Galactic Scale Star Formation
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HOBYS observations of ridges and filaments, and the evolution of massive dense cores

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http://hobys-herschel.cea.fr

Service d'Astrophysique
Laboratoire AIM

Framework

F. Motte, A. Zavagno, S. Bontemps et al. (2010):

HOBYS – The Herschel imaging survey of OB Young Stellar objects

Aim: Identification & characterisation of OB precursor cores, their cloud environment & feedback effects

Programme: FIR & submm mapping of massive galactic cloud complexes out to 3 kpc distance (+ several well-behaved HII regions)

Team: SPIRE consortium SAG3

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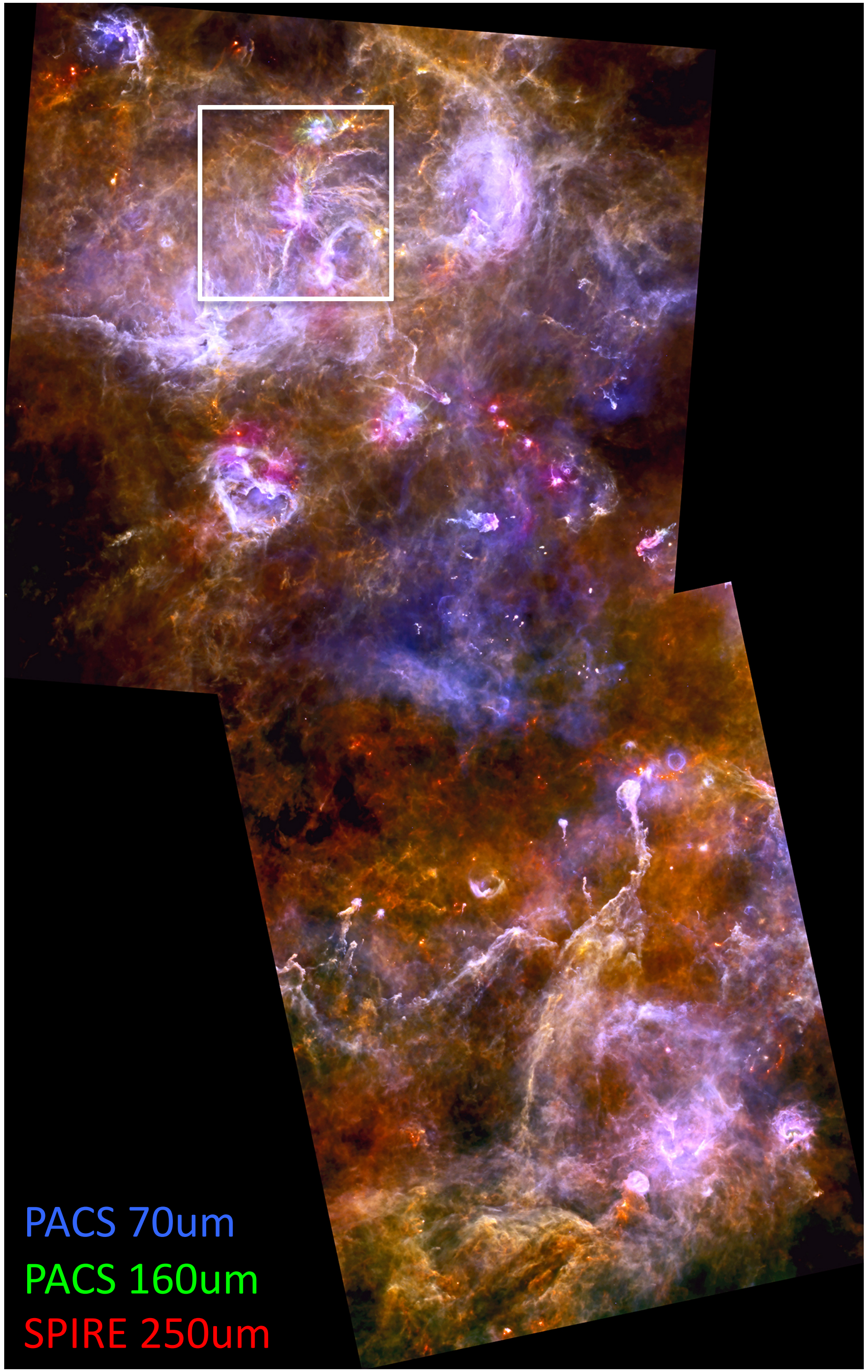
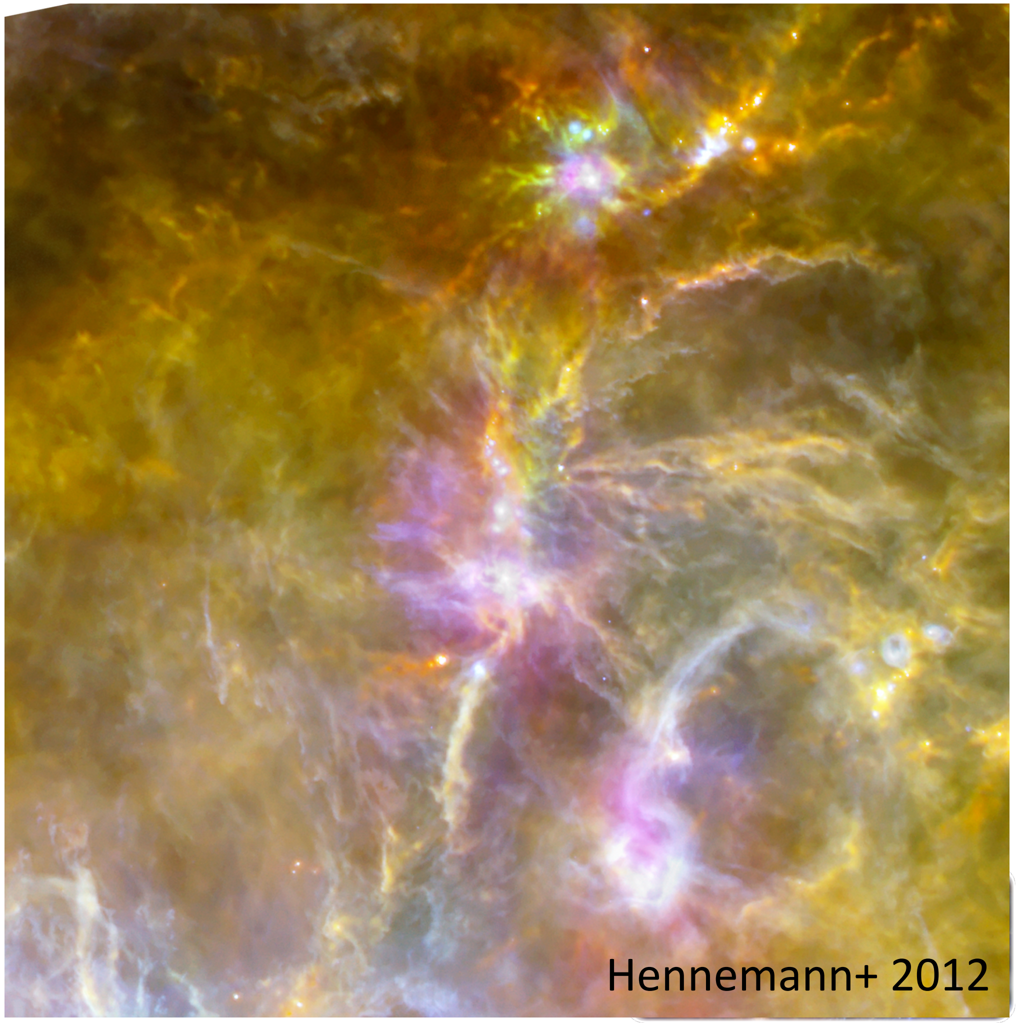
T. Sousbie, E. Schisano, L. Spinoglio, D. Ward-Thompson, G. White



