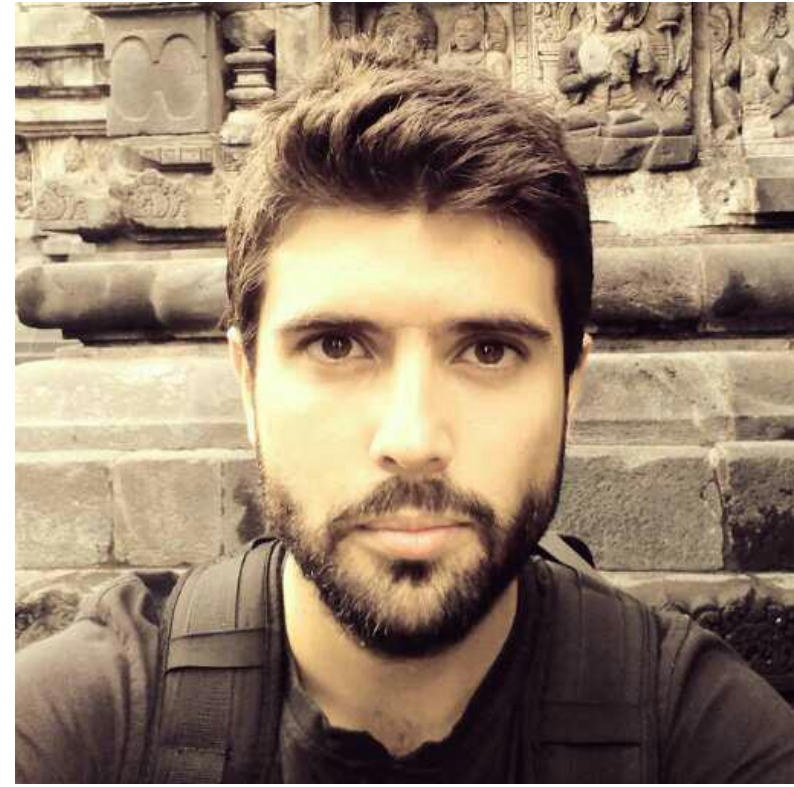


The Riccardo's effect

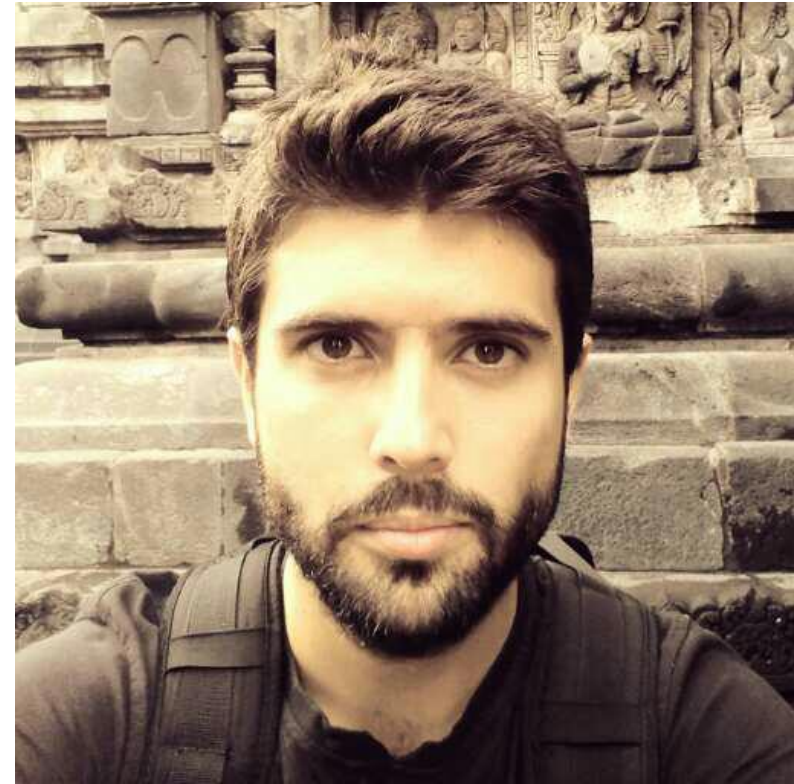


Víctor M. Rivilla
Centro de Astrobiología (CAB)
CSIC-INTA, Madrid





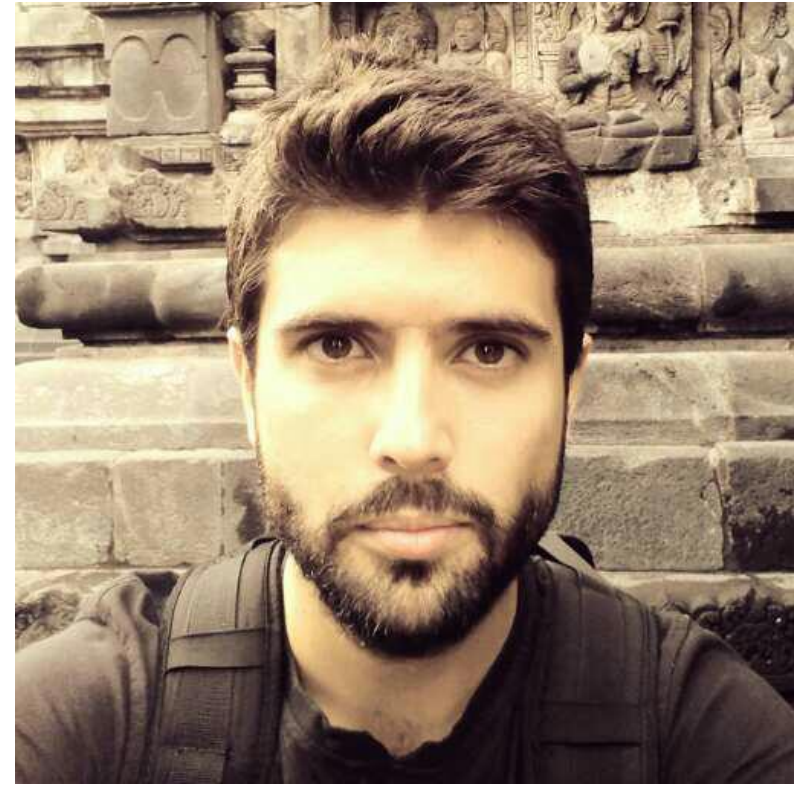
Riccardo, are you ready for the workshop?



Riccardo, are you ready for the workshop?

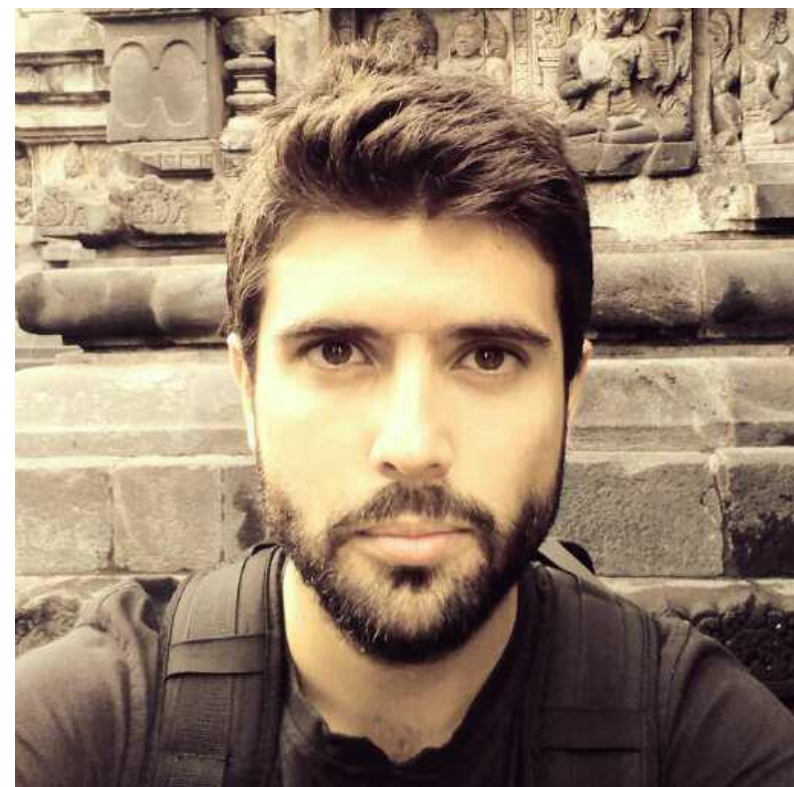
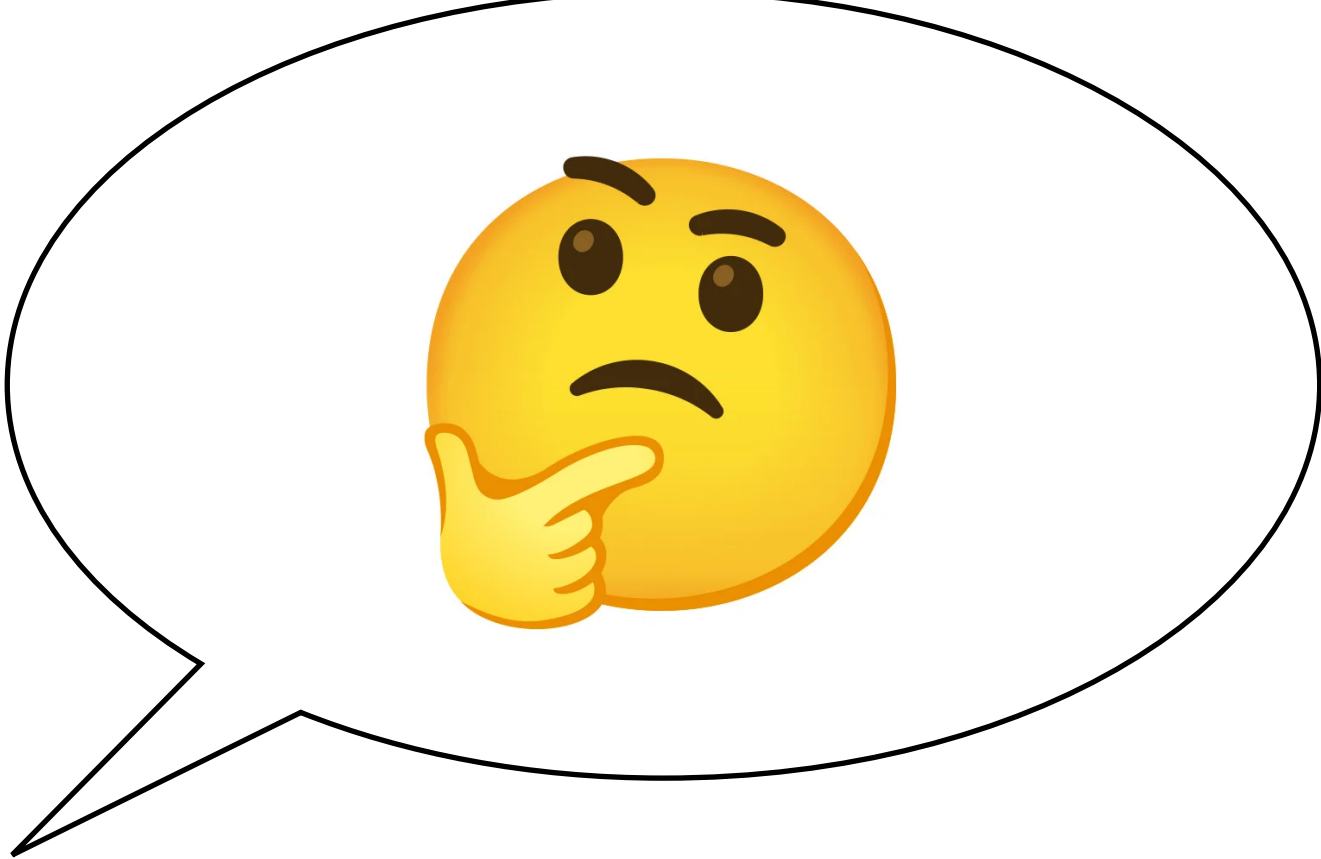
**Me?
Well, I have to do nothing...**





Riccardo, are you ready for the workshop?

**Me?
Well, I have to do nothing...**



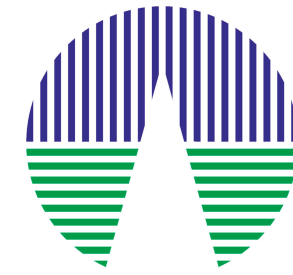
Test my memory!

Riccardo's QUIZ!

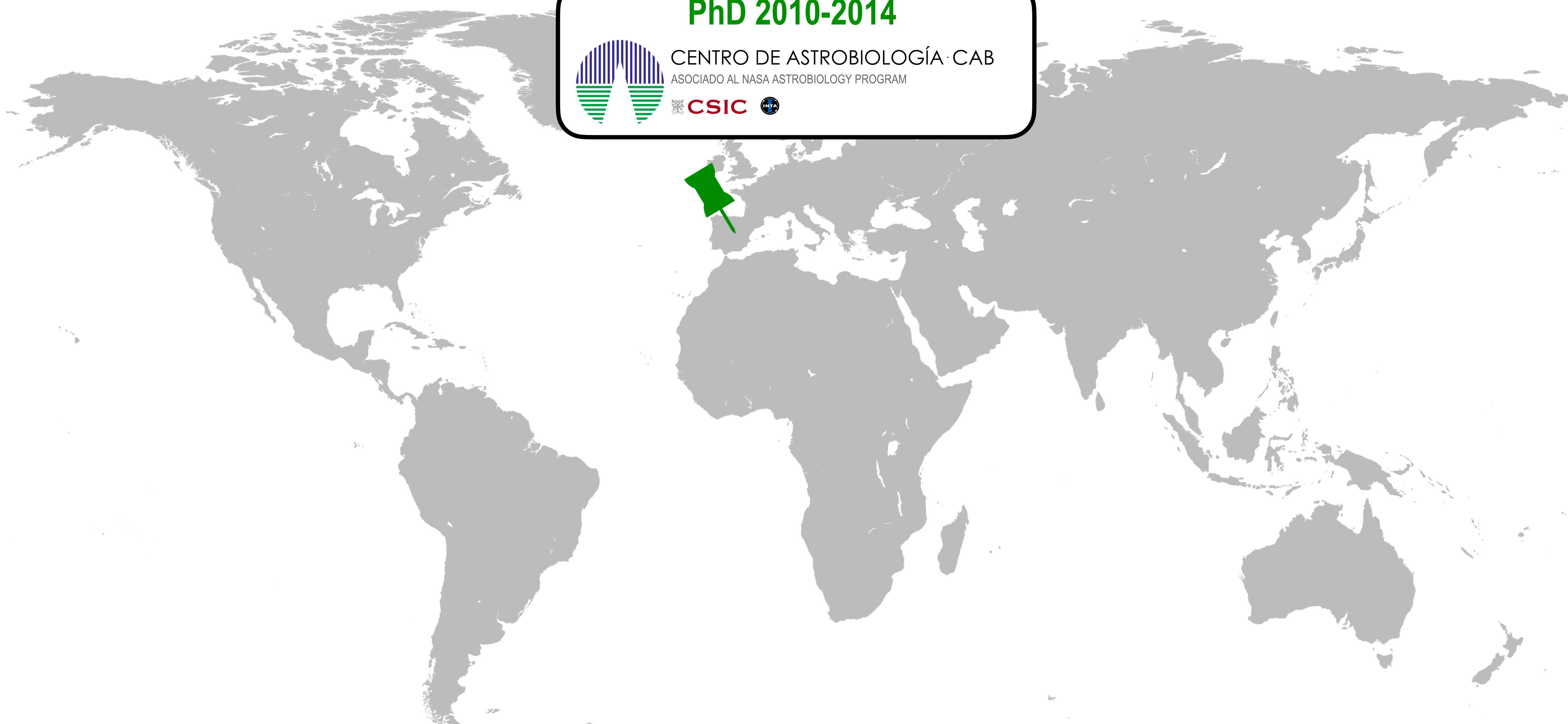


Research stays during my PhD

PhD 2010-2014

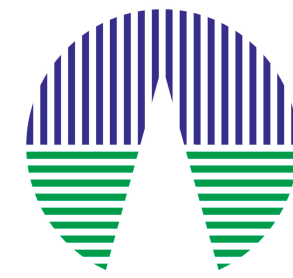


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PhD 2010-2014



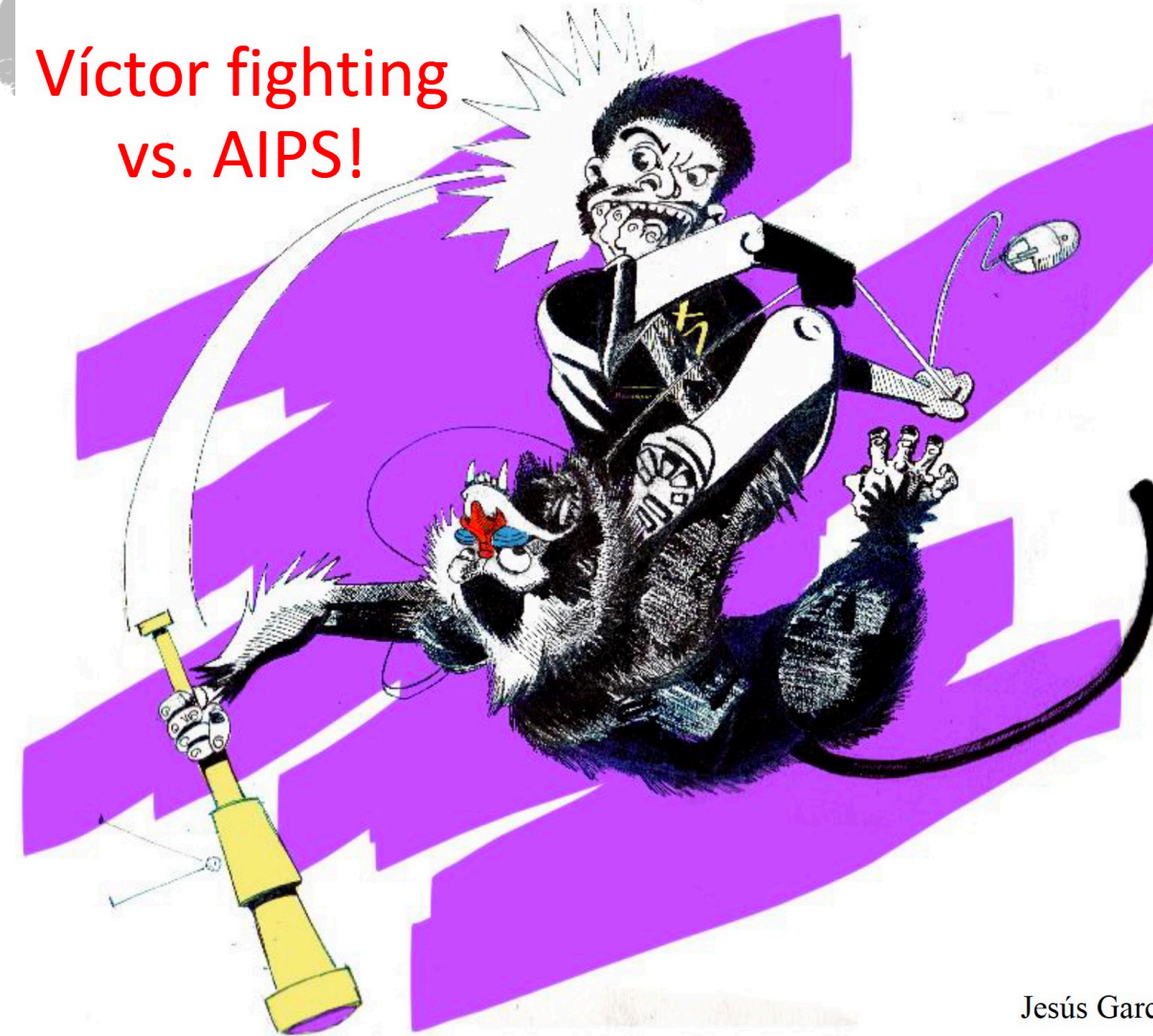
CENTRO DE ASTROBIOLOGÍA · CAB
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**National Radio Astronomy
Observatory (NRAO),
Socorro, New Mexico, USA
2009 (2 months)**



**Víctor fighting
vs. AIPS!**



Jesús García

I won!



Jesús García

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PhD 2010-2014



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**Osservatorio Astrofisico di Arcetri
Florence, Italy**



Cesaroni, the "hot core" guy





Cesaroni, the "hot core" guy



ASTRONOMY
AND
ASTROPHYSICS

Astron. Astrophys. 331, 709–725 (1998)

Sub-arcsecond structure of hot cores in the $\text{NH}_3(4,4)$ line*

R. Cesaroni¹, P. Hofner², C.M. Walmsley¹, and E. Churchwell³

¹ Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy

² Cornell University, Arecibo Observatory, P.O. Box 995, Arecibo, Puerto Rico 00613

³ Washburn Observatory, University of Wisconsin-Madison, 475 North-Charter Street, Madison, WI 53706, USA

Received 5 August 1997 / Accepted 26 September 1997



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Proceedings IAU Symposium No. 227, 2005
R. Cesaroni, M. Felli, E. Churchwell & C. M. Walmsley, eds.

Hot molecular cores

Riccardo Cesaroni

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email: cesa@arcetri.astro.it

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doi:10.1017/S1743921305004369



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Astronomy
&
Astrophysics

The structure of hot molecular cores over 1000 AU*

R. Cesaroni¹, P. Hofner^{2,3,4}, E. Araya^{5,3,6}, and S. Kurtz⁷

A&A 509, A50 (2010)
DOI: 10.1051/0004-6361/200912877
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Proceedings IAU Symposium No. 227, 2005
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Hot molecular cores

Riccardo Cesaroni

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Hot molecular cores

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email: cesa@arcetri.astro.it

A&A 533, A73 (2011)
DOI: 10.1051/0004-6361/201117206
© ESO 2011

Astronomy
&
Astrophysics

Dissecting a hot molecular core: the case of G31.41+0.31*

R. Cesaroni¹, M. T. Beltrán¹, Q. Zhang², H. Beuther³, and C. Fallscheer^{3,4}



Cesaroni, the “hot core” guy



Vol 444|7 December 2006|doi:10.1038/nature05344

nature

PROGRESS

The critical role of disks in the formation of high-mass stars

Riccardo Cesaroni¹, Daniele Galli¹, Giuseppe Lodato², Malcolm Walmsley¹ & Qizhou Zhang³

Although massive stars (commonly defined as those in excess of about eight solar masses, or with initial luminosities of a thousand times the solar luminosity or more) have an enormous impact on the galactic environment, how they form has been a mystery. The solution probably involves the existence of accretion disks. Rotational motions have been found in the gas surrounding young high-mass stars, which suggests that non-spherical accretion could be the fundamental ingredient of the massive-star formation recipe.

Research stays during my PhD

PhD 2010-2014



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Socorro, New Mexico, USA
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**Osservatorio Astrofisico di Arcetri
Florence, Italy**

QUESTION #1
When I did my visit to Arcetri?

**Oct-Dec
2009**

**Oct-Dec
2010**

**Oct-Dec
2011**

Research stays during my PhD

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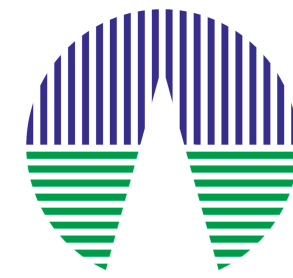
**Oct-Dec
2011**

Florence, December 17 2010



Postdoc?

