

The background of the slide is a deep space image showing a dense field of stars and nebulae, characteristic of the Large Magellanic Cloud. The stars are scattered across the dark field, with some appearing as bright, multi-colored points of light. The overall tone is dark with hints of red and blue from the nebulae.

*Spitzer View of Star Formation in the
Large Magellanic Cloud*

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Summary

- **The Large Magellanic Cloud offers an excellent site to study star formation.**
- **Spitzer observed 7 HII regions in Cycle 1.**
- **Triggered star formation is clearly seen.**
- **Massive proto stars are resolved; some are associated with HH object or Bok globules.**

Nearly face-on
→ clear, global view

At 50 kpc, $1'' = 0.25$ pc
→ stars can be resolved



Photo credit: Wei-Hao Wang

Advantages for Studying Star Formation in the LMC

- **Physical conditions of the ISM are known**
 - **gravitational instability**
 - **dynamical triggering**
 - **turbulence compression**
- **Individual (proto)stars can be resolved**
 - **formation of massive stars ($> 10 M_{\odot}$)**
 - **IMFs for clusters and for field stars**

Spitzer Observations of Star Formation in the LMC

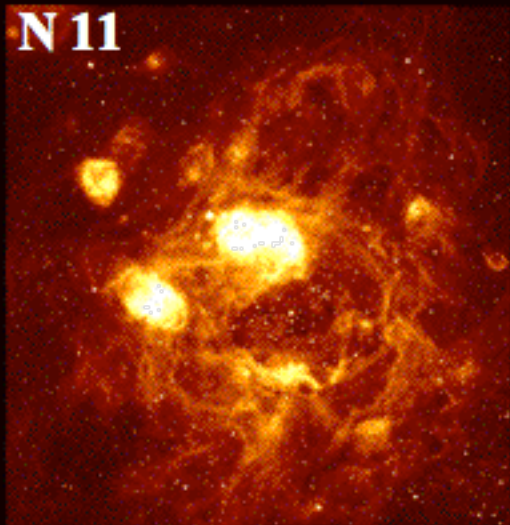
Cycle 1 GO Program (PI – Chu)

- **7 H II complexes**
 - **known massive star content**
 - **different interstellar structures**
- **IRAC maps at 3.6, 4.5, 5.6, 8.0 μm**
MIPS scan maps at 24, 70, and 160 μm
 - **dust emission, proto-stars**

