

ORIGIN OF HIGH-MASS STARS

From molecular clouds to rich clusters



Herschel

Timea CSENGERI

Max Planck Institute for Radioastronomy, Bonn

- 2002 - 2007: Eötvös Loránd University of Sciences, Budapest
- 2007 - 2010: PhD, CEA-Saclay (*S. Bontemps, N. Schneider*)
- 28. Oct. 2010: thesis defense
- 10. Nov. 2010 - MPIfR, Bonn (*F. Wyrowski, K. Menten*)



VLA

Multi-wavelength observations of high-mass (HM) star-forming regions

- single-dish and interferometers
- cm, (sub)mm observations
- molecular lines and dust continuum



APEX



IRAM 30m



IRAM PdBI



SOFIA

From molecular clouds to rich clusters



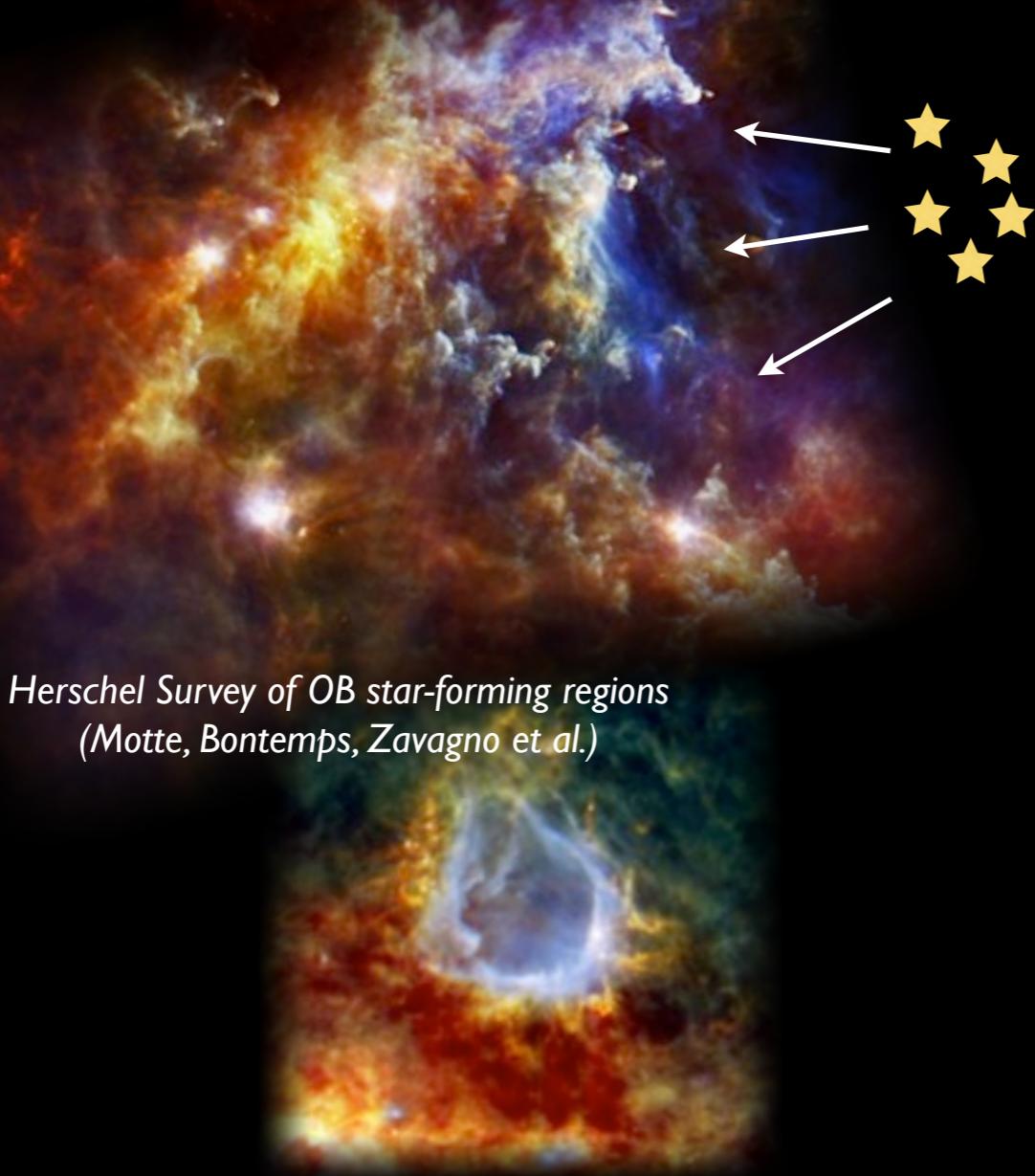
*Herschel Imaging Survey of the Galactic Plane
(Molinari et al.)*

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Herschel Survey of OB star-forming regions
(Motte, Bontemps, Zavagno et al.)

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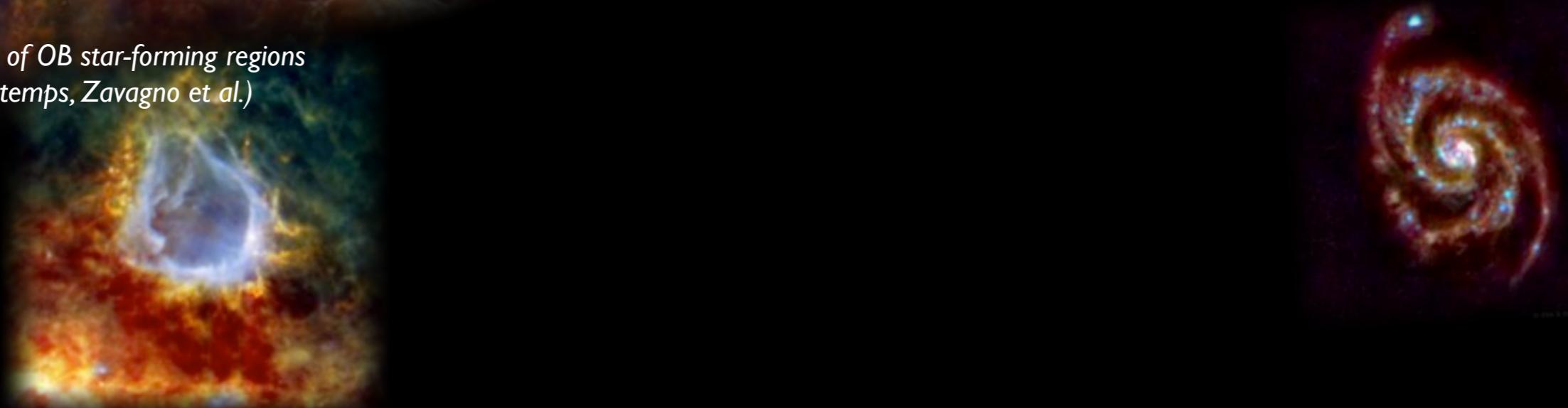
I. The early phases:

- ★ how individual high-mass stars with an envelope of 20-100 Jeans-mass are built up?
- ★ how clusters of massive stars form?

Additional support mechanism!

- Scale-up of ‘regular’ SF processes?
(turbulent-core model)
- Specific processes needed?
(merging, competitive accretion)

Herschel Survey of OB star-forming regions
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II. Feedback from massive YSOs

- ★ what are the chemical signatures?
- ★ how important are the feedback effects?

→ galactic mini starburst regions >>
templates for starburst galaxies



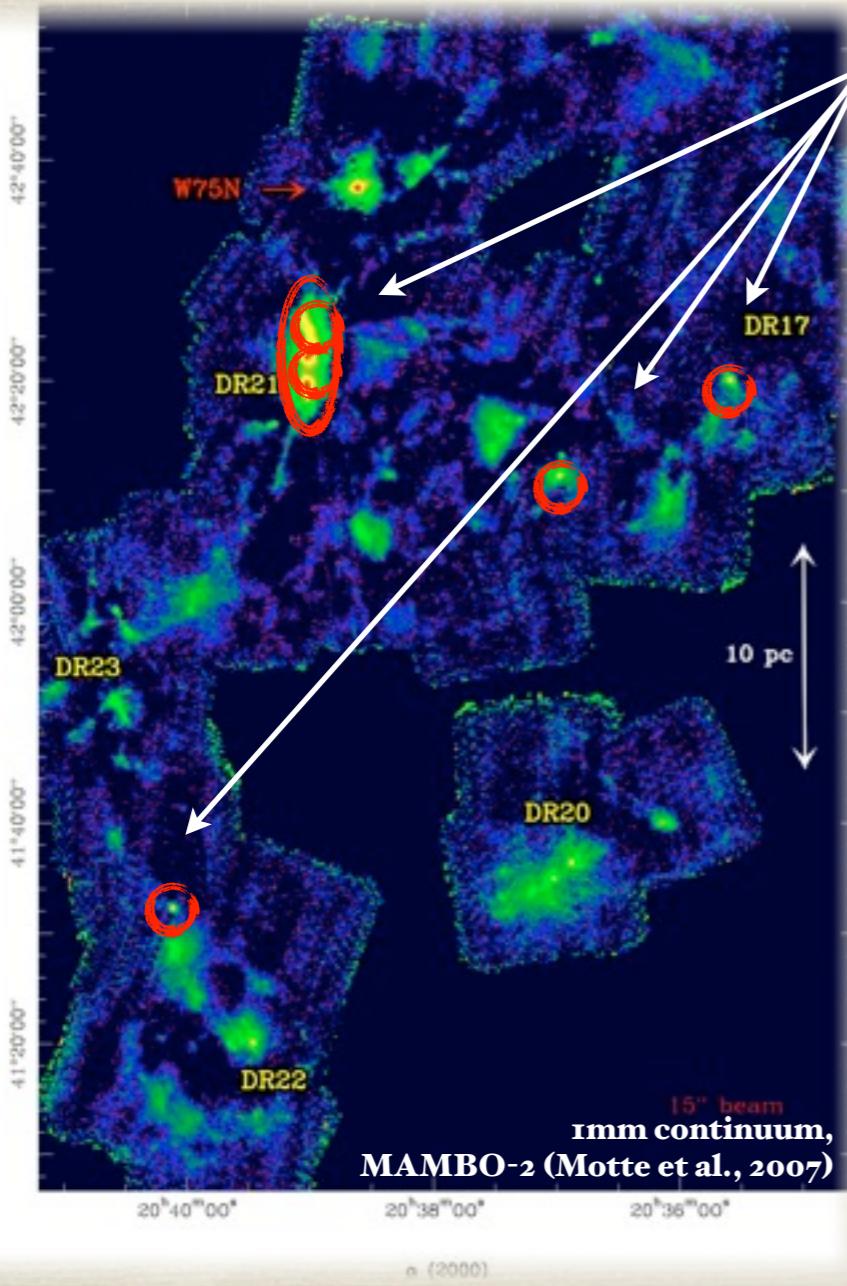
The quest for the earliest phases

Massive stars: rare >> the earliest phases are challenging to find!

