Complex structure in the cool ISM in the Galactic plane: Protostars and what comes before

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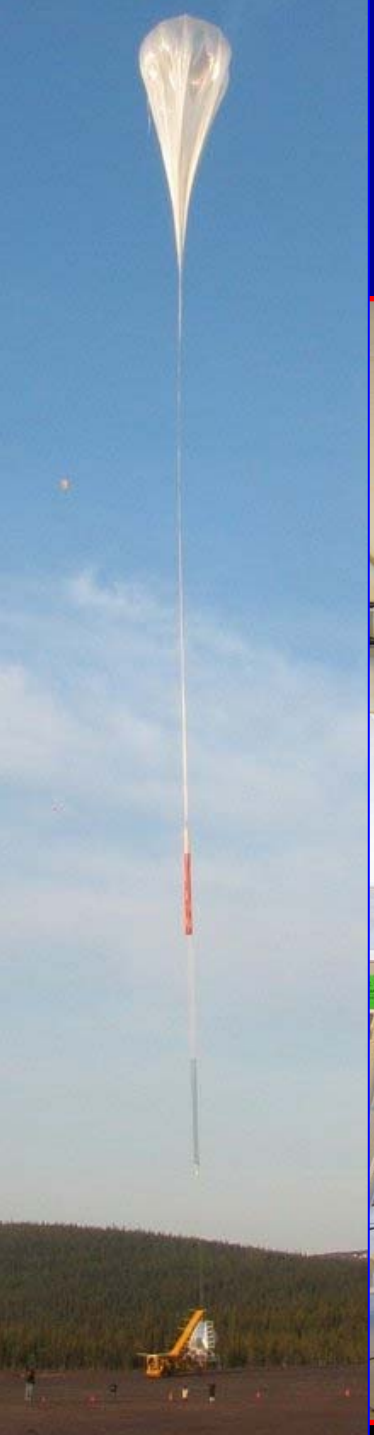
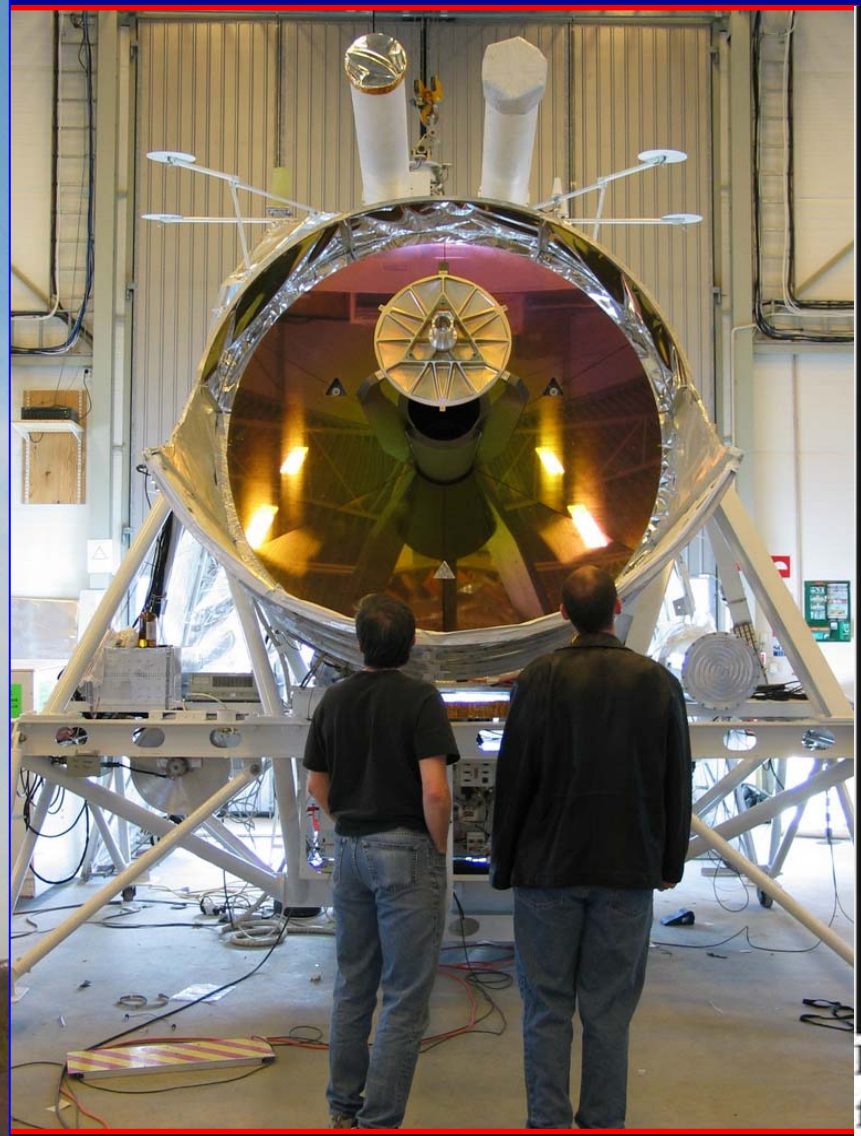
and the BLAST collaboration

Precursor to observations with Herschel/SPIRE (GT and OT – HiGAL) and SCUBA2 (JPS, GBS)

Pasadena, 30 May 2008



Balloon-borne Large Aperture Submillimetre Telescope



BLAST payload hanging from balloon a float altitude of 120,000 ft.