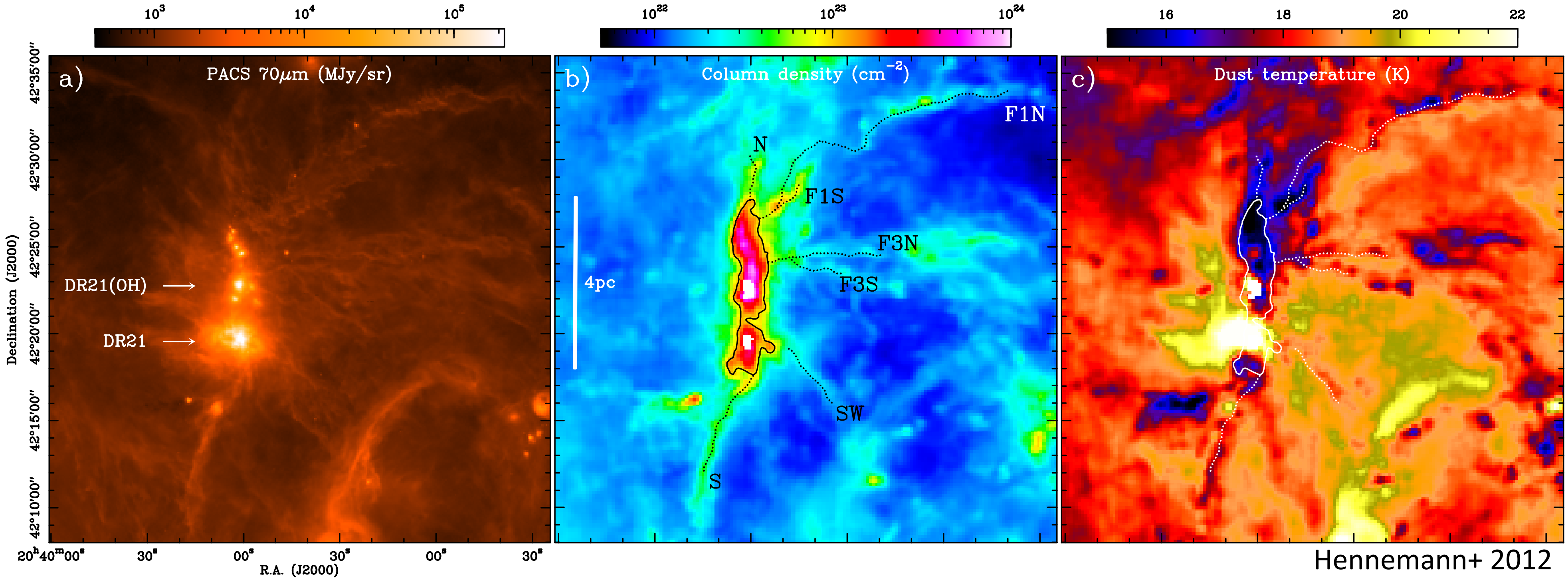
Cygnus X: DR21 ridge

Most massive structure in Cygnus X at 1.4 kpc

(… Schneider+ 2006/2010, Motte+ 2007, Roy+ 2011, Rygl+ 2012)