Massive stars: distant >> interferometers needed!

The **Cygnus-X** complex provides the best statistics to date

Protostellar envelopes: dust continuum at mm/submm wavelenghts



- ★ sample of **IR-quiet massive dense cores** (MDCs)
- ★ **PhD:** high angular res. follow-ups with the **Plateau de Bure Interferometer**
 - reach physical scales of **individual collapsing objects** (few thousands of AU)

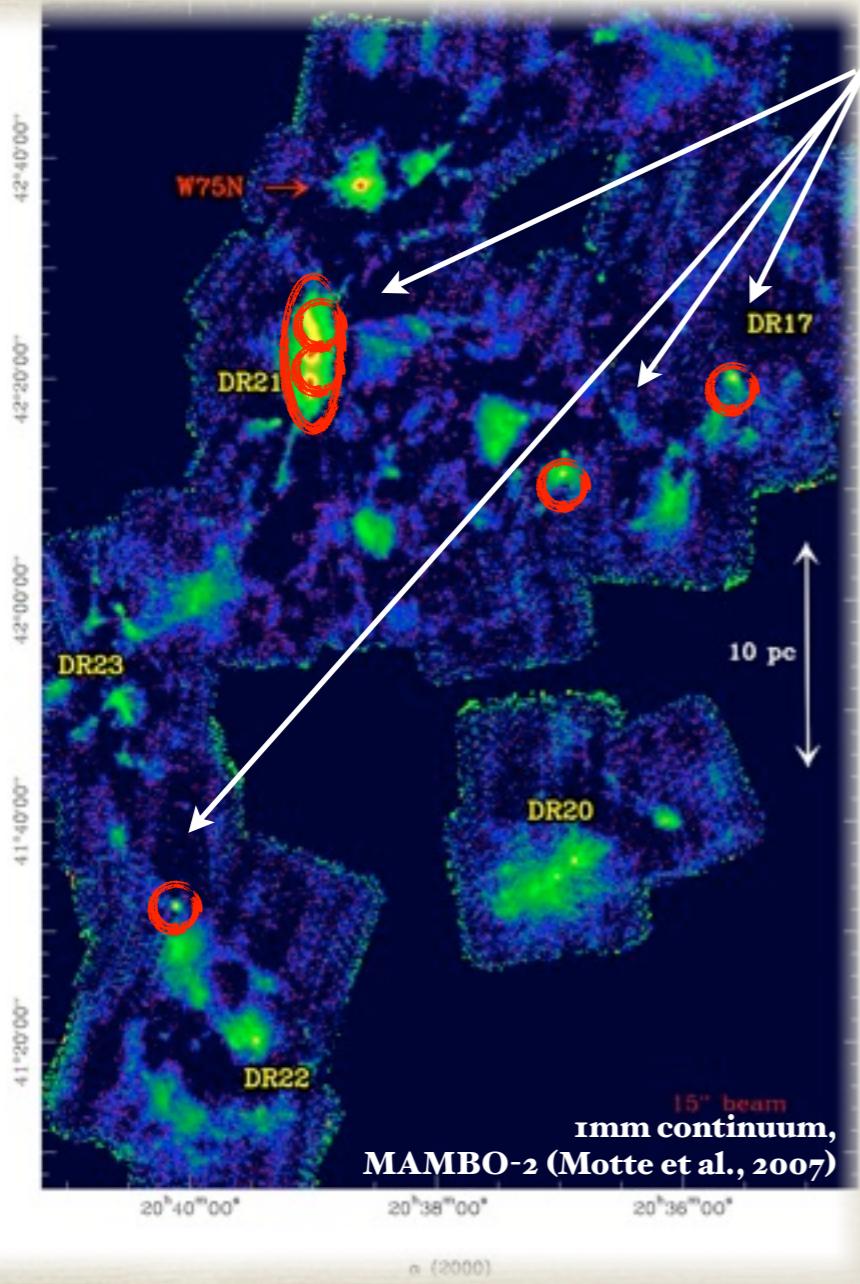
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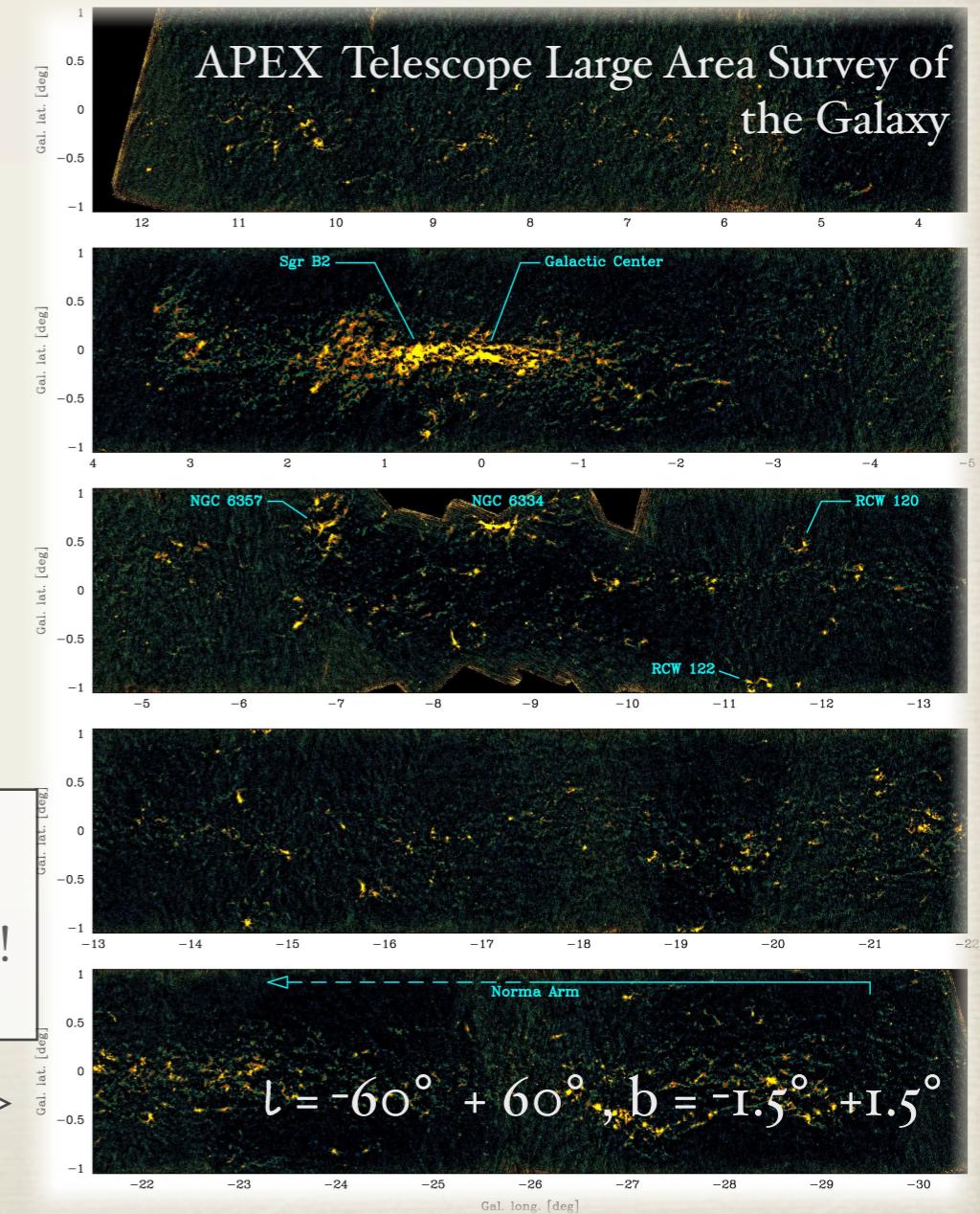


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a better statistics is crucial!
need for the Galactic Plane!
preparation for ALMA



ATLASGAL: the most complete submm survey of the **galactic plane** (*APEX/LABOCA*)