BLAST: Submillimetre IMAGING

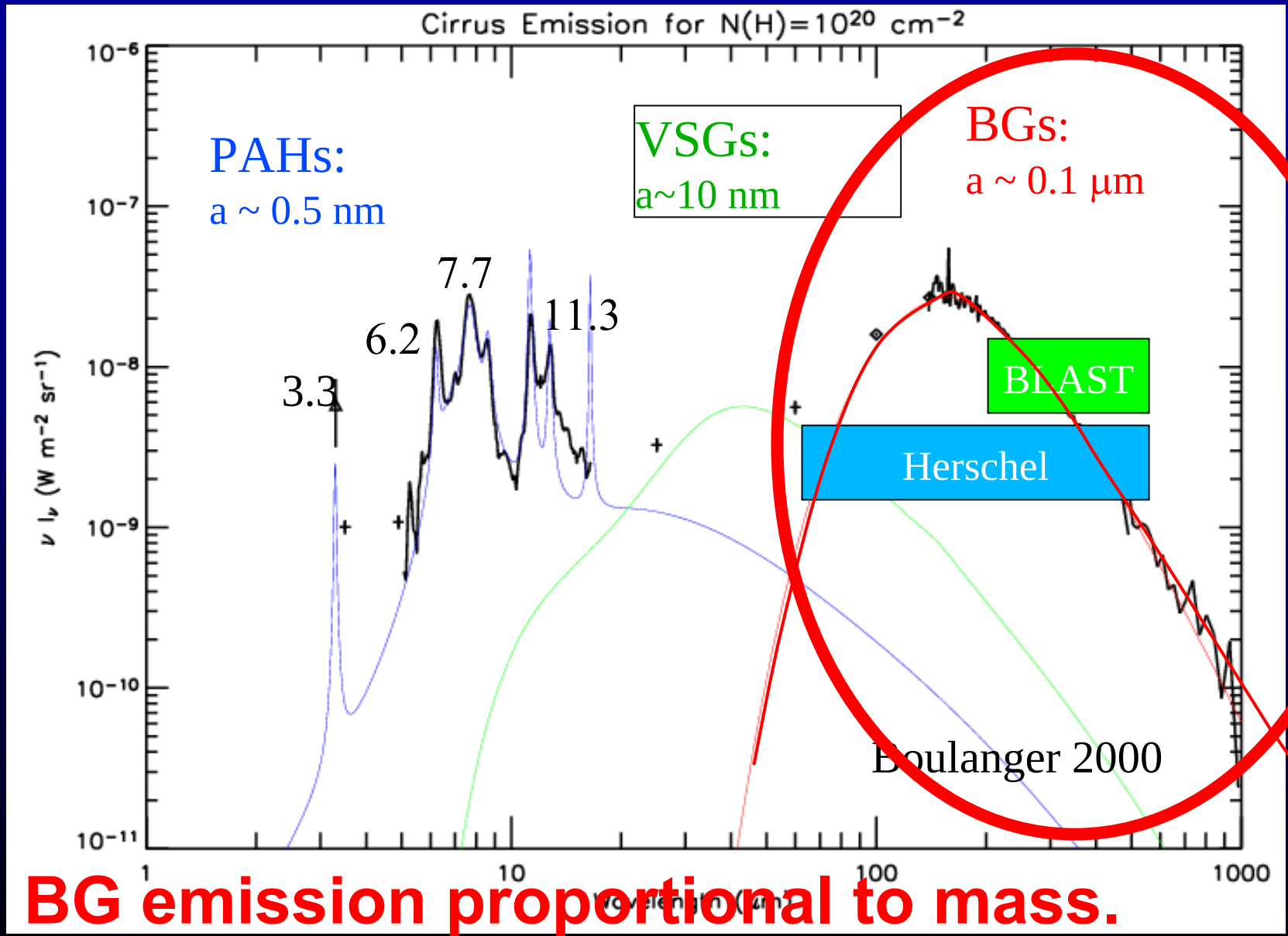
Three-colour camera almost identical to the SPIRE camera on *Herschel* : 43, 88 and 149 detectors, respectively, at

500, 350, and 250 μm.

Unique spectral coverage close to the peak of the spectrum of cool dust emission →→→ excellent determination of T, bolometric flux, and mass of compact sources.

BLAST reveals previously-unseen cold dust.

