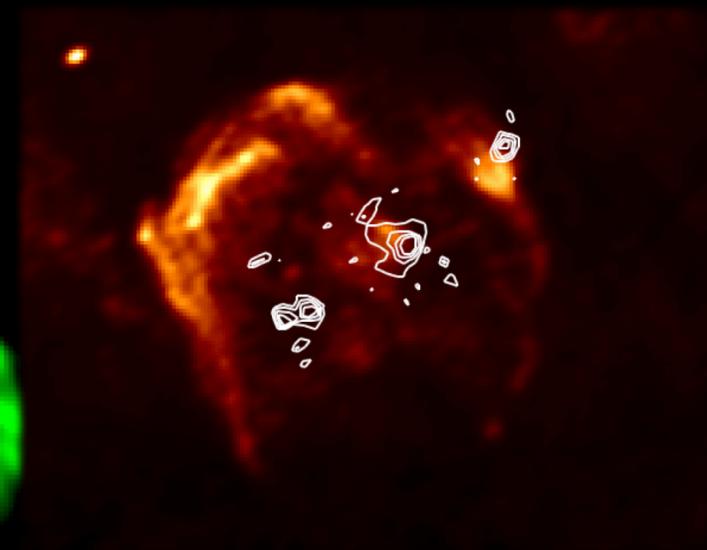
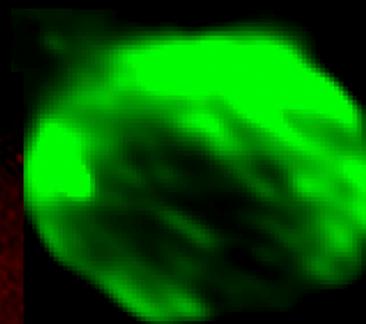
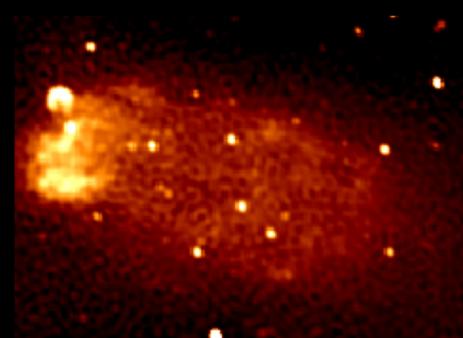
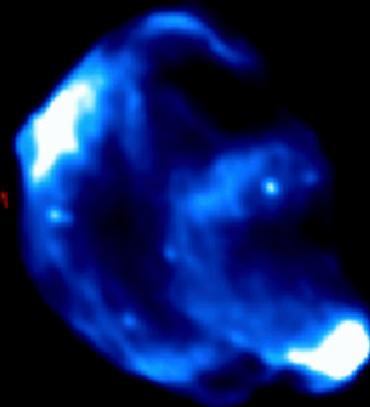
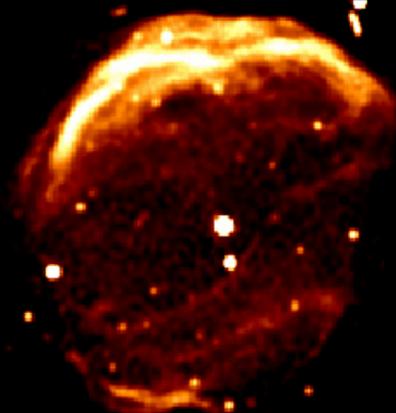
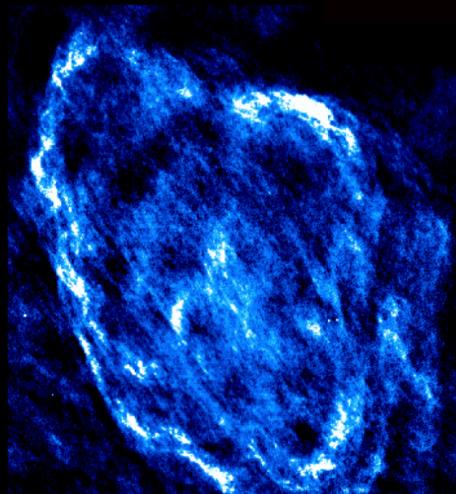
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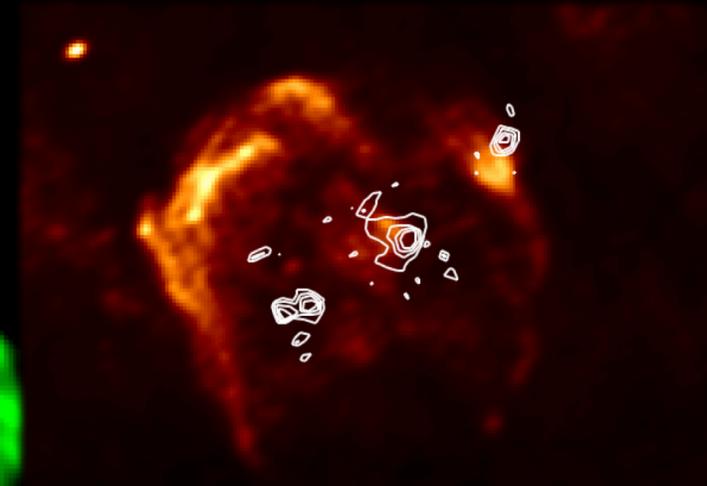