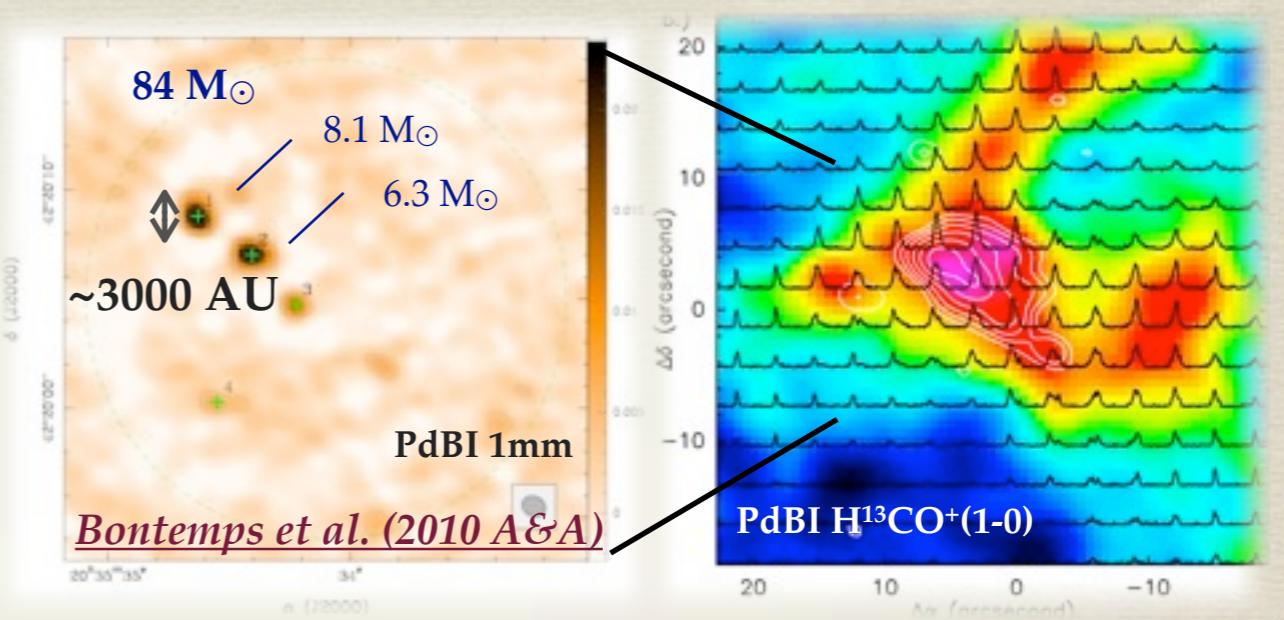


Schuller, Menten, Contreras, Wyrowski et al. (2009)

Thesis results: dynamic star-formation

I. Search for proto-OB stars in Cygnus X

- ★ MDCs host precursors of OB stars
- ★ similar scale as low mass protostars (~2000 AU), but more massive!
- ★ few but massive fragments, mass segregation



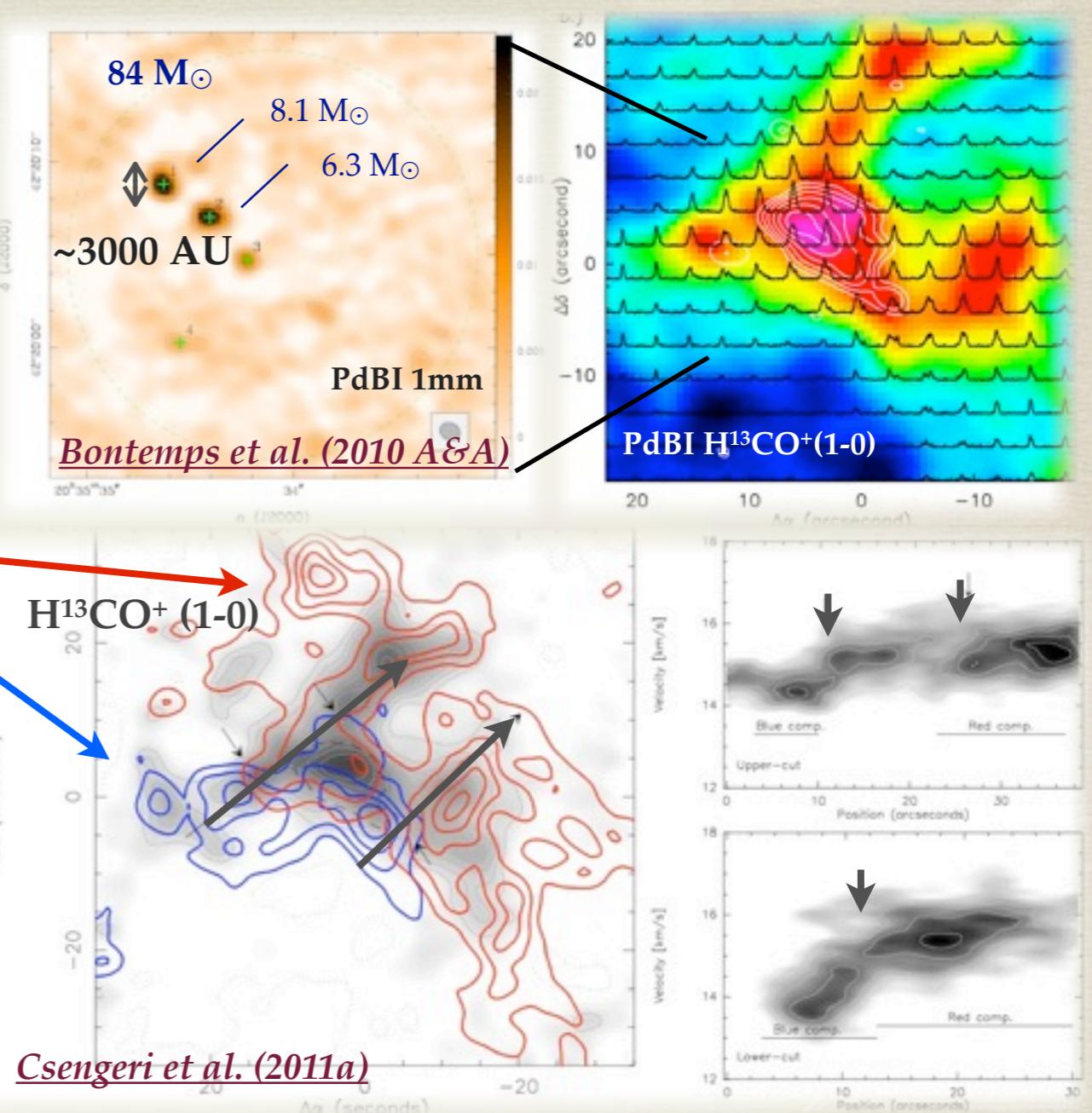
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- ★ micro-turbulence not sufficient
- ★ individual velocity components
- ★ velocity shears in the highest density regions



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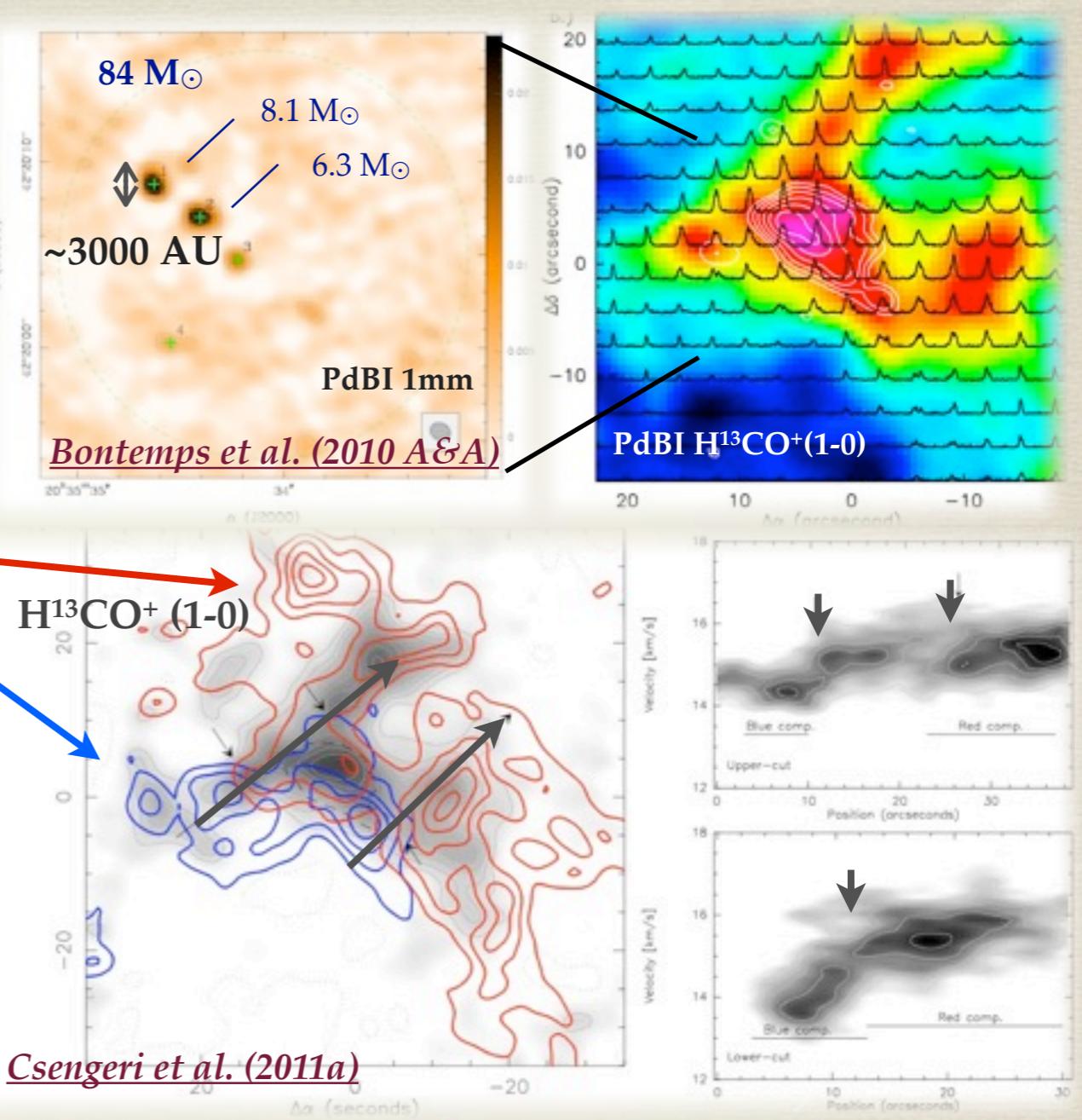
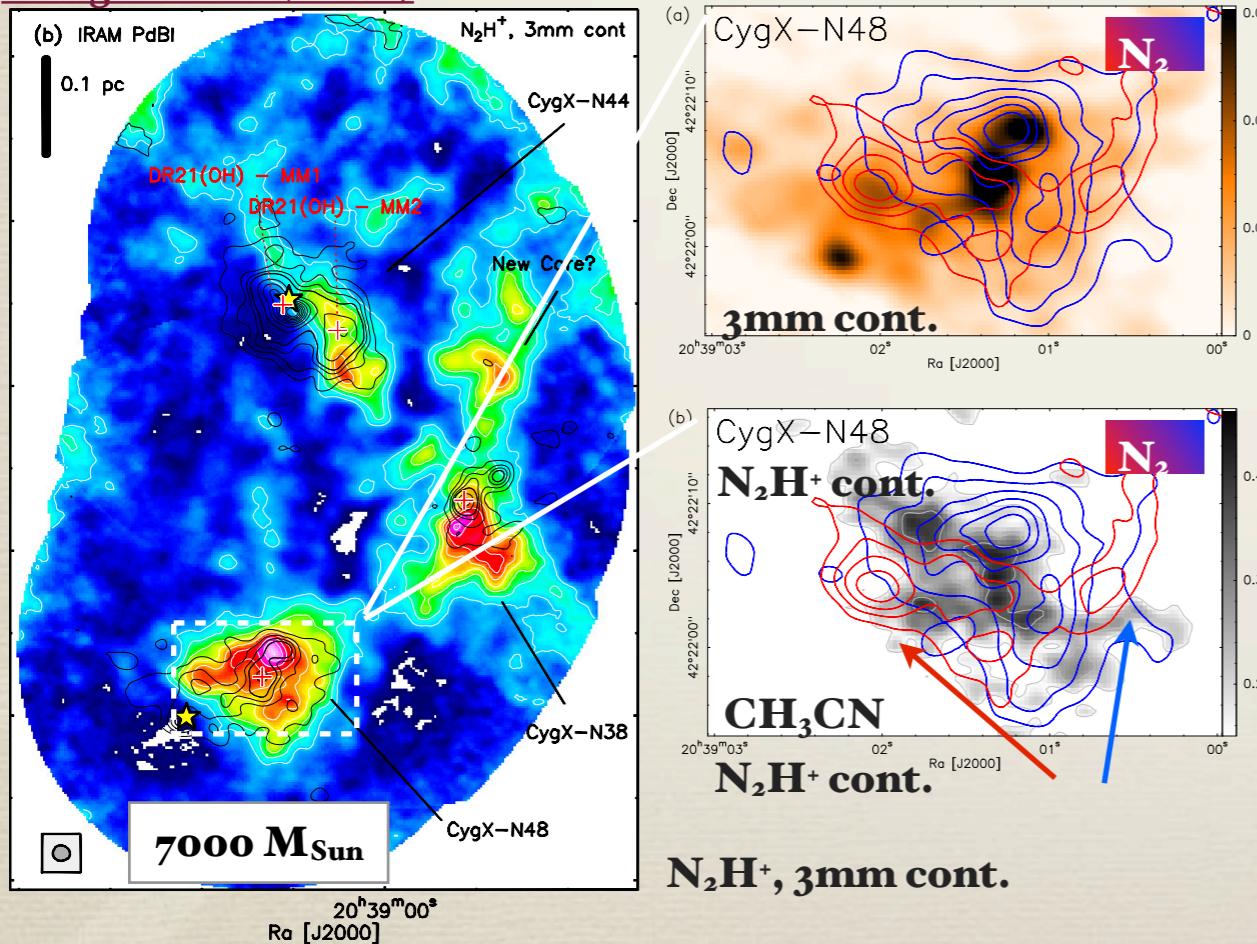
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Csengeri et al. (2011b)