Sub-filaments accreting onto the ridge



Hennemann+ 2012

70um: filamentary streamers (Marston+ 2004)

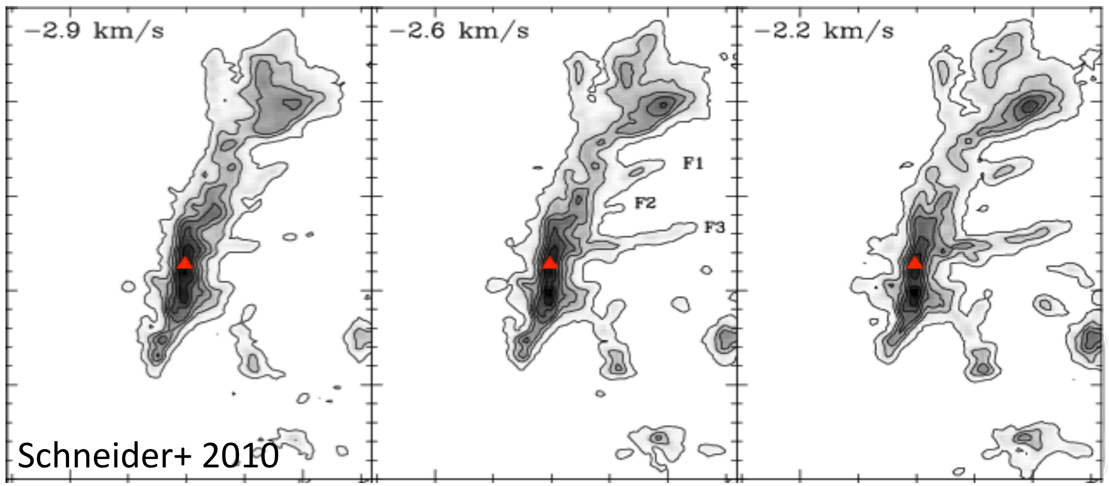
^{13}CO(1-0) by Schneider+ 2010:

3 sub-filaments with velocity gradients

F3 connected to DR21(OH) clump

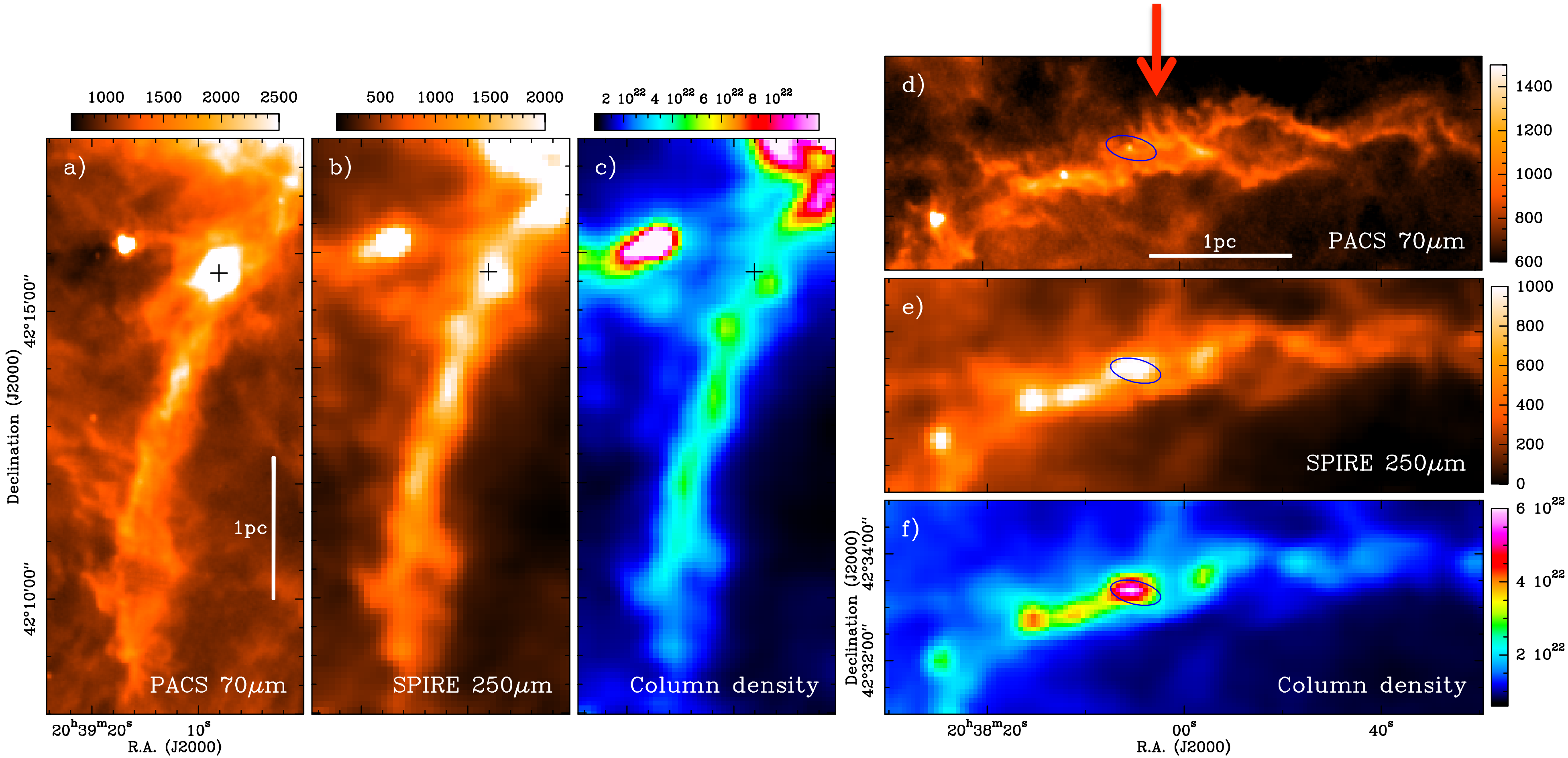
Herschel ➔ column density:

Sub-filaments gravitationally unstable



Schneider+ 2010

Core and star formation in sub-filaments

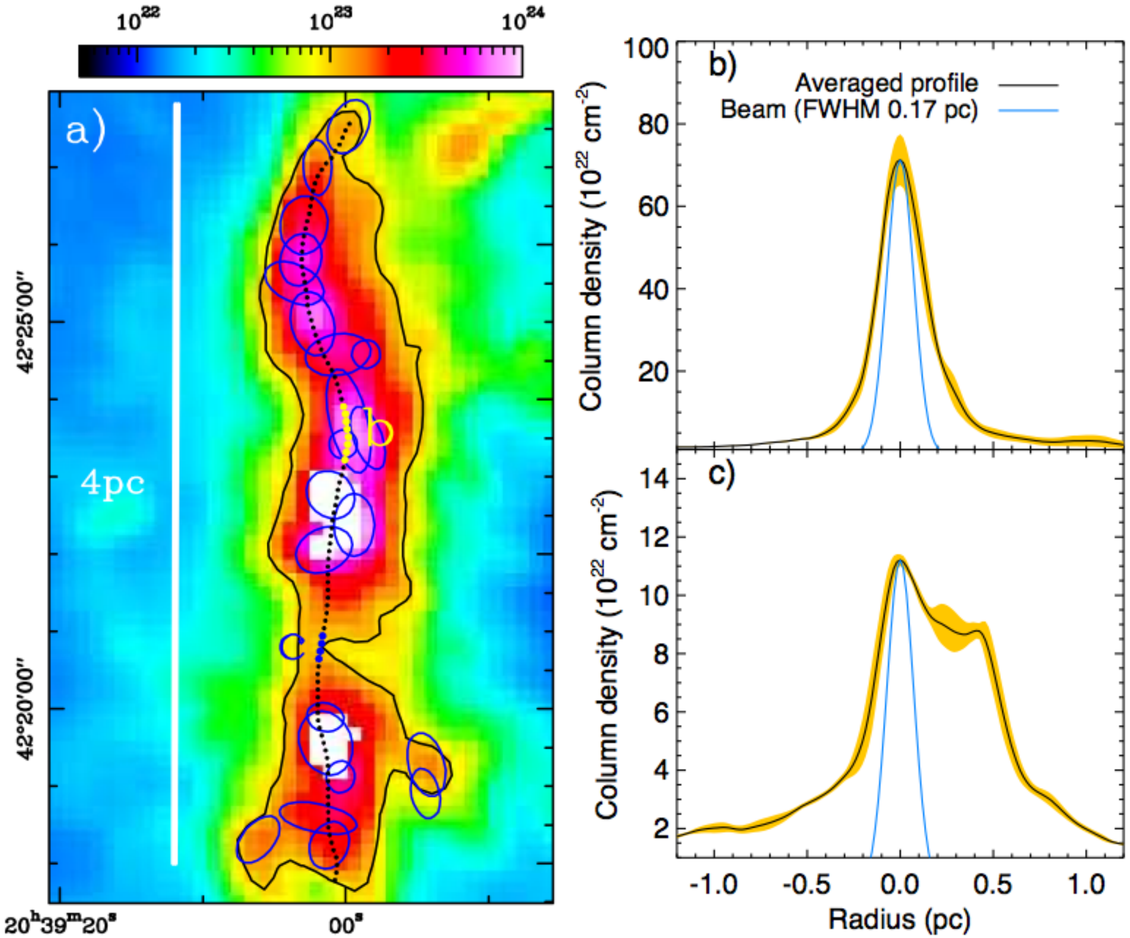


Narrow sub-filaments: mean central width 0.26 – 0.34 pc

Cores and protostar candidates

Possible striations?

Filamentary structure of the DR21 ridge



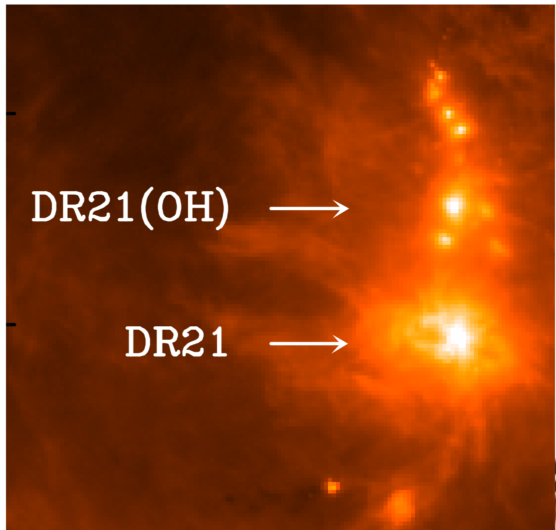
Secondary component ~10^{23} cm^{-2}

Branching in northern sub-filaments

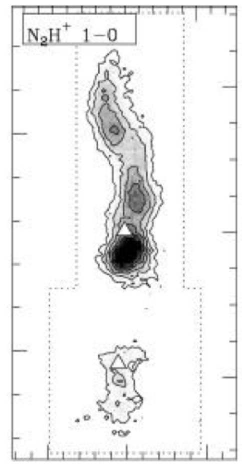
Merging of individual north-south filaments?