PhD 2010-2014



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**CfA Cambridge, USA
2011 (3 months)**

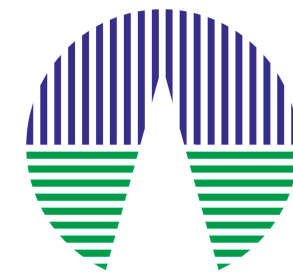
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HARVARD & SMITHSONIAN

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Postdoc?

PhD 2010-2014



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I N A F

Istituto Nazionale di Astrofisica

OSSERVATORIO ASTROFISICO DI ARCETRI

Largo Enrico Fermi, 5 - 50125 FIRENZE (ITALIA)

Tel. ++ 39-055-2752258

Fax ++ 39-055-220039

Contratto n. 1 del 07.01.2015

Dott. Victor Manuel Rivilla Rodriguez
Embacaciones 22 3° B Tres Cantos
28760 Madrid (Spain)

CONTRATTO DI COLLABORAZIONE AD ATTIVITA' DI RICERCA

PROGRAMMA DI RICERCA

"HIGH-ANGULAR RESOLUTION OBSERVATIONS OF COMPLEX ORGANIC MOLECULES IN
STAR FORMING REGIONS"

Tra l'Istituto Nazionale di Astrofisica (C.F. 97220210583), in persona del Direttore dell'Osservatorio Astrofisico di Arcetri, **Dott. Filippo Mannucci** e Il **Dott. Victor Manuel Rivilla Rodriguez**, nato a Madrid (Spagna), il 21.09.1985 e residente in Embacaciones 22 3° B Tres Cantos - 28760 Madrid (Spagna) – C.F.

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QUESTION #2

Which interstellar sources are among the most chemically rich in the ISM?

Your beloved
hot cores

High-z
galaxies

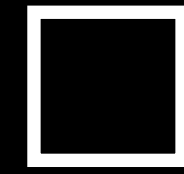
Black
holes

QUESTION #2

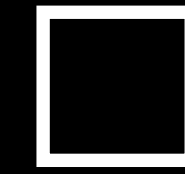
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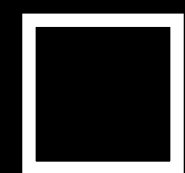
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High-z
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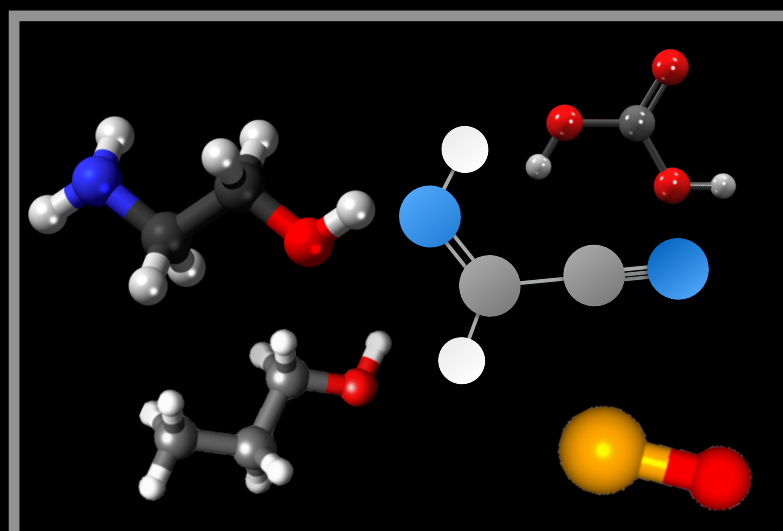
Black
holes

Forging giants: massive stars and their disks ... and their molecules

A celebration of Riccardo Cesaroni's career
















Florence - Villa Galileo

May 4-6, 2026





Towards the dark side... (astrochemistry)

- 1 2020MNRAS.492.1180R 2020/02 cited: 97   
ALMA and ROSINA detections of phosphorus-bearing molecules: the interstellar thread between star-forming regions and comets
Rivilla, V. M.; Drozdovskaya, M. N.; Altwegg, K. *and 20 more*
- 2 2019MNRAS.483..806R 2019/02 cited: 42   
First ALMA maps of HCO, an important precursor of complex organic molecules, towards IRAS 16293-2422
Rivilla, V. M.; Beltrán, M. T.; Vasyunin, A. *and 4 more*
- 3 2017A&A...599A..26R 2017/03 cited: 34   
On the chemical ladder of esters. Detection and formation of ethyl formate in the W51 e2 hot molecular core
Rivilla, V. M.; Beltrán, M. T.; Martín-Pintado, J. *and 3 more*
- 4 2017A&A...598A..59R 2017/02 cited: 119   
Formation of ethylene glycol and other complex organic molecules in star-forming regions
Rivilla, V. M.; Beltrán, M. T.; Cesaroni, R. *and 3 more*
- 5 2016ApJ...826..161R 2016/08 cited: 107   
The First Detections of the Key Prebiotic Molecule PO in Star-forming Regions
Rivilla, V. M.; Fontani, F.; Beltrán, M. T. *and 4 more*



CrossMark

THE FIRST DETECTIONS OF THE KEY PREBIOTIC MOLECULE PO IN STAR-FORMING REGIONS

V. M. RIVILLA¹, F. FONTANI¹, M. T. BELTRÁN¹, A. VASYUNIN^{2,3}, P. CASELLI², J. MARTÍN-PINTADO⁴, AND R. CESARONI¹

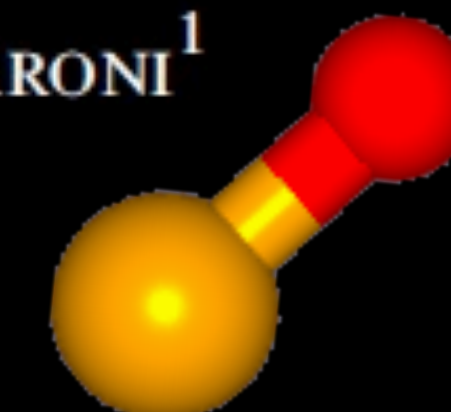
¹Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125, Firenze, Italy

²Max-Planck Institute for Extraterrestrial Physics, Giessenbachstrasse 1, D-85748, Garching, Germany

³Ural Federal University, Ekaterinburg, Russia

⁴Centro de Astrobiología (CSIC-INTA), Ctra. de Torrejón a Ajalvir km 4, E-28850, Torrejón de Ardoz, Madrid, Spain

Received 2016 April 28; revised 2016 May 14; accepted 2016 May 17; published 2016 July 28





CrossMark

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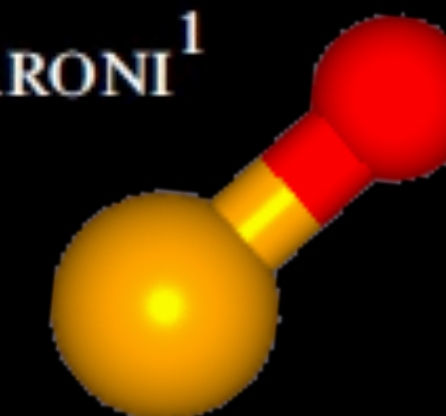
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Monthly Notices

of the

ROYAL ASTRONOMICAL SOCIETY



MNRAS **483**, 806–823 (2019)

Advance Access publication 2018 November 16

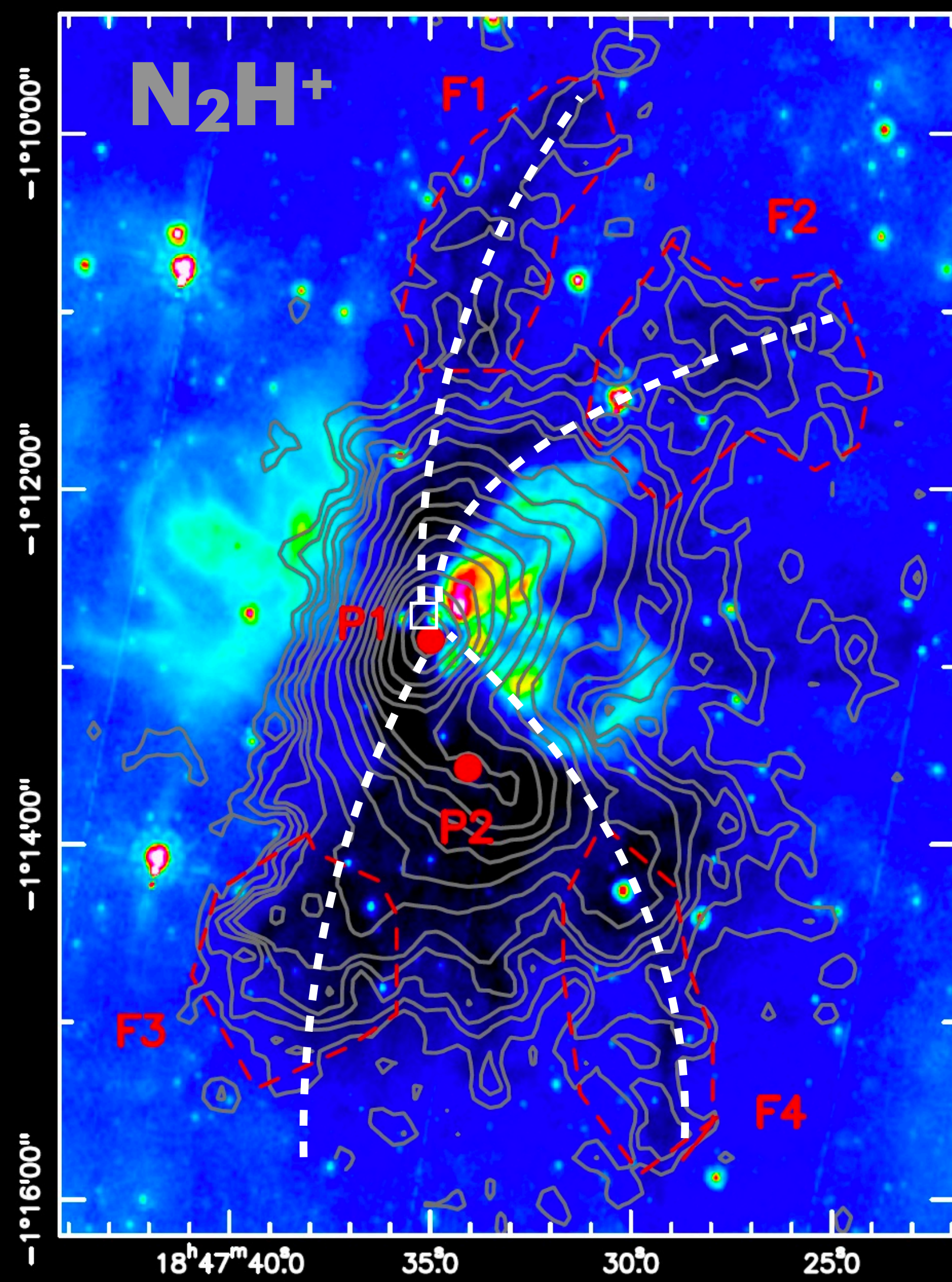
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First ALMA maps of HCO, an important precursor of complex organic molecules, towards IRAS 16293–2422

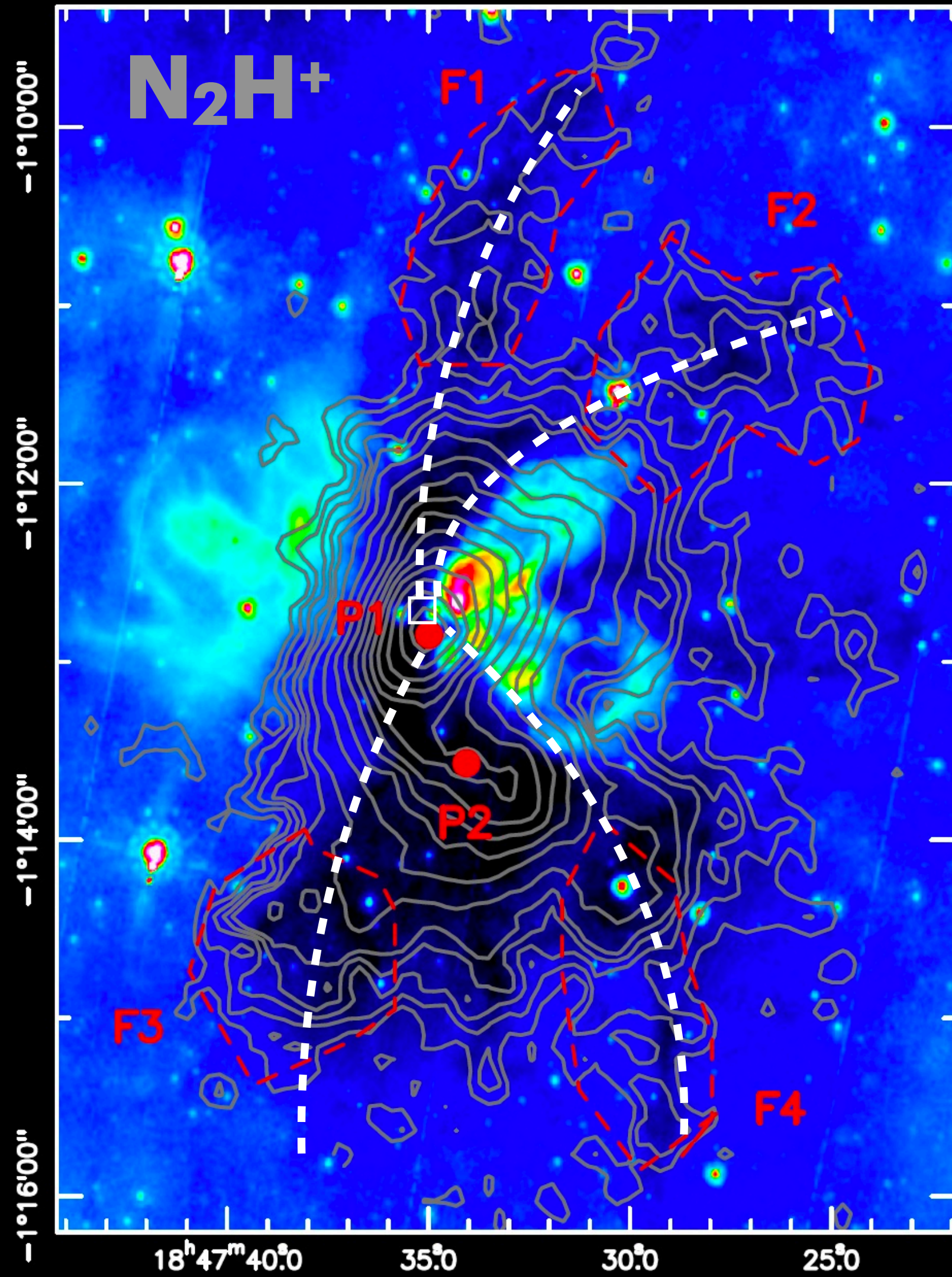
V. M. Rivilla,¹★ M. T. Beltrán,¹ A. Vasyunin,^{2,3,4} P. Caselli,² S. Viti,⁵ F. Fontani¹ and R. Cesaroni¹

¹INAF-Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125 Florence, Italy

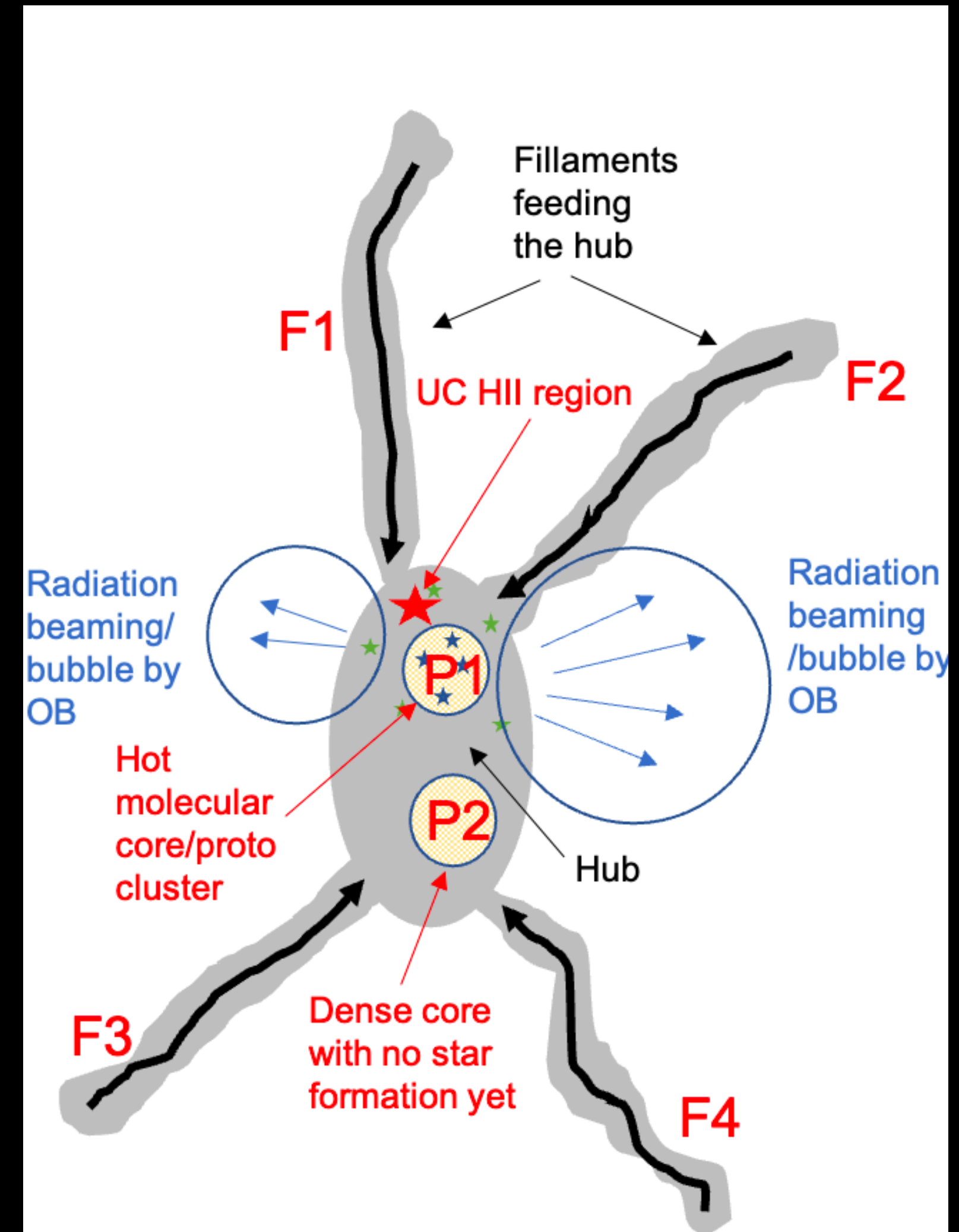
IR Spitzer 8microns image



IR Spitzer 8microns image

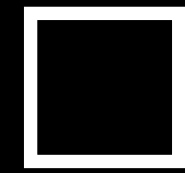


Beltrán et al. (2022)

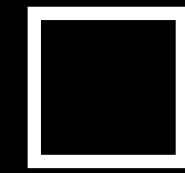


QUESTION #3

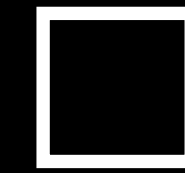
Where glycolaldehyde (HCOCH_2OH) was detected for the first time outside the Galactic Center?



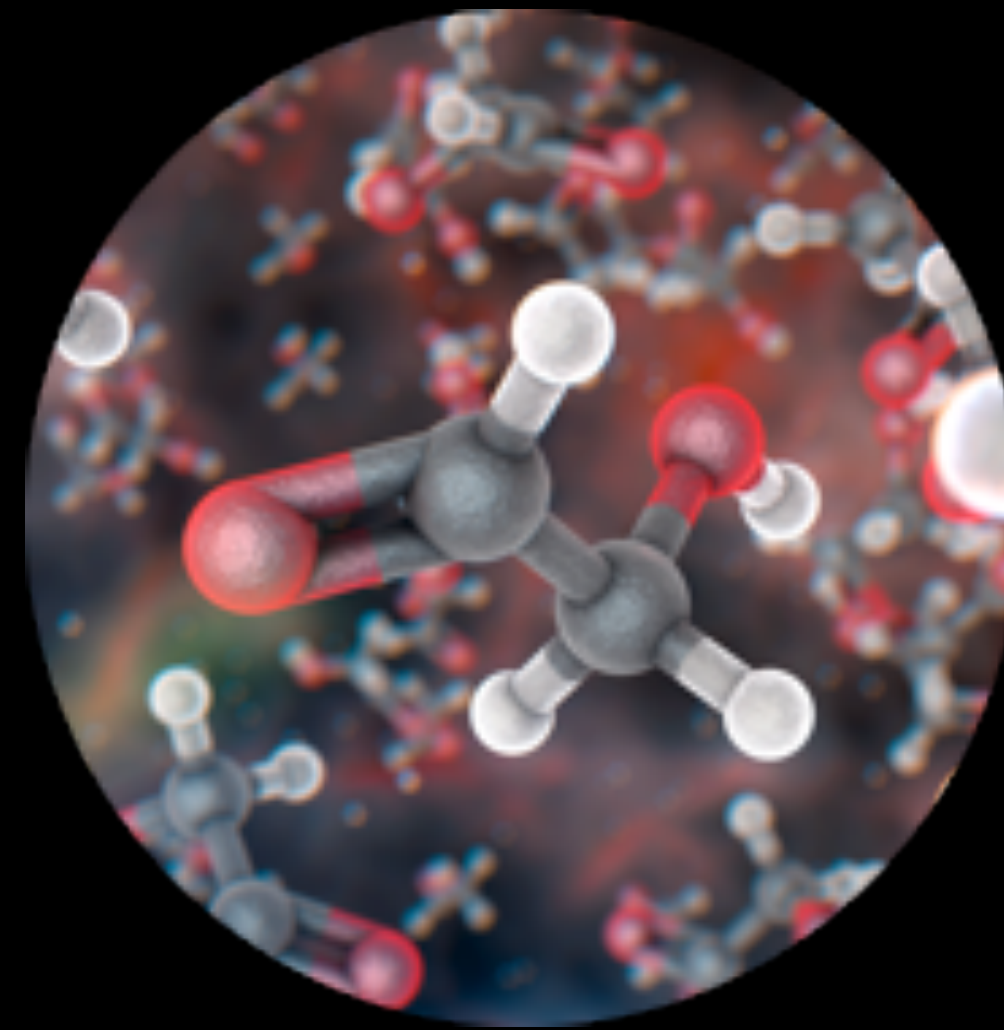
IRAS
16293-2422



Orion KL



G31.41+0.31

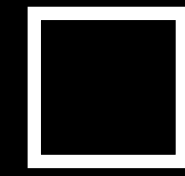


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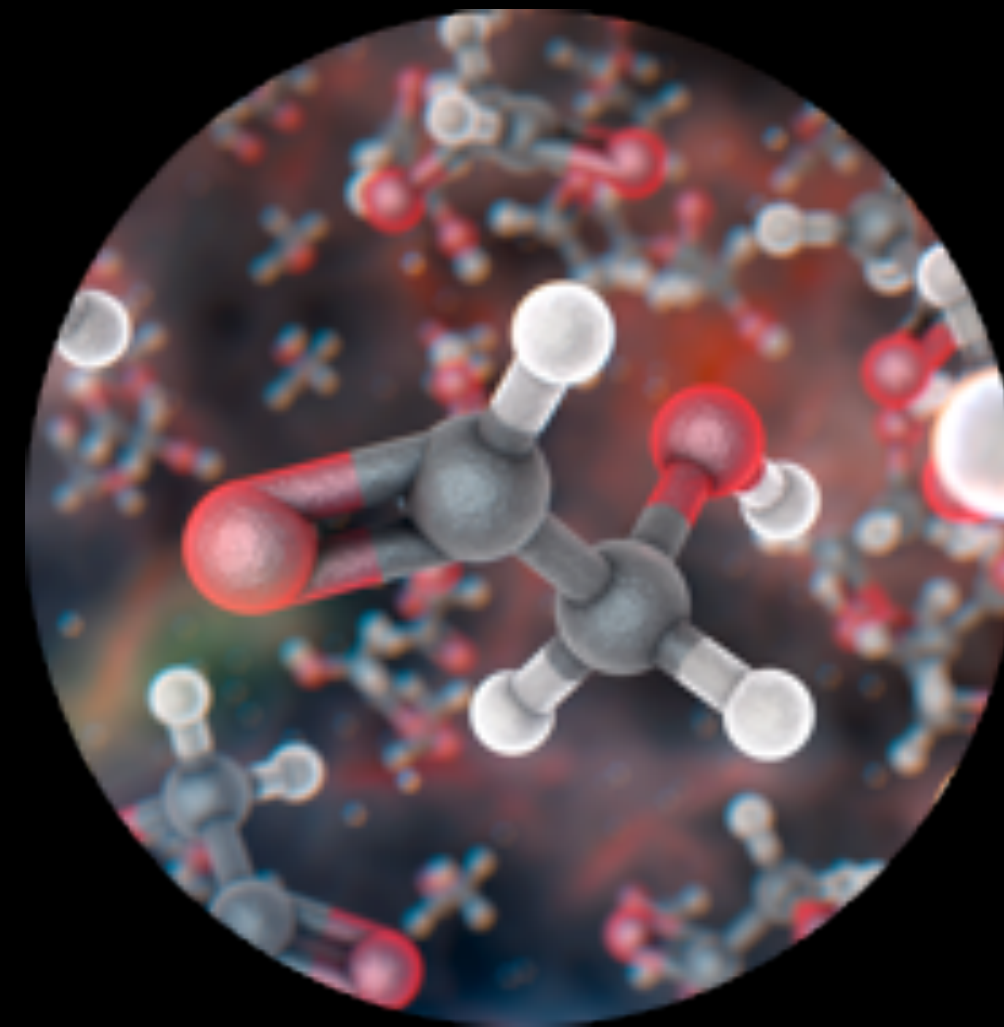
IRAS
16293-2422