For the first time we witness **convergent flows** and **low-velocity shocks** associated with them!

Post-doc results: low velocity shocks at the origin of HM stars

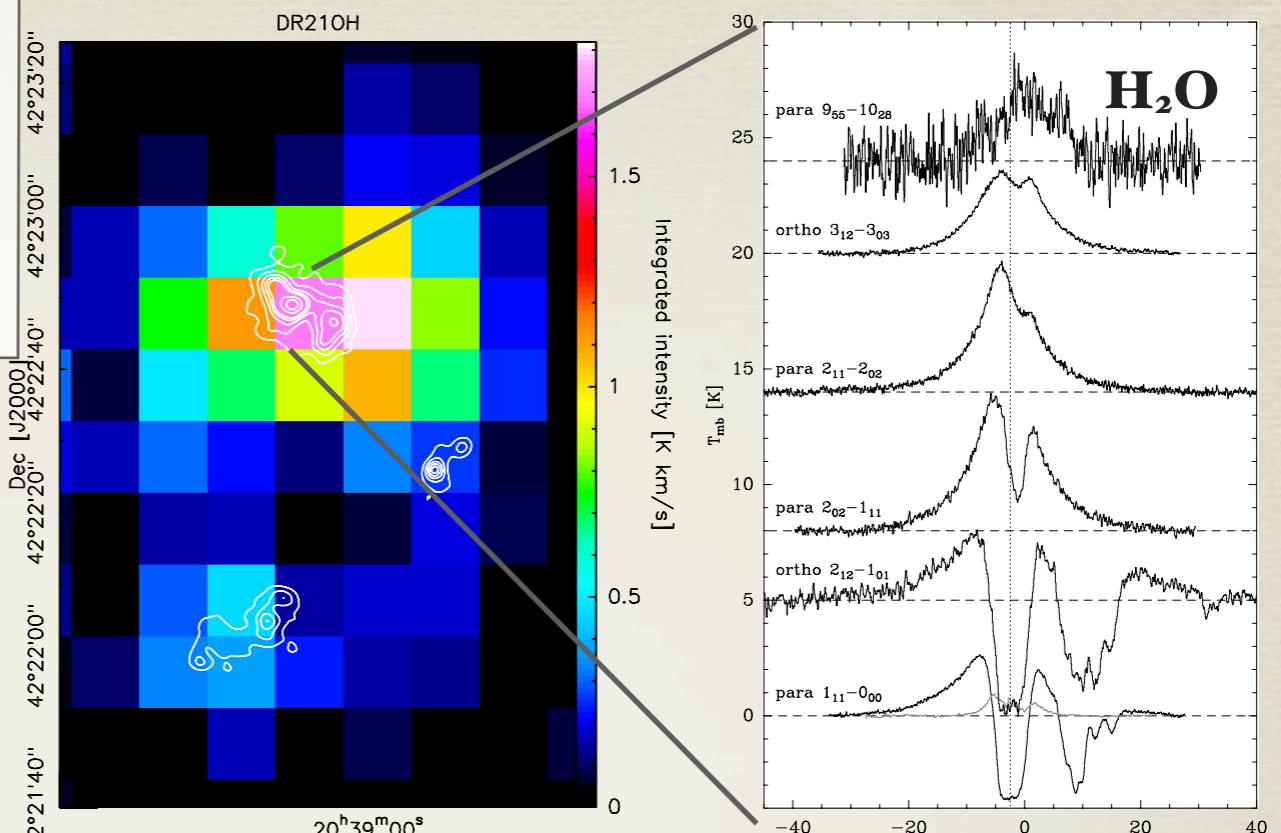
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2. Observational signatures of such shocks: cooling lines in the far-IR range+models (with A. Gusdorf)

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Herschel/HIFI spectroscopy

- ★ **H₂O lines** of DR₂₁(OH) (WISH GT)
- ★ **H₂O survey of massive protostars in Cygnus X** (Bontemps et al)
- ★ **OT2** proposal for a complete spectral survey towards the position of low-velocity shocks (PACS+SPIRE+HIFI)