BLAST/Herschel: SED in submm
Good definition of BG temperatures



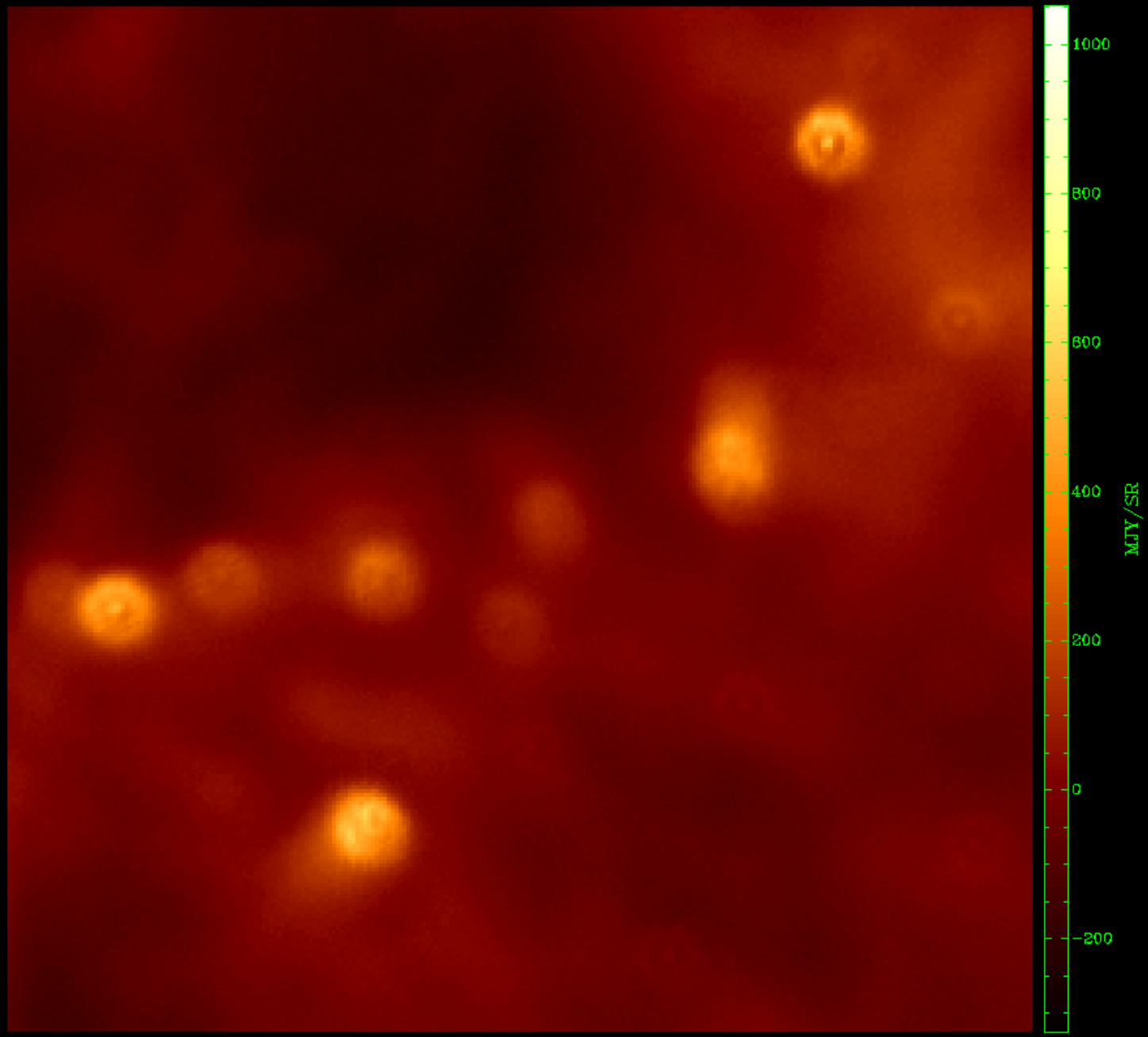
BG emission proportional to mass.

BLAST05: Submm IMAGING

BLAST05 was out of focus → extragalactic science goals abandoned, but lots of Galactic results.

Have recently improved all of these maps using Lucy-Richardson deconvolution, enhancing the derived science.

(Arabindo Roy)