Advanced merging in south, continuing northwards?

70um



N_2H^+
(Schneider+ 2010)

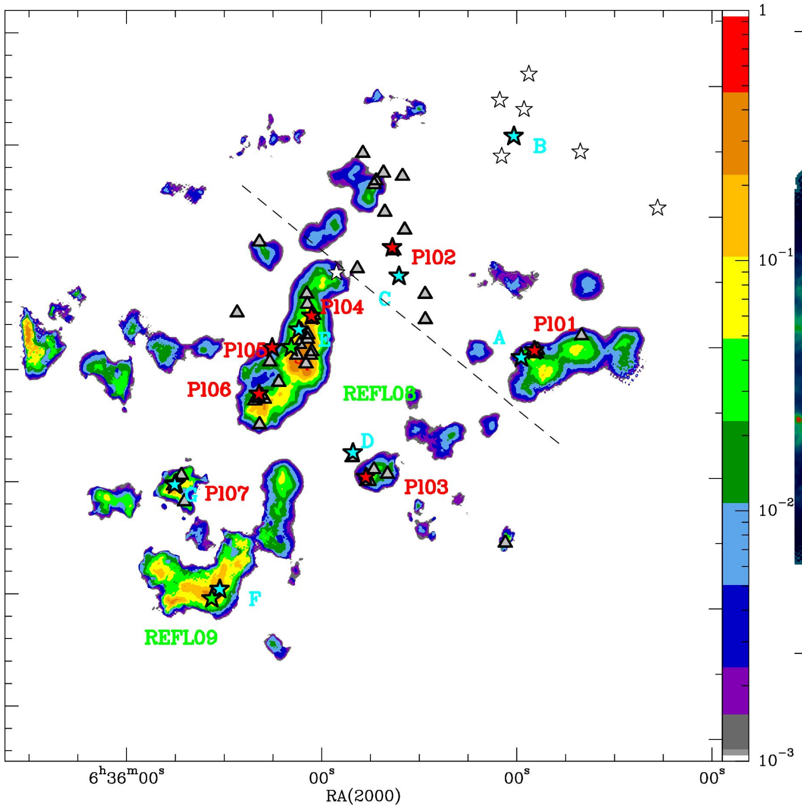


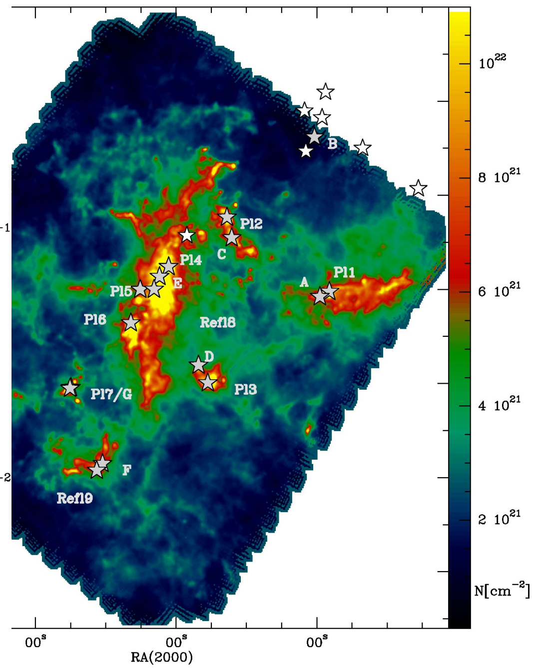
Total ridge mass: 15 000 Msun

Total mass in (selected) sub-filaments: 5 000 Msun

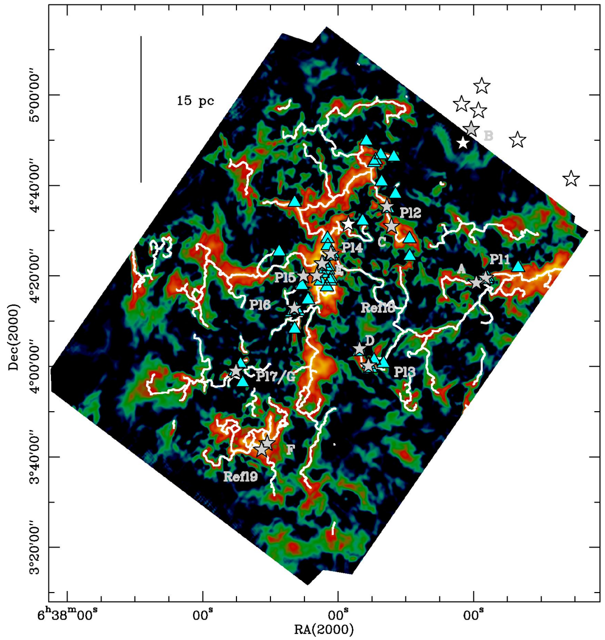
Filamentary structure in the Rosette Molecular cloud