H₂O: kinematics of the inner envelope

infall and outflows, oxygen based chemistry

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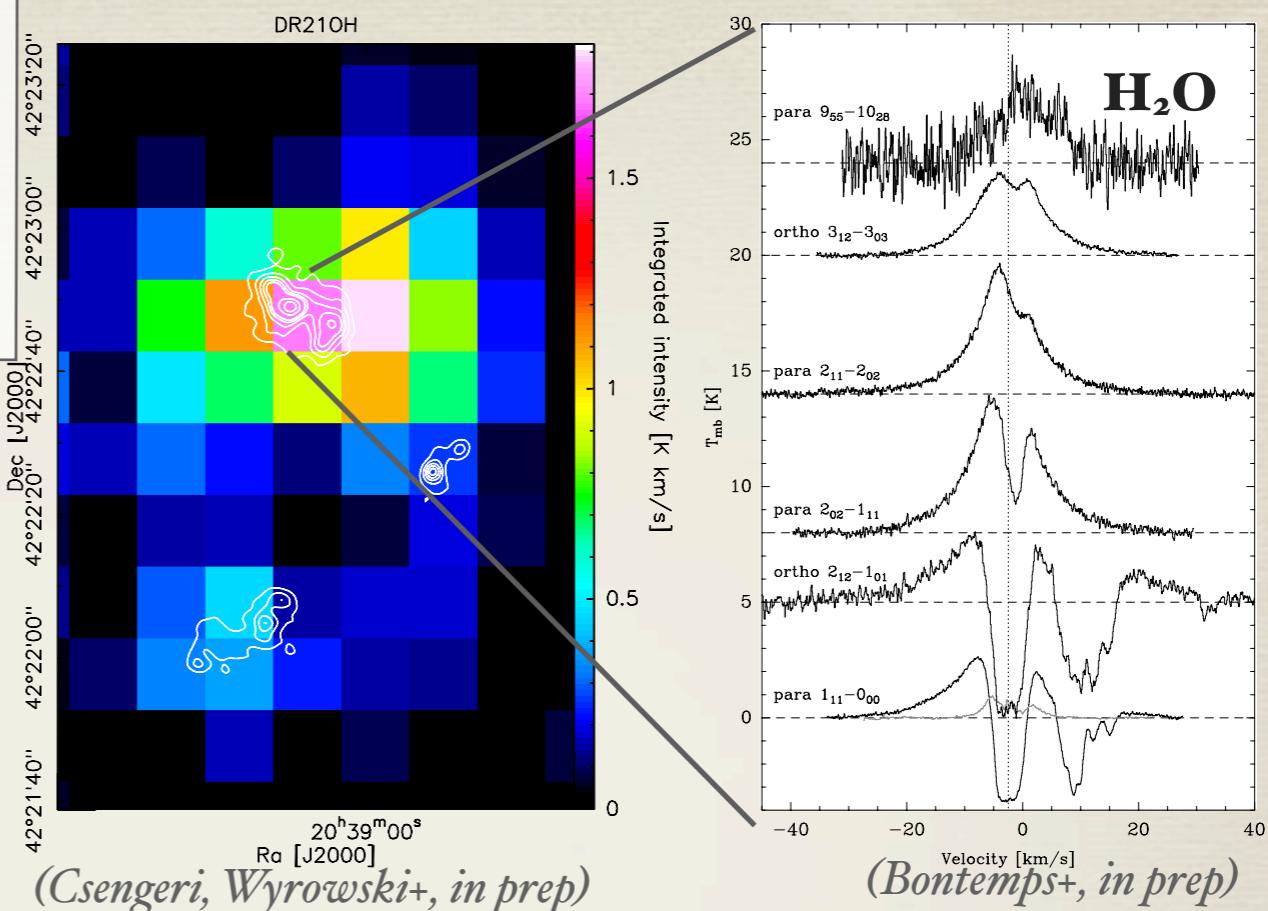
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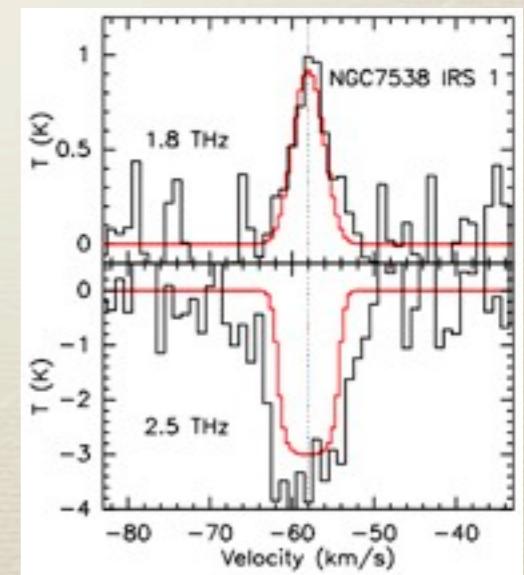
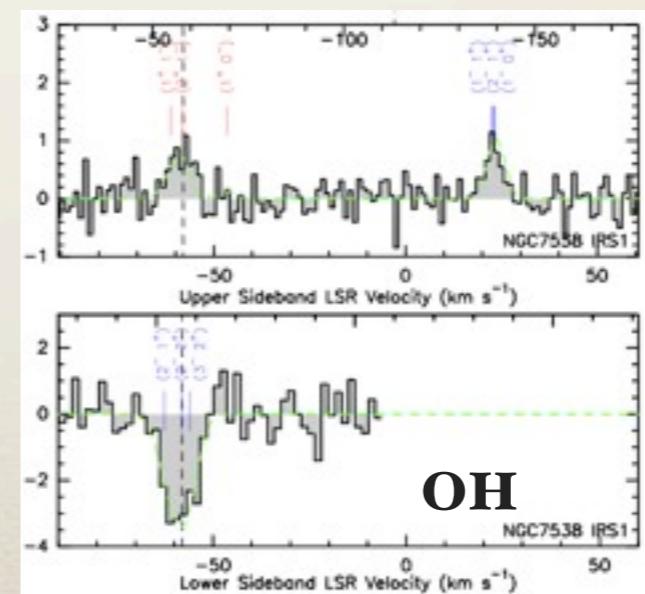
SOFIA

- ★ Early Science: OH observations of classical UCHII regions
(Csengeri, Menten, Wyrowski+, 2012)

Cooling of dense gas id the new frontier for star-formation!



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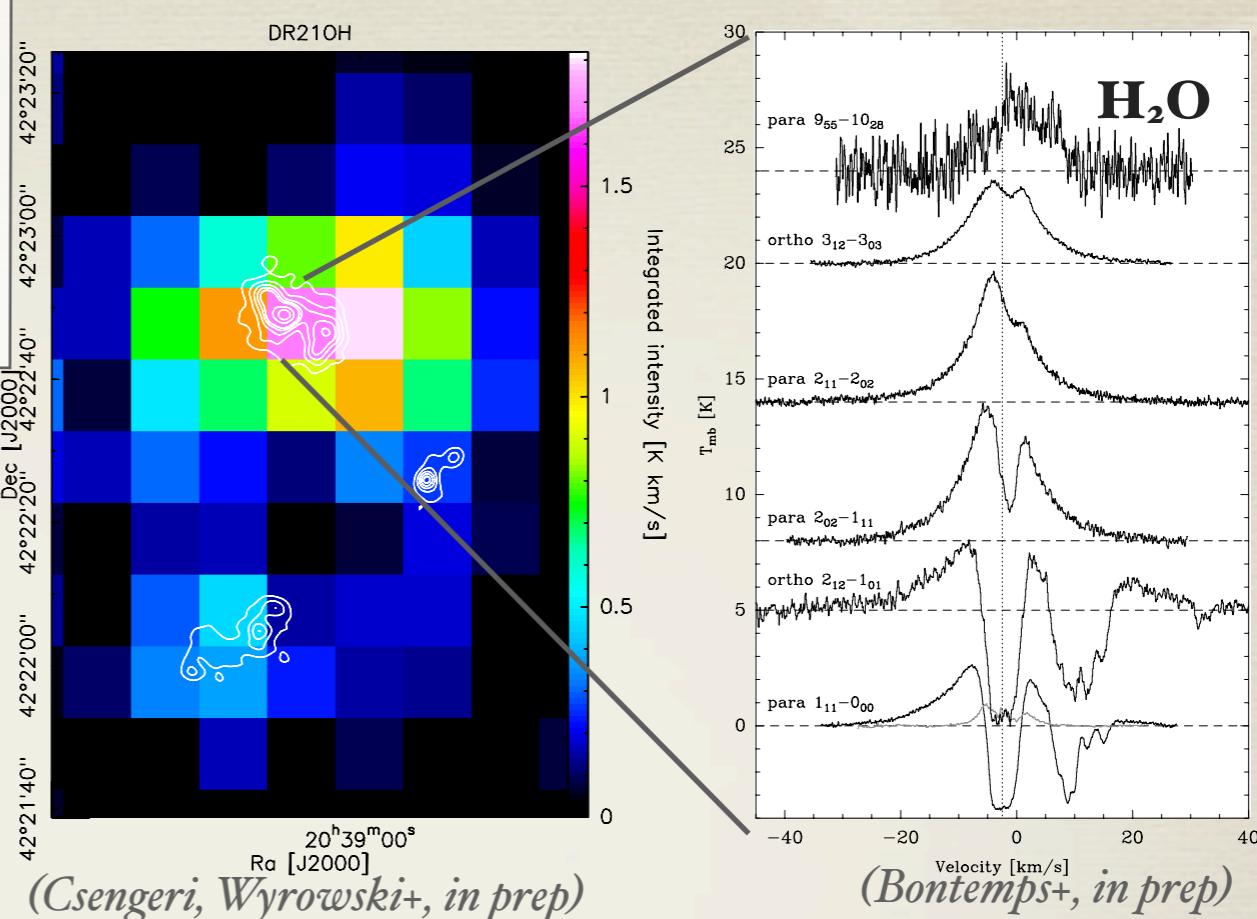
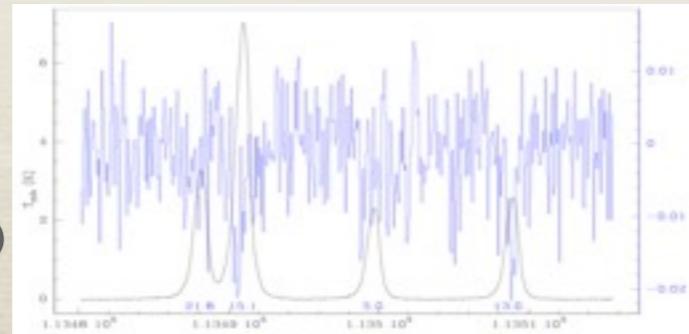
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3. Other physical ingredients?

- ★ measurements of the
magnetic field in
Cyg-X (Herpin,
Wiesemeyer, Hezareh)

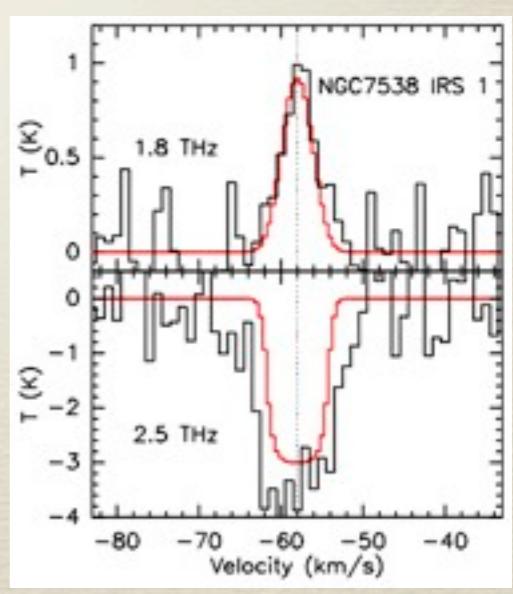
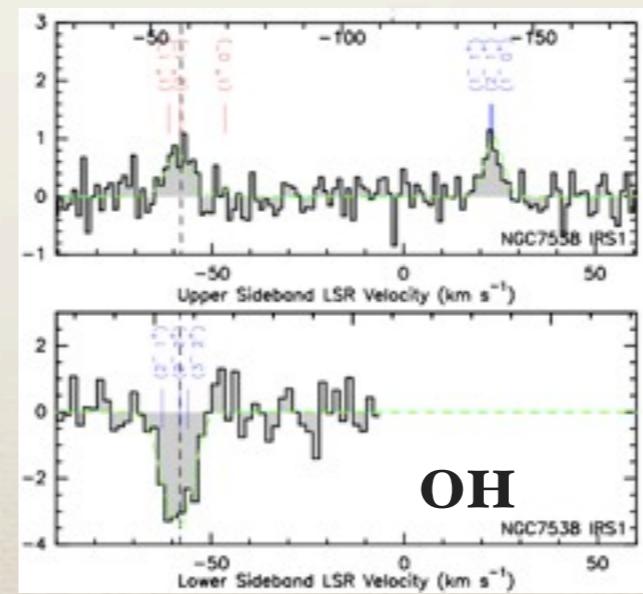


Rd [JZ000]
(Csengeri, Wyrowski+, in prep)

(Bontemps+, *in prep*)

H₂O: kinematics of the inner envelope

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Post-doc results: towards a better statistics the Galactic plane

I. Compact source catalog

Csengeri et al. (in prep)

- ★ find the most extreme objects (DR₂₁) (OH), W₄₃-MMI)
- ★ at the same time: statistical sample of all evolutionary stages!

