SMA + JCMT Survey of Massive Star-forming cores in Cygnus-X

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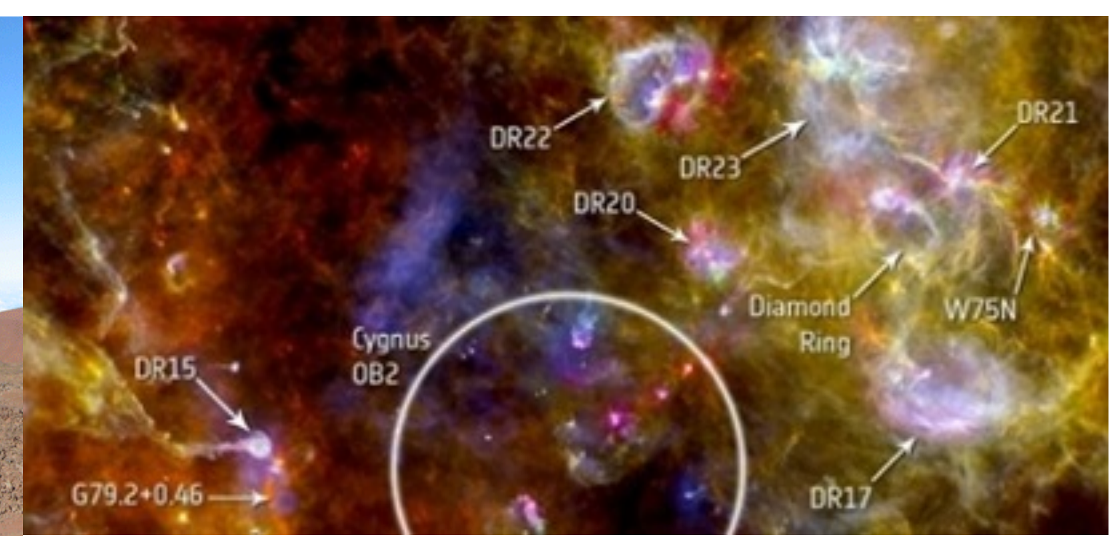


Outline

- Background
- Surveys of Cygnus-X cores
- JCMT+SMA: existing data, and observations to be proposed
- Summary

In the context of high-mass star formation

Big Questions in high-mass star formation:

initial conditions ?

earliest stages?

$\gtrsim 10^4 M_\odot$ clouds ? $10^3 M_\odot$ clumps

10s - 100pc *~1 - 10pc*

~0.1pc (10" for D ~ 2kpc)

massive ($10^2\ M_\odot$) cores ? → massive stars

?

Jeans-mass or super Jeans-mass ($\sim$1 - 10 $M_\odot$) seeds ? → massive stars

~0.01pc and smaller

collapse/fragment governed by G/T/B/R ?

further mass grow process?

~ How to break great barriers (radiation, ionization) ?

disks accretion (collimated jets and outflows) ?