Schneider+ 2012





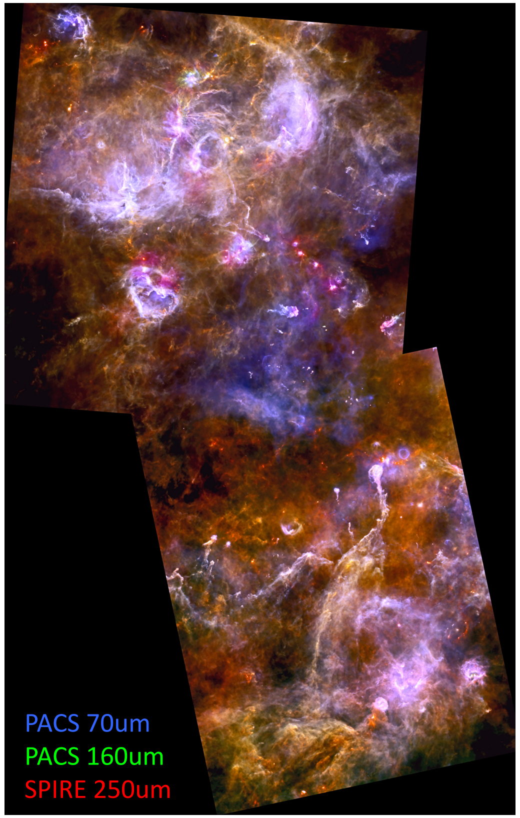
Column density



Curvelet map and Disperse filaments

1) Massive stars/clusters form where *filaments merge* (Dale & Bonnell 2011, 2012)
2) Radiation has little impact on dense gas because photo-ionizing flux is absorbed

Cygnus X: Compact objects



OB star precursor candidates: Massive Dense Cores (MDCs)

(dec.) FWHM < 0.1 pc

First statistical samples from mm-mapping:

Cygnus X (Motte+ 2007): 129 DCs including 33 MDCs (> 40 Msun), all protostellar

Herschel HOBYS observations:

- larger coverage & higher dynamic range ➔ better statistics, low- to high-mass regime
- FIR-submm photometry ➔ (better) constraints on T_{dust}, (bolometric) luminosity

Multi-scale, multi-wavelength source extraction: *getsources* (Mensh'chikov+ 2012)

