The density structure of the W51 GMC

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Cold dust does not imply cold gas [see poster too]

$\text{H}_2\text{CO} + \text{CO}$ can effectively provide line-of-sight geometry information & SF rate prediction

Massive stars have formed and are forming in the W51 protoclusters
W51 GMC

7% of Galactic MSF luminosity (Urquhart et al 2014a)
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$D = 5.1 \, \text{kpc}$: closest massive proto-cluster
Column

Filament $N \sim 2 \times 10^{22} \text{ cm}^{-2}$

HiGal SED fits

Wang, Testi, Ginsburg, Walmsley, Molinari, Schisano submitted
CO 3-2

$T_B \sim 10 - 50 \text{ K}$

Parsons et al. 2012
FIR Luminosity

Massive Protoclusters

Giant HII regions

SNR interaction

$\sim 10^7 L_\odot$
Low density: not much star formation
Low density: not much star formation

High density: lots of star formation!
Low density: not much star formation

High density: lots of star formation!

High density: no star formation?
"Star-forming gas" map:
Integrated $^{13}$CO with corresponding $n(\text{H}_2) > 10^4$

- $M > 10M_\odot$
- $M < 10M_\odot$

Kang 2009
Extragalactic-style “star formation map”:
Only agrees above $n > 10^5 \text{ cm}^{-3}$

Stars formed here, but no clusters
High density gas on the edge of a supernova: not forming many more stars
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Large scale summary:

Feedback from distributed massive stars stops or slows star formation on cloud (100 pc) scales

Star formation continues in the densest gas, unaffected by feedback (so far)

W51 has not yet formed a mature, exposed massive star cluster, yet it is already the most active and luminous star-forming complex in the Galaxy. Perhaps the clusters will end its reign?
Until then, though, we can determine what is happening in the clusters.

In $>10^4 \, M_\odot$, $R<1 \, pc$ clusters, ionized gas remains bound.
What happens in cluster-forming GMCs?

- (most) gas can’t escape from proto-YMCs
- What is the final star formation efficiency? Does the gas all get consumed?
- What happens at the bottom of the potential well?
W51 IRS 2

0.1 pc
Lacy et al 2007: 12um ionized jet?

Extremely high velocity, ~100 km/s
Lacy et al 2007: 12um ionized jet?

Extremely high velocity, ~100 km/s
Zhang 1997, Zapata 2009
HOT molecular core (1500 K molecules)

Goddi 2015, Henkel 2013: High-J NH$_3$
NACO NIR K-band

+14.520°
+14.519°
+14.518°
+14.517°
+14.516°

290.918° 290.917° 290.916° 290.915°

RA (J2000)

Dec (J2000)

O4
Proto-O?

0.1 pc

Figueredo 2008
Barbosa 2008
Cooperative accretion?
Most massive star pushing gas onto neighbors
Foreground layer of H$_2$CO
Cold dust does not imply cold gas
[see poster too]

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