HOBYS observations of ridges and filaments, and the evolution of massive dense cores

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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

Cygnus X: DR21 ridge

Most massive structure in Cygnus X at 1.4 kpc

Sub-filaments accreting onto the ridge

70um: filamentary streamers (Marston+ 2004)

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

3 sub-filaments with velocity gradients

F3 connected to DR21(OH) clump

Herschel ➔ column density:

Sub-filaments gravitationally unstable
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 $\sim 10^{23}$ cm$^{-2}$

Branching in northern sub-filaments

Merging of individual north-south filaments?

Advanced merging in south, continuing northwards?

Total ridge mass: 15 000 Msun

Total mass in (selected) sub-filaments: 5 000 Msun
Filamentary structure in the Rosette Molecular cloud

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 $T_{\text{dust}}$, (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 $T_{\text{dust}},$ Mass, $L_{\text{bol}}$

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

~120 massive cores (> 40 Msun)
Evolution of dense cores

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

Evolutionary diagram sampled for up to ~20 Msun stars

8 Msun star

20 Msun star

Cores
Massive cores

Background column density (1/cm^2)
Core formation efficiency

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

Cloud mass
Mass in cores
Mass in cores (using background 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%?