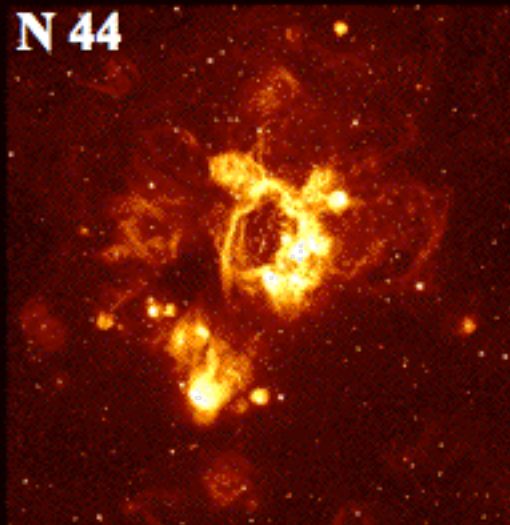
The Magnificent Seven

H α

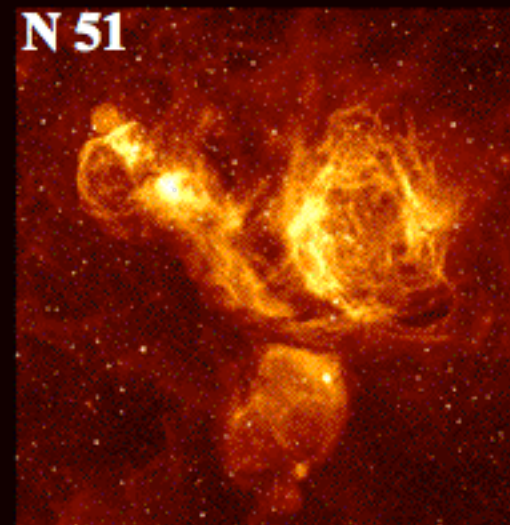
N 11



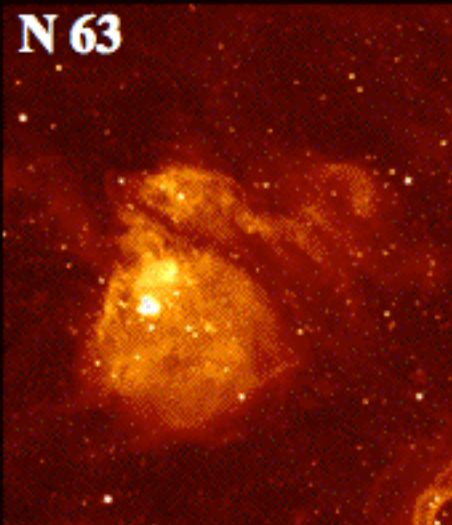
N 44



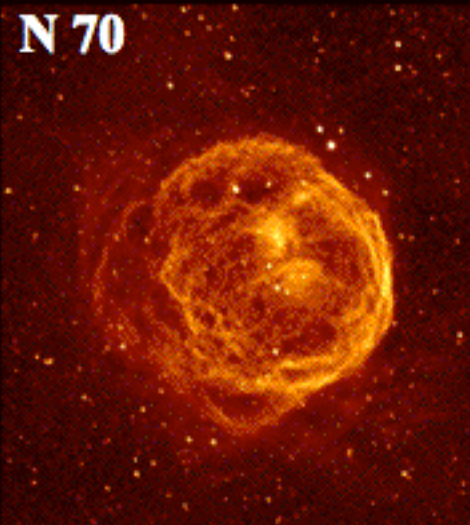
N 51



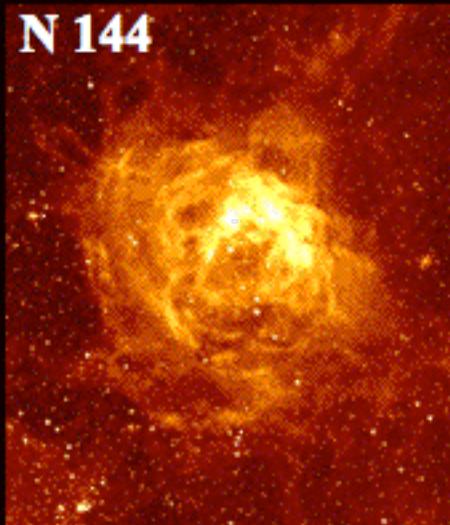
N 63



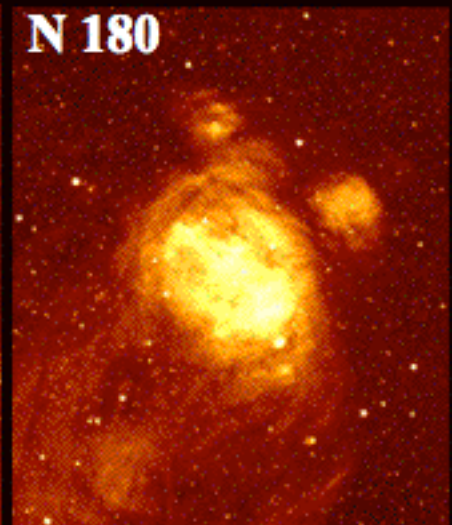
N 70



N 144



N 180



The Magnificent Seven

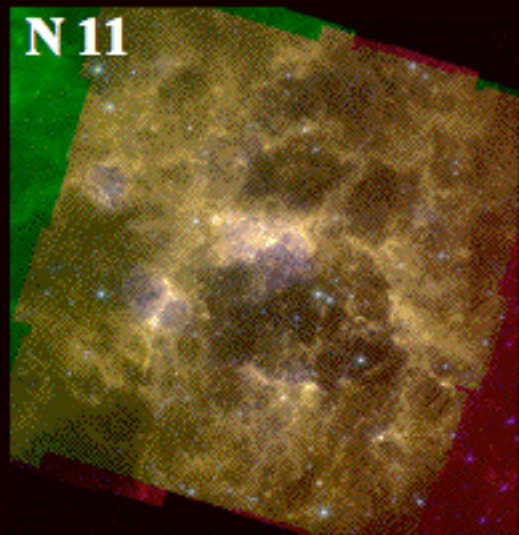
IRAC

8.0 μm - red

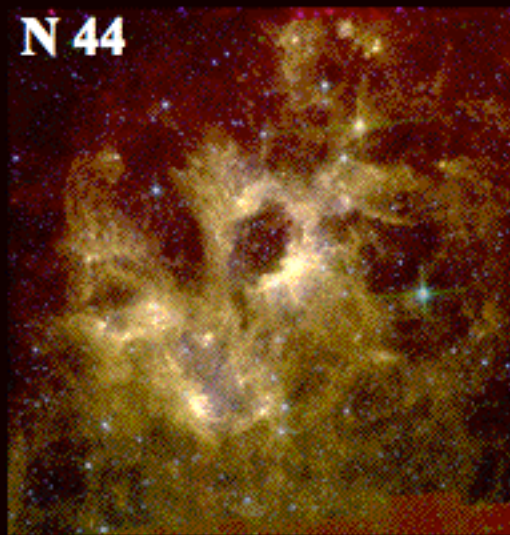
5.6 μm - green

4.5 μm - blue

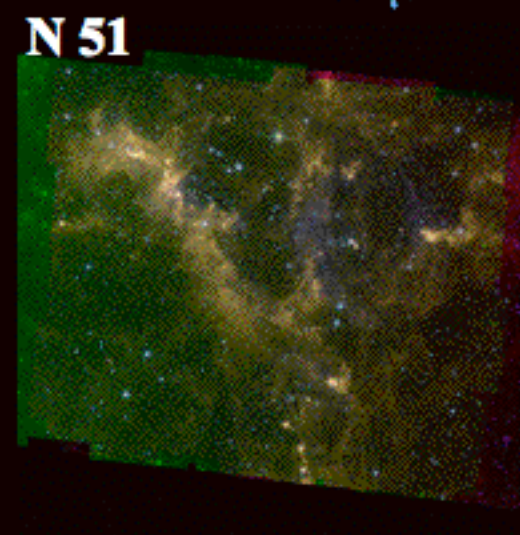
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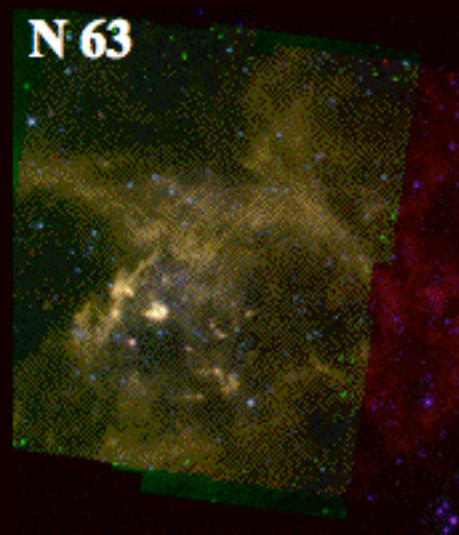
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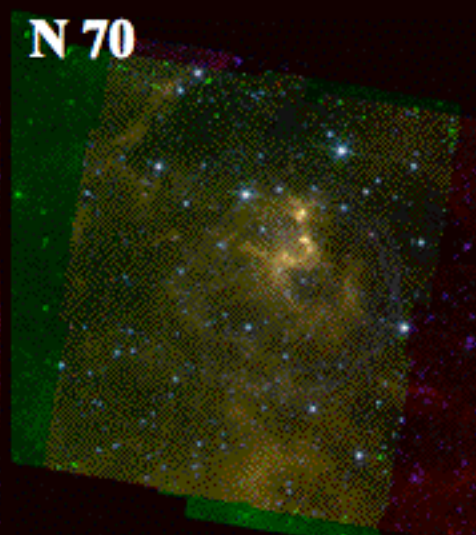
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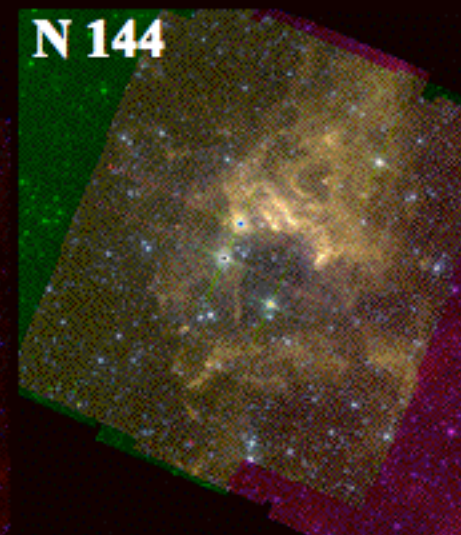
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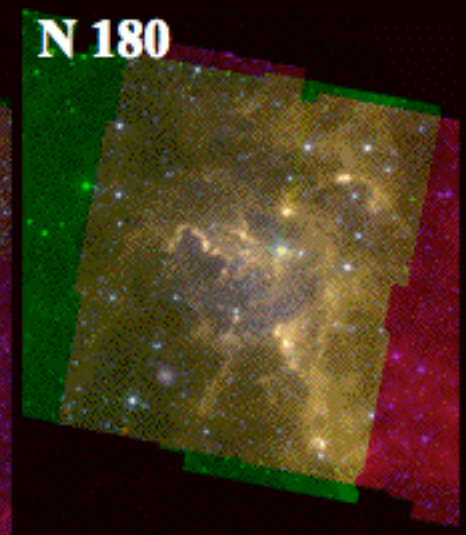
N 70