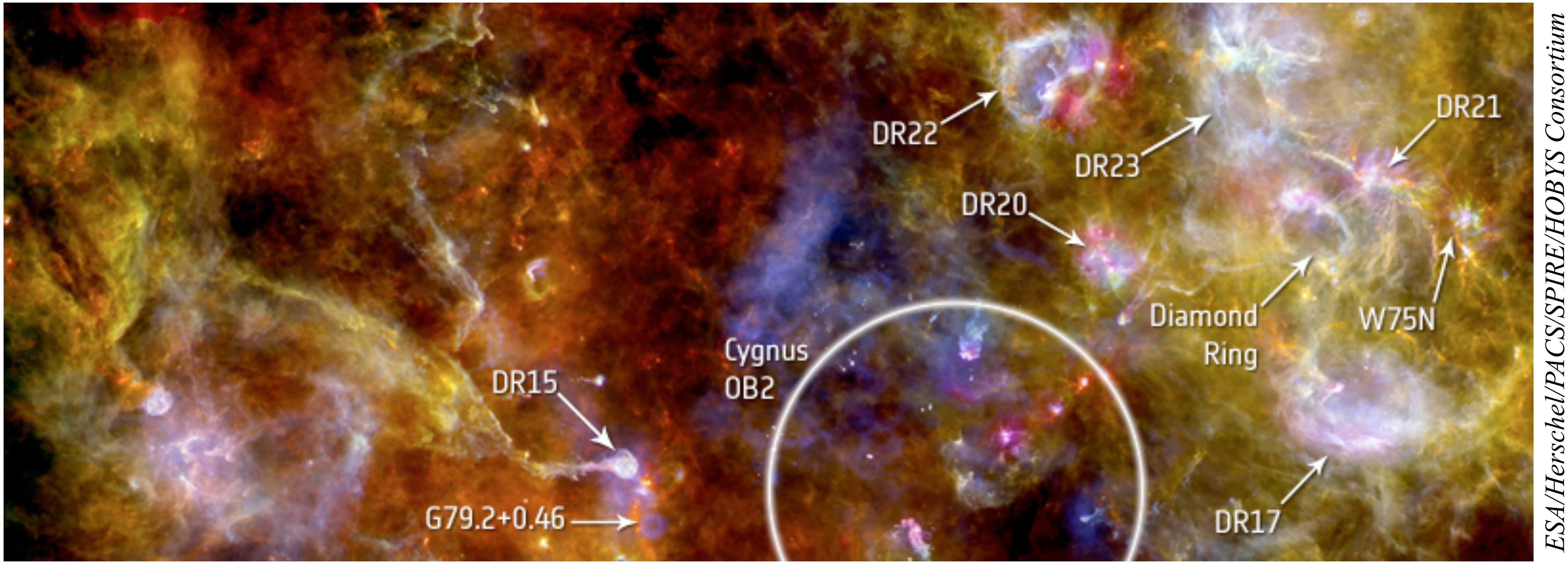
competitive accretion / merging ?

Interferometers (SMA, JVLA, CARMA, ALMA)

+

JCMT

Why Cygnus X?