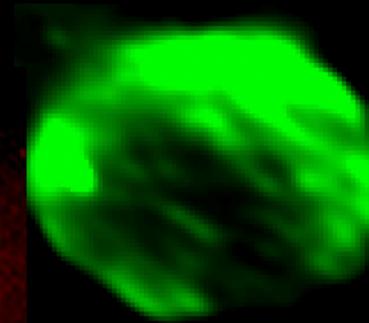
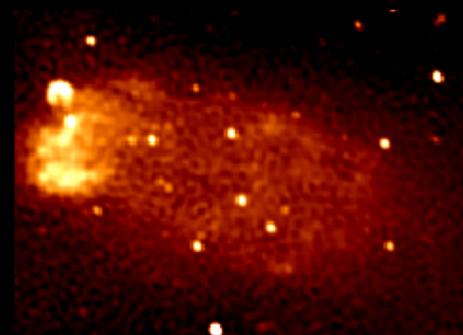
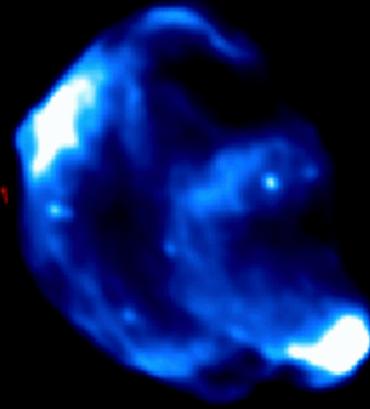
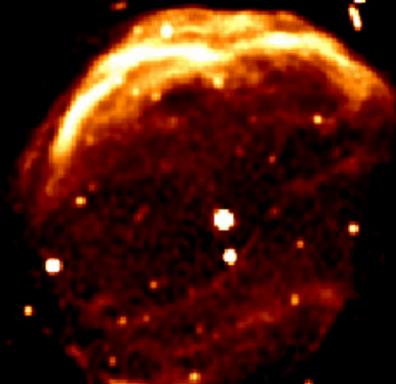
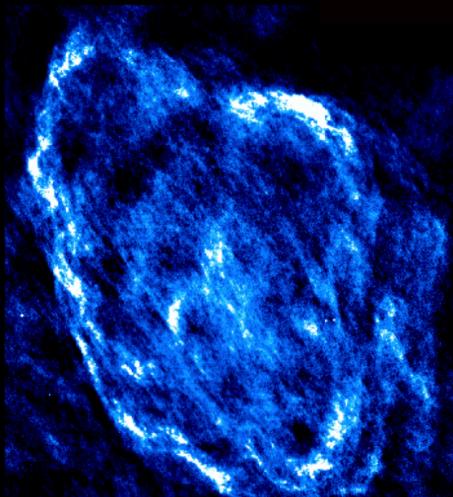
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Astronomía y Aplicaciones Espaciales