N 144

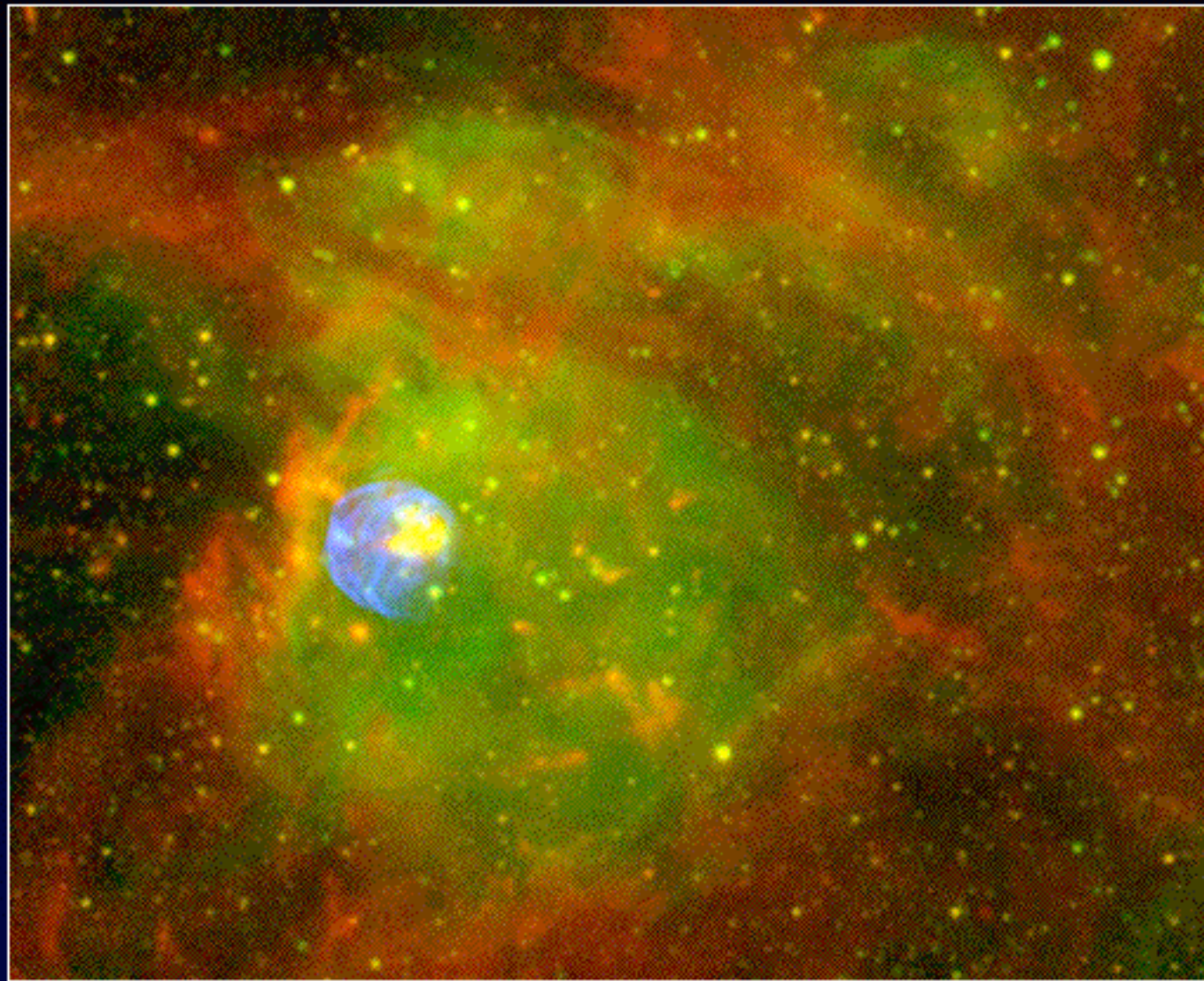


N 180



Star Formation in N 63

“ triggered by HII region, enriched by SNR ”



8'
(120 pc)