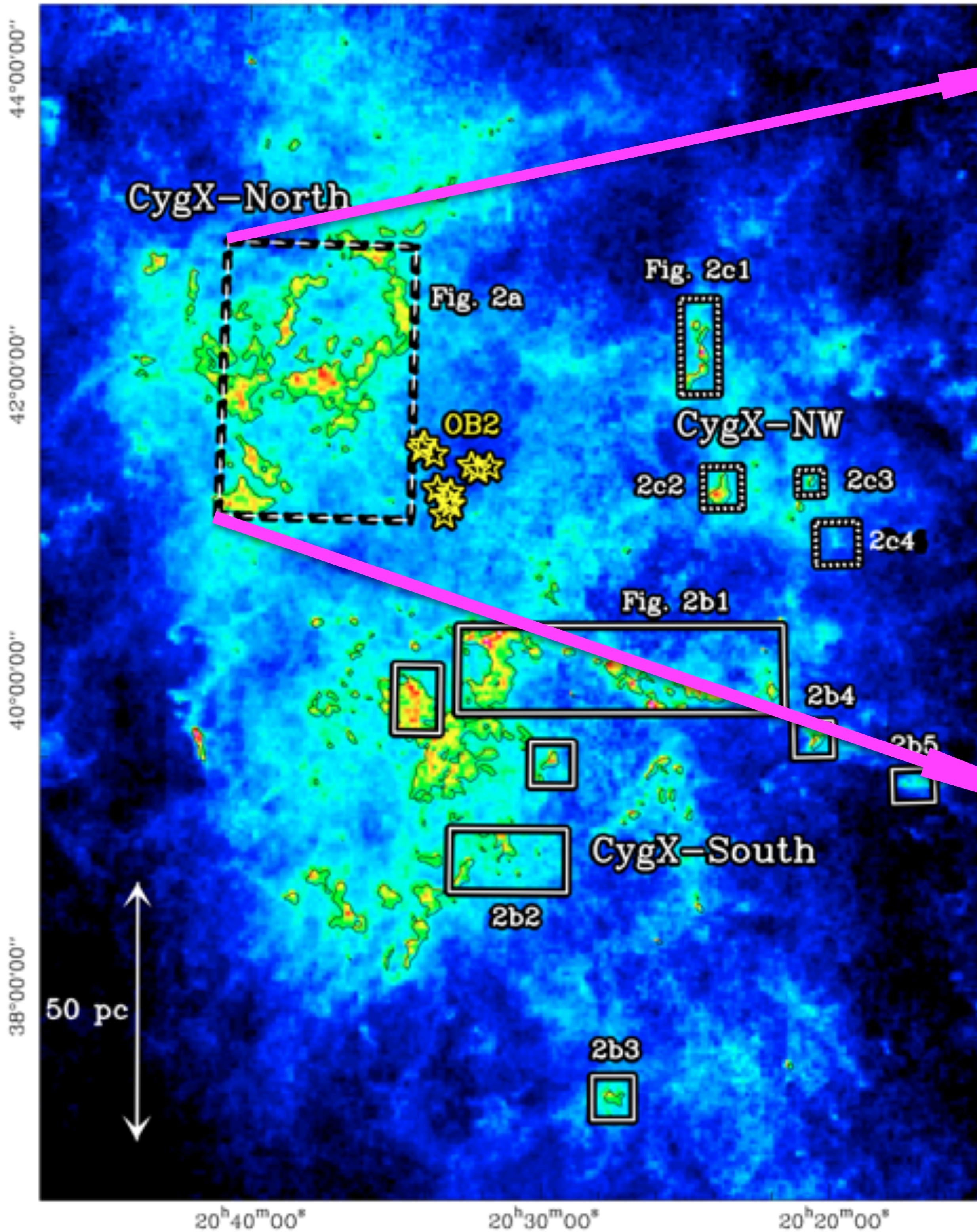


One of the **richest** molecular cloud and HII region complexes located at a **distance <2 kpc** (~1.4 kpc, Rygl+2012);

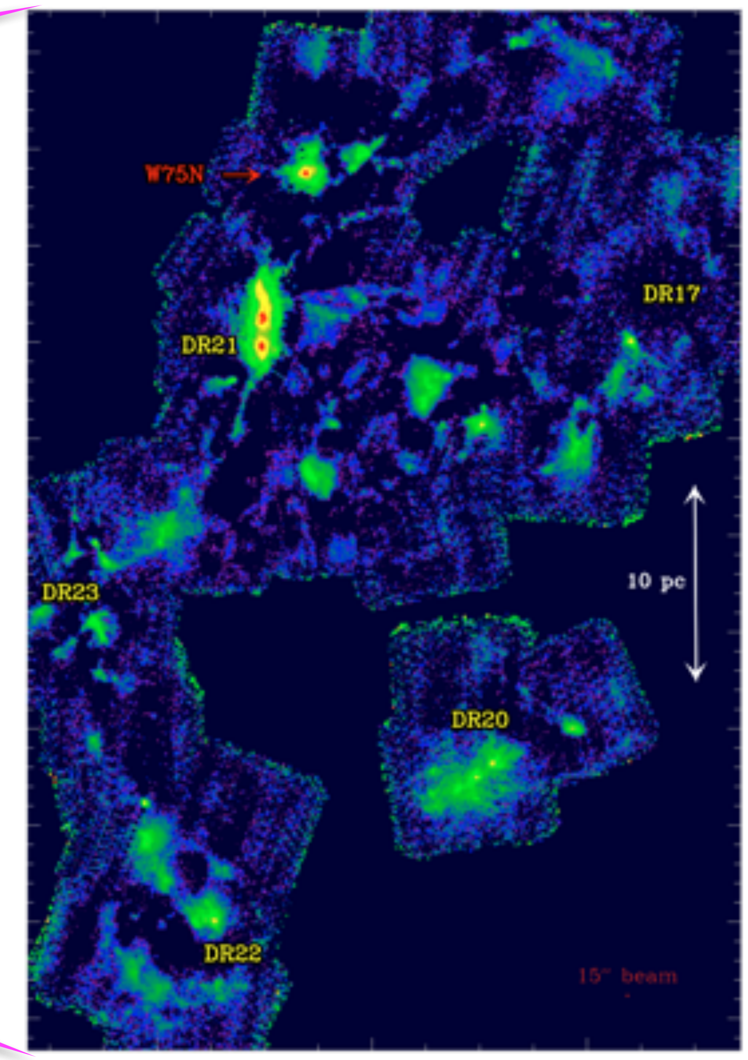
The molecular cloud complex: mass ~ **10^6 M$_\odot$**; size ~ **a few 100 pc**;

Already Mapped by various IR to mm telescopes (e.g., Spitzer, Herschel, JCMT, IRAM 30m).