Orion KL

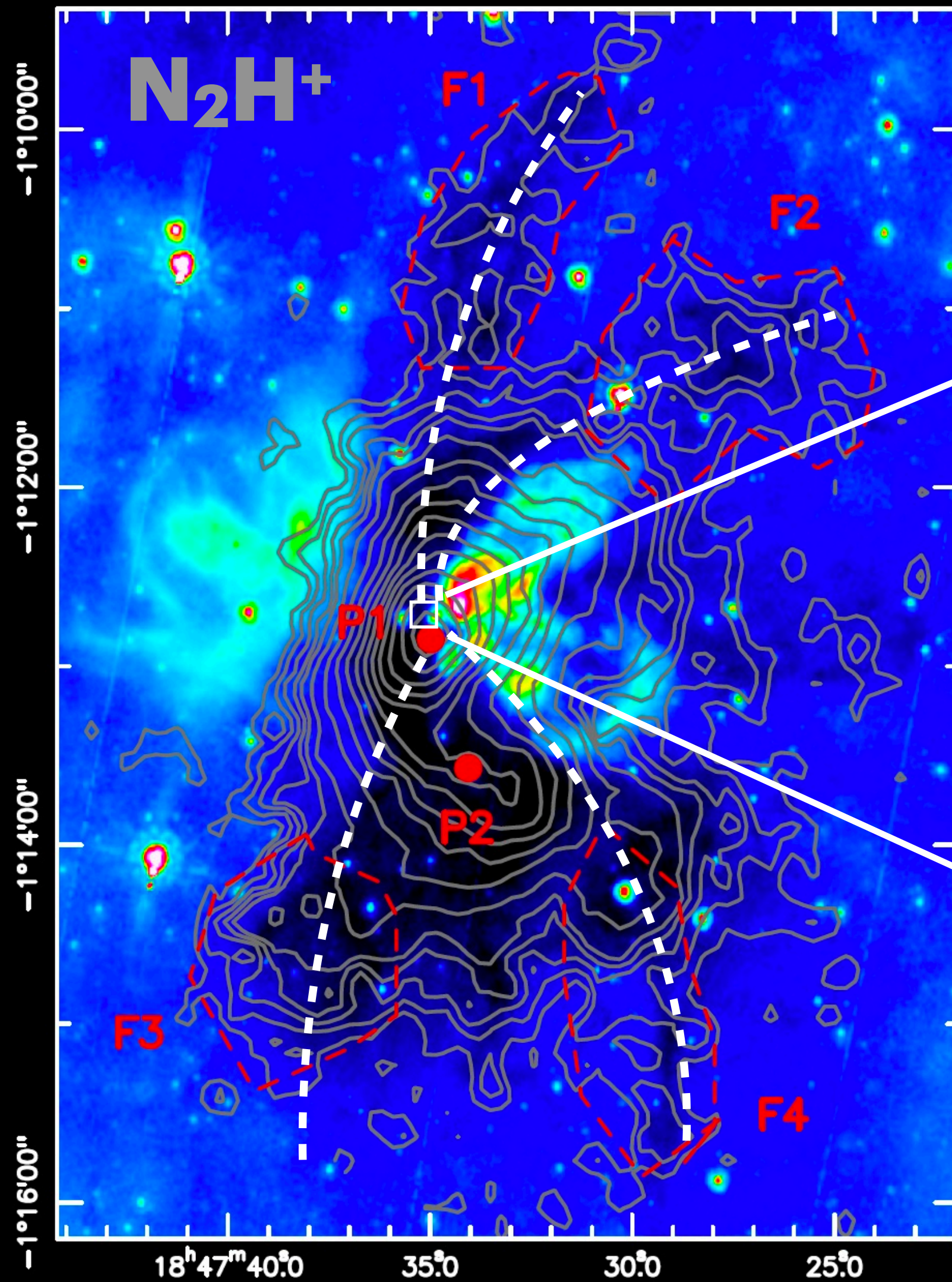


G31.41+0.31



The G31.41+0.31 massive star-forming region

IR Spitzer 8microns image

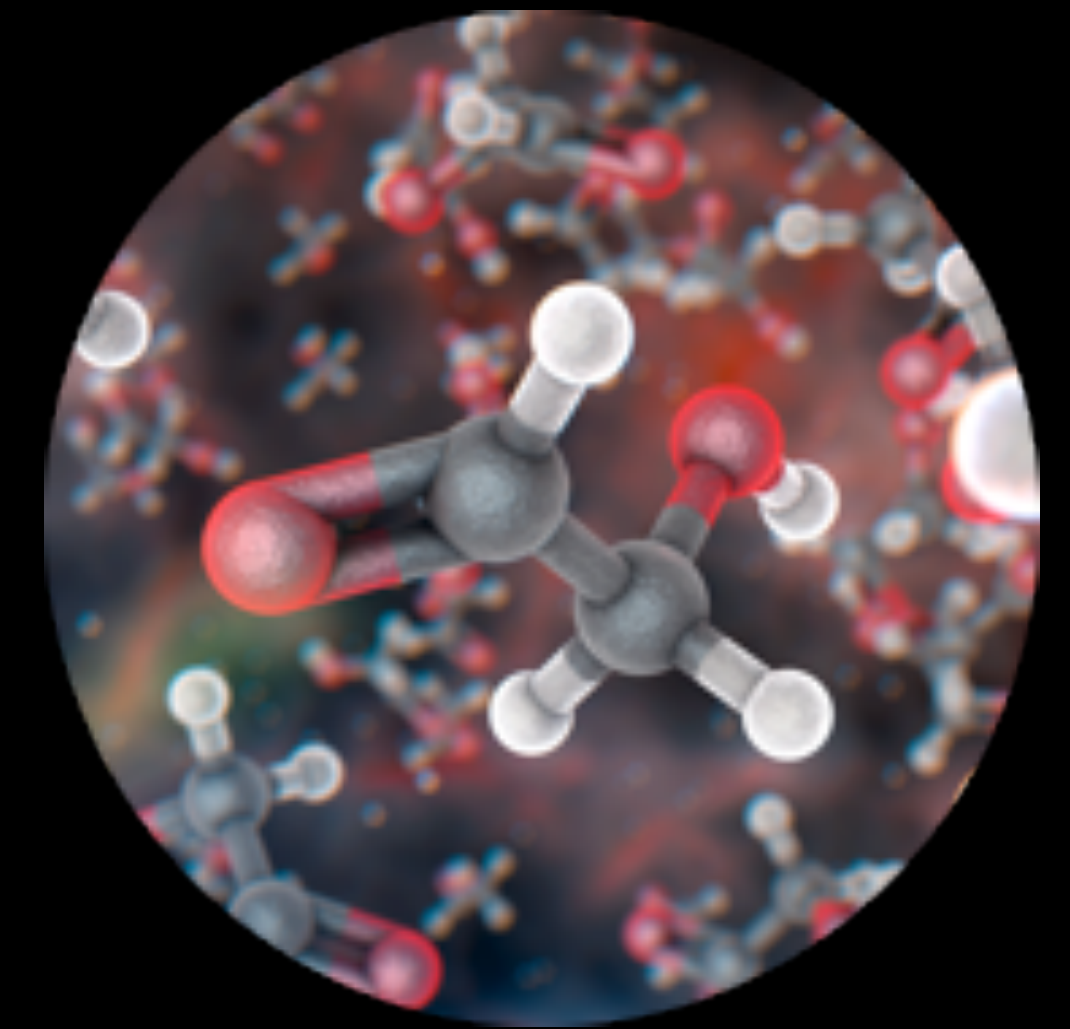
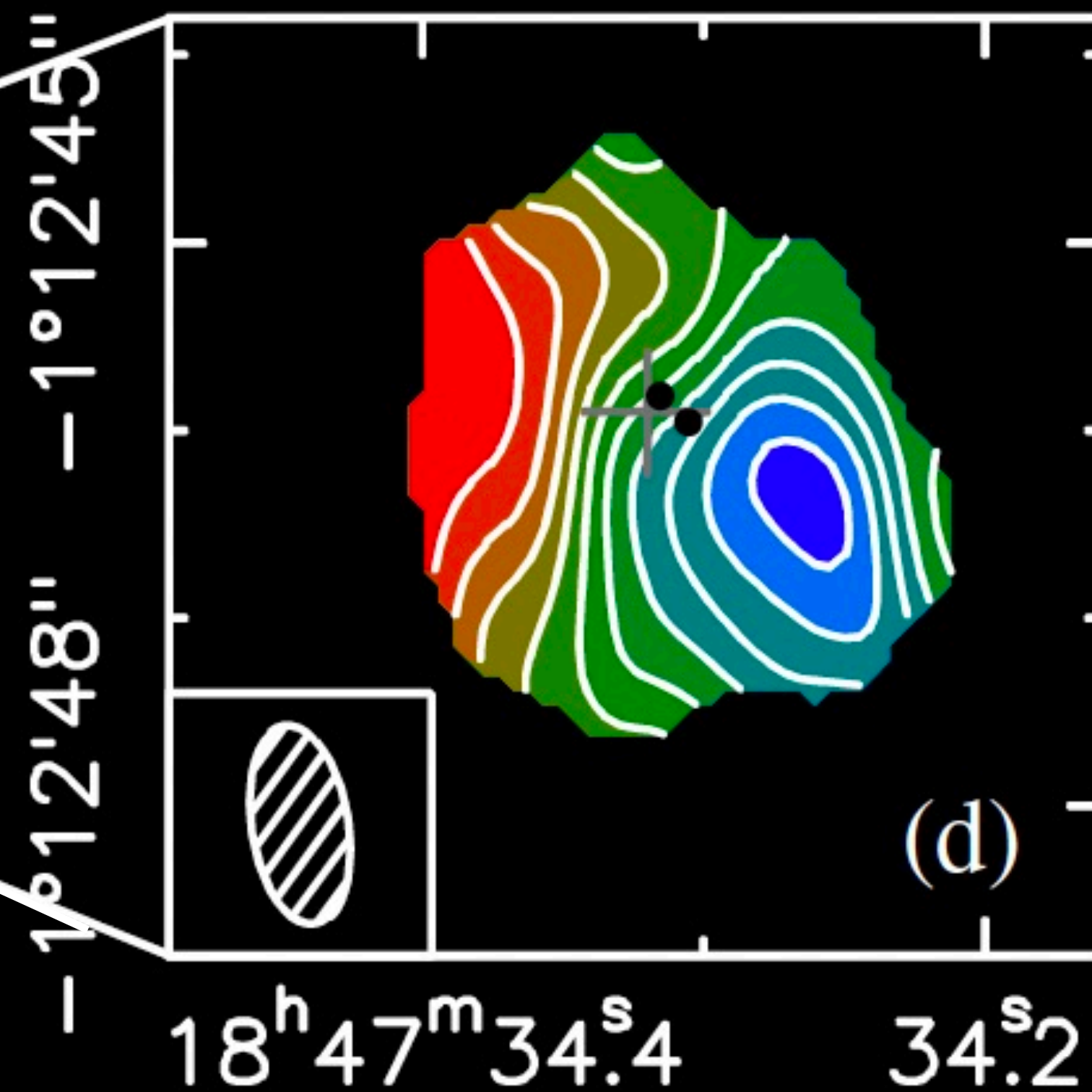


THE ASTROPHYSICAL JOURNAL, 690:L93–L96, 2009 January 10
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doi:10.1088/0004-637X/690/2/L93

FIRST DETECTION OF GLYCOLALDEHYDE OUTSIDE THE GALACTIC CENTER*

M. T. BELTRÁN¹, C. CODELLA², S. VITI³, R. NERI⁴, AND R. CESARONI⁵



Beltrán et al. (2009)

The G31.41+0.31 massive star-forming region

THE ASTROPHYSICAL JOURNAL, 435:L137–L140, 1994 November 10

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A MASSIVE YOUNG EMBEDDED OBJECT ASSOCIATED WITH THE UC H II REGION G31.41 + 0.31

R. CESARONI

Osservatorio Astrofisico di Arcetri, L.go Enrico Fermi 5, I-50125 Firenze, Italy; cesa@arcetri.astro.it

L. OLMI

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C. M. WALMSLEY

Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany; p003wal@mpifr.bonn.mpg.de

AND

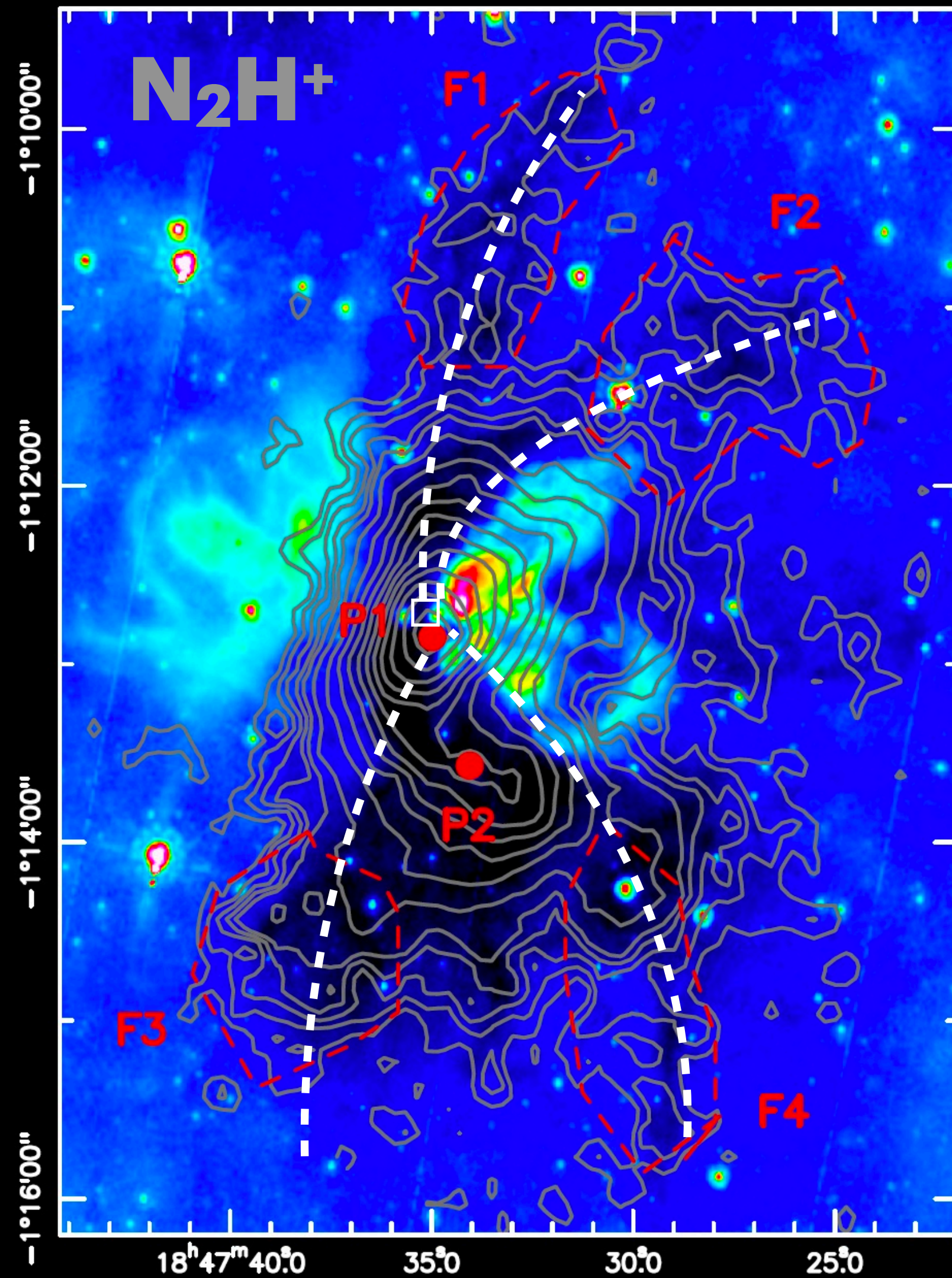
E. CHURCHWELL AND P. HOFNER

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churchwell@madraf.astro.wisc.edu; hofner@madraf.astro.wisc.edu

