Milky Way Structure and the Initial Conditions for High-Mass Star Formation
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Evolutionary sequence and wavelengths

- High-Mass Protostellar Objects
- High-Mass Cores With Embedded Intermediate-mass Protostars
- High-Mass Starless Cores

Color: Spitzer 24µm
Contours: SCUBA 850µm

mm single-dish resolution between 11” and 23” → 40000 to 85000AU
Interferometers <=1” → order 2000AU
- Galactic structure and starless clump timescales inferred from ATLASGAL observations

- The earliest evolutionary stages as revealed by Herschel
Galactic structure from ATLASGAL data I

ATLASGAL 875µm coverage of Galactic plane on top of IRAS data
Galactic structure from ATLASGAL

ATLASGAL 875µm coverage of Galactic plane on top of IRAS data

Grey: ATLASGAL: 1 degree bins
Green: GLIMPSE: 1 degree bins

Sagittarius
Scutum
M17
NGC6334
Norma
Scutum

Beuther et al. 2012
Galactic structure from ATLASGAL

ATLASGAL 875μm coverage of Galactic plane on top of IRAS data

GLIMPSE: green markers “red” sources

Churchwell et al. 2009, Robitaille et al. 2010

Schuller et al. 2009

Beuther et al. 2012
Galactic structure from ATLASGAL

ATLASGAL 875μm coverage

Grey: new data:
Dashed: old data

Anderson et al. 2011

Grey: ATLASGAL: 1 degree bins
Green: GLIMPSE: 1 degree bins

Beuther et al. 2012
Approximate ATLASGAL scale height $\leq 46$ pc.
- In $20\,\text{deg}^2$, 210 out of 901 clumps starless \(\rightarrow\) about 25\%, column density threshold $> 1 \times 10^{23}\,\text{cm}^{-2}$
- $14 > 1000\,M_{\odot}$, $3 > 3000\,M_{\odot}$
- Lifetime estimate $(5+-4) \times 10^4\,\text{yr}$
Topics

- Galactic structure and starless clump timescales inferred from ATLASGAL observations

- The earliest evolutionary stages as revealed by Herschel
EPOS example images
Image side-length vary between 5 to 10 arcmin

Sample paper: Ragan et al., 2012
talk tomorrow
Quiescent cores near the mini-starburst W43

Beuther et al. 2012
Quiescent cores near the mini-starburst W43

Beuther et al. 2012
Quiescent cores near the mini-starburst W43

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Grey: new data:
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Beuther et al. 2012
Quiescent cores near the mini-starburst W43

Beuther et al. 2012
Spectral energy distributions

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Spectral energy distributions

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Quiescent cores near the mini-starburst W43

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Quiescent cores near the mini-starburst W43

Beuther et al. 2012
Anderson et al. (2011) also find many HII regions with 2 velocity components in that region.

Color: 40km/s, contours: 100km/s
A very massive starless clump in IRDC18310-4
A very massive starless clump in IRDC18310-4

Contours: 875 µm

Color: 70 µm

Dec. (J2000.0)

R.A. (J2000.0)
A very massive starless clump in IRDC18310-4

Contours: 875 \( \mu \text{m} \)

Color: 70\( \mu \text{m} \)
White: 3mm

Dec. (J2000.0) -8\degree 21\arcmin 00\arcsec
dec. (J2000.0) -8\degree 22\arcmin 00\arcsec

0.7\, pc

250\, \mu m
A very massive starless clump in IRDC18310-4

Contours: 875 µm

color: 70 µm
white: 3 mm
red: N$_2$H$^+$

25000 AU

0.7 pc

250 µm

Dec. (J2000.0)

R.A. (J2000.0)
A very massive starless clump in IRDC18310-4

Contours: 875 µm

70 µm

Δv_1 = 1.2 km/s  ν_1(peak) = 86.4 km/s
Δv_2 = 1.7 km/s  ν_2(peak) = 89.1 km/s

color: 70 µm
white: 3 mm
red: N_2H^+
Summary and Outlook

- Galaxy-wide surveys allow us to study the Milky Way as a whole (spiral and bar structures, scale height ...)

- Starless clump time scale or order $5 \times 10^4$ yr

- Herschel starts to unravel the earliest formation stages.

- We find peculiar velocity structures in W43. Chance projection or real physics?

- Spectral line data important to study dynamics!

- Lots to come in the field with Herschel/SOFIA and now also ALMA.