1000
800
600
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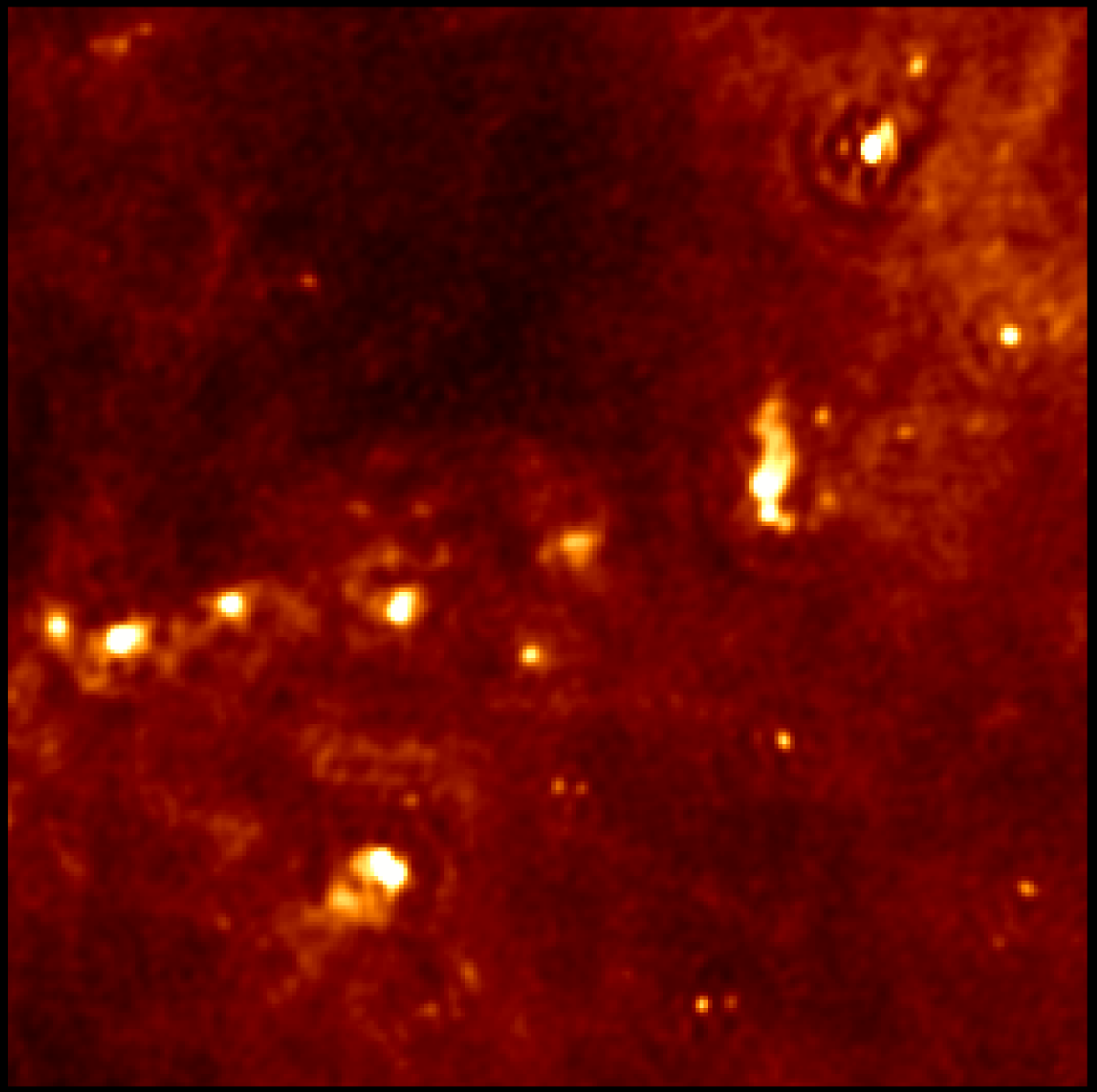
MJY/SR