Received 1994 June 9; accepted 1994 August 22

The G31.41+0.31 massive star-forming region

IR Spitzer 8microns image

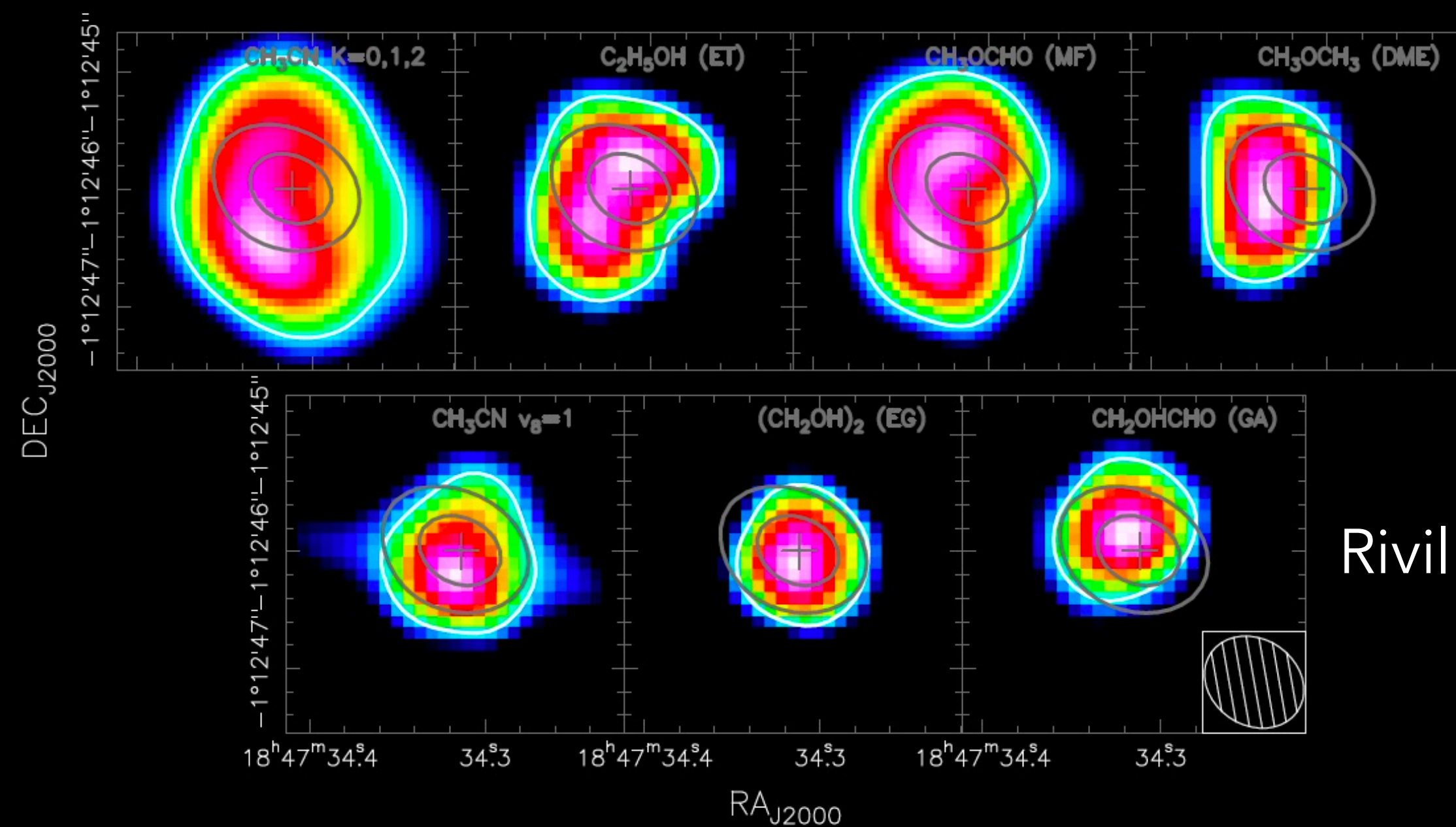


A&A 598, A59 (2017)
DOI: 10.1051/0004-6361/201628373
© ESO 2017

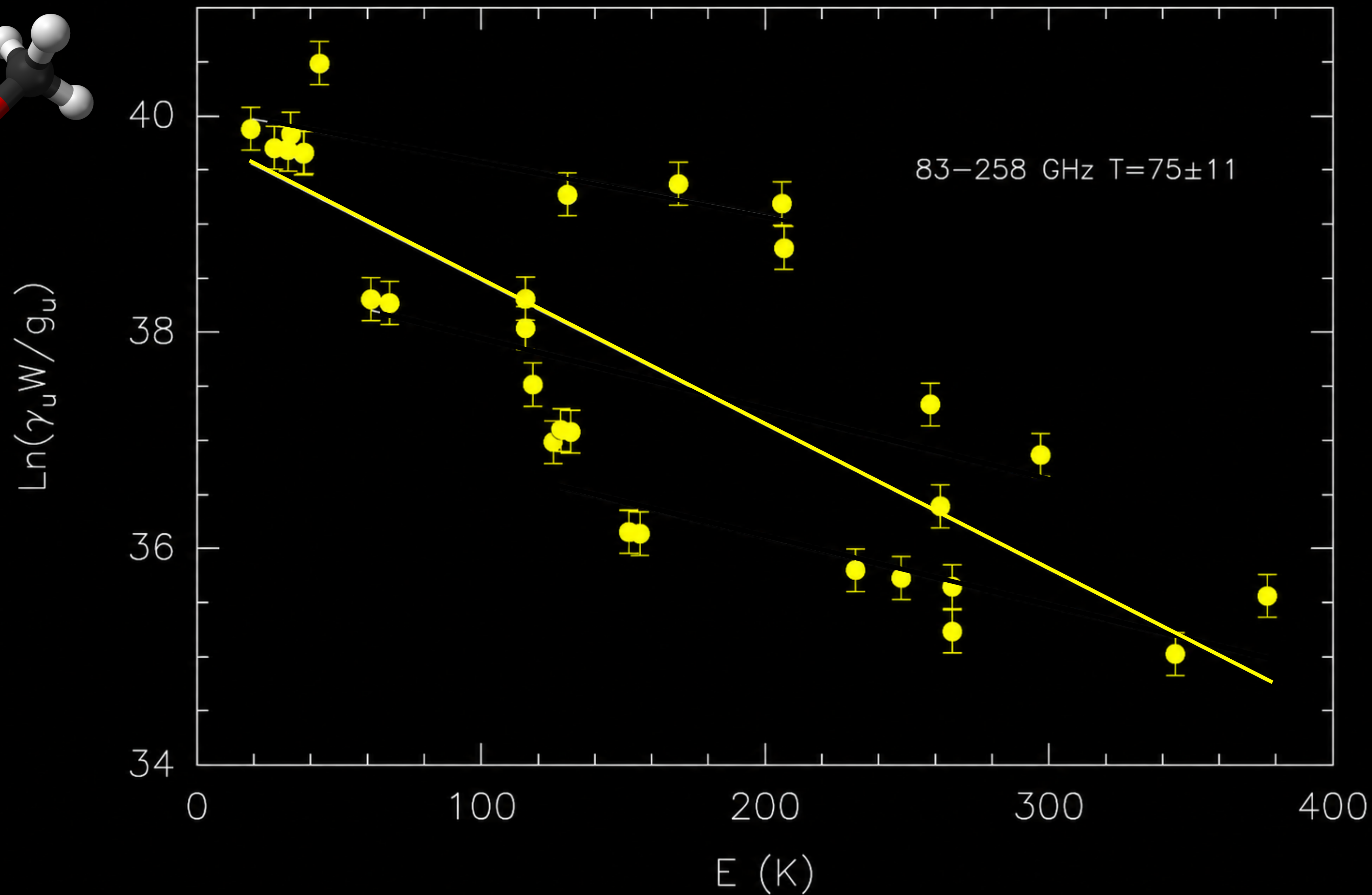
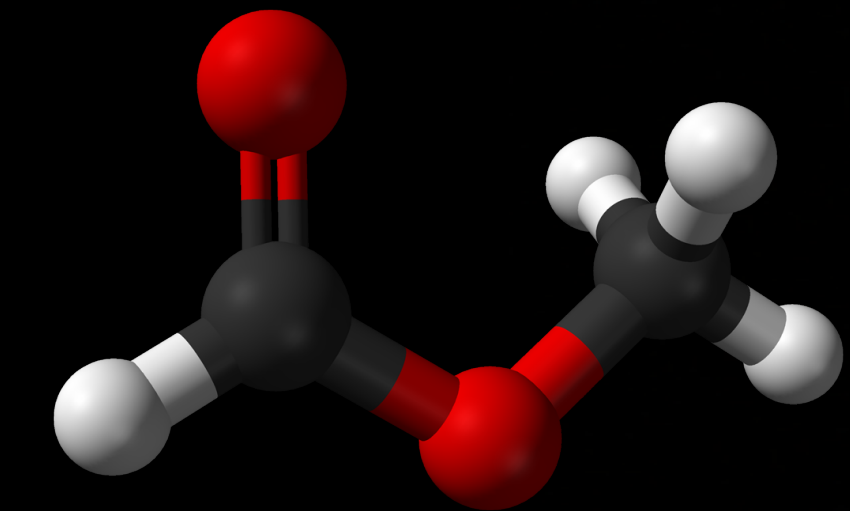
Astronomy
&
Astrophysics

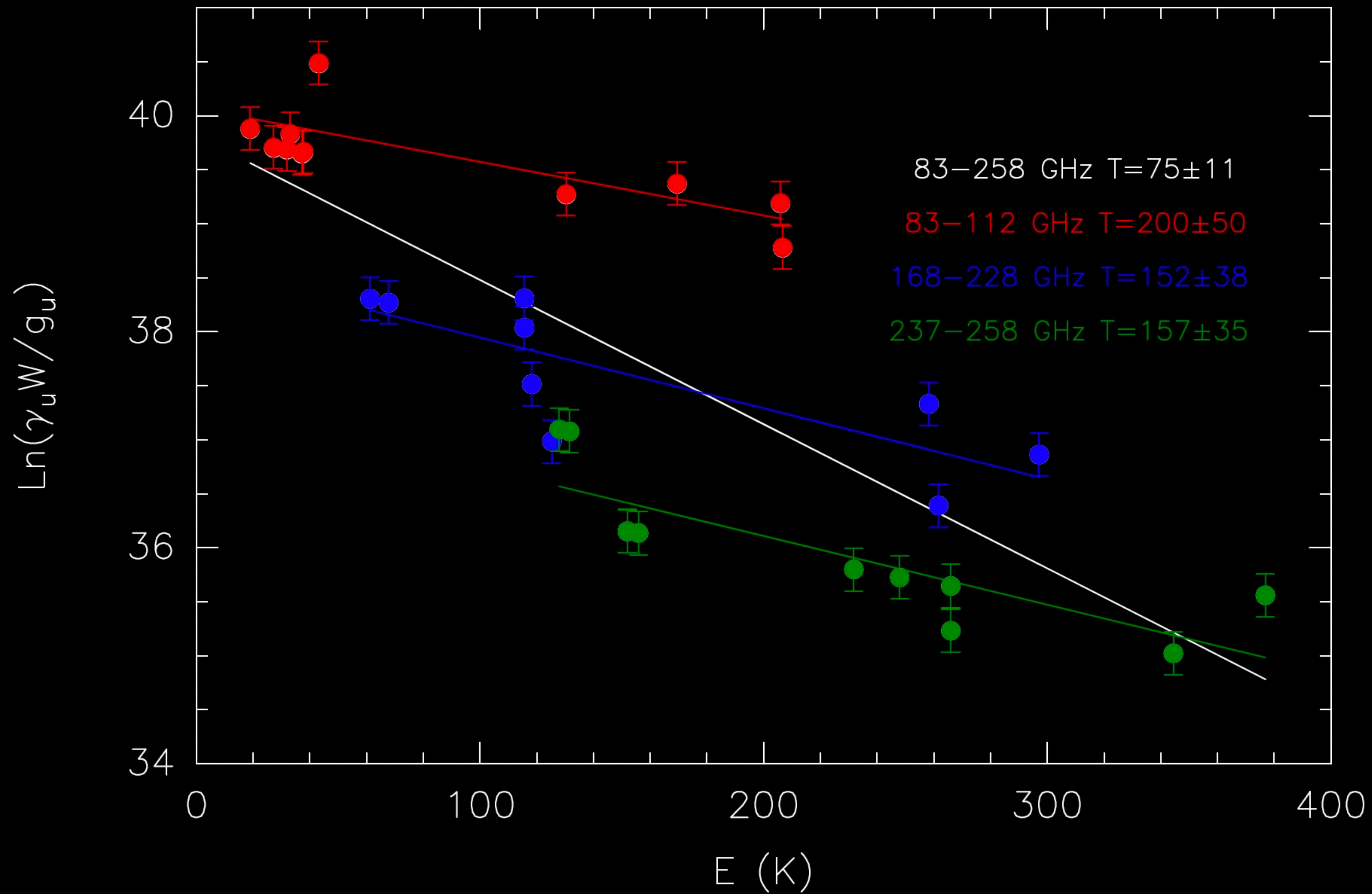
Formation of ethylene glycol and other complex organic molecules
in star-forming regions[★]

V. M. Rivilla¹, M. T. Beltrán¹, R. Cesaroni¹, F. Fontani¹, C. Codella¹, and Q. Zhang²

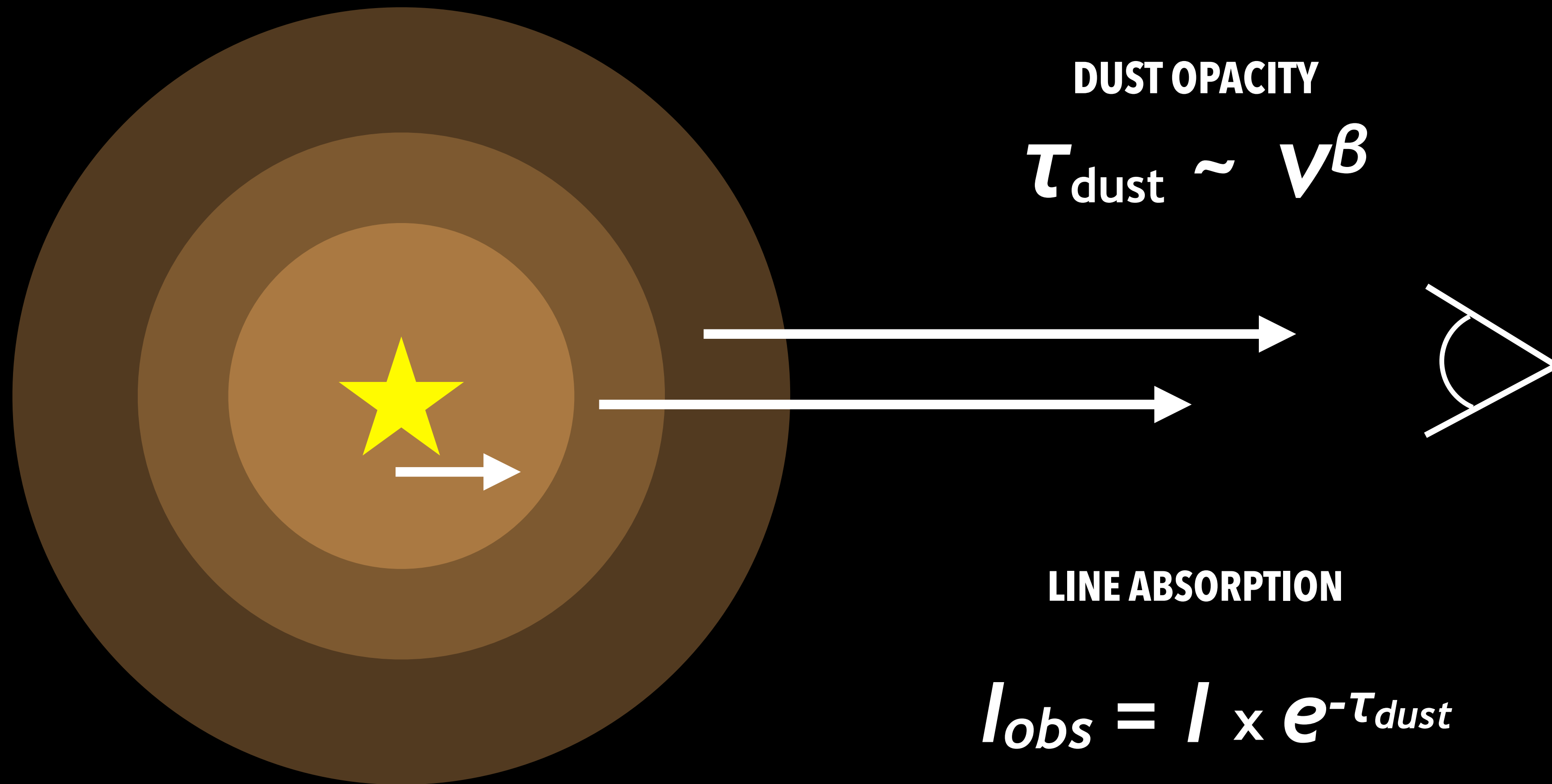


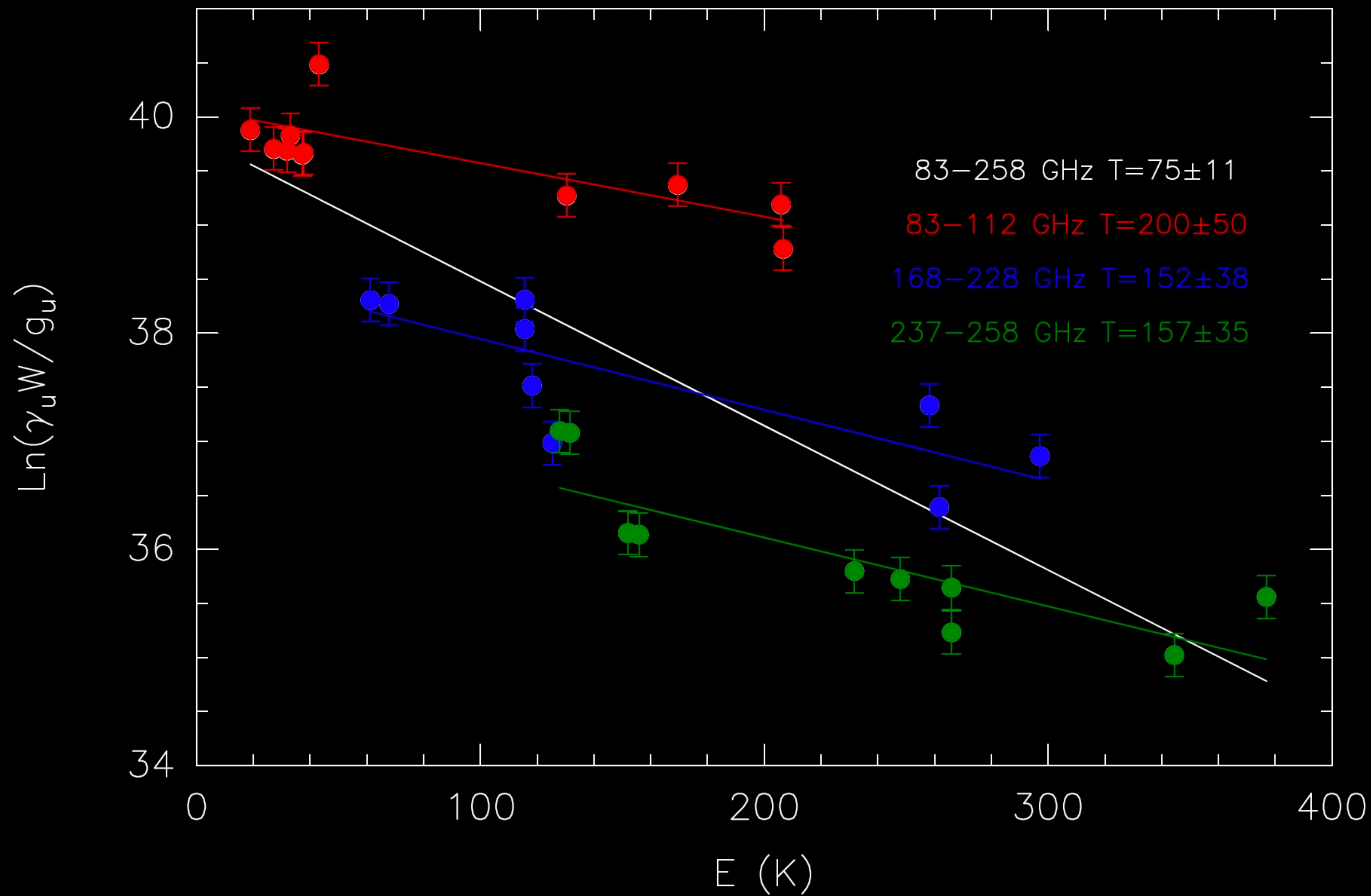
Rivilla et al. (2017a)

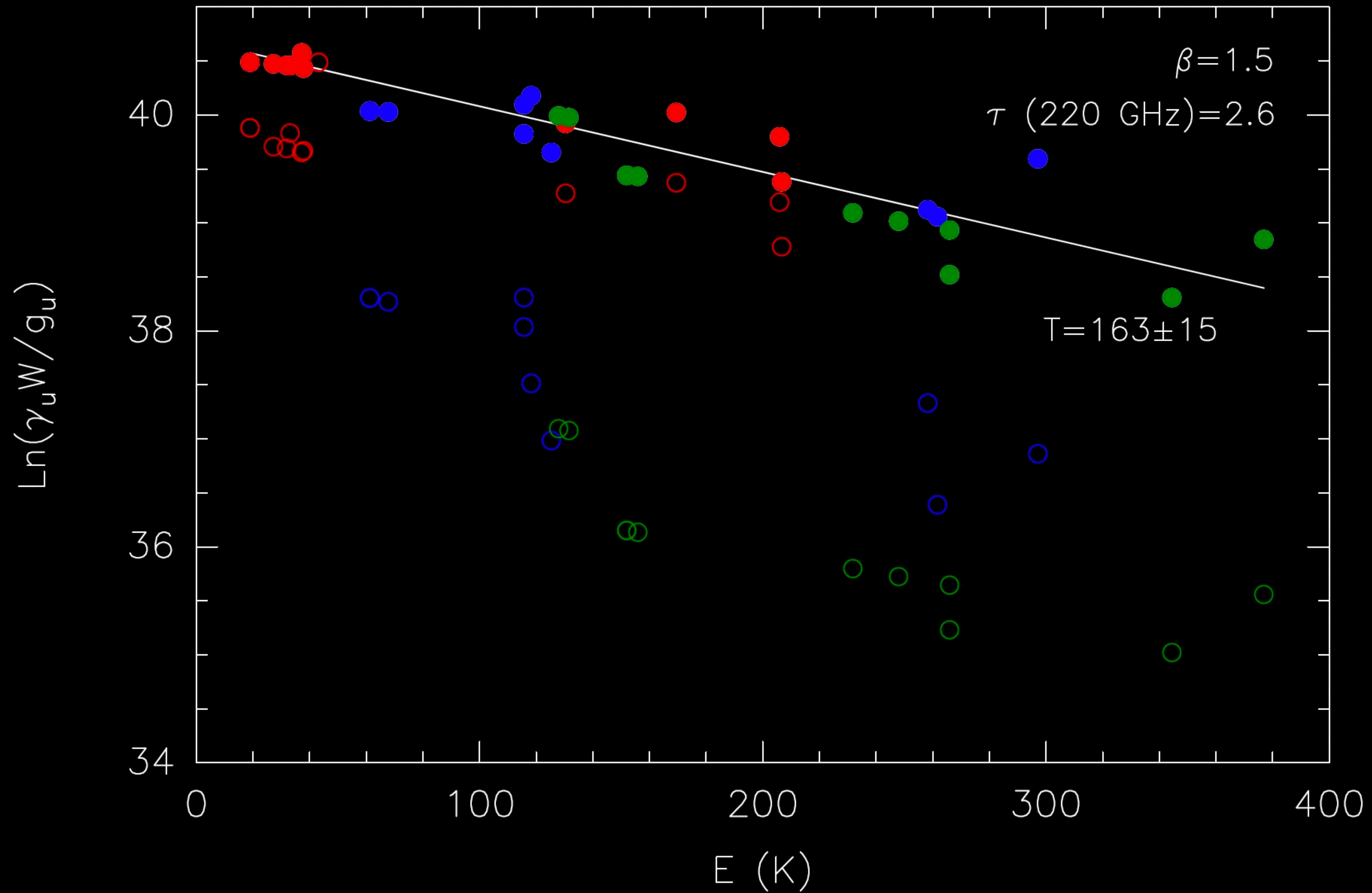




The Riccardò's effect







SEPIA Band 9 Science Verification Proposal

The critical role of dust absorption on line emission of dense cores

Investigators	Institute	EMAIL
Víctor M. Rivilla	Osservatorio Astrofisico di Arcetri, OAA-INAF	rivilla@arcetri.astro.it
Riccardo Cesaroni	Osservatorio Astrofisico di Arcetri, OAA-INAF	cesa@arcetri.astro.it
Maite Beltrán	Osservatorio Astrofisico di Arcetri, OAA-INAF	mbeltran@arcetri.astro.it

Total execution time request:

1 hour.

PWV, modes and tunings:

PWV = 0.5 mm; mode = Position switching; Tunings = 687.75 GHz.