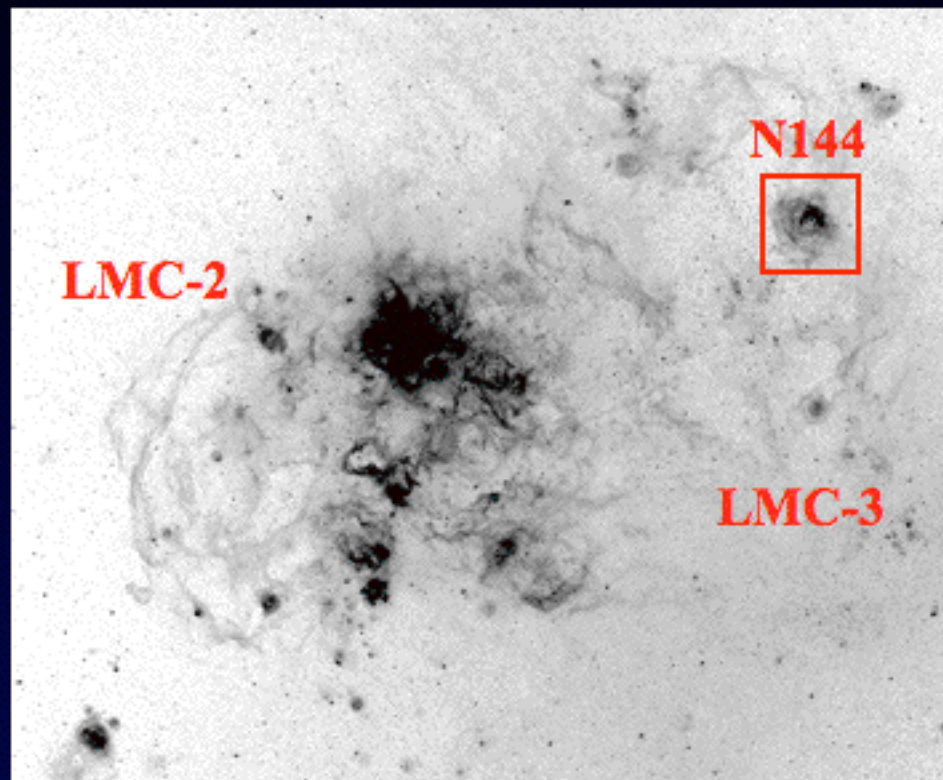
Blue - X-ray

Green - H α

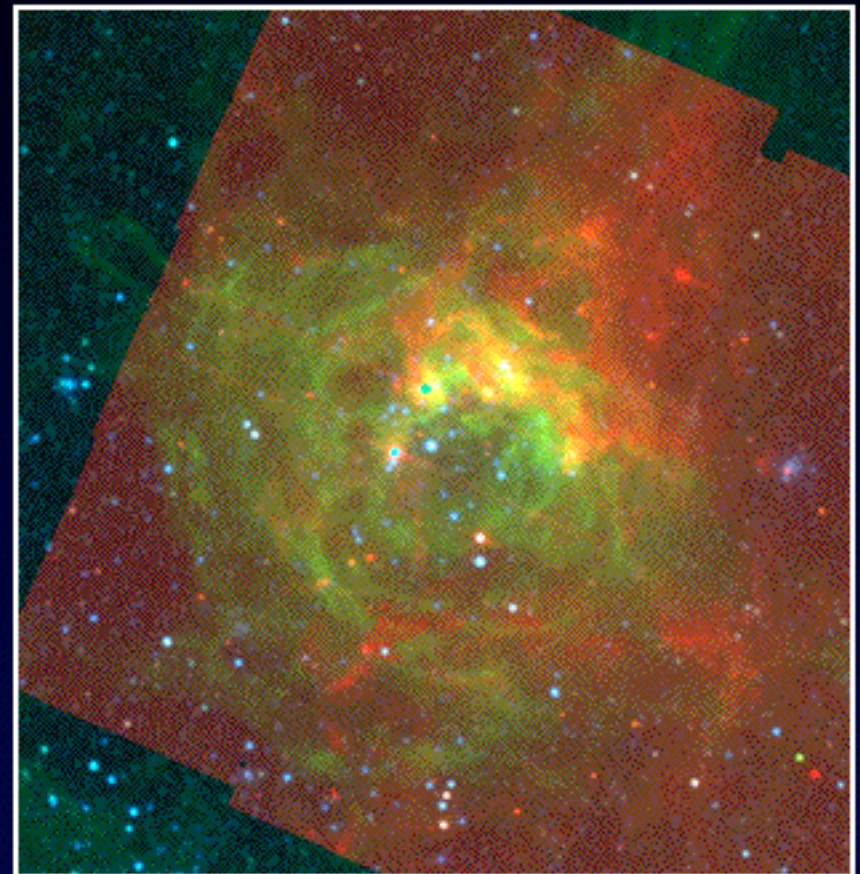
Red - 8 μ m

N 144 and Supergiant Shell LMC-3

Triggered or propagated star formation



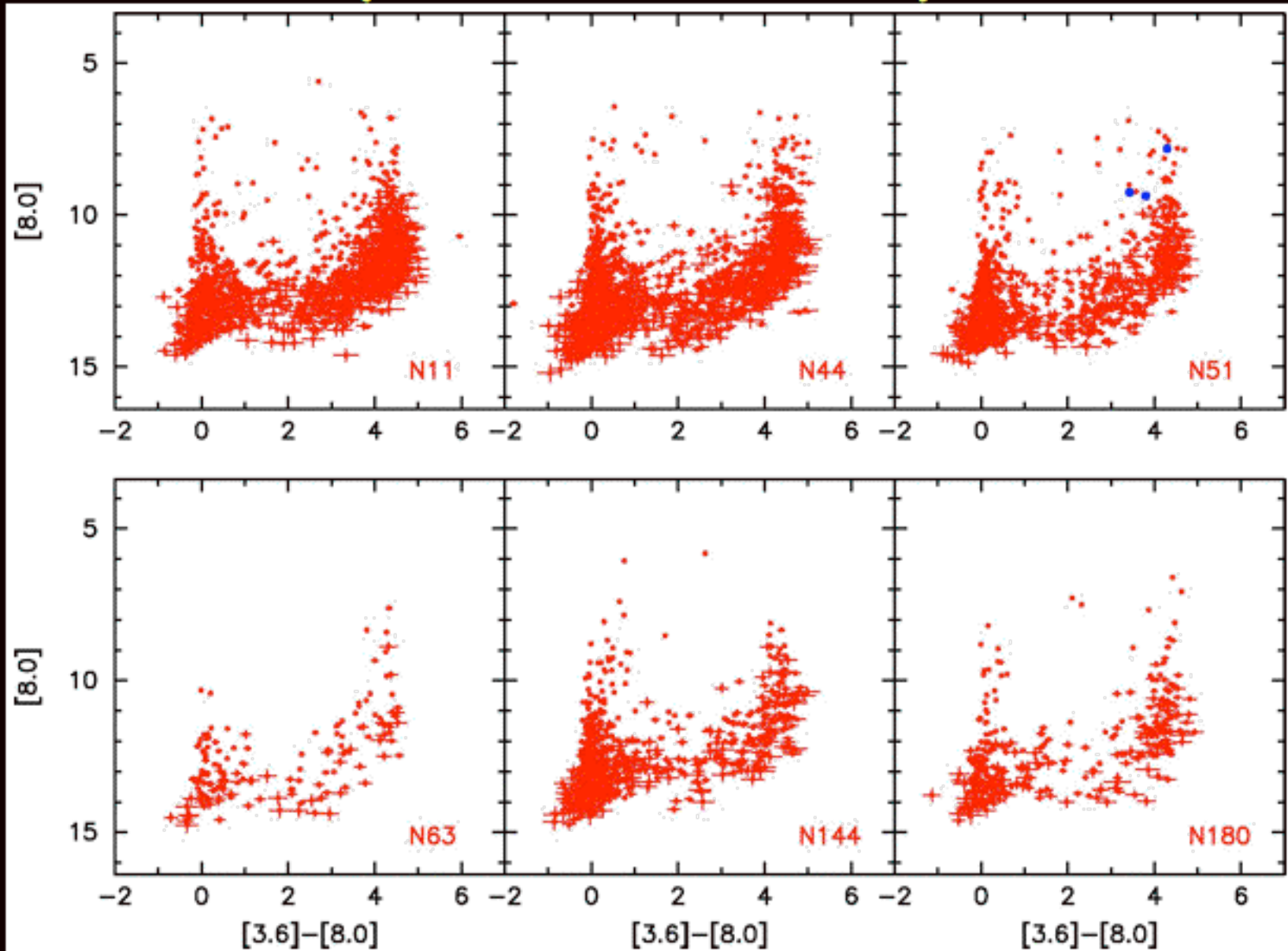
1° (900 pc)