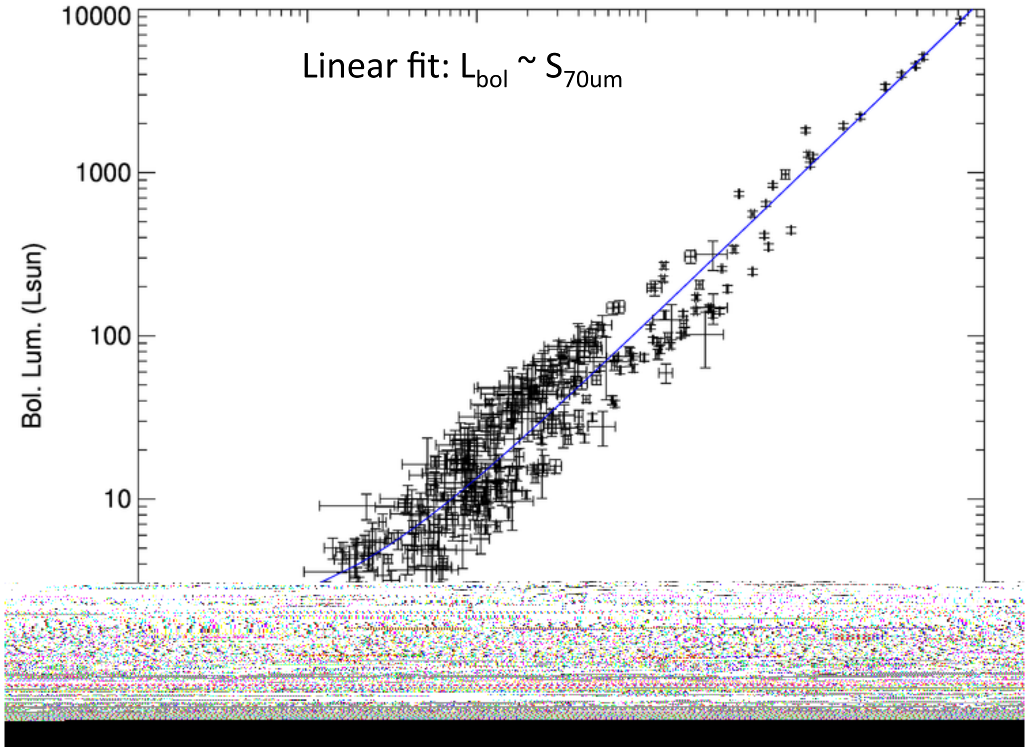
Dense core candidates

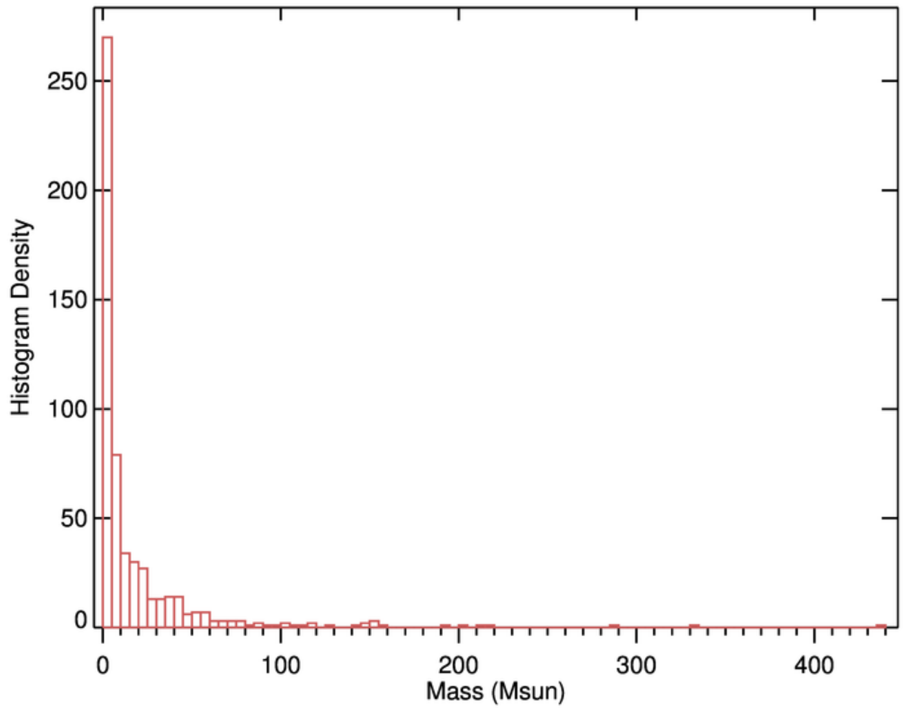
Multi-scale, multi-wavelength source extraction: *getsources* (Mensh'chikov+ 2012)

Selection of ~1000 cores: dec. FWHM < 0.1 pc, constrained T_{dust}, Mass, L_{bol}

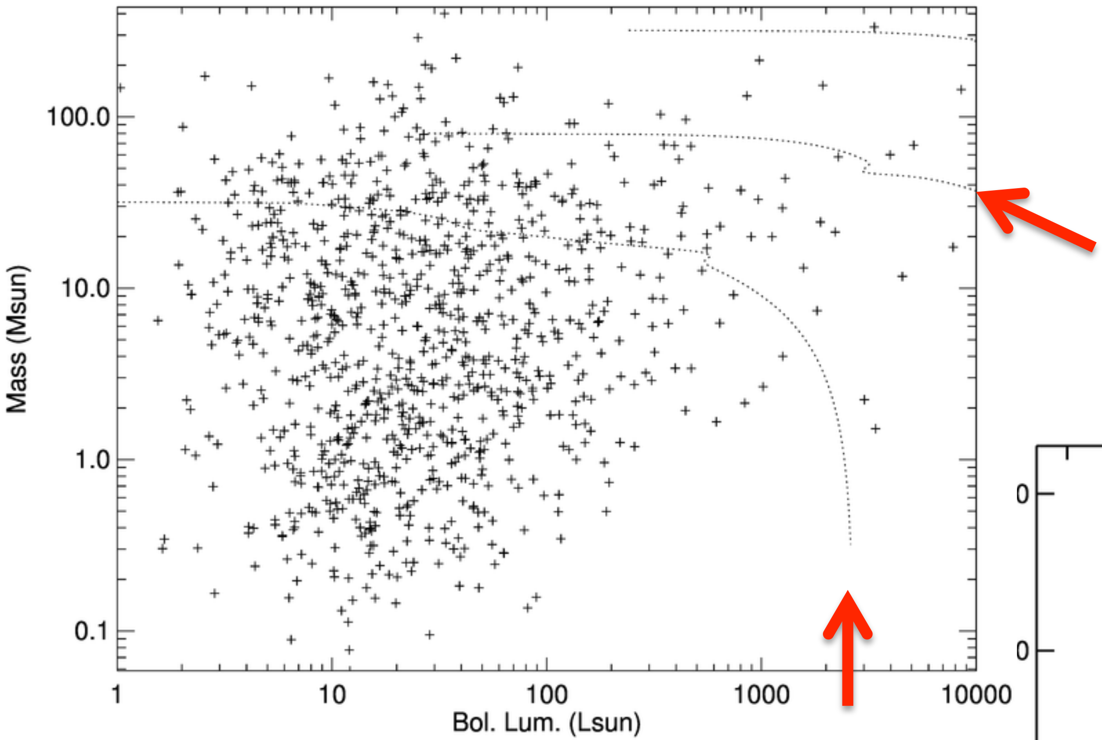
including Spitzer photometry (Cygnus X Legacy, Hora et al.)

~120 massive cores (> 40 Msun)