survey targets



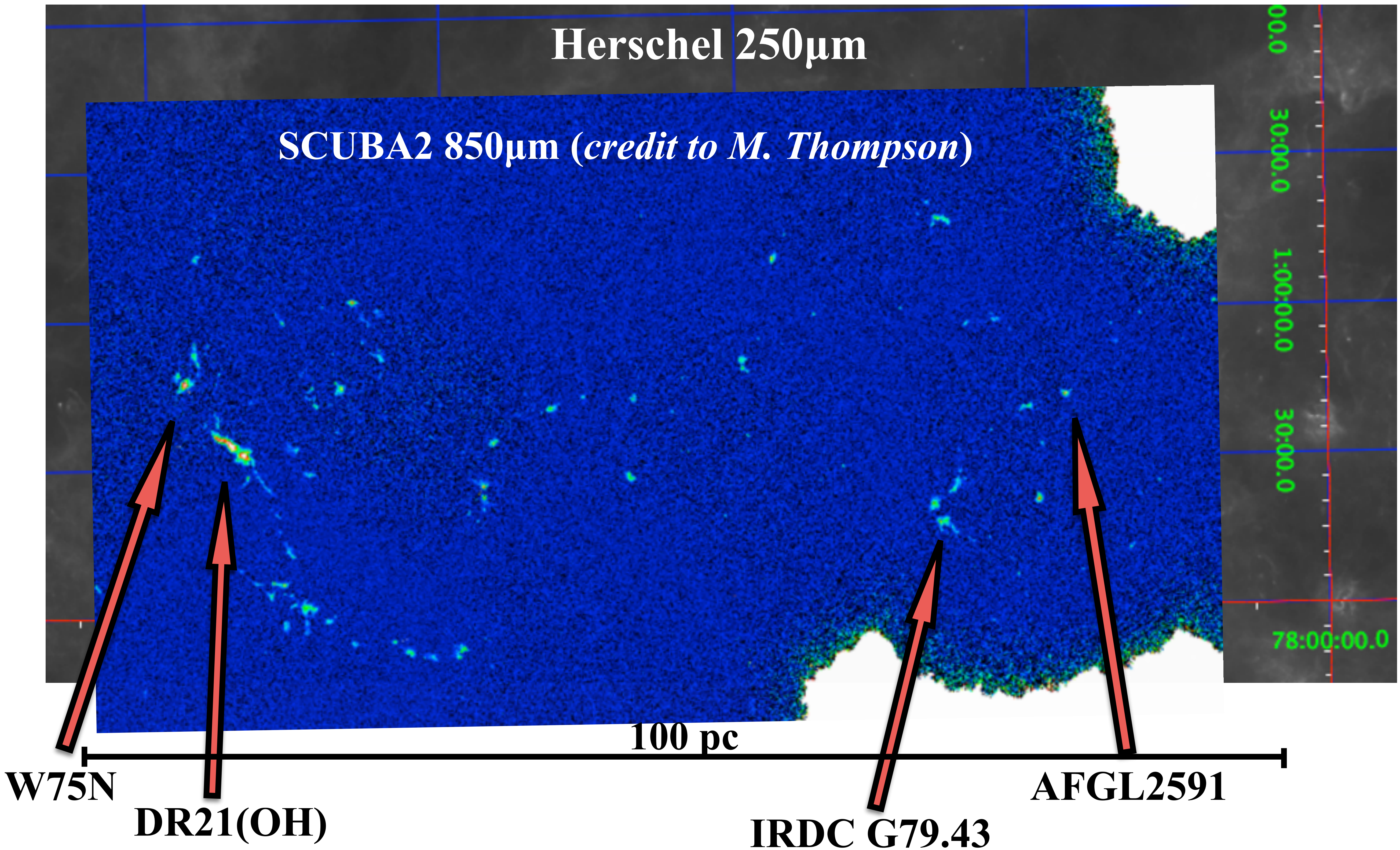
2MASS extinction map (Motte+ 2007)



MAMBO 1.2mm survey:
discovered **129 cores** (~0.1pc);
42 massive (>30 M$_\odot$)

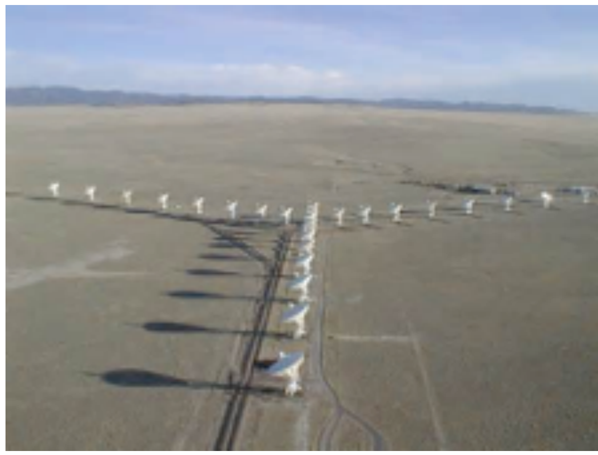
(Motte+ 2007; also see followups by Schneider+ 2010; Bontemps+ 2010; Csengeri+ 2010; 2011; Duarte-Cabral+ 2013, 2014)