SEPIA Band 9 Science Verification Proposal

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Maite Beltrán	Osservatorio Astrofisico di Arcetri, OAA-INAF	mbeltran@arcetri.astro.it

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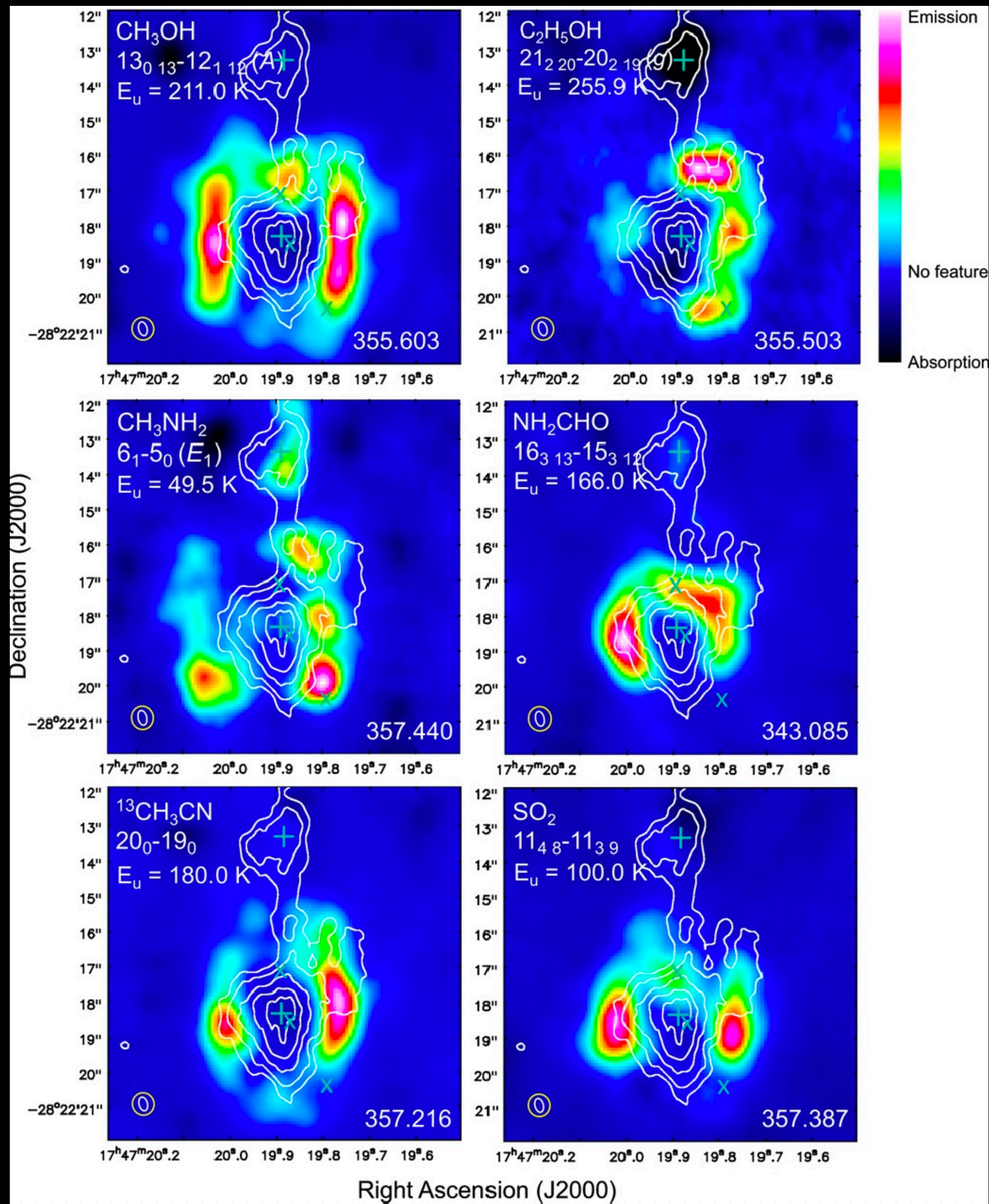
	Testing line quenching in the G31.41+0.31 hot molecular core	2017.1.00752.S
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ABSTRACT					
<p>Single-dish and interferometric observations have provided us with evidence of large dust opacities in hot molecular cores (HMCs). Large dust optical depth indeed appears to dramatically damp line emission in the HMC in SgrB2 even at 850 micron, a result that casts serious doubts on the effectiveness of observations of HMCs at high frequencies, where ALMA attains its best angular resolution (a few AU at the typical distance of OB-type stars). This is a critical issue, which requires further investigation, as high-mass star formation studies would highly benefit from milli-arcsec imaging of HMCs.</p> <p>In order to establish the critical frequency beyond which line quenching may hinder imaging of HMCs, we propose to observe the template case of the HMC in G31.41+0.31 at band 3 and band 9. We will cover a large number of methyl formate (CH₃OCHO) lines, which span a broad range of excitation energies. The choice of this molecule is based on previous IRAM 30-m observations of G31, which provide us with a clear indication of CH₃OCHO line absorption by dust.</p>					

PI NAME:	Riccardo Cesaroni			SCIENCE CATEGORY:	ISM, star formation and astrochemistry
PI E-MAIL:	cesa@arcetri.astro.it			PI INSTITUTE:	Arcetri Astrophysical Observatory, INAF
ESTIMATED 12M TIME:	1.1 h	ESTIMATED ACA TIME:	0.0 h	ESTIMATED NON-STANDARD MODE TIME (12-M):	0.6 h
CO-PI NAME(S): (Large & VLBI Proposals only)					
CO-INVESTIGATOR NAME(S):	Victor Manuel Rivilla; Maite Beltran; Alvaro Sanchez-Monge; Peter Schilke				
DUPLICATE OBSERVATION JUSTIFICATION:					

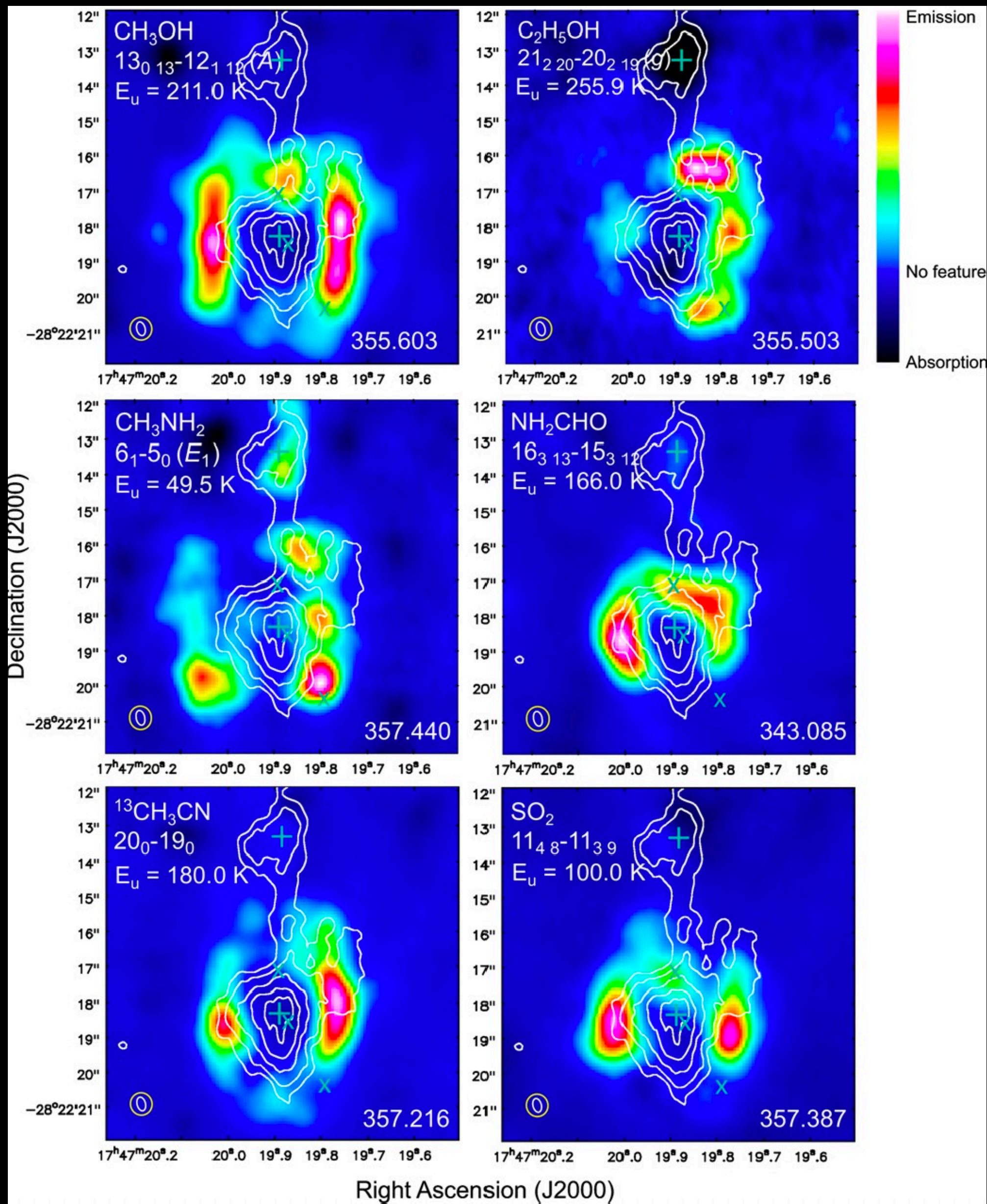
HOT CORES

Neill et al. (2012)



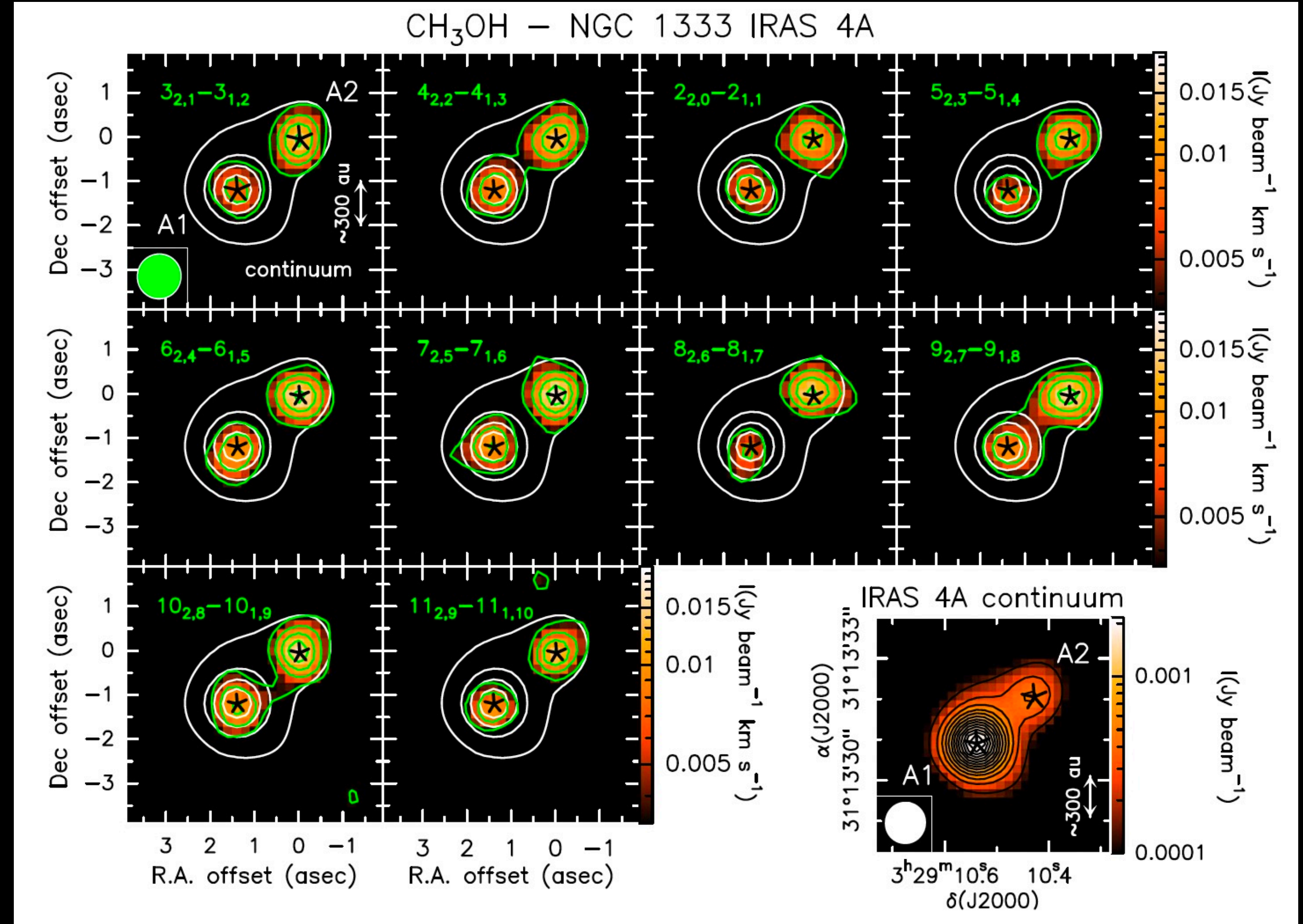
HOT CORES

Neill et al. (2012)



HOT CORES

De Simone et al. (2020)



G31.41+0.31 as an astrochemical template



GUAPOS: G31.41+0.31 Unbiased ALMA sPectral Observational Survey

2017.1.00501.S

ABSTRACT

We propose to carry out an unbiased spectral line survey in Band 3 of the hot molecular core (HMC) G31.41+0.31 (G31). This is one of the most chemically rich HMCs in the Galaxy and an excellent target to search for heavy complex organic molecules (COMs), especially prebiotic ones. Band 3 is preferred because with respect to higher frequencies line blending is less severe and the dust emission is optically thinner. The main driver of the project is the identification of species never detected before outside the Galactic Center and of new species not yet detected in star-forming regions. We will concentrate on the study of: i) heavy COMs (especially with >10 atoms); ii) N-bearing COMs: like amino acetonitrile, precursor of glycine; iii) deuterated species: to obtain a more complete census of COMs in HMCs; iv) P-bearing and S-bearing species; and v) isotopologues: to understand the processes governing fractionation. The proper identification of species will allow us to derive important physical parameters, such as abundances, needed to constrain the chemical models and to investigate the relative contribution of surface-chemistry and gas-phase chemistry on the formation of COMs.

PI NAME:	Maite Beltran			SCIENCE CATEGORY:	ISM, star formation and astrochemistry
PI E-MAIL:	mbeltran@arcetri.astro.it			PI INSTITUTE:	Arcetri Astrophysical Observatory, INAF
ESTIMATED 12M TIME:	11.2 h	ESTIMATED ACA TIME:	0.0 h	ESTIMATED NON-STANDARD MODE TIME (12-M):	0.0 h
CO-PI NAME(S): (Large & VLBI Proposals only)					
CO-INVESTIGATOR NAME(S):	Victor Manuel Rivilla; Riccardo Cesaroni; Peter Schilke; Alvaro Sanchez-Monge; Serena Viti; Izaskun Jimenez-Serra; Leonardo Testi; Francesco Fontani; Laura Colzi; Chiara Mininni; David Quénard				
DUPLICATE OBSERVATION JUSTIFICATION:					

G31.41+0.31 as an astrochemical template



GUAPOS: G31.41+0.31 Unbiased ALMA sPectral Observational Survey

2017.1.00501.S

ABSTRACT

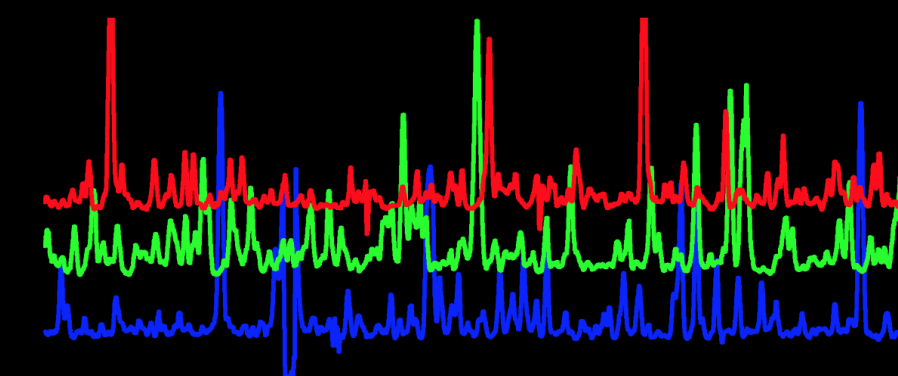
We propose to carry out an unbiased spectral line survey in Band 3 of the hot molecular core (HMC) G31.41+0.31 (G31). This is one of the most chemically rich HMCs in the Galaxy and an excellent target to search for heavy complex organic molecules (COMs), especially prebiotic ones. Band 3 is preferred because with respect to higher frequencies line blending is less severe and the dust emission is optically thinner. The main driver of the project is the identification of species never detected before outside the Galactic Center and of new species not yet detected in star-forming regions. We will concentrate on the study of: i) heavy COMs (especially with >10 atoms); ii) N-bearing COMs: like amino acetonitrile, precursor of glycine; iii) deuterated species: to obtain a more complete census of COMs in HMCs; iv) P-bearing and S-bearing species; and v) isotopologues: to understand the processes governing fractionation. The proper identification of species will allow us to derive important physical parameters, such as abundances, needed to constrain the chemical models and to investigate the relative contribution of surface-chemistry and gas-phase chemistry on the formation of COMs.

PI NAME:	Maite Beltran			SCIENCE CATEGORY:	ISM, star formation and astrochemistry
PI E-MAIL:	mbeltran@arcetri.astro.it			PI INSTITUTE:	Arcetri Astrophysical Observatory, INAF
ESTIMATED 12M TIME:	11.2 h	ESTIMATED ACA TIME:	0.0 h	ESTIMATED NON-STANDARD MODE TIME (12-M):	0.0 h
CO-PI NAME(S): (Large & VLBI Proposals only)					
CO-INVESTIGATOR NAME(S):	Victor Manuel Rivilla; Riccardo Cesaroni; Peter Schilke; Alvaro Sanchez-Monge; Serena Viti; Izaskun Jimenez-Serra; Leonardo Testi; Francesco Fontani; Laura Colzi; Chiara Mininni; David Quénard				
DUPLICATE OBSERVATION JUSTIFICATION:					

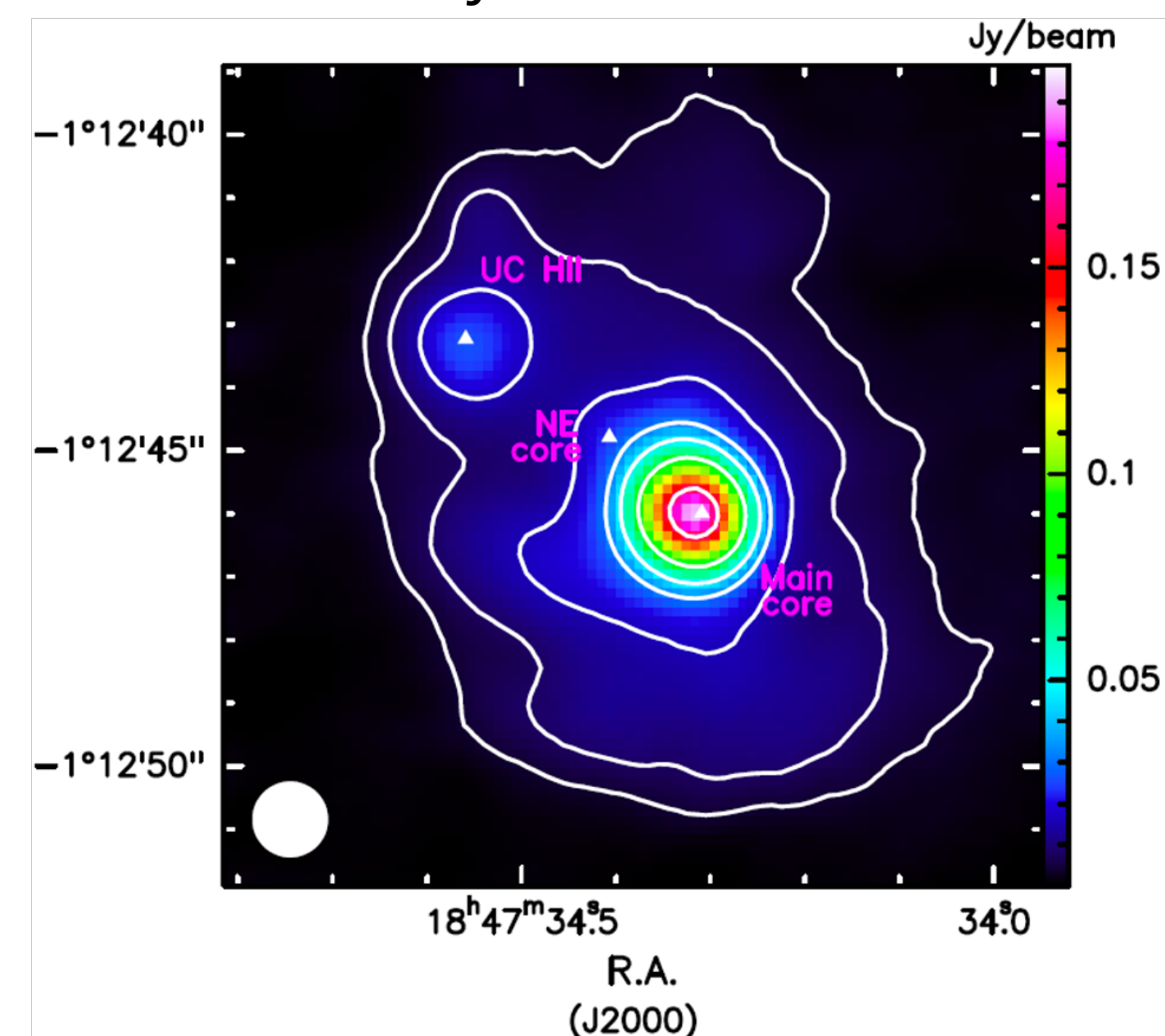
Priority Grade **A**

Overall evaluation:
This is an ambitious proposal providing valuable data to the community.