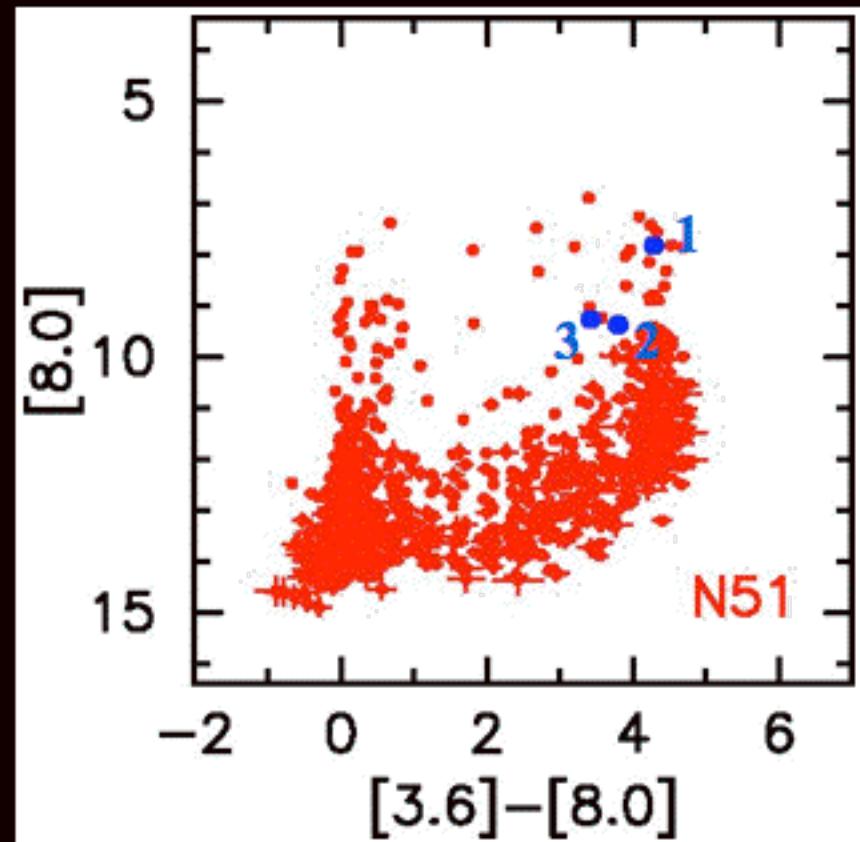
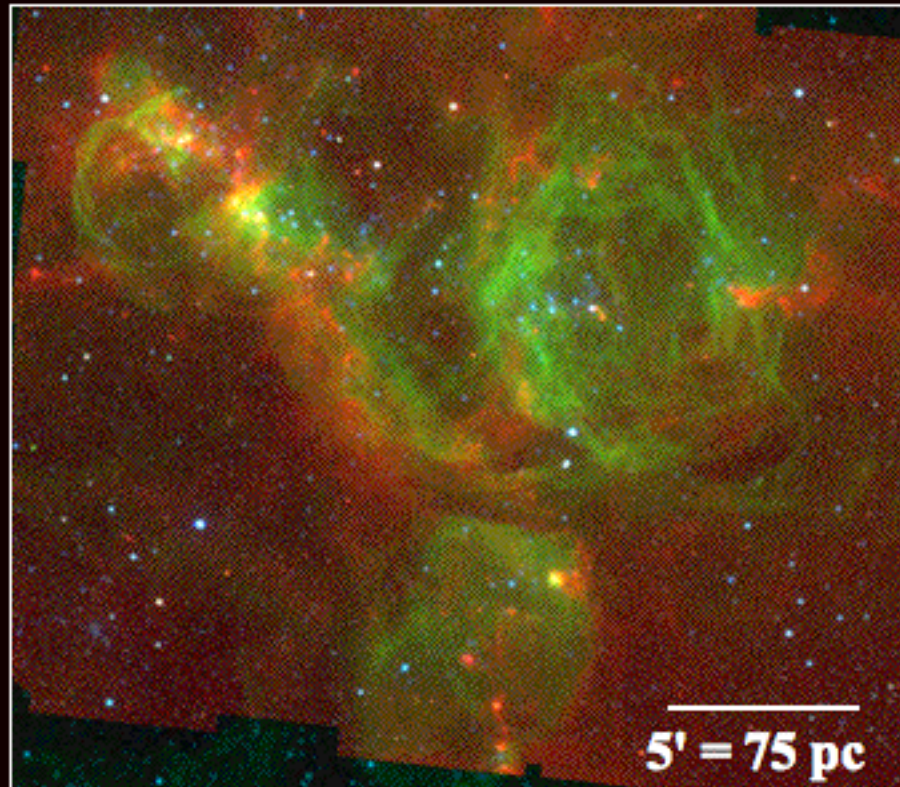
5000 Å (B) H α (G) 8 μ m (R)

Color-Magnitude Diagrams

(D.M. of the LMC = 18.5)