survey targets



survey strategies

JVLA (PI & archive)
radio cont., NH_3

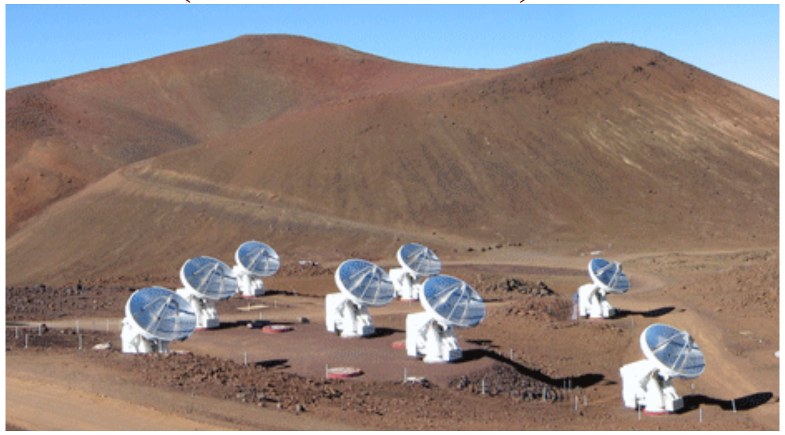


JCMT (PI & archive)
dust cont., CO, …

MYSOs, jets/outflows,
Temp., turbulence

clump frag, CO outflows, B
field

SMA (PI & archive): dust cont., CO, SiO, CH3OH, CH3CN, …



core frag., kinematics,
toroids/disks, outflows,
chemistry, B field, …

selected sources

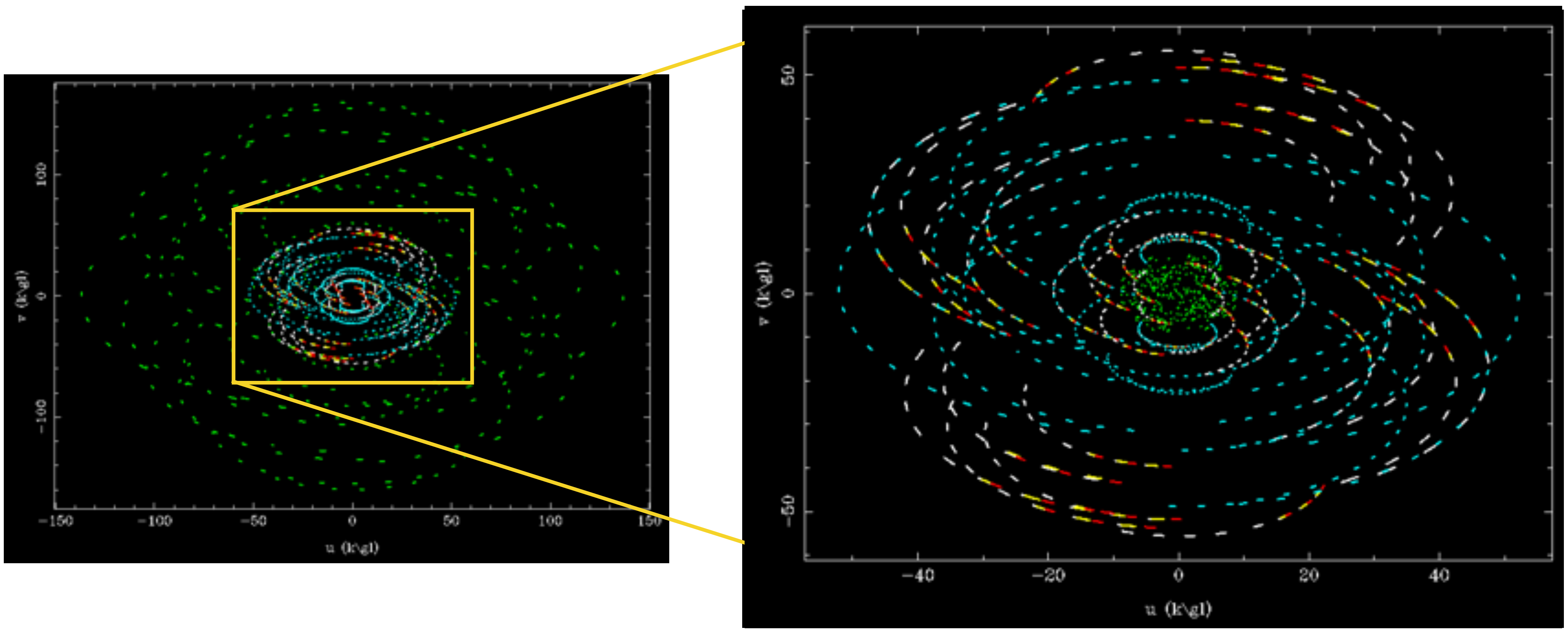
selected sources

ALMA

CARMA

Preliminary results - CO outflows with the SMA

CO outflows: SMA + JCMT

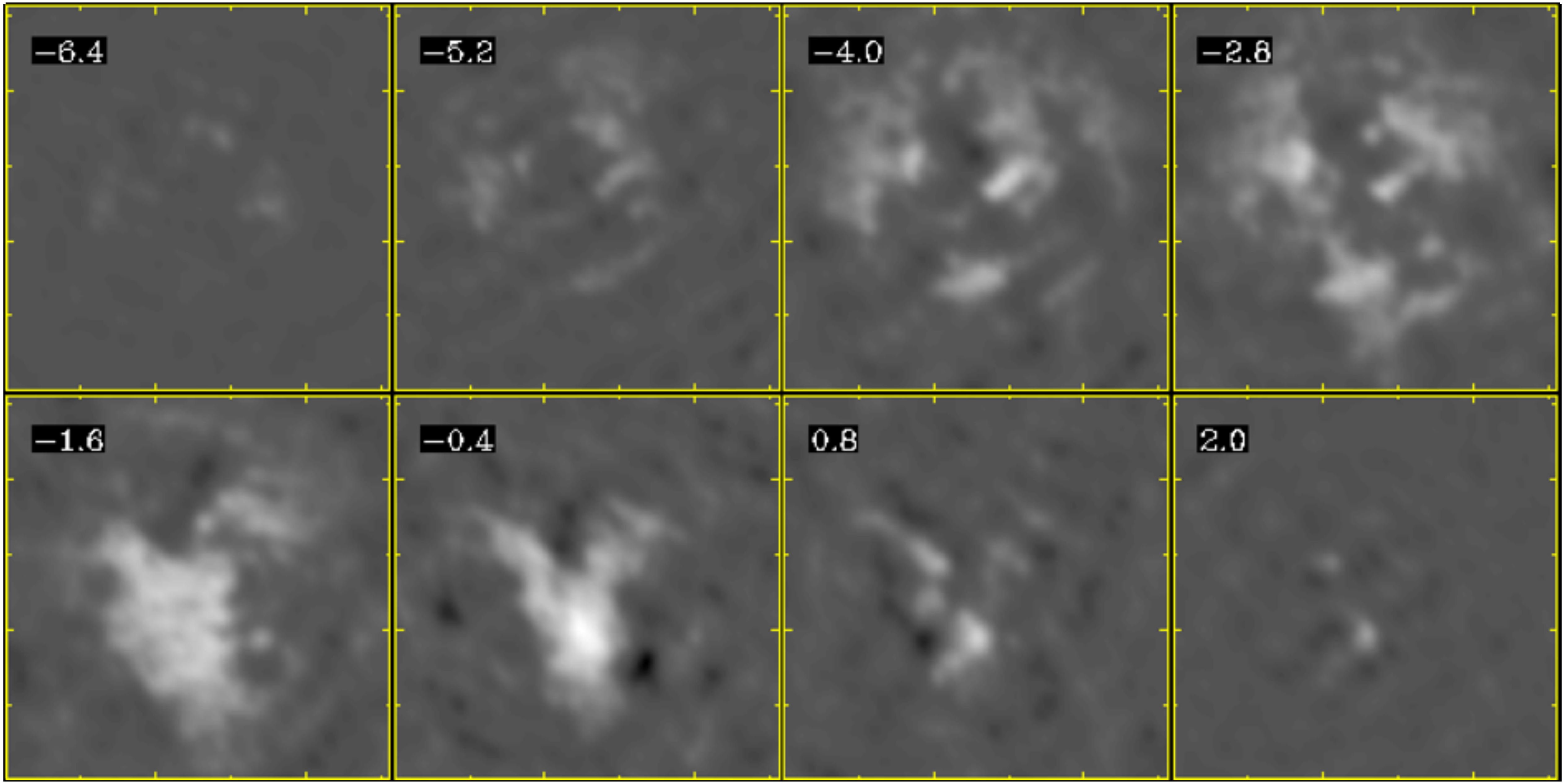


SMA

velocity

SMA + JCMT

another example

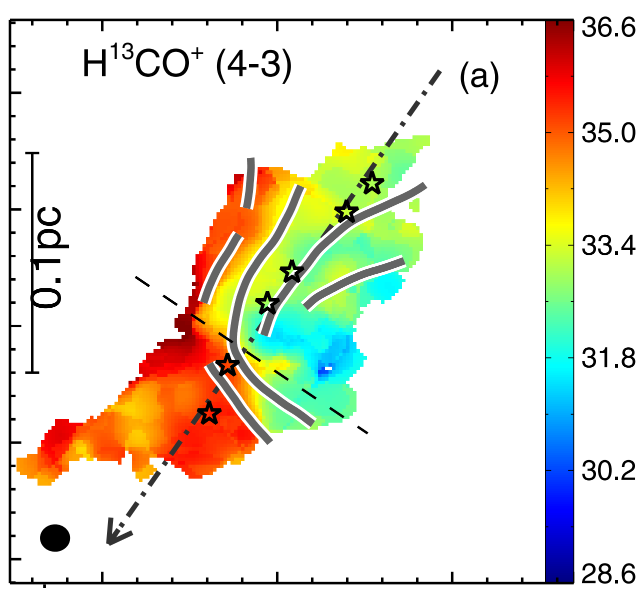