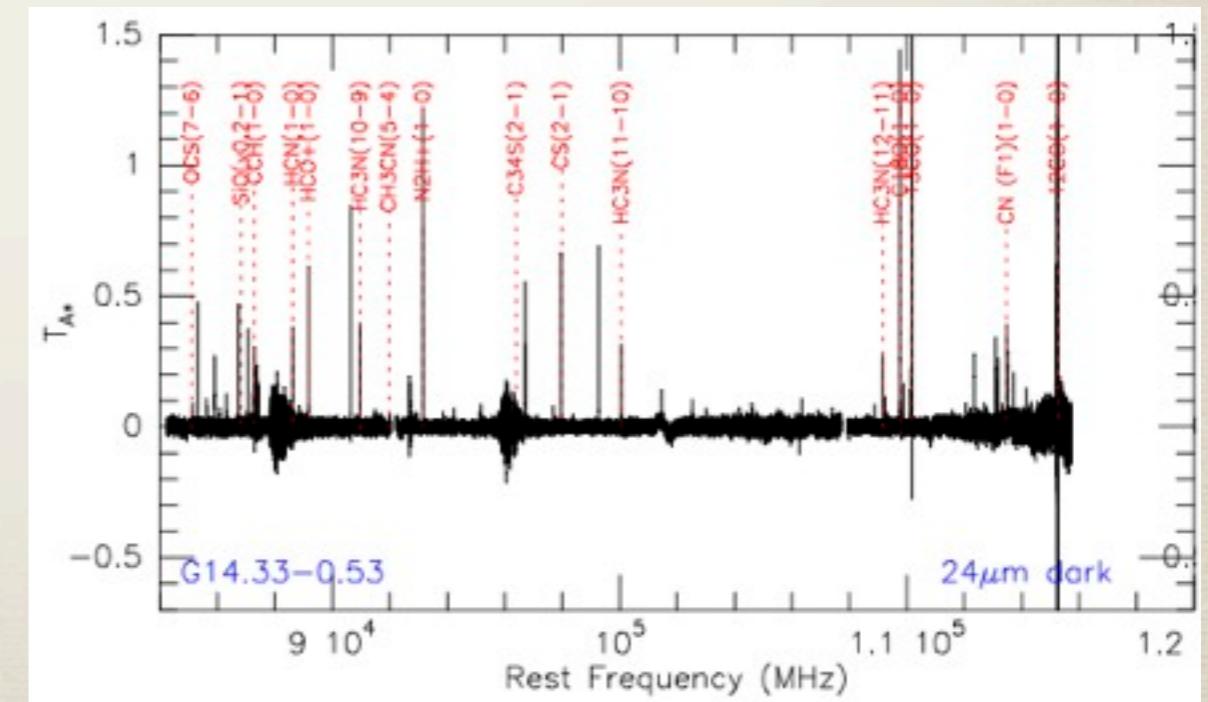
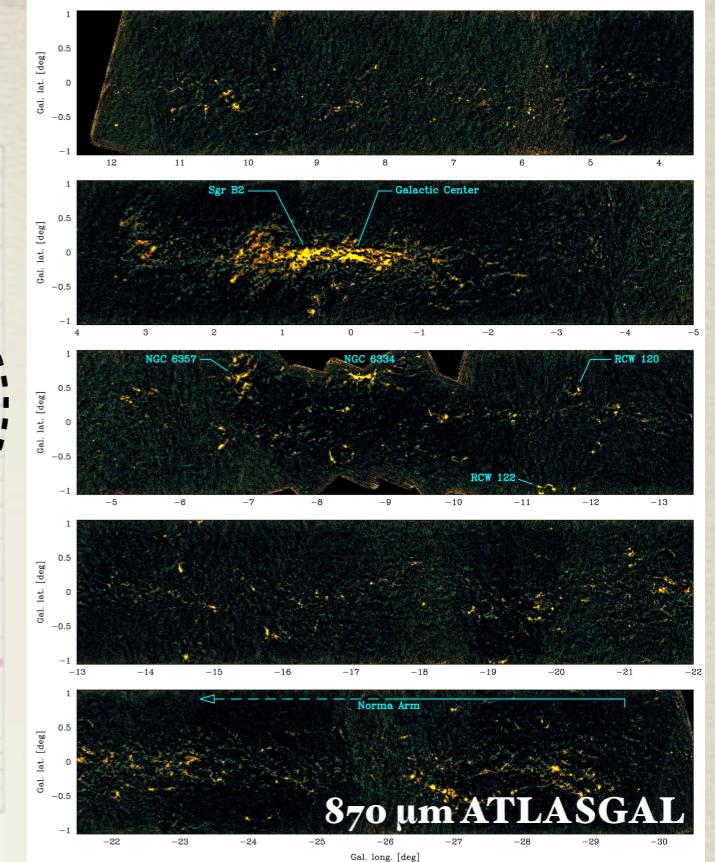
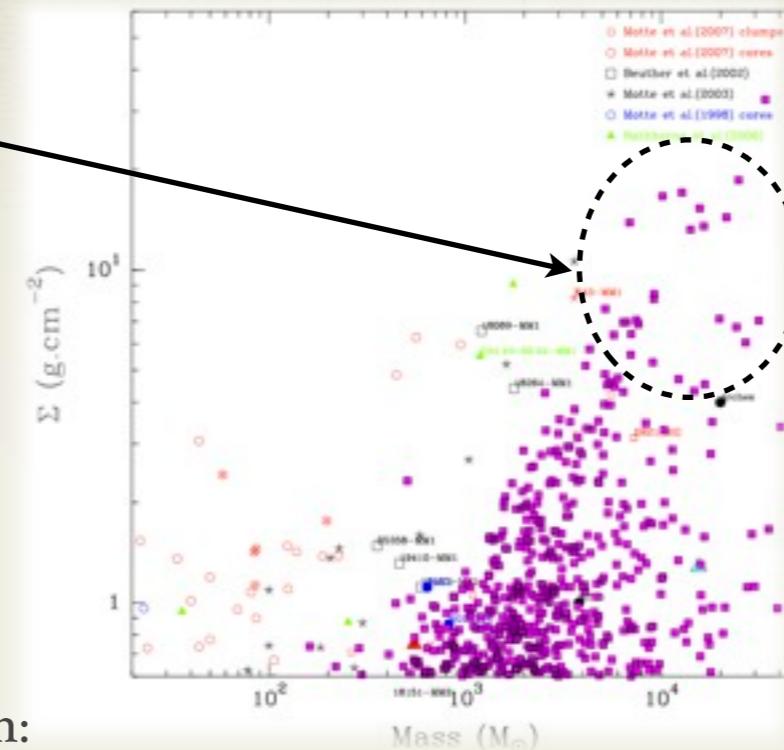
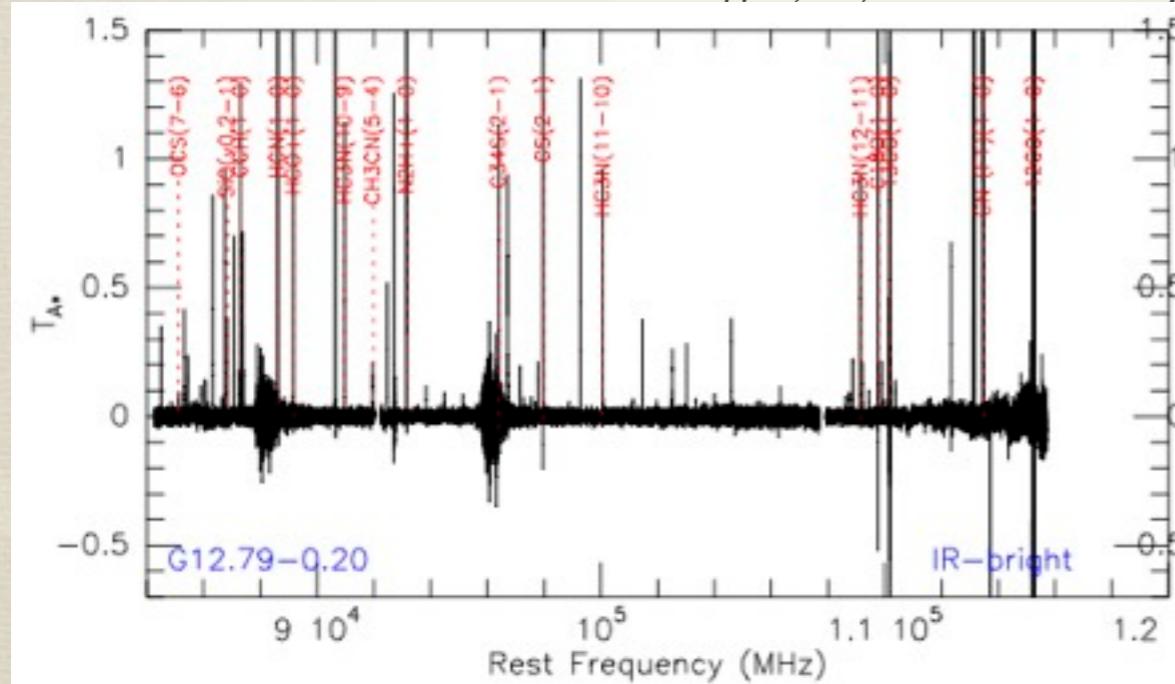
Systematic spectroscopic follow-ups

- ★ MALT90 (souther sky)
- ★ IRAM 30m (northern sky):

Molecular fingerprints of HM star-formation:

→ unbiased spectral survey of 500 sources

Csengeri, Wyrowski et al. (in prep)



Post-doc results: towards a better statistics zooming in the Galactic plane

II. Follow-ups at high angular resolution

★ reach few thousands AU physical scales!