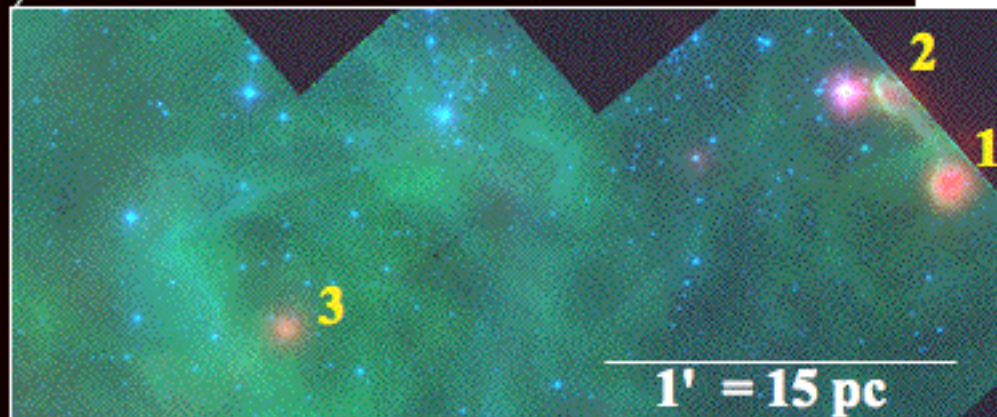
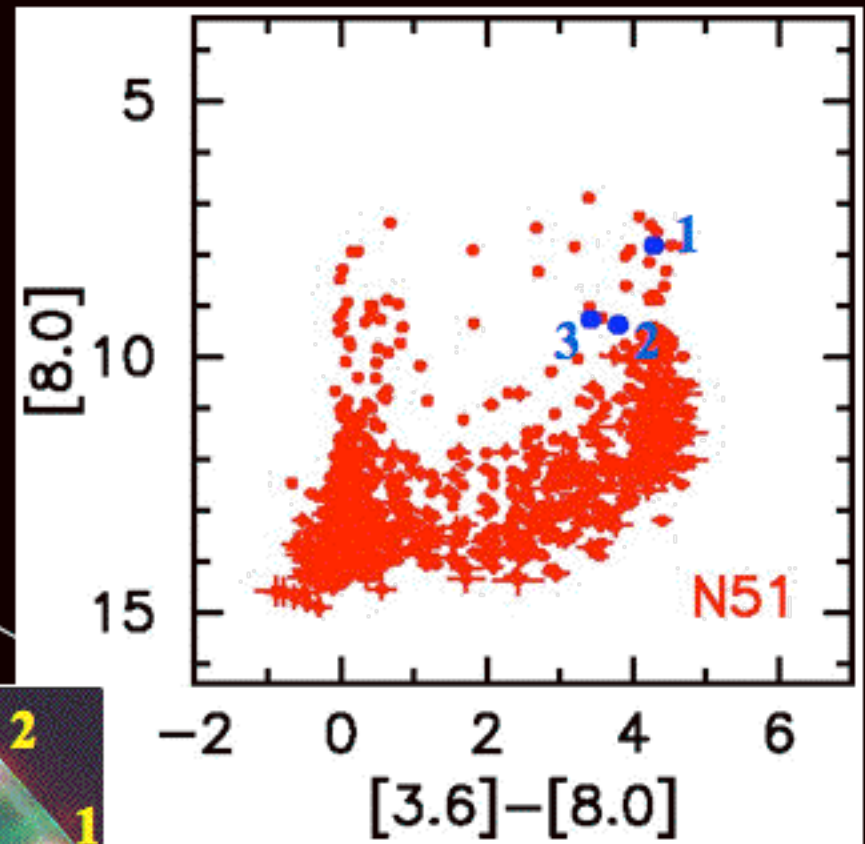
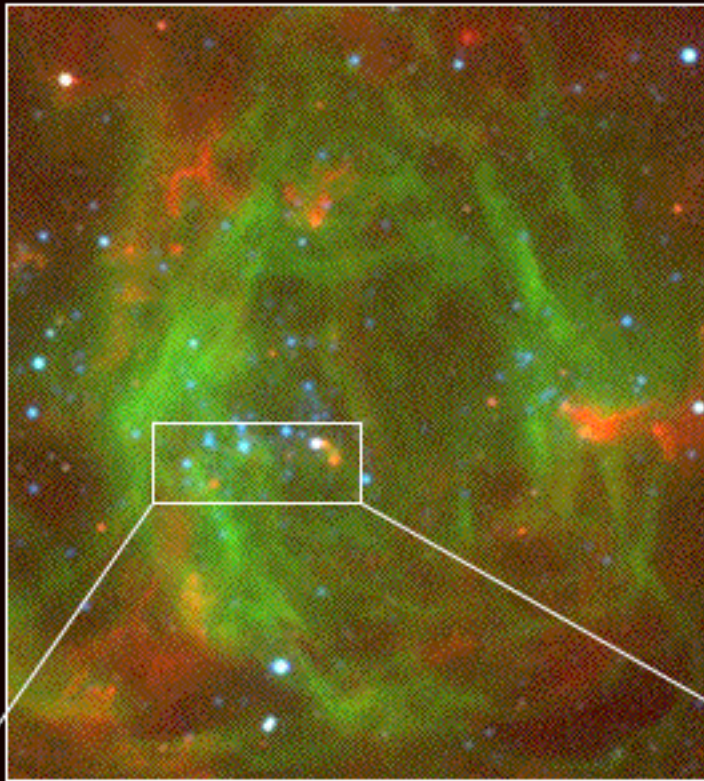


The Star Forming Complex N 51



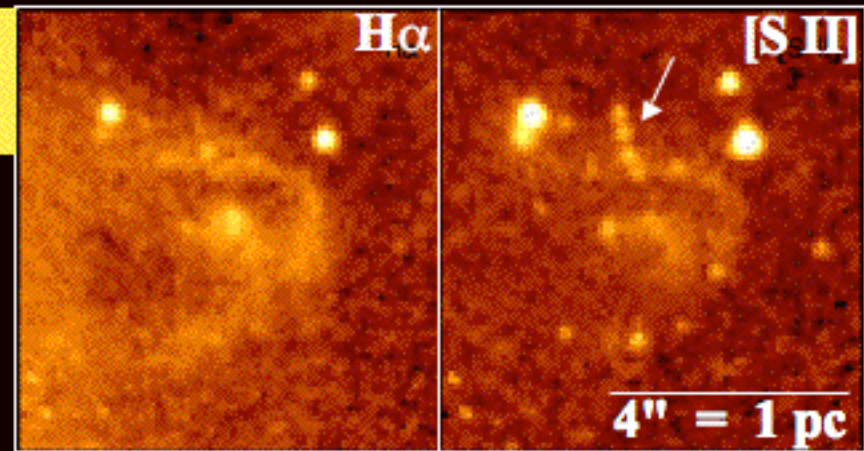
5000 Å (B) H α (G) 8 μ m (R)

The Star Forming Complex N 51



The Star Forming Complex N 51

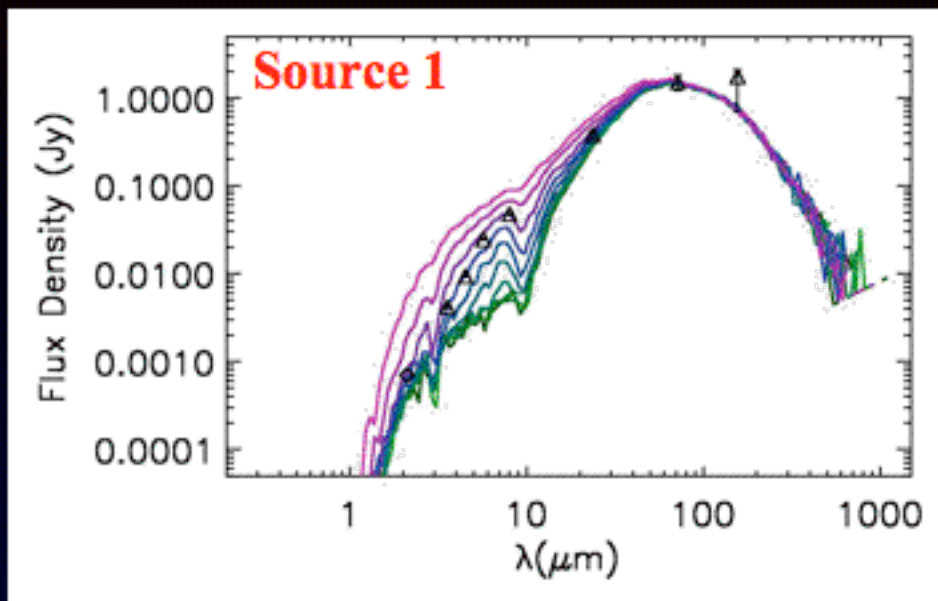
HH object



*Protostars in
Bok globules*

H α (G)
[S II] (B)
8 μ m (R)