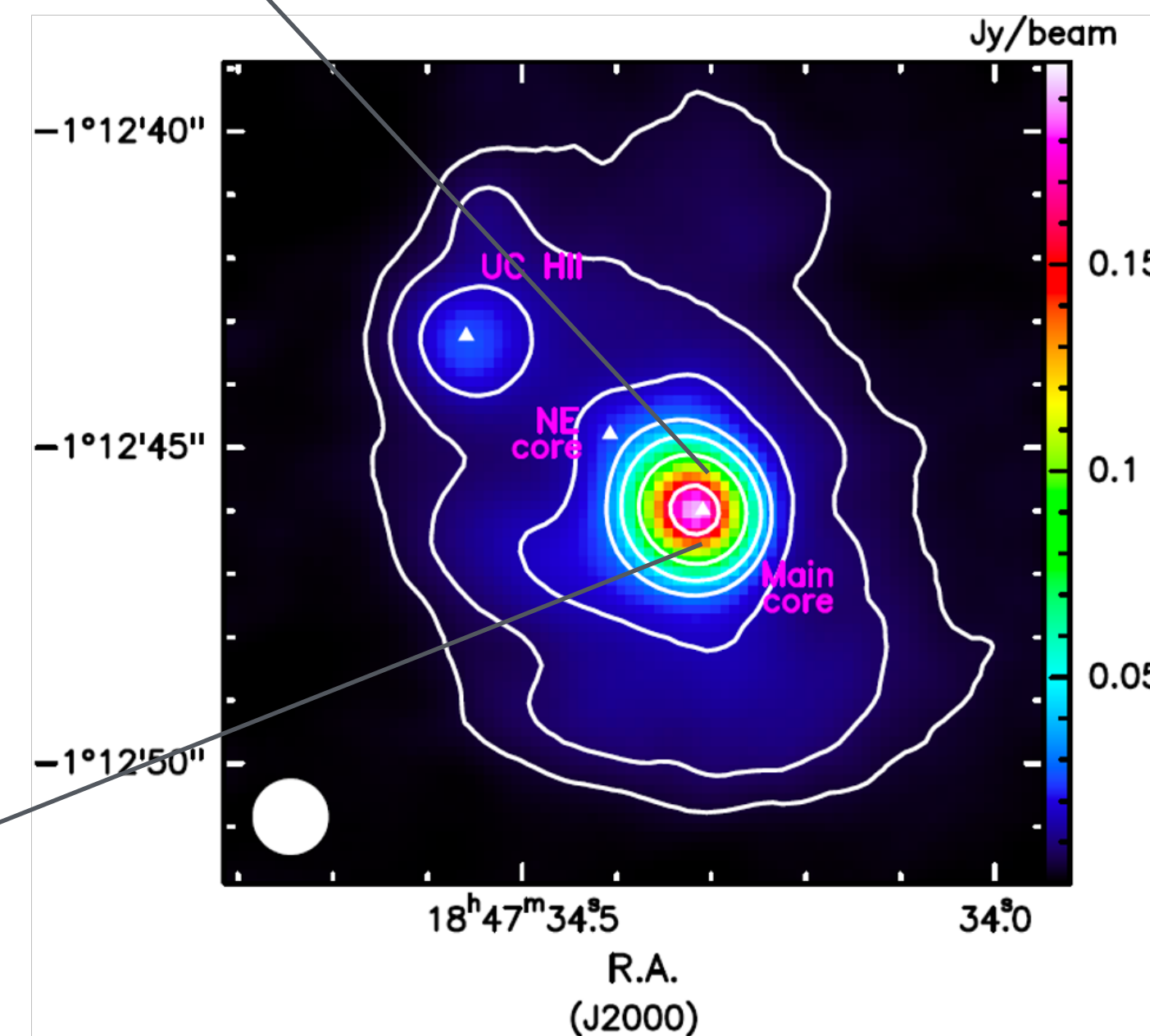
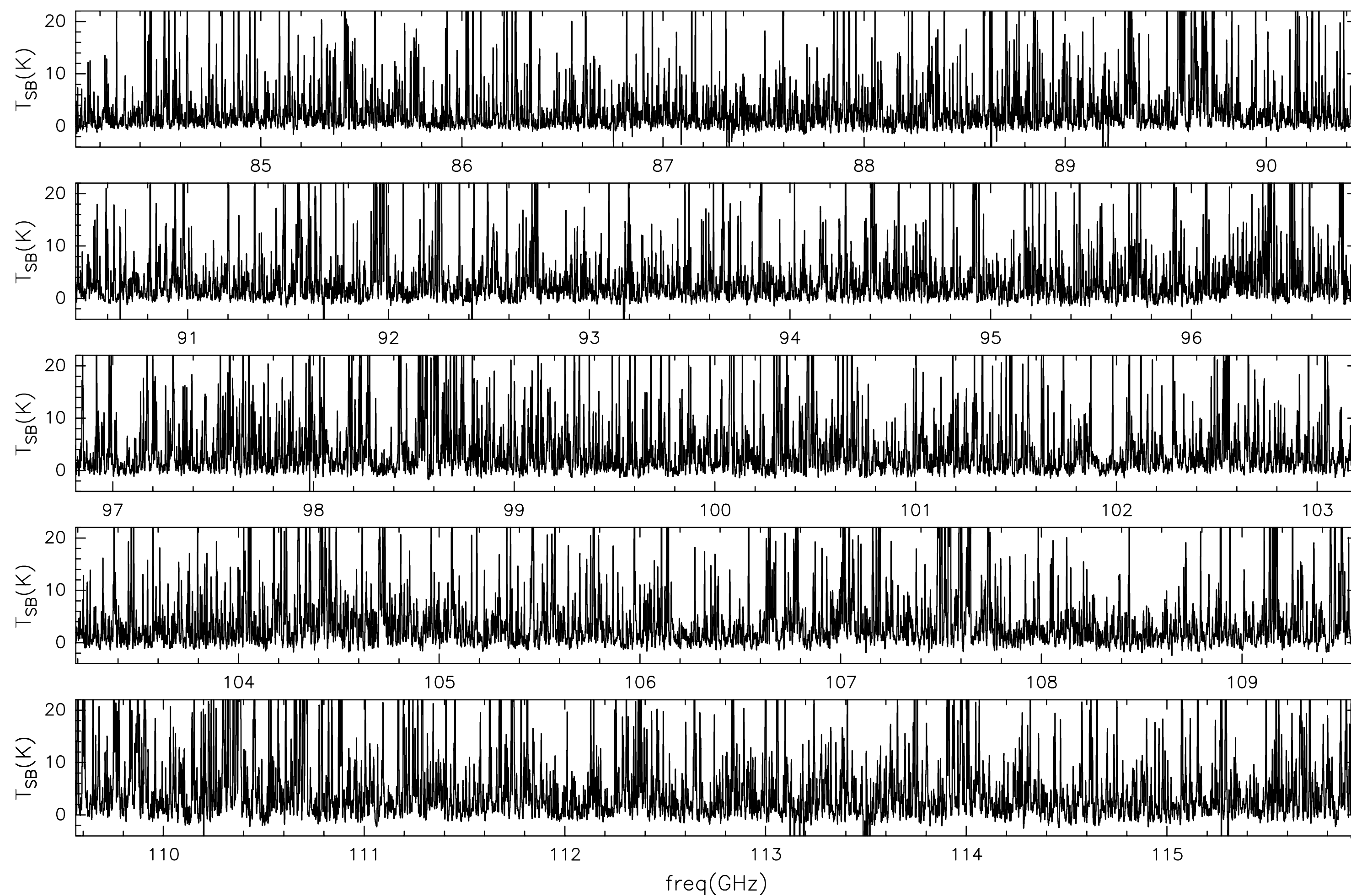
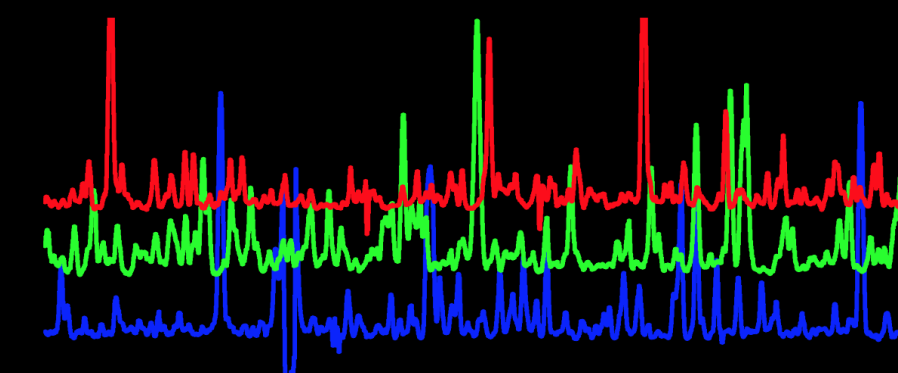
GUAPOS: G31.41+0.31 Unbiased ALMA sPectral Observational Survey



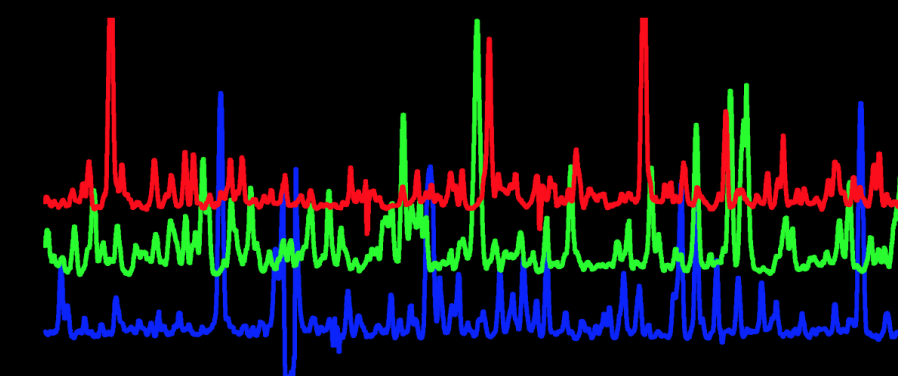
- PI: Maite Beltrán
- Target: G31.41+0.31 hot molecular core
- Spectral resolution (~ 0.5 MHz) = 1.2-1.7 km/s
- Final spatial resolution 1.2'' (about 4500 au).
- rms = 0.5 - 1.9 mJy/beam.



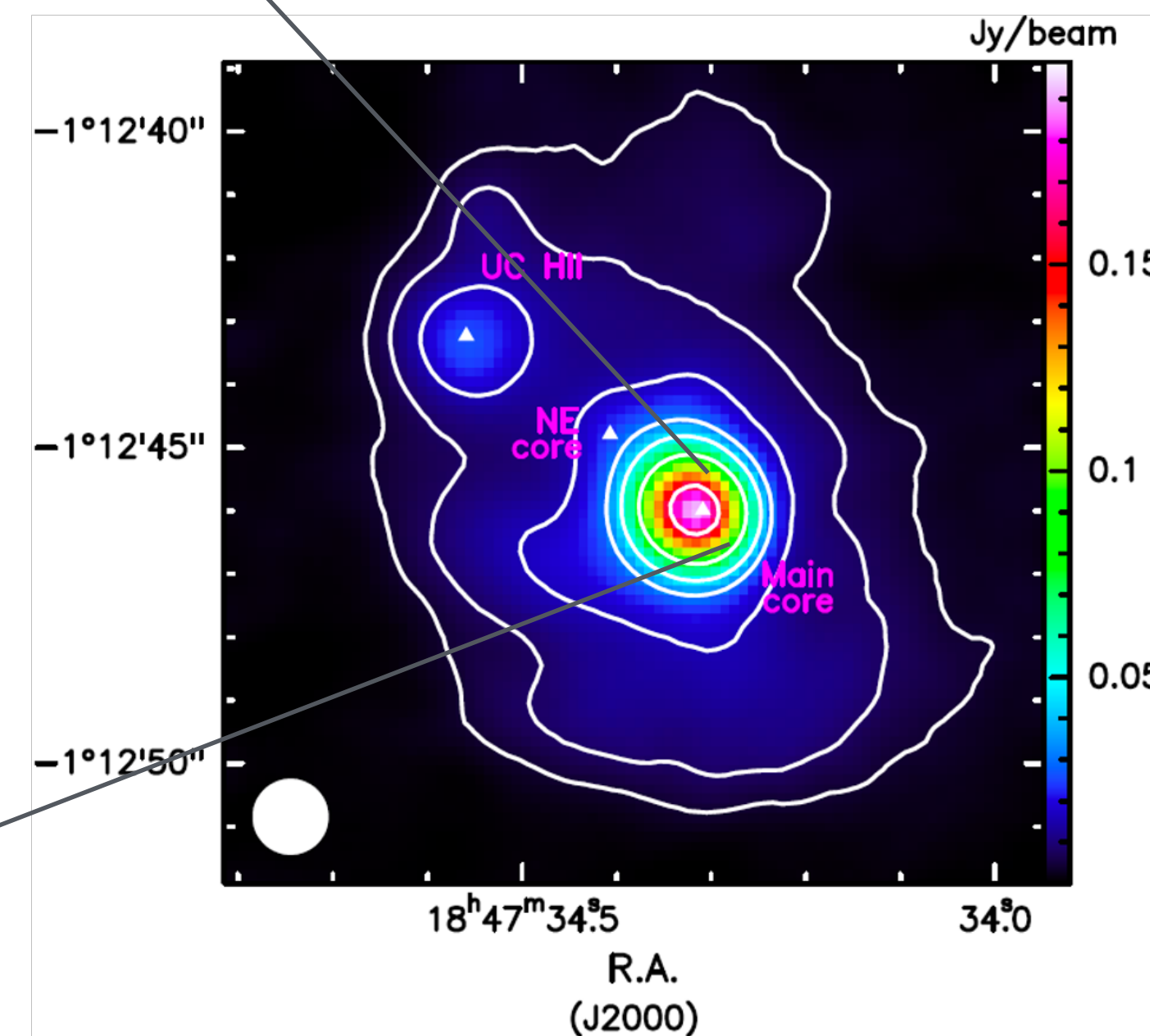
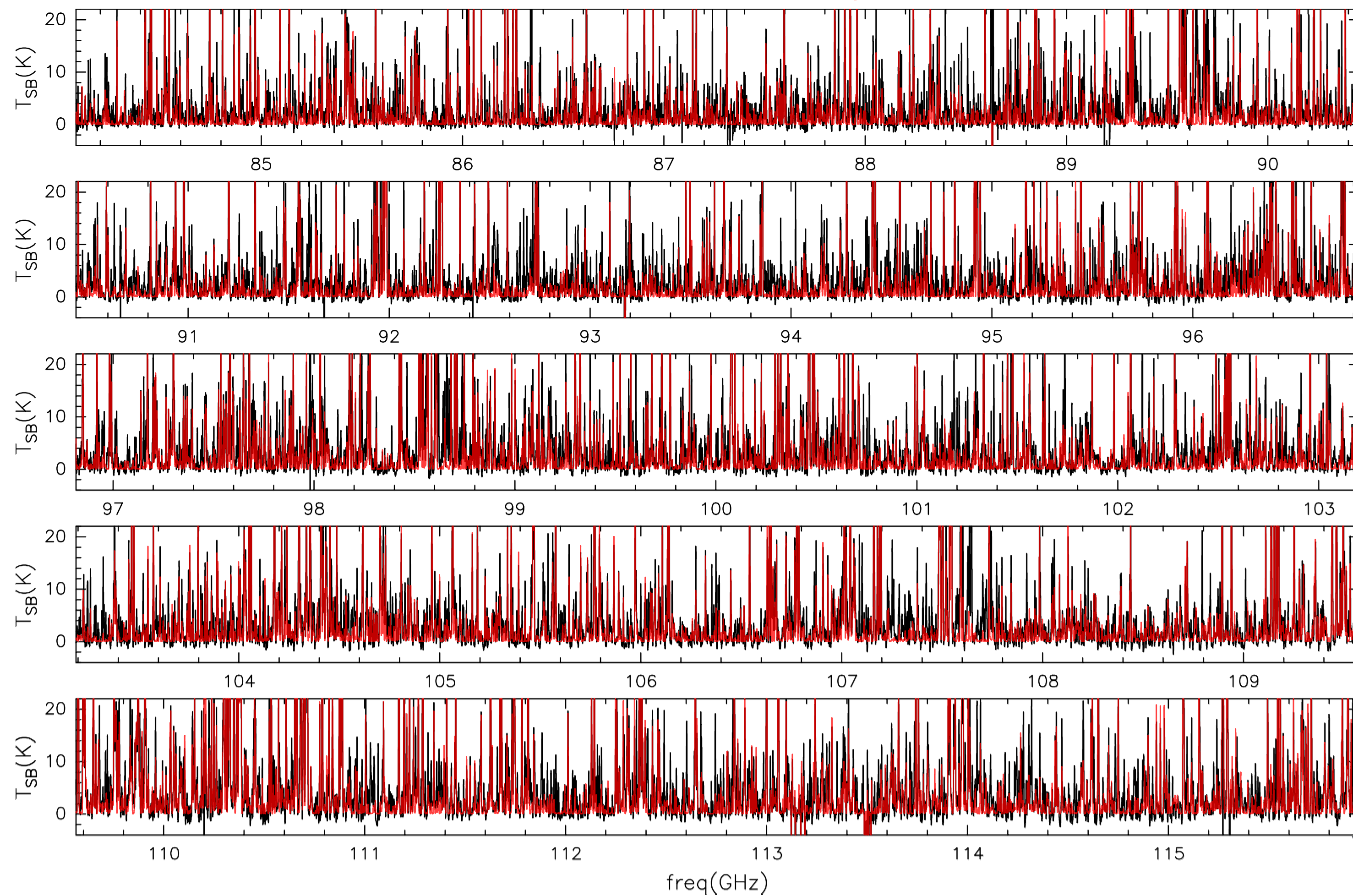
GUAPOS: G31.41+0.31 Unbiased ALMA sPectral Observational Survey

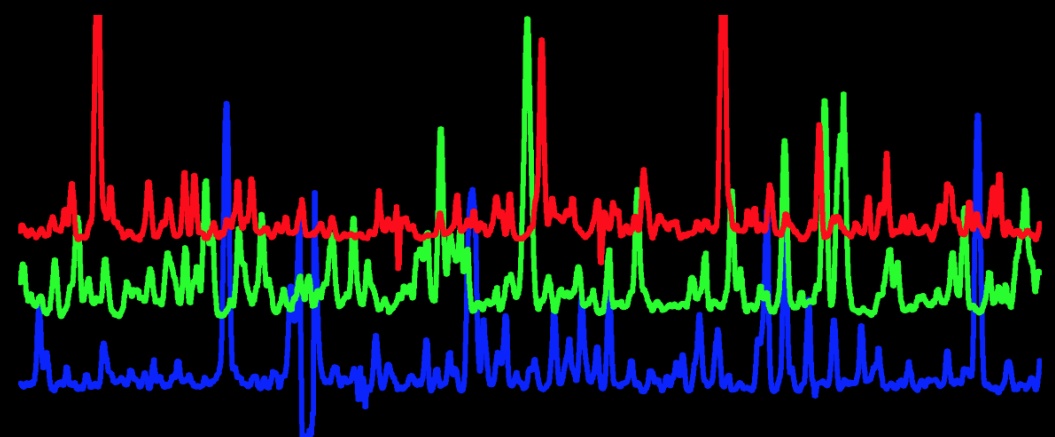


GUAPOS: G31.41+0.31 Unbiased ALMA sPectral Observational Survey



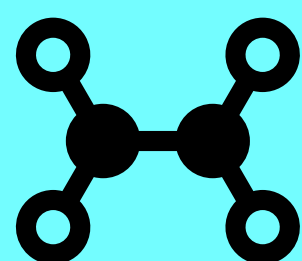
LTE modelling considering all species identified



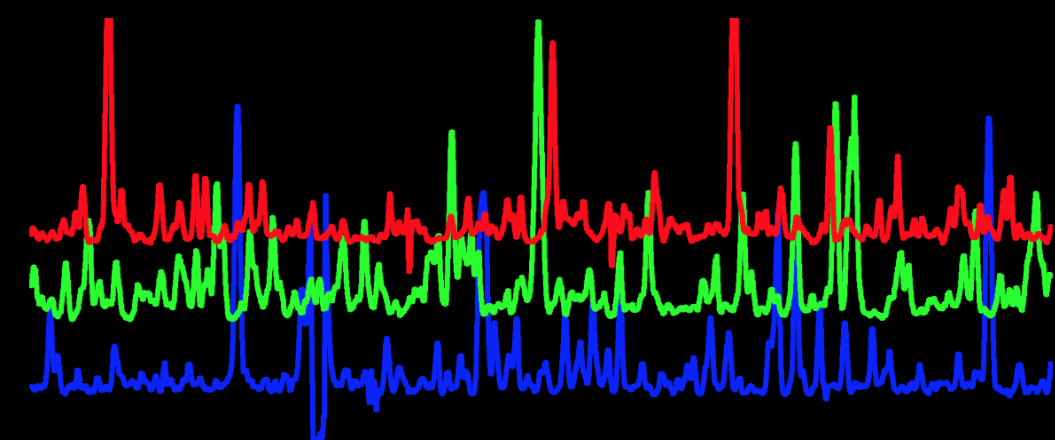


NH ₃	Ammonia	C ₂ H ₃ CN	Vinyl cyanide
HCN	Hydrogen cyanide	C ₂ H ₅ CN	Ethyl cyanide
CO	Carbon monoxide	CH ₃ NCO	Methyl Isocyanate
H ₂ CO	Formaldehyde	C ₂ H ₅ CHO	Propanal
CH ₃ OH	Methanol	CH ₃ COCH ₃	Acetone
CH ₃ CCH	Propyne	CH ₃ C(O)NH ₂	Acetamide
CH ₃ CN	Methyl cyanide	CH ₃ NHCHO	N-Methylformamide
CH ₃ NC	Methyl isocyanide	OCS	Carbonyl sulphide
NH ₂ CN	Methyl isocyanide	CH ₃ OCHO	Methyl formate
HNCO	Isocyanic acid	CH ₂ OHCHO	Glycolaldehyde
CH ₃ CHO	Acetaldehyde	CH ₃ COOH	Acetic acid
c-C ₂ H ₄ O	Ethylene oxide	aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
CS	Carbon monosulphide	gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
NH ₂ CHO	Formamide	CH ₃ OCH ₂ OH	Methoxymethanol
H ₂ CS	Thioformaldehyde	SO ₂	Sulphur dioxide
C ₂ H ₅ OH	Ethanol		
CH ₃ OCH ₃	Dimethyl ether		
t-HCOOH	Formic acid		
HONO	Nitrous acid		
CH ₃ SH	Methyl mercaptan		
SO	Sulphur monoxide		
HC ₃ N	Cyanoacetylene		

MOLECULAR SAMPLE



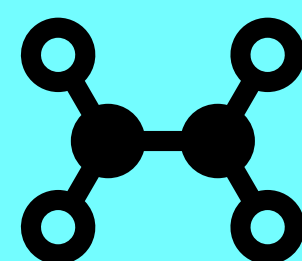
- **51 different species**
- **42 isotopologues**
- **23 COMs (> 5 atoms)**



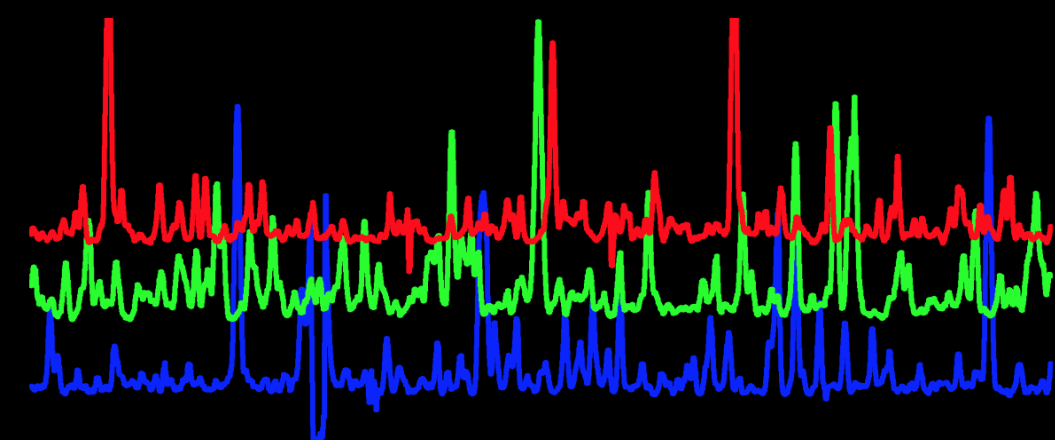
GUAPOS I (Mininni et al. 2020)

NH ₃	Ammonia	C ₂ H ₃ CN	Vinyl cyanide
HCN	Hydrogen cyanide	C ₂ H ₅ CN	Ethyl cyanide
CO	Carbon monoxide	CH ₃ NCO	Methyl Isocyanate
H ₂ CO	Formaldehyde	C ₂ H ₅ CHO	Propanal
CH ₃ OH	Methanol	CH ₃ COCH ₃	Acetone
CH ₃ CCH	Propyne	CH ₃ C(O)NH ₂	Acetamide
CH ₃ CN	Methyl cyanide	CH ₃ NHCHO	N-Methylformamide
CH ₃ NC	Methyl isocyanide	OCS	Carbonyl sulphide
NH ₂ CN	Methyl isocyanide	CH ₃ OCHO	Methyl formate
HNCO	Isocyanic acid	CH ₂ OHCHO	Glycolaldehyde
CH ₃ CHO	Acetaldehyde	CH ₃ COOH	Acetic acid
c-C ₂ H ₄ O	Ethylene oxide	aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
CS	Carbon monosulphide	gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
NH ₂ CHO	Formamide	CH ₃ OCH ₂ OH	Methoxymethanol
H ₂ CS	Thioformaldehyde	SO ₂	Sulphur dioxide
C ₂ H ₅ OH	Ethanol		
CH ₃ OCH ₃	Dimethyl ether		
t-HCOOH	Formic acid		
HONO	Nitrous acid		
CH ₃ SH	Methyl mercaptan		
SO	Sulphur monoxide		
HC ₃ N	Cyanoacetylene		

MOLECULAR SAMPLE



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- **23 COMs (> 5 atoms)**



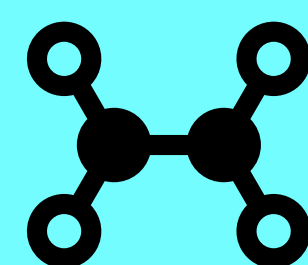
NH ₃	Ammonia
HCN	Hydrogen cyanide
CO	Carbon monoxide
H ₂ CO	Formaldehyde
CH ₃ OH	Methanol
CH ₃ CCH	Propyne
CH ₃ CN	Methyl cyanide
CH ₃ NC	Methyl isocyanide
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HNCO	Isocyanic acid
CH ₃ CHO	Acetaldehyde
c-C ₂ H ₄ O	Ethylene oxide
CS	Carbon monosulphide
NH ₂ CHO	Formamide
H ₂ CS	Thioformaldehyde
C ₂ H ₅ OH	Ethanol
CH ₃ OCH ₃	Dimethyl ether
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HONO	Nitrous acid
CH ₃ SH	Methyl mercaptan
SO	Sulphur monoxide
HC ₃ N	Cyanoacetylene

C ₂ H ₃ CN	Vinyl cyanide
C ₂ H ₅ CN	Ethyl cyanide
CH ₃ NCO	Methyl Isocyanate
C ₂ H ₅ CHO	Propanal
CH ₃ COCH ₃	Acetone
CH ₃ C(O)NH ₂	Acetamide
CH ₃ NHCHO	N-Methylformamide
OCS	Carbonyl sulphide
CH ₃ OCHO	Methyl formate
CH ₂ OHCHO	Glycolaldehyde
CH ₃ COOH	Acetic acid
aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
CH ₃ OCH ₂ OH	Methoxymethanol
SO ₂	Sulphur dioxide