★ studies of *particular* sources:

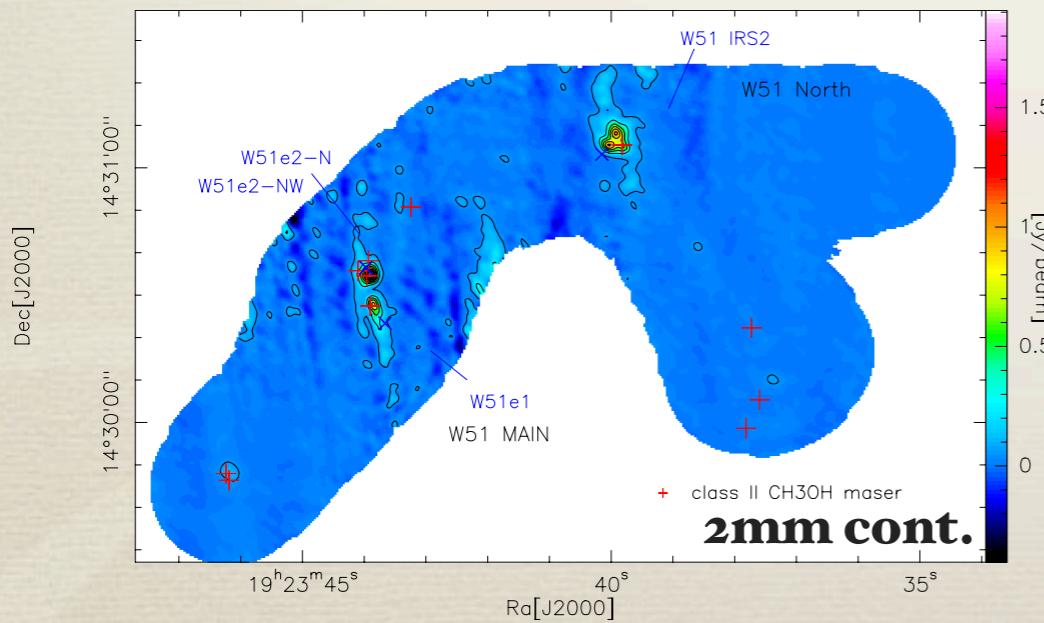
- chemical signatures of more evolved stages (PdBI):
brightest, but unknown AG sources with mid-IR
embedded protostars (new hot cores?)

- search for embedded objects (EVLA, PdBI)
indirect indications for star-formation activity, but
no mir-IR embedded sources visible

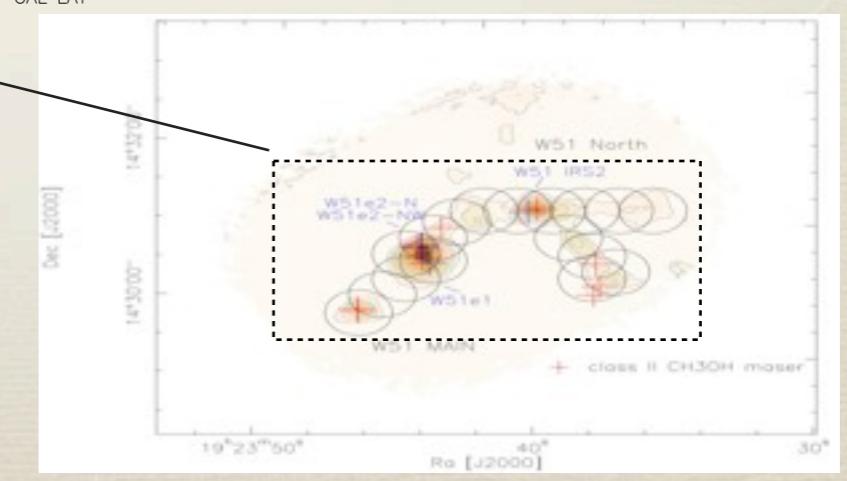
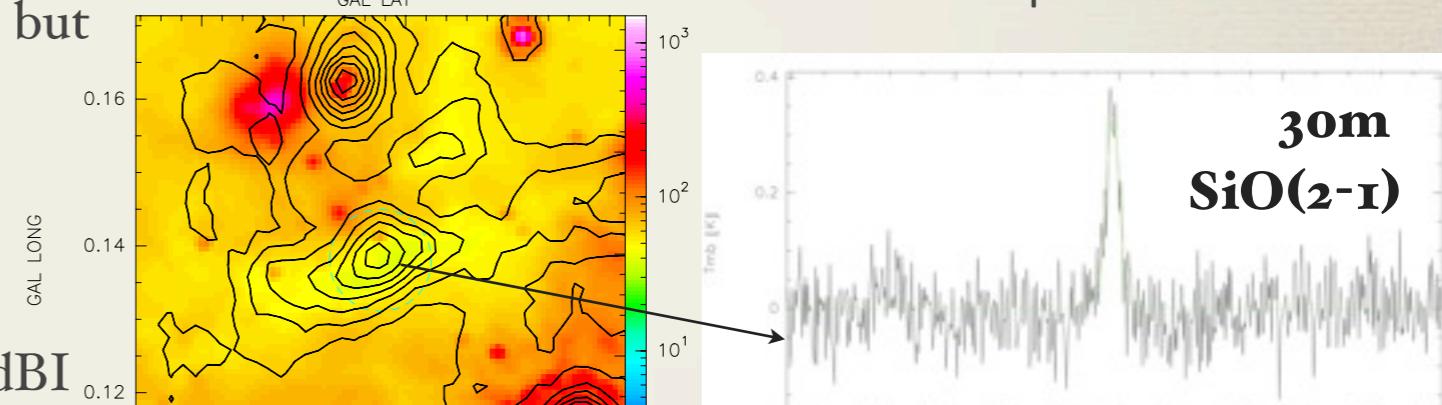
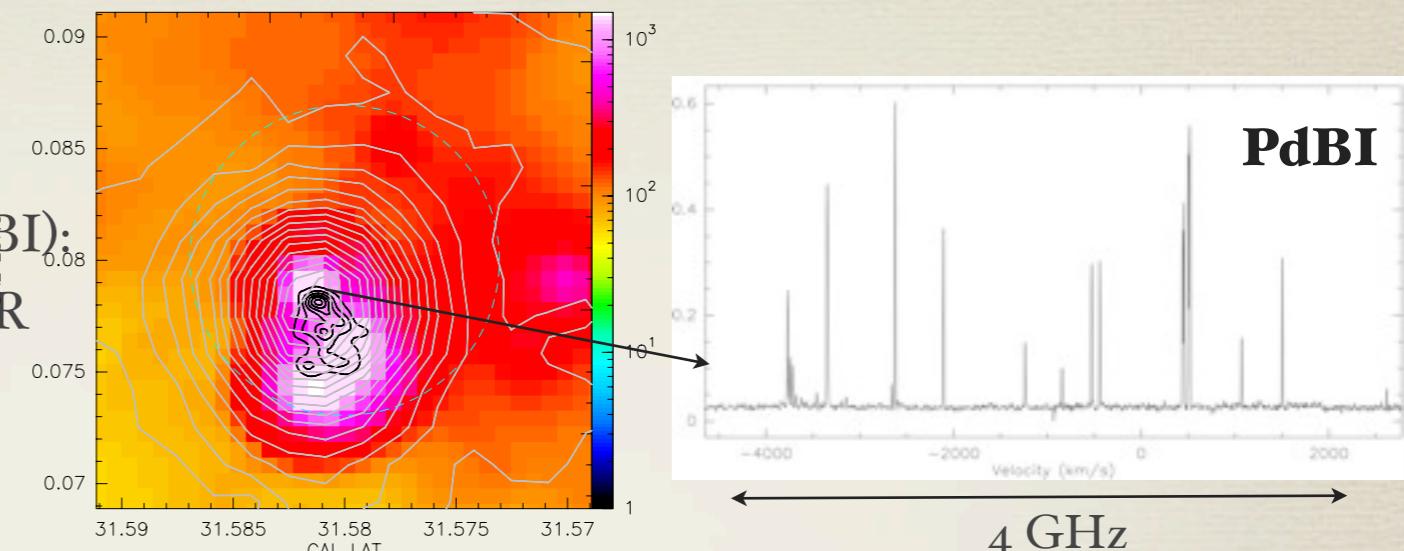
EVLA: NH₃ study (observations pending)

PdBI: proposal submitted

- specific study of W51 Main: mosaic with the PdBI



PdBI + EVLA



Research plan (mid/long term)

I. ALMA (PdBI, NOEMA): Galactic plane

- ★ Statistical studies are needed!!
- ★ ALMA: ES too competitive, Cycle 1 ideal for such follow-ups!
already building up experience with ALMA:
co-I of an accepted proposal: Kóspál et al.

II. Reveal the missing element: magnetic field (direction + strength)

- ★ **polarimetry** (SMA, ALMA)
 - Zhang et al. SMA large program (the most interesting sources in Cygnus X)
- ★ **Zeeman-measurements** (IRAM 30m, Herpin, Wiesemeyer, Hezareh et al.)
- ★ hopefully soon available at the PdBI as well

III. Astrochemistry

- ★ if the physics is better known, models can be improved
- ★ broad-band backends: enormous spectral information!