SiO(1-0) 43.3 GHz
SiO(2-1) 86.8 GHz

Shock Interaction

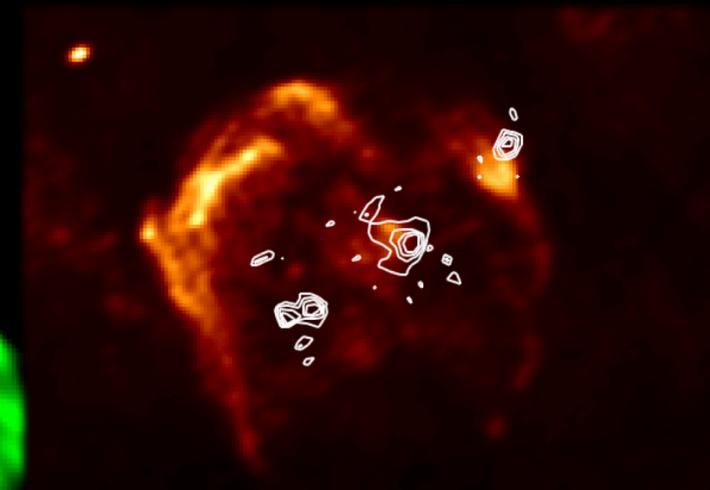
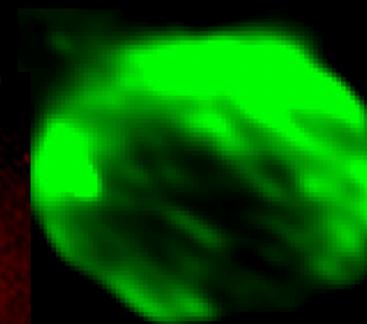
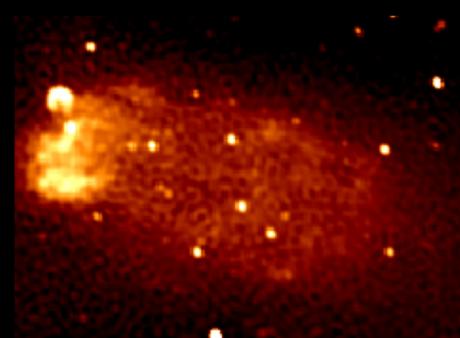
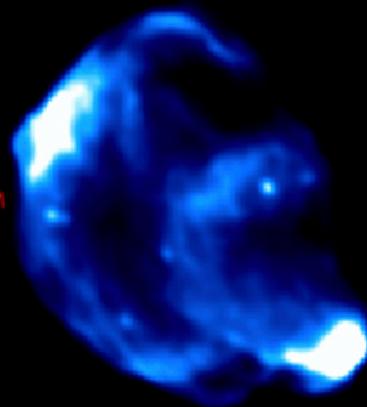
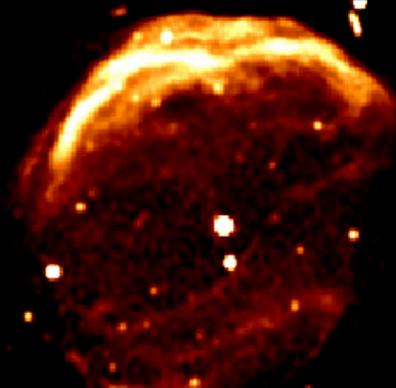
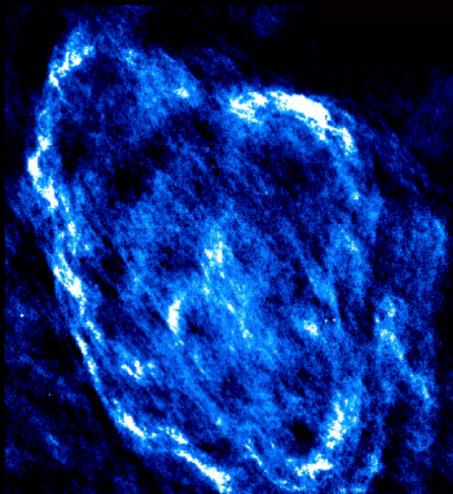
Between Supernova

S H R E C

Remnants and

Molecular Clouds

Cosentino et al. 2022



SiO(1-0) 43.3 GHz
SiO(2-1) 86.8 GHz

Can SNR shocks impacting molecular clouds...

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set the physical conditions to form stars?

SNR shock may enhance the gas density enough to ignite star formation

Early-stage star formation may be seen in the dense gas morphology and kinematics

The molecular material may be a significant carrier of momentum

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Thank you!