GUAPOS I (Mininni et al. 2020)

GUAPOS II (Colzi et al. 2021)

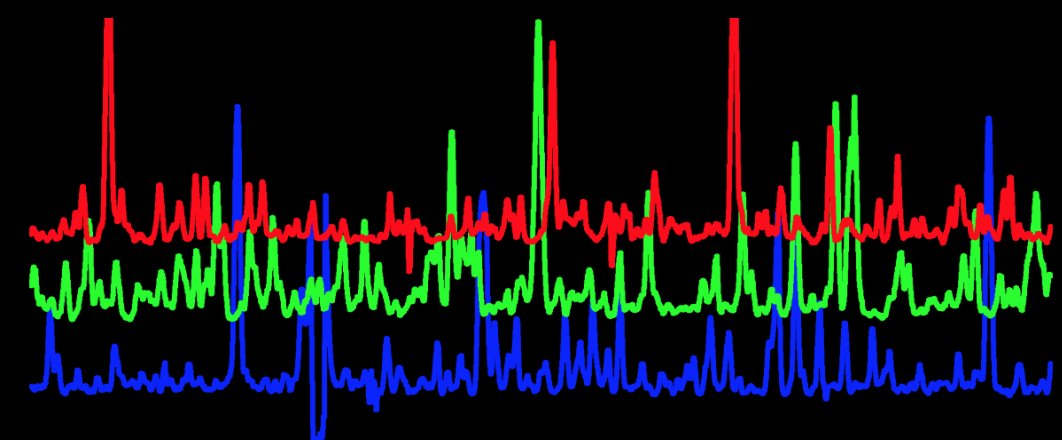
MOLECULAR SAMPLE



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NH ₃	Ammonia
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CO	Carbon monoxide
H ₂ CO	Formaldehyde
CH ₃ OH	Methanol
CH ₃ CCH	Propyne
CH ₃ CN	Methyl cyanide
CH ₃ NC	Methyl isocyanide
NH ₂ CN	Methyl isocyanide
HNCO	Isocyanic acid
CH ₃ CHO	Acetaldehyde
c-C ₂ H ₄ O	Ethylene oxide
CS	Carbon monosulphide
NH ₂ CHO	Formamide
H ₂ CS	Thioformaldehyde
C ₂ H ₅ OH	Ethanol
CH ₃ OCH ₃	Dimethyl ether
t-HCOOH	Formic acid
HONO	Nitrous acid
CH ₃ SH	Methyl mercaptan
SO	Sulphur monoxide
HC ₃ N	Cyanoacetylene

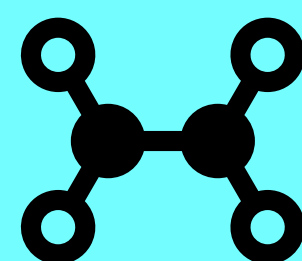
C ₂ H ₃ CN	Vinyl cyanide
C ₂ H ₅ CN	Ethyl cyanide
CH ₃ NCO	Methyl Isocyanate
C ₂ H ₅ CHO	Propanal
CH ₃ COCH ₃	Acetone
CH ₃ C(O)NH ₂	Acetamide
CH ₃ NHCHO	N-Methylformamide
OCS	Carbonyl sulphide
CH ₃ OCHO	Methyl formate
CH ₂ OHCHO	Glycolaldehyde
CH ₃ COOH	Acetic acid
aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
CH ₃ OCH ₂ OH	Methoxymethanol
SO ₂	Sulphur dioxide

GUAPOS I (Mininni et al. 2020)

GUAPOS II (Colzi et al. 2021)

GUAPOS III (Mininni et al. 2022)

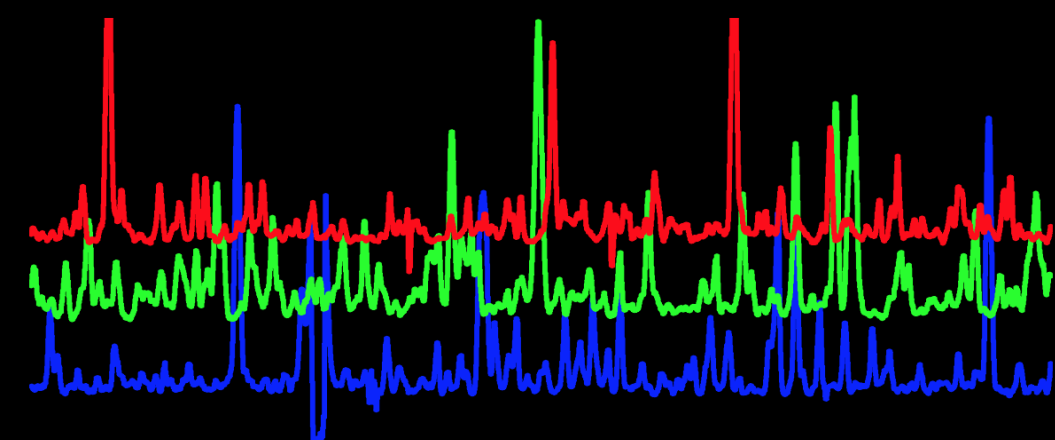
MOLECULAR SAMPLE



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CH ₃ OH	Methanol
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CH ₃ CN	Methyl cyanide
CH ₃ NC	Methyl isocyanide
NH ₂ CN	Methyl isocyanide
HNCO	Isocyanic acid
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CS	Carbon monosulphide
NH ₂ CHO	Formamide
H ₂ CS	Thioformaldehyde
C ₂ H ₅ OH	Ethanol
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HONO	Nitrous acid
CH ₃ SH	Methyl mercaptan
SO	Sulphur monoxide
HC ₃ N	Cyanoacetylene

C ₂ H ₃ CN	Vinyl cyanide
C ₂ H ₅ CN	Ethyl cyanide
CH ₃ NCO	Methyl Isocyanate
C ₂ H ₅ CHO	Propanal
CH ₃ COCH ₃	Acetone
CH ₃ C(O)NH ₂	Acetamide
CH ₃ NHCHO	N-Methylformamide
OCS	Carbonyl sulphide
CH ₃ OCHO	Methyl formate
CH ₂ OHCHO	Glycolaldehyde
CH ₃ COOH	Acetic acid
aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
CH ₃ OCH ₂ OH	Methoxymethanol
SO ₂	Sulphur dioxide

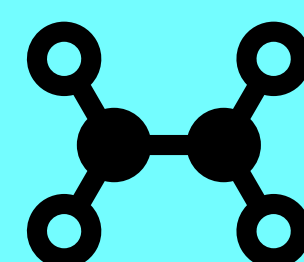
GUAPOS I (Mininni et al. 2020)

GUAPOS II (Colzi et al. 2021)

GUAPOS III (Mininni et al. 2022)

GUAPOS IV (Fontani et al. 2023)

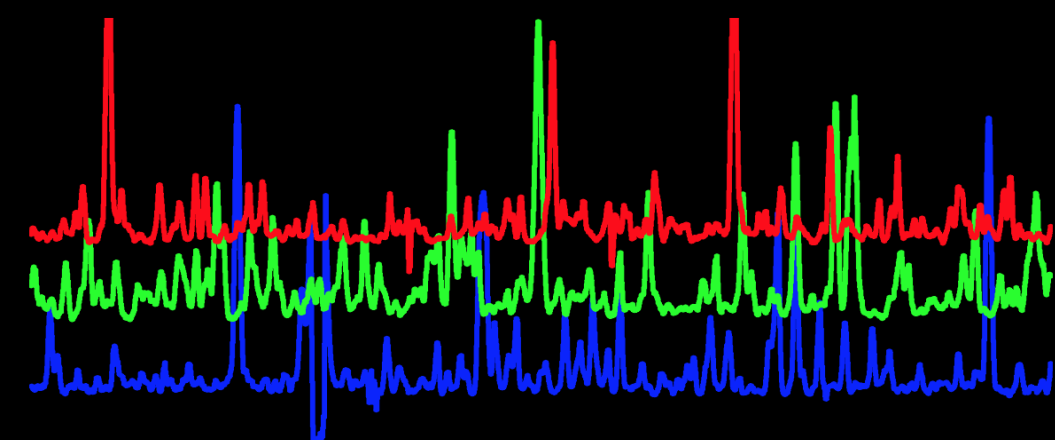
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NH ₃	Ammonia
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CH ₃ OH	Methanol
CH ₃ CCH	Propyne
CH ₃ CN	Methyl cyanide
CH ₃ NC	Methyl isocyanide
NH ₂ CN	Methyl isocyanide
HNCO	Isocyanic acid
CH ₃ CHO	Acetaldehyde
c-C ₂ H ₄ O	Ethylene oxide
CS	Carbon monosulphide
NH ₂ CHO	Formamide
H ₂ CS	Thioformaldehyde
C ₂ H ₅ OH	Ethanol
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HONO	Nitrous acid
CH ₃ SH	Methyl mercaptan
SO	Sulphur monoxide
HC ₃ N	Cyanoacetylene

C ₂ H ₃ CN	Vinyl cyanide
C ₂ H ₅ CN	Ethyl cyanide
CH ₃ NCO	Methyl Isocyanate
C ₂ H ₅ CHO	Propanal
CH ₃ COCH ₃	Acetone
CH ₃ C(O)NH ₂	Acetamide
CH ₃ NHCHO	N-Methylformamide
OCS	Carbonyl sulphide
CH ₃ OCHO	Methyl formate
CH ₂ OHCHO	Glycolaldehyde
CH ₃ COOH	Acetic acid
aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
CH ₃ OCH ₂ OH	Methoxymethanol
SO ₂	Sulphur dioxide

GUAPOS I (Mininni et al. 2020)

GUAPOS II (Colzi et al. 2021)

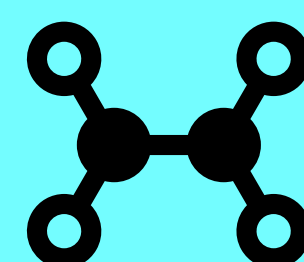
GUAPOS III (Mininni et al. 2022)

GUAPOS IV (Fontani et al. 2023)

GUAPOS V (Lopez-Gallifa et al. 2024)

GUAPOS VI (López Gallifa et al. 2025)

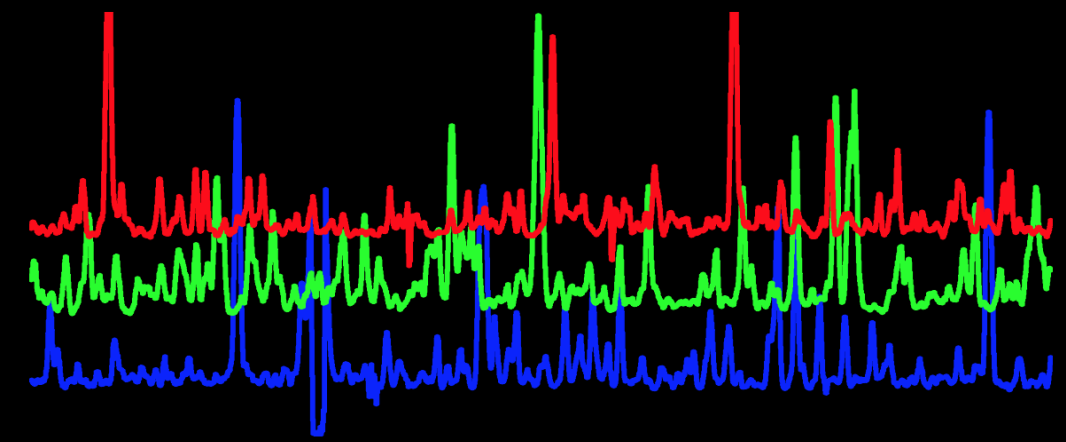
MOLECULAR SAMPLE



• **51 different species**

• **42 isotopologues**

• **23 COMs (> 5 atoms)**



NH ₃	Ammonia	C ₂ H ₃ CN	Vinyl cyanide
HCN	Hydrogen cyanide	C ₂ H ₅ CN	Ethyl cyanide
CO	Carbon monoxide	CH ₃ NCO	Methyl Isocyanate
H ₂ CO	Formaldehyde	C ₂ H ₅ CHO	Propanal
CH ₃ OH	Methanol	CH ₃ COCH ₃	Acetone
CH ₃ CCH	Propyne	CH ₃ C(O)NH ₂	Acetamide
CH ₃ CN	Methyl cyanide	CH ₃ NHCHO	N-Methylformamide
CH ₃ NC	Methyl isocyanide	OCS	Carbonyl sulphide
NH ₂ CN	Methyl isocyanide	CH ₃ OCHO	Methyl formate
HNCO	Isocyanic acid	CH ₂ OHCHO	Glycolaldehyde
CH ₃ CHO	Acetaldehyde	CH ₃ COOH	Acetic acid
c-C ₂ H ₄ O	Ethylene oxide	aGg'-((CH ₂ OH) ₂)	aGg'- Ethylene glycol
CS	Carbon monosulphide	gGg'-((CH ₂ OH) ₂)	gGg'- Ethylene glycol
NH ₂ CHO	Formamide	CH ₃ OCH ₂ OH	Methoxymethanol
H ₂ CS	Thioformaldehyde	SO ₂	Sulphur dioxide
C ₂ H ₅ OH	Ethanol		
CH ₃ OCH ₃	Dimethyl ether		
t-HCOOH	Formic acid		
HONO	Nitrous acid		
CH ₃ SH	Methyl mercaptan		
SO	Sulphur monoxide		
HC ₃ N	Cyanoacetylene		

GUAPOS I (Mininni et al. 2020)

GUAPOS II (Colzi et al. 2021)

GUAPOS III (Mininni et al. 2022)

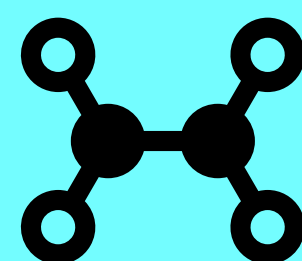
GUAPOS IV (Fontani et al. 2023)

GUAPOS V (Lopez-Gallifa et al. 2024)

GUAPOS VI (López Gallifa et al. 2025)

GUAPOS VII (Cesaroni et al. 2026)

MOLECULAR SAMPLE



• **51 different species**










• **42 isotopologues**

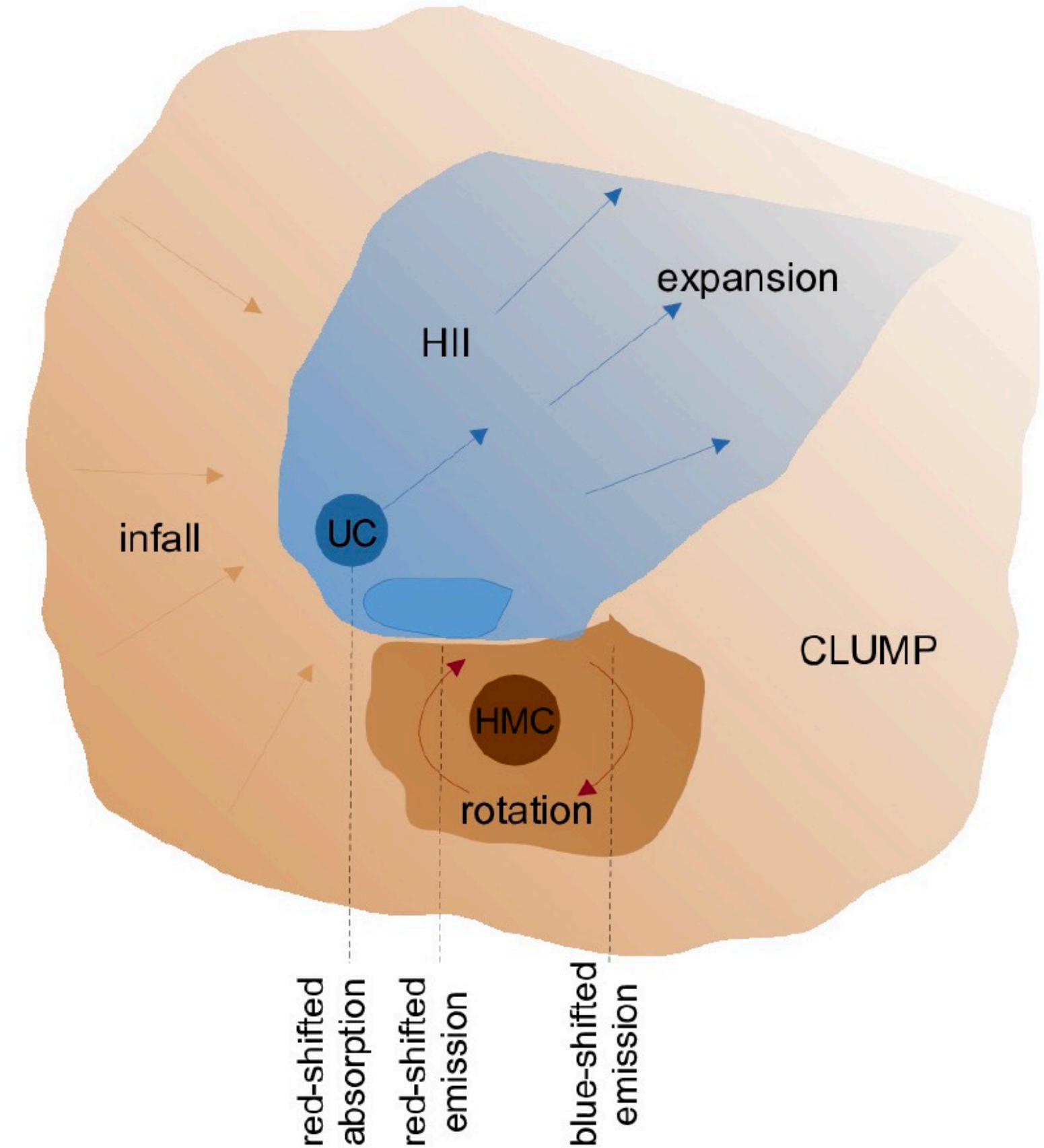
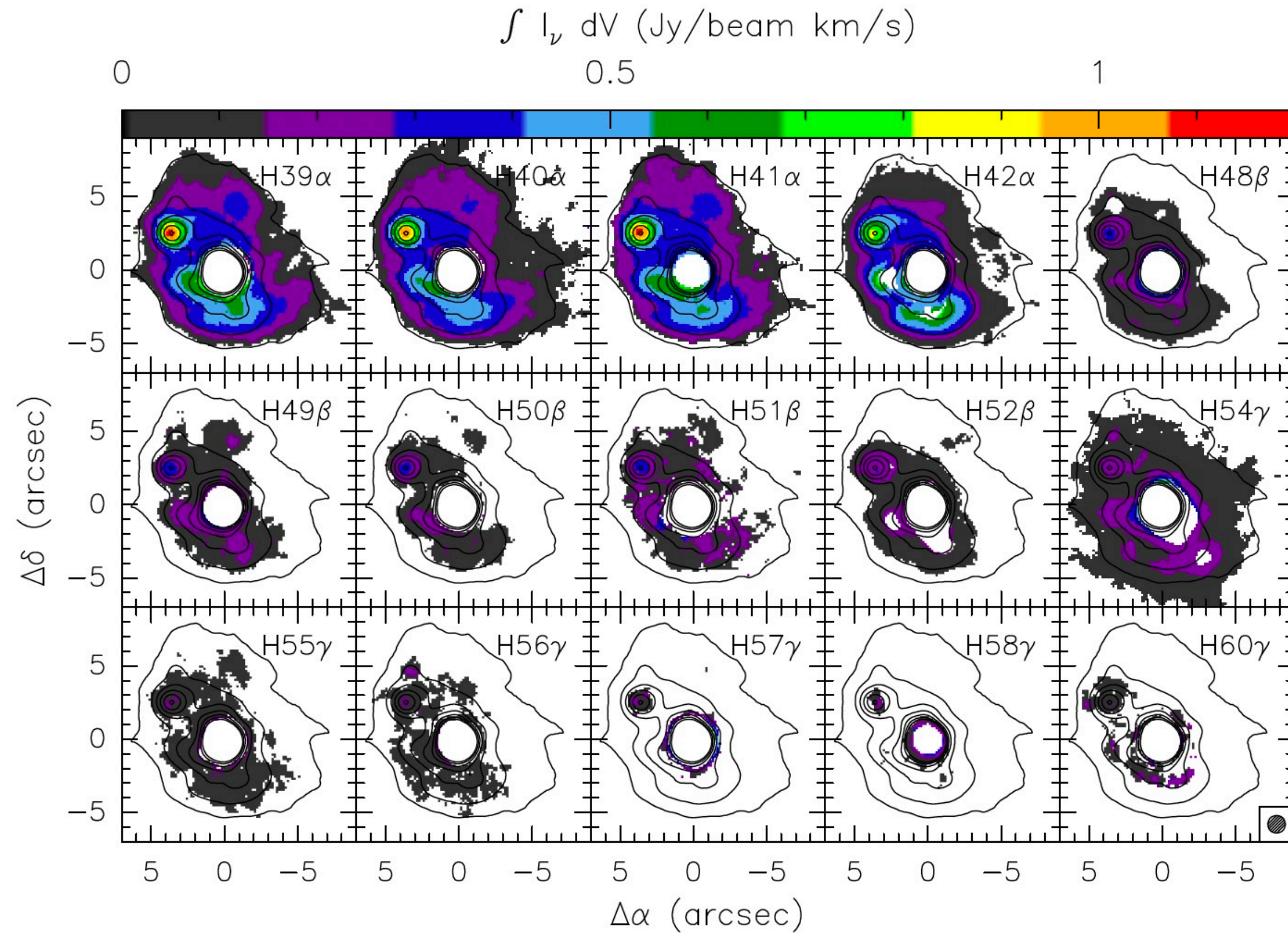
• **23 COMs (> 5 atoms)**