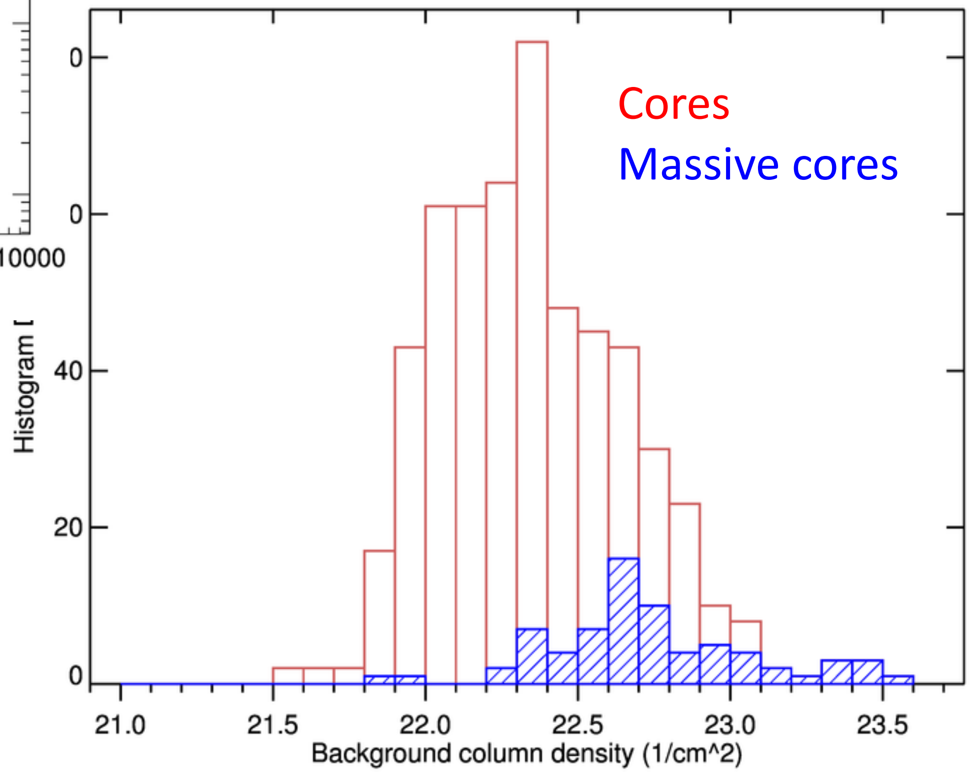
Evolution of dense cores



Evolutionary diagram sampled for up to ~20 Msun stars

20 Msun star

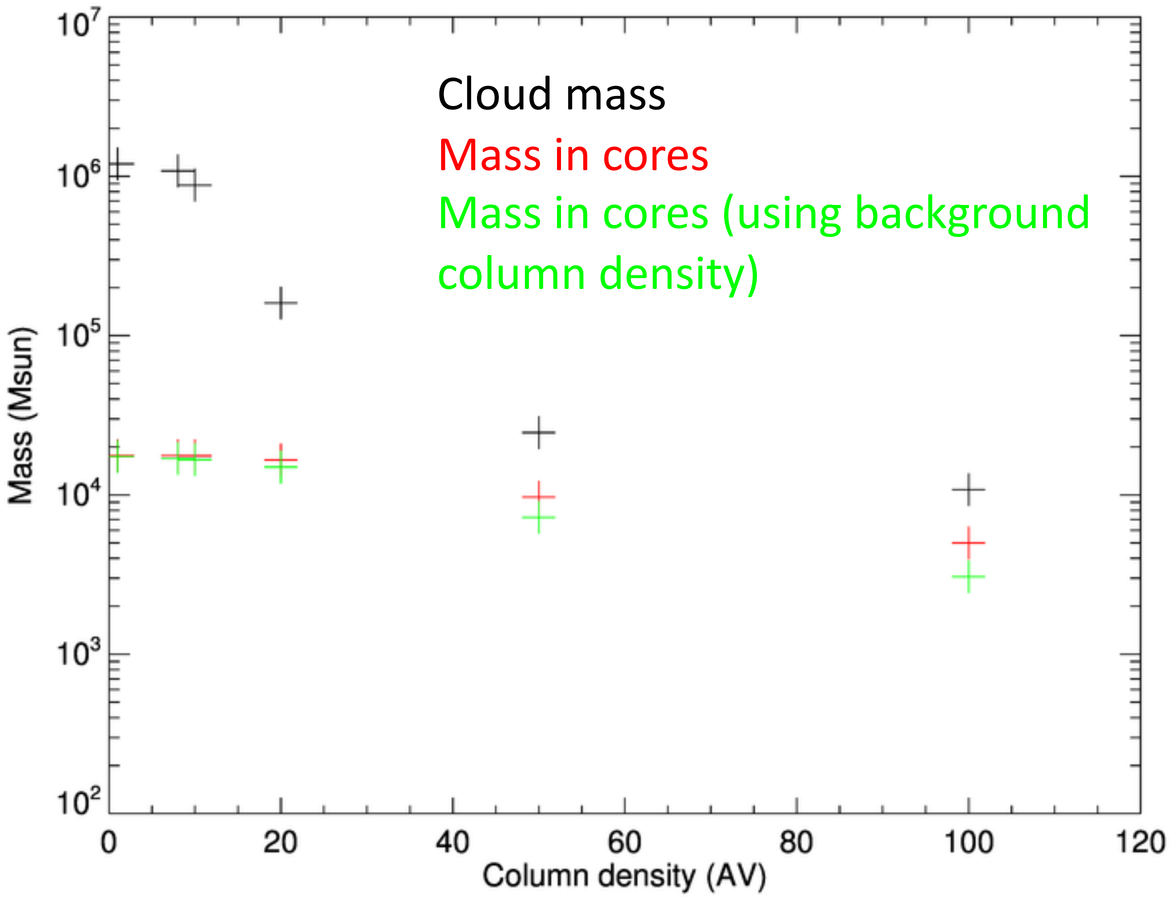
8 Msun star



Where do we find cores and massive cores (> 40 Msun)?

Core formation efficiency

Mass in cores versus cloud mass: Increase in efficiency over column density



Summary

- DR21 ridge: high-mass & cluster formation at filament intersection
  - Formed through filament merger?
- Accretion flows through core- and star-forming filaments
- Cygnus X: population of massive cores forming up to 20 Msun stars
- Core formation efficiency increases with A_V
  - from ~1% to ~30% ?