First time detected outside the Galaxy



Disk+Envelope for Src 1

$$L = 10,500 L_{\odot}$$

$$M = 12 M_{\odot}$$

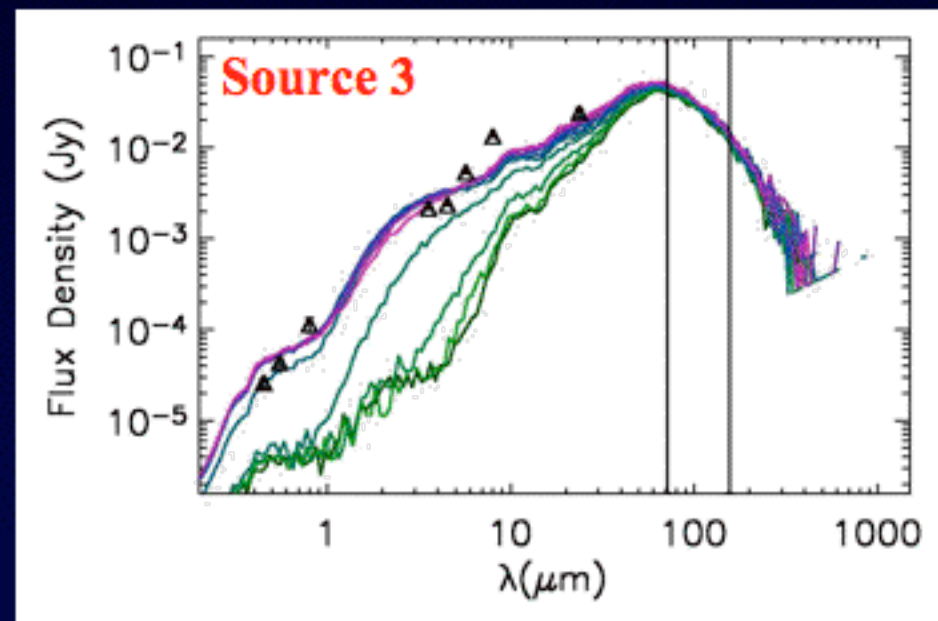
$$dM/dt = 2 \times 10^{-4} M_{\odot}/\text{yr}$$

$$R_{\text{disk}} = 300 \text{ AU}$$

$$\text{Cavity opening} = 15^{\circ}$$

$$M_{\text{disk}} = 0.1 M_{\odot}$$

$$R_{\text{max}} = 100,000 \text{ AU}$$



Disk Only for Src 3 (HH)