The GUAPOS project

VII. Physical structure and molecular environment of the G31.41+0.31

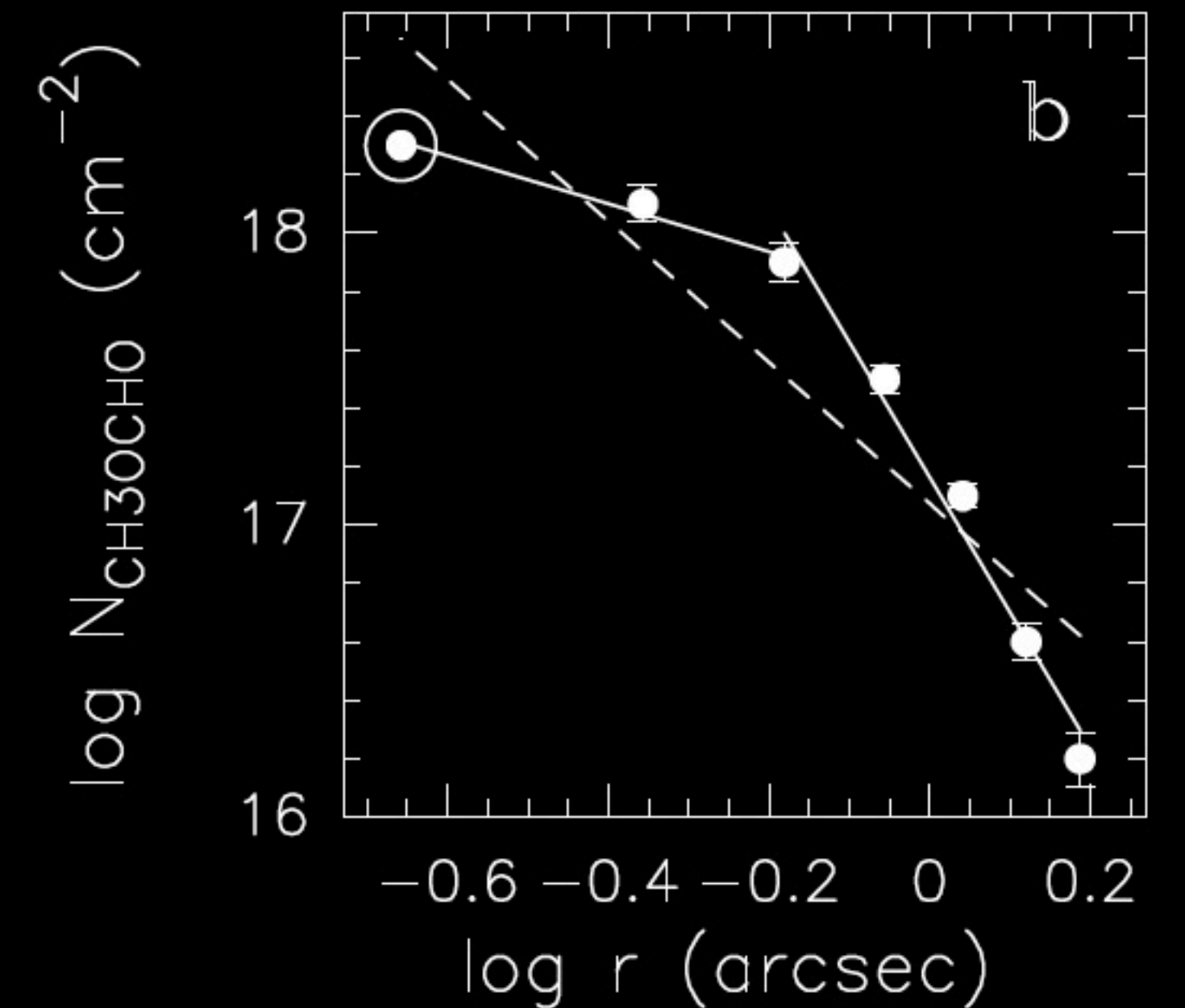
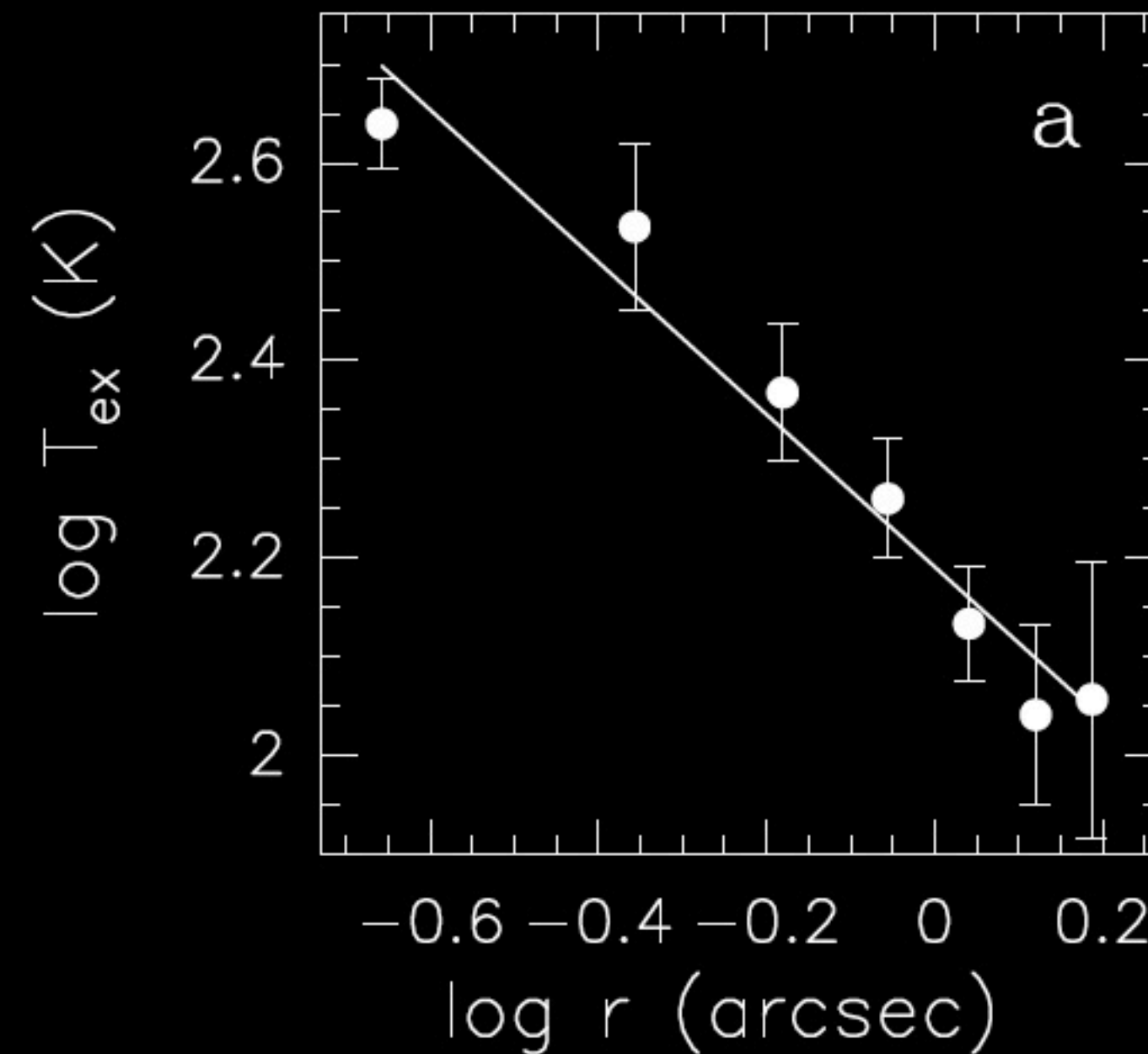
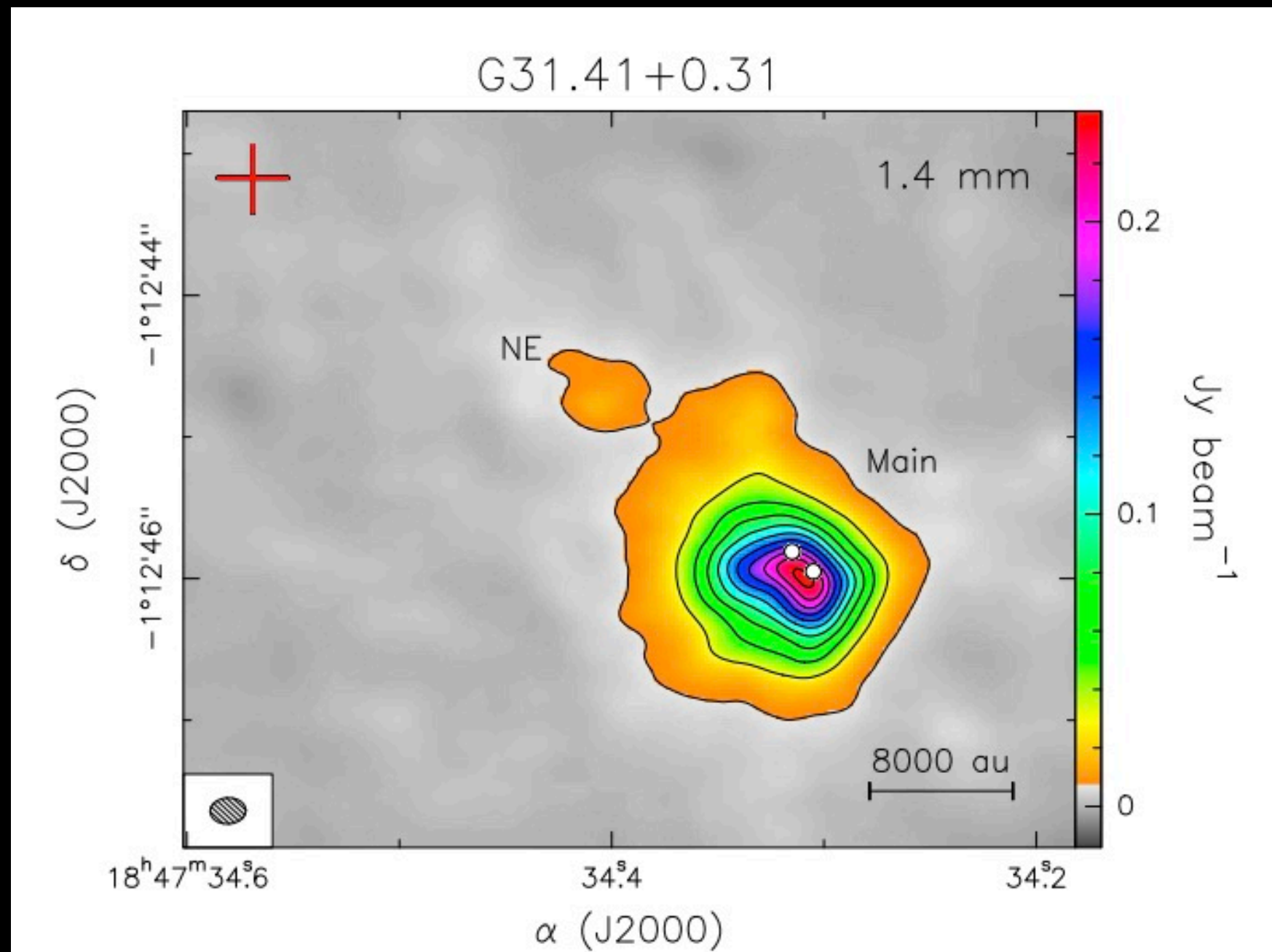
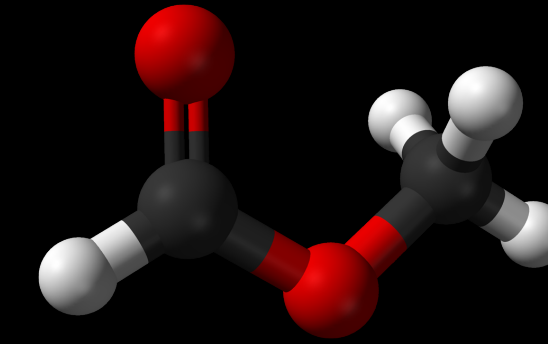
HII region ★

R. Cesaroni^{1,★} , M. T. Beltrán¹ , V. M. Rivilla² , Á. Sánchez-Monge^{3,4} , L. Colzi² , F. Fontani¹ ,
 Á. López-Gallifa² , A. Lorenzani¹ , and C. Mininni⁵ 



Accelerating infall and rotational spin-up in the hot molecular core G31.41+0.31

M. T. Beltrán¹, R. Cesaroni¹, V. M. Rivilla¹, Á. Sánchez-Monge², L. Moscadelli¹, A. Ahmadi³, V. Allen^{4,5},
H. Beuther³, S. Eto⁶, D. Galli¹, R. Galván-Madrid⁷, C. Goddi^{8,9}, K. G. Johnston¹⁰, P. D. Klaassen¹¹,
A. Kölligan¹², R. Kuiper¹², M. S. N. Kumar^{13,14}, L. T. Maud^{15,9}, J. C. Mottram³, T. Peters¹⁶, P. Schilke², L. Testi^{1,17},
F. van der Tak^{4,5}, and C. M. Walmsley^{*}



The (true) Riccardo's effect

The (true) Riccardo's effect

the title of this talk does not refer to the effect of dust opacity on line emission...

The (true) Riccardo's effect

the title of this talk does not refer to the effect of dust opacity on line emission...

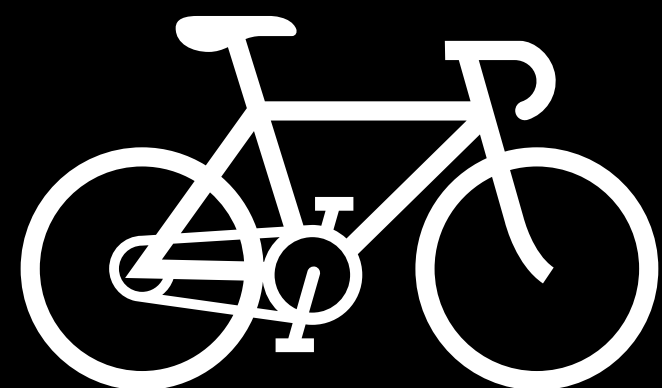
...but to the crucial impact that Ric had in my professional (and personal) path

Countless nice moments at the Observatory...



...and outside





~782 km

~50 hr

DATA	BICI	PERCORSO	DISTANZA (km)	TEMPO (hh:mm)	MEDIA (km/h)
07/06/15	BC	<i>P.zza delle Cure, Pian di Mugnone, Fiesole, Bosconi, Olmo, Bivigliano, Montesenario, Olmo, Caldine, Pian di Mugnone, P.zza delle Cure, V.le dei Mille, V.le Paoli, V.le Fanti, Via del Mezzetta, casa [con Paolo e Victor]</i>	48,5	2:53	16,8
18/07/15	BC	<i>Borgo S. Lorenzo, Ronta, Colla, Sambuca, Colla, Ronta, Borgo S. Lorenzo [con Victor]</i>	45,5	2:58	15,3
13/09/15	BC	<i>casa, P.zza di Badia, Ponte a Ema, Cinque Strade, Ponte a Ema, Grassina, S. Polo, Poggio alla Croce, S. Polo, Strada, Grassina, P.zza di Badia, casa [con Victor]</i>	52,0	2:53	18,1
27/09/15	BC	<i>Ponte a Ema, Grassina, Strada, Cintoia, Dudda, Ponte agli Stolti, Brollo, Poggio alla Croce, S. Polo, Grassina, Ponte a Ema, P.zza di Badia, casa [con Victor]</i>	56,8	3:12	17,7
15/11/15	BC	<i>casa, P.zza di Badia, Ponte a Ema, Cascine del Riccio, Galluzzo, Gore, Chiesanuova, S. Casciano, Mercatale, Gabbiano, Ferrone, Strada, Grassina, Ponte a Ema, P.zza di Badia, casa [con Victor] [contachilometri inserito male fino alle Gore: distanza vera percorsa circa 55 km]</i>	42,2	2:16	18,7
22/11/15	BC	<i>casa, P.zza di Badia, Ponte a Ema, Cascine del Riccio, Galluzzo, Gore, Cerbaia, S. Casciano, Luiano, Impruneta, S. Gersolè, Grassina, Ponte a Ema, P.zza di Badia, casa [con Paolo e Victor]</i>	55,5	3:13	17,3
29/11/15	BC	<i>casa, P.zza di Badia, Ponte a Ema, Grassina, San Gersolè, Impruneta, Ferrone, Gabbiano, Quattro Strade, Poggio di Testalepre, Montefioralle, Greve, Spedaluzzo, Strada, Grassina, Ponte a Ema, P.zza di Badia, casa [con Paolo e Victor]</i>	59,6	3:32	16,9
17/01/16	BC	<i>Panzano, Lucarelli, Radda, bivio Castellina, Panzano [con Victor]</i>	35,3	2:11	16,2
21/02/16	BC	<i>casa, Compiobbi, Monteloro, Passo della Catena, Olmo, Fiesole, S. Domenico, P.zza Edison, Coverciano, Varlungo, casa [con Victor]</i>	39,2	2:23	16,4
20/03/16	BC	<i>casa, P.za di Badia, Antella, Osteria Nuova, S. Donato, Cellai, Rignano, Bombone, Rosano, Candeli, V.le Europa, casa [con Victor]</i>	47,6	2:41	17,7
03/04/16	BC	<i>Galluzzo, Tavarnuzze, Scopeti, S. Casciano, Cerbaia, Chiesanuova, le Gore, Galluzzo [con Victor]</i>	32,3	1:42	19,1
22/05/16	BC	<i>P.zza delle Cure, Pian di Mugnone, Fiesole, Bosconi, Olmo, Bivigliano, Viliani, Caselline, S. Jacopo, Caldine, P.zza delle Cure, Via del Mezzetta, casa [con Victor]</i>	42,0	2:25	17,4
03/07/16	BC	<i>bivio Bosco ai Frati, Galliano, Scarperia, Ponzalla, Giogo, Ponzalla, Scarperia, Bosco ai Frati, bivio Bosco ai Frati [con Victor]</i>	39,6	2:20	17,0
04/09/16	BC	<i>Scarperia, Galliano, Panna, Futa, Raticosa, Futa, Panna, Galliano, Scarperia [con Victor]</i>	68,6	3:59	17,2
15/01/17	BC	<i>P.zza delle Cure, Caldine, Olmo, Vetta le Croci, Bosconi, Fiesole, S. Domenico, V.le Duse, casa [con Paolo e Victor]</i>	31,0	1:48	17,3
22/01/17	BC	<i>casa, Sieci, Monterifrassine, Doccia, S. Brigida, Monteloro, Via Aretina, casa [con Paolo e Victor]</i>	48,8	3:00	16,3
29/01/17	BC	<i>casa, Ponte a Mensola, Vincigliata, Bosconi, Olmo, Vetta le Croci, Olmo, Passo della Catena, Monte Fanna, Fiesole, Maiano, Coverciano, Settignano, Via del Rossellino, Via del Loretino, Via Spadaro, casa [con Victor]</i>	38,0	2:40	14,3



QUESTION #4

Where are we?

Tourmalet

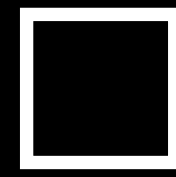
Mortirolo

Raticosa

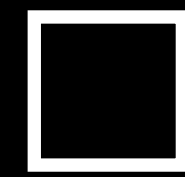


QUESTION #4

Where are we?



Tourmalet



Mortirolo



Raticosa





100

50

LAURENCE
LAURENCE
LAURENCE

TREK

When I go to Riccardo's office...

When I go to Riccardo's office...



When I go to Riccardo's office...



Jannick Sinner and Carlos Alcaraz in Indian Wells

Riccardo tenista



When I go to Riccardo's office...



Jannick Sinner and Carlos Alcaraz in Indian Wells

“La Maja vestida”, Francisco de Goya, Museo del Prado, Madrid



When I go to Riccardo's office...

majo, ja

D**e** Diccionario de la
lengua española


REAL ACADEMIA ESPAÑOLA

De or. inc.

Artículo

Sinónimos o afines

Antónimos u opuestos

1. **adj. coloq.** Que gusta por su simpatía, belleza o gracia.
SIN.: simpático, agradable, guapo, arreglado, acicalado, compuesto.
ANT.: antipático.
2. **adj. coloq.** Lindo, hermoso, vistoso.
SIN.: lindo, hermoso, vistoso, coqueto, mono¹, cuco².
ANT.: feo.
3. **adj. coloq.** Ataviado, compuesto, lujoso.
4. **m. y f.** En los siglos XVIII y XIX, persona de las clases populares de Madrid que en su porte, acciones y vestidos afectaba libertad y guapeza.
SIN.: chulo, chulapo, castizo, curro².



“Parpusa”: traditional cap that madrileños wear in the San Isidro festivity



“Parpusa”: traditional cap that madrileños wear in the San Isidro festivity



QUESTION #5

When is San Isidro day?

15 August

15 May

15 February

“Parpusa”: traditional cap that madrileños wear in the San Isidro festivity



QUESTION #5

When is San Isidro day?

15 August



15 May

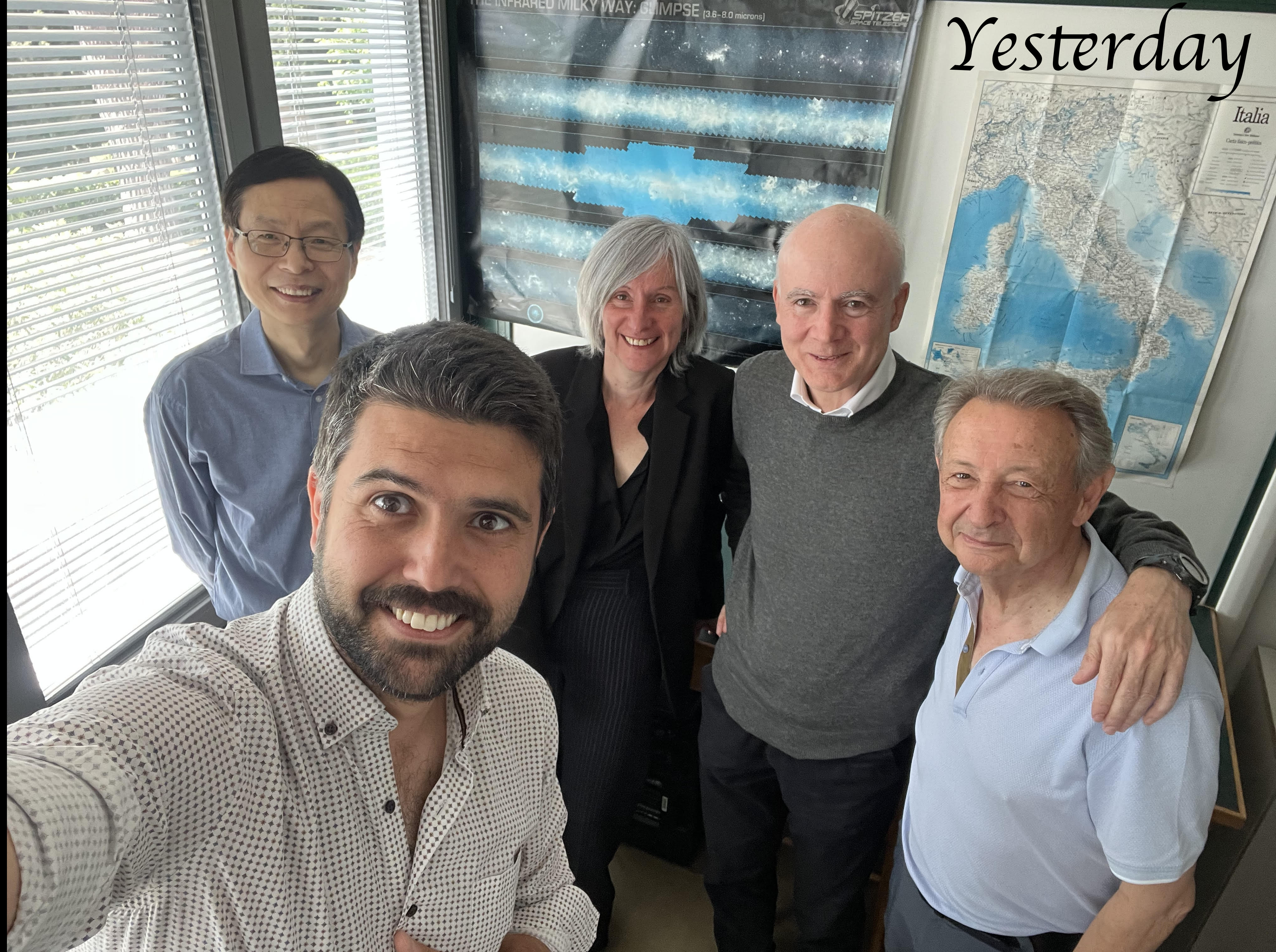
15 February

Riccardo's birthday!

Riccardo chulapo



Yesterday



Riccardie Mercury



Grazie Ric!



The Riccardo's effect



Víctor M. Rivilla
Centro de Astrobiología (CAB)
CSIC-INTA, Madrid