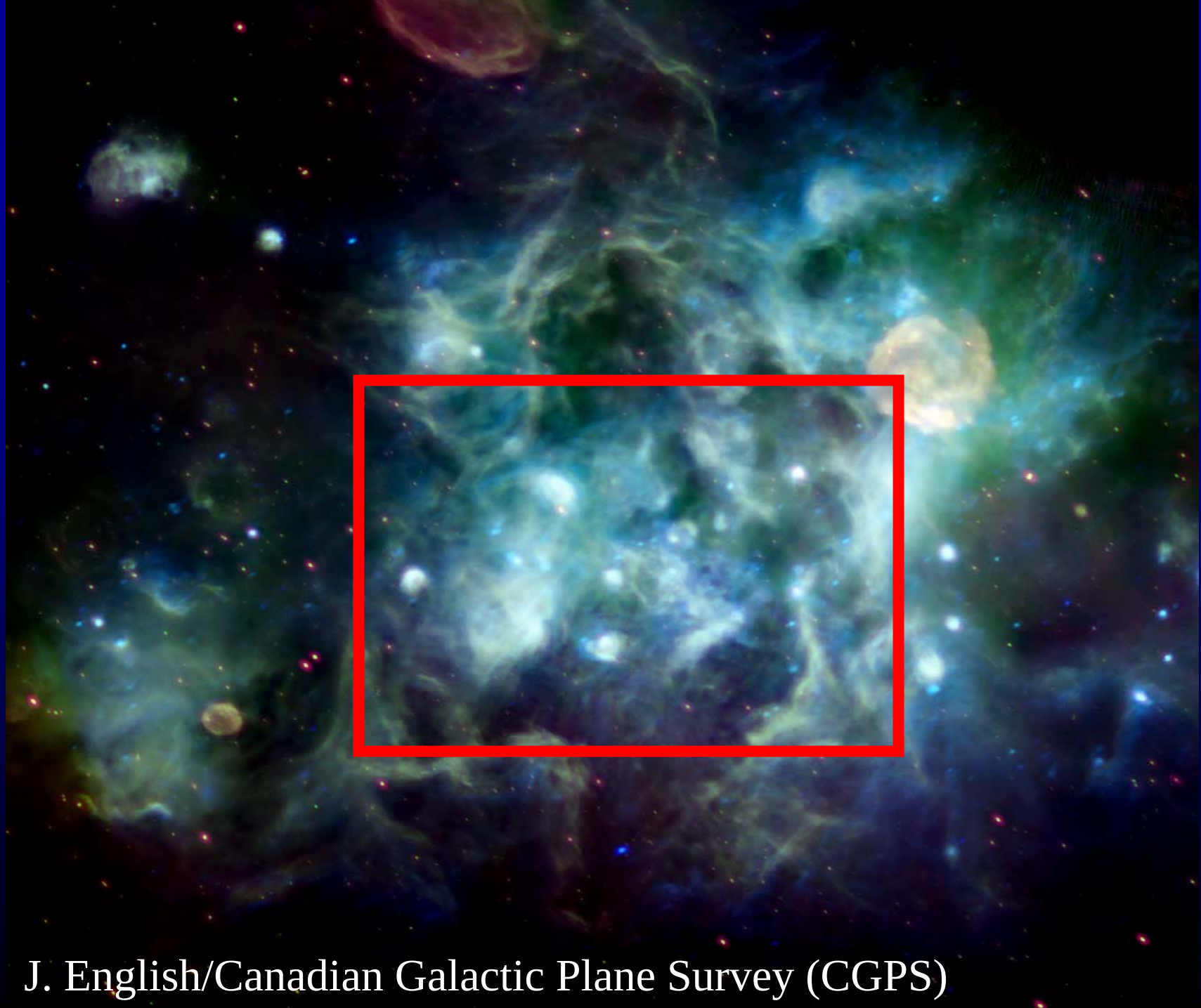

1200
1000
800
600
400
200
0
MJY/SR

BLAST: a survey instrument

One of the regions of high mass star formation surveyed by BLAST05 was Cyg X: AREA ~4 X 3 = 12 square degrees.

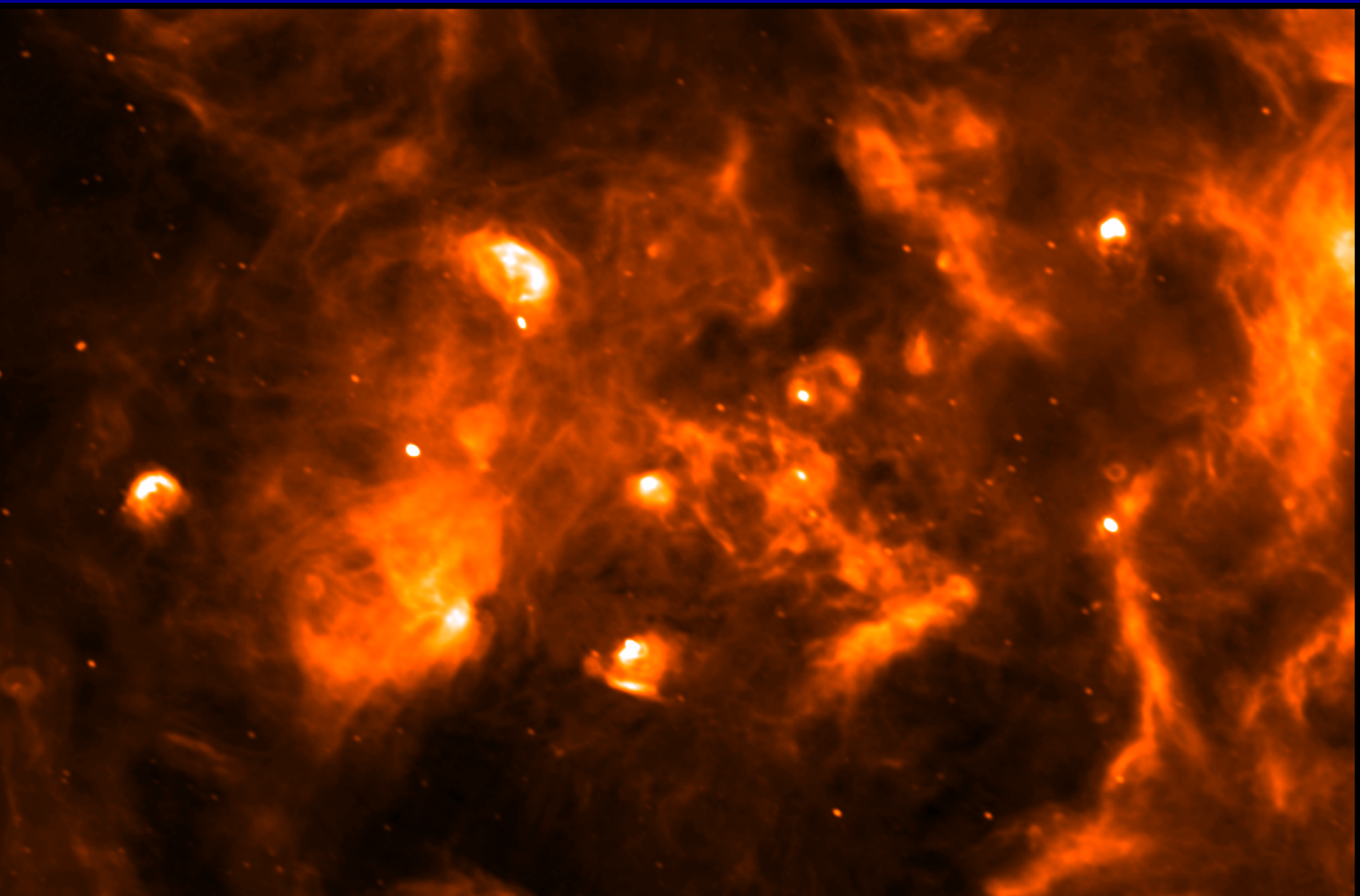
(One of the great features of BLAST was the ability to survey large regions. Will show a region ~50 sq. degrees in Vela Molecular Ridge, done during the Antarctic flight, BLAST06).

For Cyg X will first show a multiwavelength, hence multispecies view (from CGPS) to reveal how complex and information rich is this ISM discipline, and the unique contributions of BLAST.