$$L = 1,000 L_{\odot}$$

$$M = 7.6 M_{\odot}$$

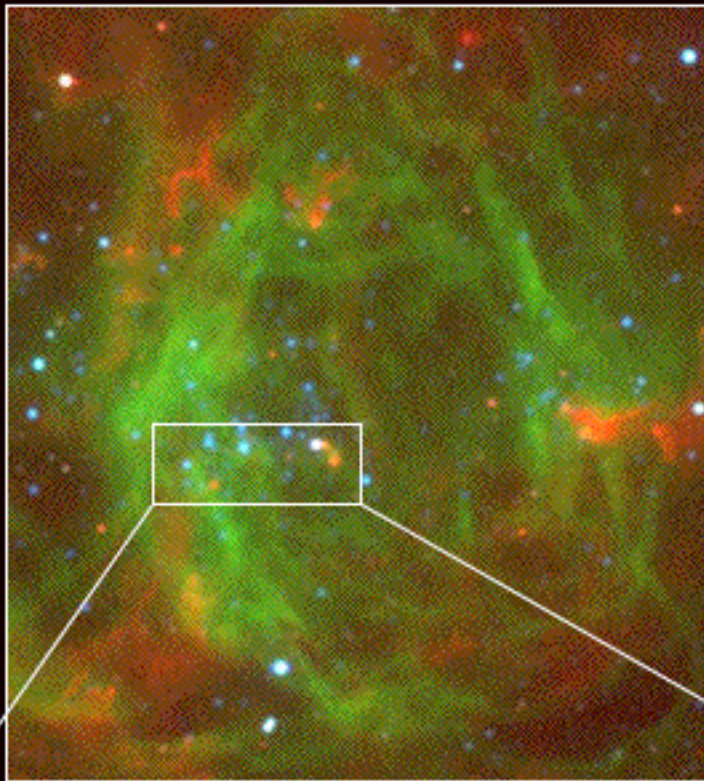
$$R_{\text{disk}} = 400 \text{ AU}$$

$$M_{\text{disk}} = 0.05 M_{\odot}$$

$$R_{\text{max}} = 75,000 \text{ AU}$$

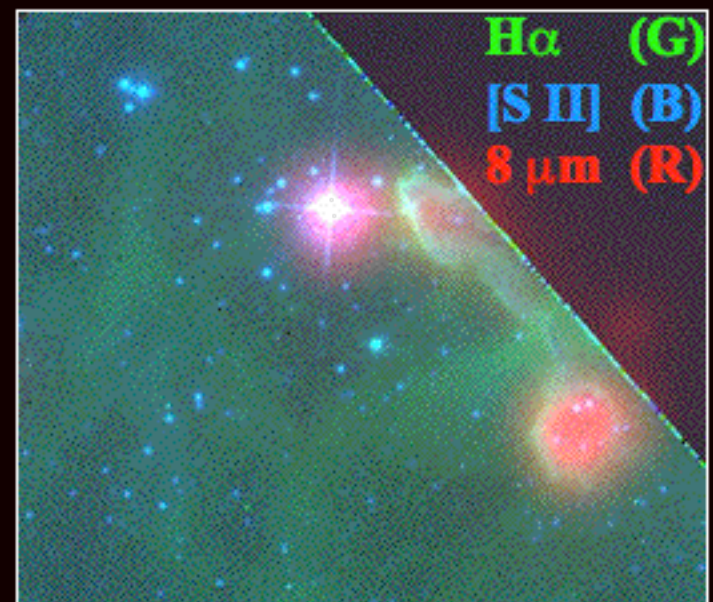
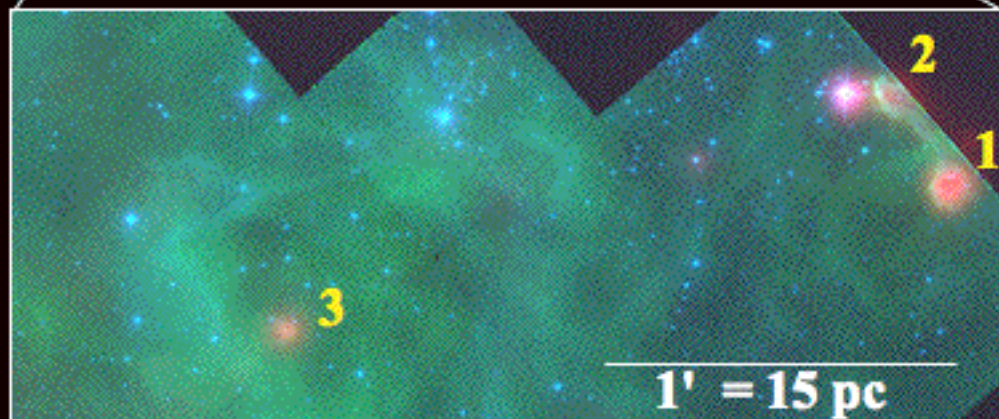
Modeled by B. Whitney

The Star Forming Complex N 51



$$N_e \sim 90 - 140 \text{ cm}^{-3}$$
$$T_e \sim 10^4 \text{ K}$$

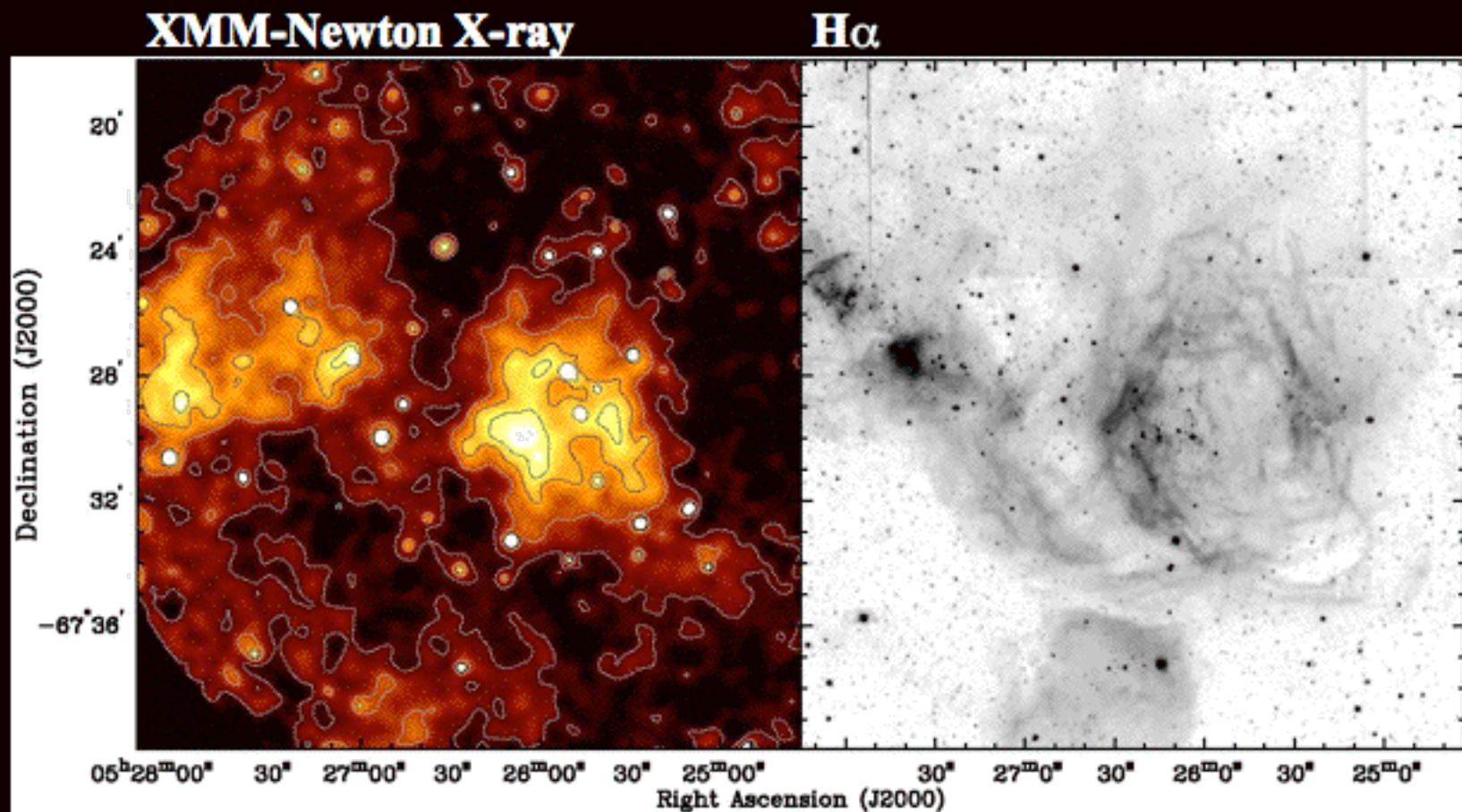
Chen et al. 2000, AJ, 119, 1317



N51D: an X-ray-bright Superbubble

Hot gas: $n_e \sim 0.03 \text{ cm}^{-3}$, $T_e \sim 2.3 \times 10^6 \text{ K}$

(Cooper et al. 2004, ApJ, 605, 751)



What Induced the Star Formation in N51's Bok Globules?

	n_e (cm^{-3})	T_e (K)	$n_e T_e$ ($\text{cm}^{-3} \text{K}$)
Hot gas	0.03	2.3×10^6	7×10^4
Warm gas	100	10^4	10^6
Cold gas	10^3 H_2	10	10^5

*But the Jeans radius $\sim 0.48 \text{ pc}$, and
the globule radius $\sim 0.75 \text{ pc}$.*

Spontaneous or triggered?

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- **Spitzer survey of the LMC starts tonight, and data will be archived immediately.**

Scientific Genealogy