Preliminary results - 1.3 mm continuum with the SMA

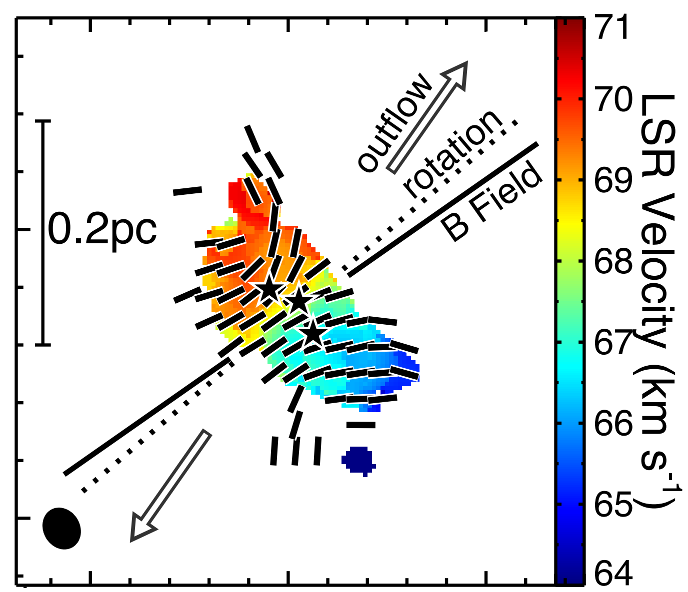
A joint analysis of SMA and JCMT continuum data focusing on the clump/core fragmentation is ongoing …

JCMT+SMA observations in the plan — B field

SMA dust polarization



Qiu et al. (2013)



Qiu et al. (2014)

Mapping the field on multi scales (cloud ➛ clump ➛ core ➛ envelope/ disk) is the key to a better understanding of the role of the field

JCMT+SMA observations in the plan — B field

magnetic field on ~1pc scales — CSO dust polarization

JCMT & SMA **dust polarization** observations of CygX massive cores will reveal the importance of B fields with an unprecedented sample that the sources are at a single **distance** and the **mass density**, **outflow**, **turbulence**, and **evolutionary stage** information all already available from the existing observations.

JCMT+SMA observations in the plan — coldest gas

summary

- Our JCMT CO(2-1) observations successfully recovered large scale structures missing in the SMA data, and clearly improved the image quality;
- A joint analysis of clump and core fragmentation with the JCMT and SMA dust continuum observations is ongoing;
- We will pursue future JCMT + SMA observations, aimed at, e.g., mapping the dust polarization and distribution of coldest gas.