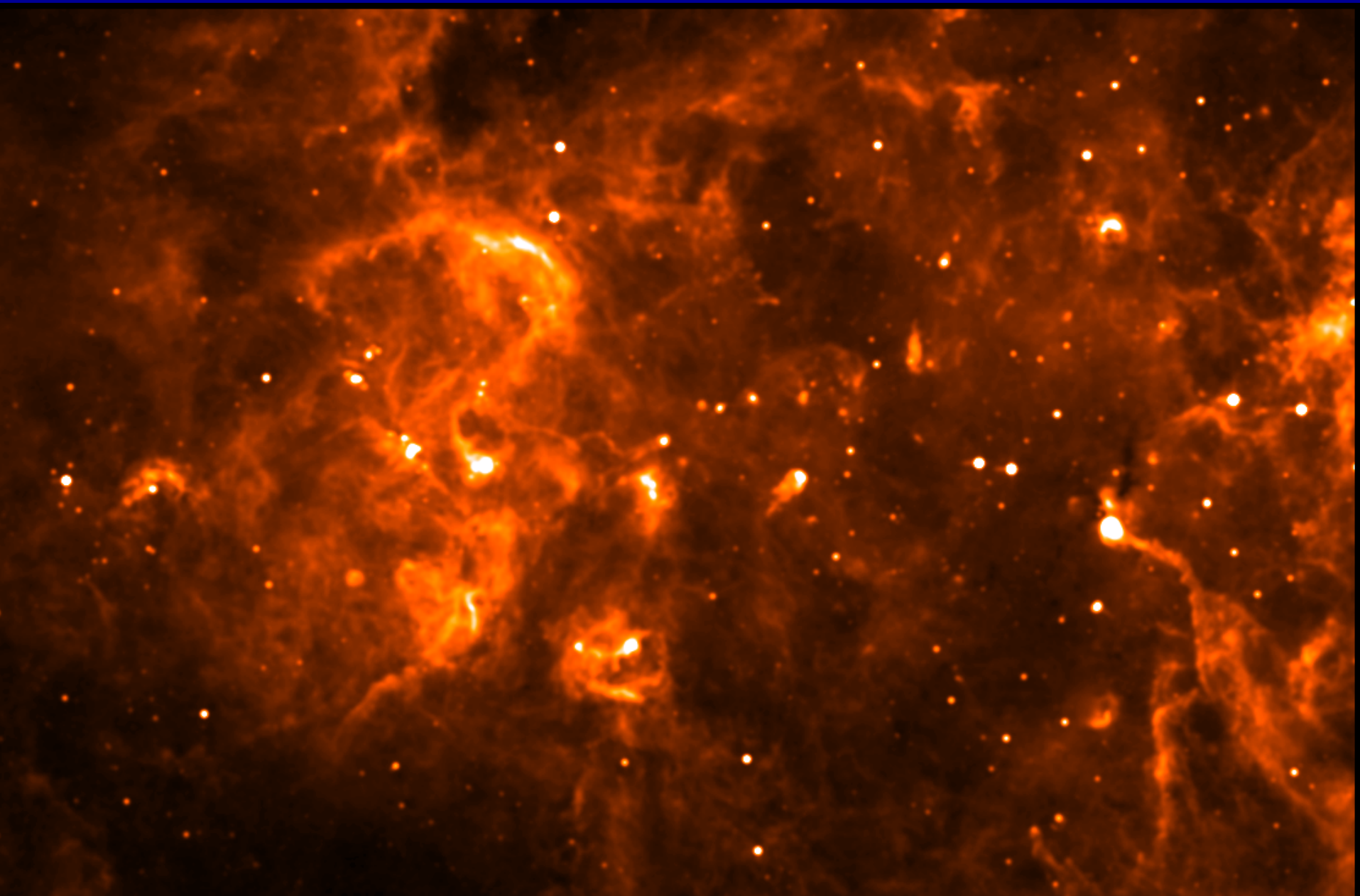


J. English/Canadian Galactic Plane Survey (CGPS)