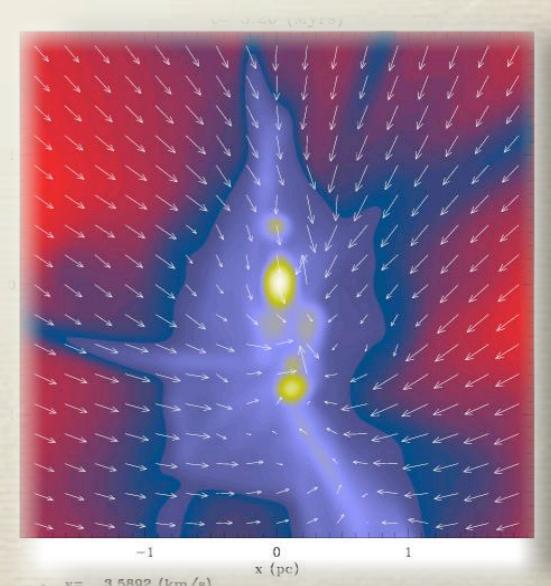
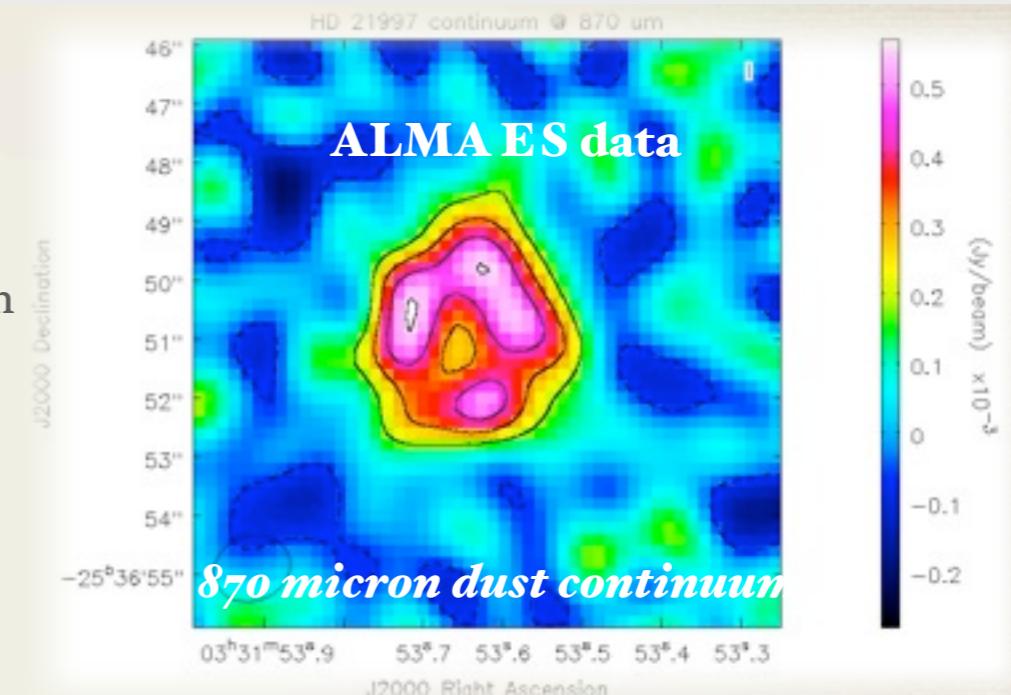
IV. Numerical simulations

- ★ In collaboration with P. Hennebelle, R. Klessen, Ch. Federrath, B. Commerçon
- ★ test the importance of physical ingredients (turbulence, magnetic field)
- ★ evolution in time

Long term: ALMA, SKA, SPICA

Bordeaux

galactic massive SF: S. Bontemps, F. Herpin, T. Jacques,
A. Baudry, +2 post-docs
extragalactic SF: J. Braine
astrochemistry: D. Despois, N. Brouillet, V. Wakelam
ANR ProBeS (2009-2012, Bontemps+)



Tâche de services

Experience

- ★ Observational experience with several instruments:
IRAM 30m/PdBI, Effelsberg, APEX (both heterodyne and bolometer observations!)
- ★ APEX: service observing

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AA-SO₂: ALMA commissioning (short term)

- ★ experience at Chajnantor thanks to APEX + observing experience with interferometers (EVLA + ATCA)

→ commissioning provides a hands-on experience with the array!!

- ★ **ES:** debris disk project (co-I), Cycle 1: proposal in preparation

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high-mass star-formation group: this is the next scientific step!

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AA-SO₃: SKA (long term)

- ★ strengthening the french participation
- ★ compared to the **EVLA**: improvement in sensibility
- ★ Young stellar objects: studies of the immediate vicinity of the protostar (jets)
high-mass star-formation: ionizing radiation
- ★ representing the whole french community from the very beginning of the SKA project!

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AA-SO₂: SPICA/SAFARI (long term)

- ★ SAFARI: far-IR imaging spectrometer
- ★ The next opportunity to perform far-IR spectroscopy and study cooling lines!
- ★ ICC-type work: instrument testing, software testing
- ★ Bordeaux: HIFI ICC (F. Herpin)

Tâche de services

Teachning/outreach:

- ★ work with PhD students in Bonn (M. Wieren, C. Röllig)
- ★ translation of popular science articles in on-line magazines (www.urvilag.hu; www.mcse.hu)
- ★ outreach activity in the Hungarian Association for Amateur Astronomy

Csengeri Tímea  Címke RSS

CSENGERI TÍMEA KAPCSOLÓDÓ CÍMKÉI: víz, bolygó, NASA, Merkúr, Marson [Címkefelhő](#) >

Címke Szűkítés
KERESÉS Csengeri Tímea és címkek között

10 | 50 | 100 legfrissebb | legrégebbi

A Venus Express első eredményei
[origo] Tudomány | 2006.08.03 CSÜTÖRTÖK | 20:08
Az európai Venus Express 2006. április 11-én érkezett meg belső bolygószomszédunkhoz, majd 2006. május 7-én elérte végső, 24 óra keringési idejű pályáját. Az alábbiakban az eddigi eredményekből mutatunk be néhányat: például egy szokatlan, kettős sarkvidéki légörvényt és az átlagosnál magasabb felhőzetet.
CÍMKÉK: Csengeri Tímea, Keresztfuri Ákos, tudományos cél, Venus Express, bolygó

Egy csillag váratlan elhalványodása - magyar megfigyelés
[origo] Tudomány | 2005.12.12 HÉTFŐ | 09:46
A V1647 Orionis nevű fiatal csillag két évvel ezelőtti kitörését követő váratlan halványodását figyelték meg az MTA Csillagászati Kutatóintézetének munkatársai. A jelenség alapján az objektum nem sorolható be az eddig ismert aktív, fiatal csillagok egyik osztályába sem.
CÍMKÉK: Csengeri Tímea, csillagok, csillagászat, csillag

2030 körül élet lesz a Marson
[origo] Vendégszoba | 2004.01.19 HÉTFŐ | 12:05
A Mars múltjának megismérésével jobban megérhetjük saját bolygónk fejlődését, és talán választ kaphatunk arra a kérdésre, hogy mivel is megtörtént-e az élet csodálatos kialakulása. Vendégünk volt a Mars Society magyar tagozatának két szervezője, Csengeri Tim
CÍMKÉK: Csengeri Tímea, Sik András, Föld, Európa, USA, Marson, Vénusz, költségvetés, Mer NASA, Mars Society, Rover

Az Univerzum eddig ismert legnagyobb víztározója
Csengeri Tímea
2011. augusztus 10., szerda

Egy távoli kvarában vízmolekulák jelenlétéit mutatták ki amerikai csillagászok. A megmért vízgőz össztömege százezeresre a Nap tömegének, ami 140 milliárdszor nagyobb vízmennyiséget jelent, mint amennyi a Föld oceánjaiban található.

Kozmikus "hangrobanások" a csillagközi anyagban
Csengeri Tímea
2011. június 14., kedd

A Herschel-űrtávcső látványos felvételek sokaságán örökötte meg a csillagközi anyag szálas szerkezetét, amelynek legsűrűbb részein csillagok keletkeznek. A páratlan észlelési anyag új fényt vet a filamentumok keletkezésére.

Újabb Herschel-meglepés: távoli galaxisok „lencsevégen”
Csengeri Tímea
2010. december 06., hétfő

A Herschel-űrtávcső felvételein gravitációs lencséhatás által leképezett, szubmilliméteres tartományban fényes galaxisokat fedeztek fel a csillagászok.

Földi ablak az Univerzum hideg tájaira
Csengeri Tímea
2009. augusztus 03., hétfő

A chilei APEX távcső segítségével elkészült a Tejtrendszer belső vidékeinek szubmilliméteres térképe.

Hatalmas sötét felhő - egyelőre csillagok nélkül
Csengeri Tímea
2009. július 01., hétfő

Csengeri Tímea: Ez a hatalmas sötét felhő az országosan ismert, ám csillagokat nincs.

Publications

- * **Csengeri**, Menten, Wyrowski et al. (*A&A*, arXiv:1203.4987)
- * Schneider, **Csengeri** et al. (*A&A*, in press)
- * Hezareh, **Csengeri**, Houde et al. (submitted to *A&A*)
- * **Csengeri**, Bontemps, Schneider, Motte, Gueth, Hora (2011 *ApJ Letter*, 740, 5)
- * **Csengeri**, Bontemps, Schneider, Motte, Dib (2011 *A&A*, 527, 135)
- * Bontemps, Motte, **Csengeri**, Schneider (2010 *A&A*, 524, 18)
- * Schneider, **Csengeri**, Bontemps, Motte, Simon, Hennebelle, Federrath, Klessen (2010 *A&A*, 520, 49)
- * Dib, Hennebelle, Pineda, **Csengeri**, Bontemps, Audit, Goodman (2010, *ApJ*, 723, 425)

In prep

- * *Csengeri*, Schneider et al.: The density structure of molecular clouds
- * *Csengeri* et al.: The ATLASGAL compact source catalog

Herschel Special Issue

- * Hennemann, Motte, Bontemps, Schneider, **Csengeri**, Balog, di Francesco, Zavagno, André, Men'shchikov, et al. (2010 *A&A*, 518, L84)
- * di Francesco, Sadavoy, Motte, Schneider, Hennemann, **Csengeri**, Bontemps, Balog, Zavagno, André, Saraceno, Griffin, Men'shchikov et al. (2010 *A&A*, 518, L91)
- * Schneider, Motte, Bontemps, Hennemann, di Francesco, André, Zavagno, **Csengeri**, Men'shchikov, et al (2010 *A&A*, 518, L83)

In collaboration with the Konkoly Observatory (debris disks)

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