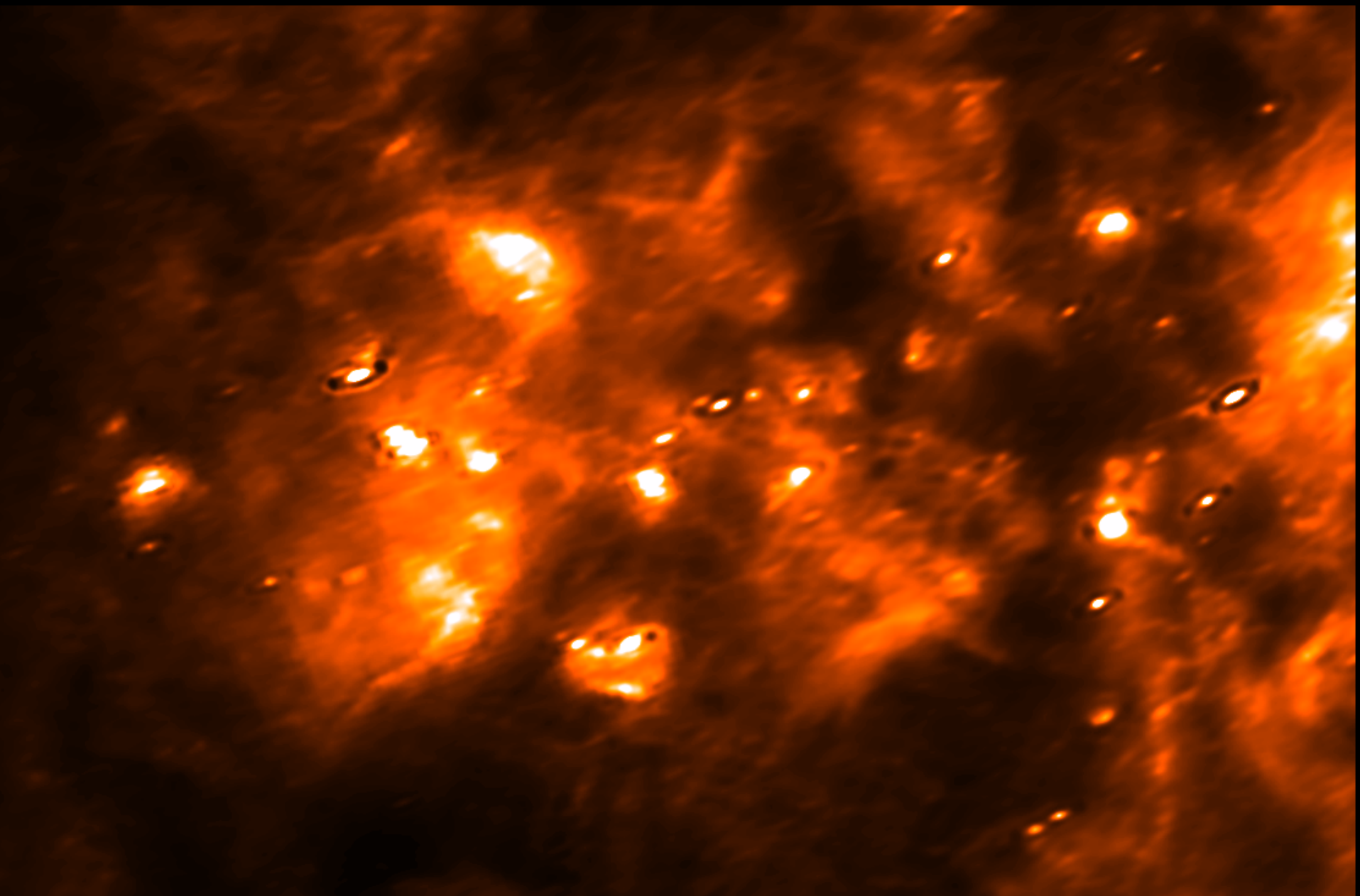
Radio continuum – DRAO ST 21 cm



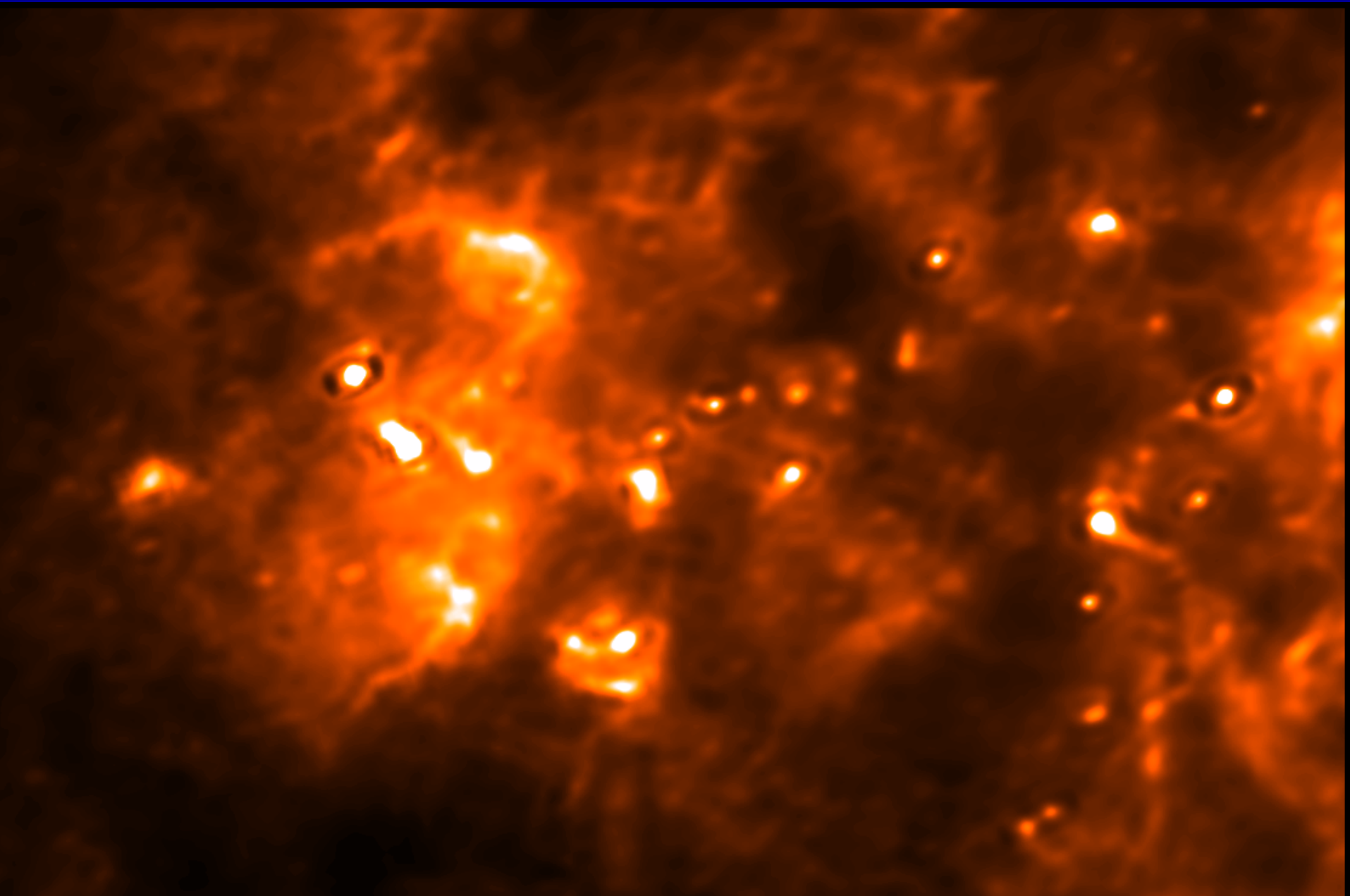
PAH emission – 8.6 micron MSX



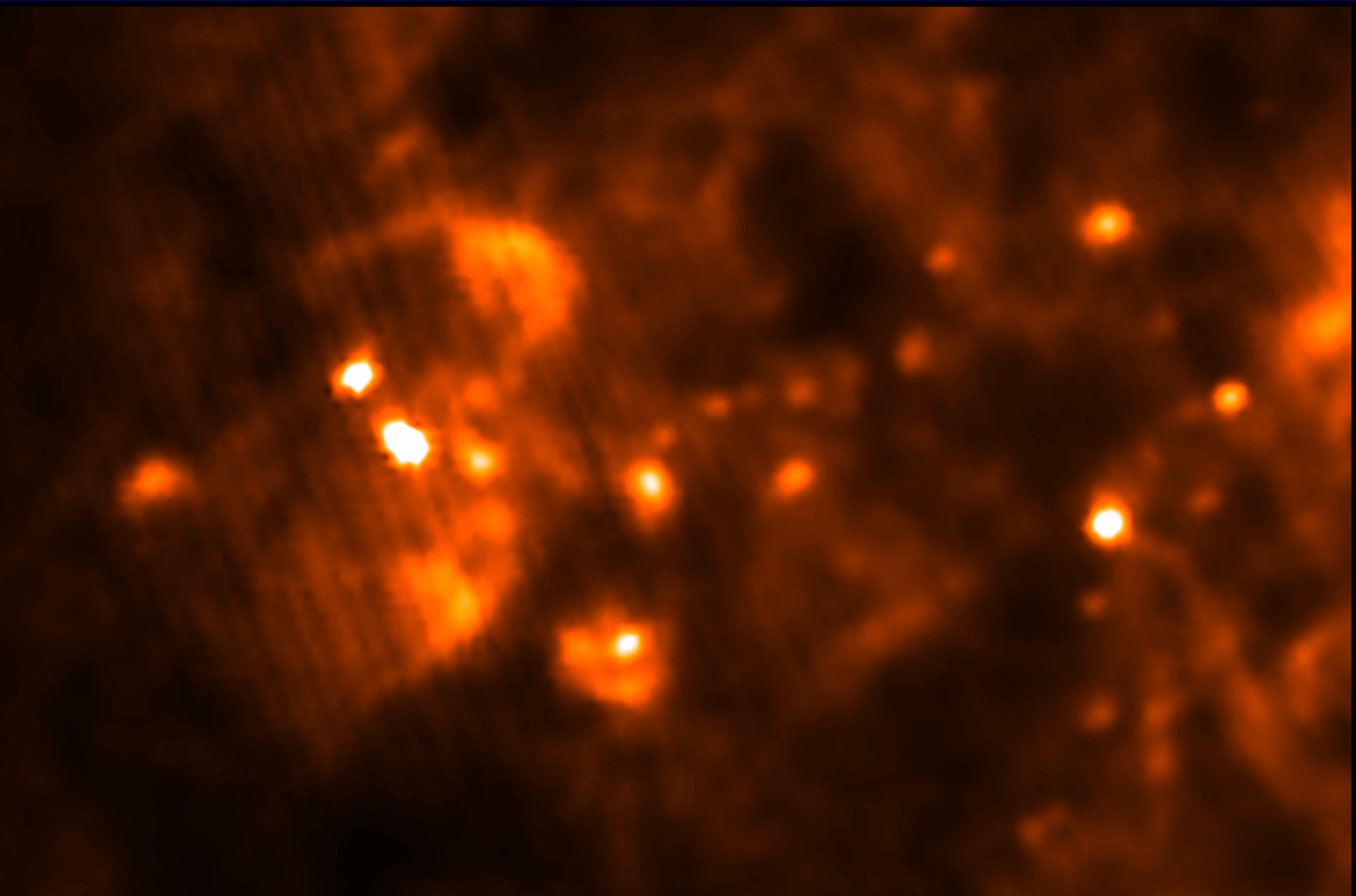
60 micron IRAS (HIRES)



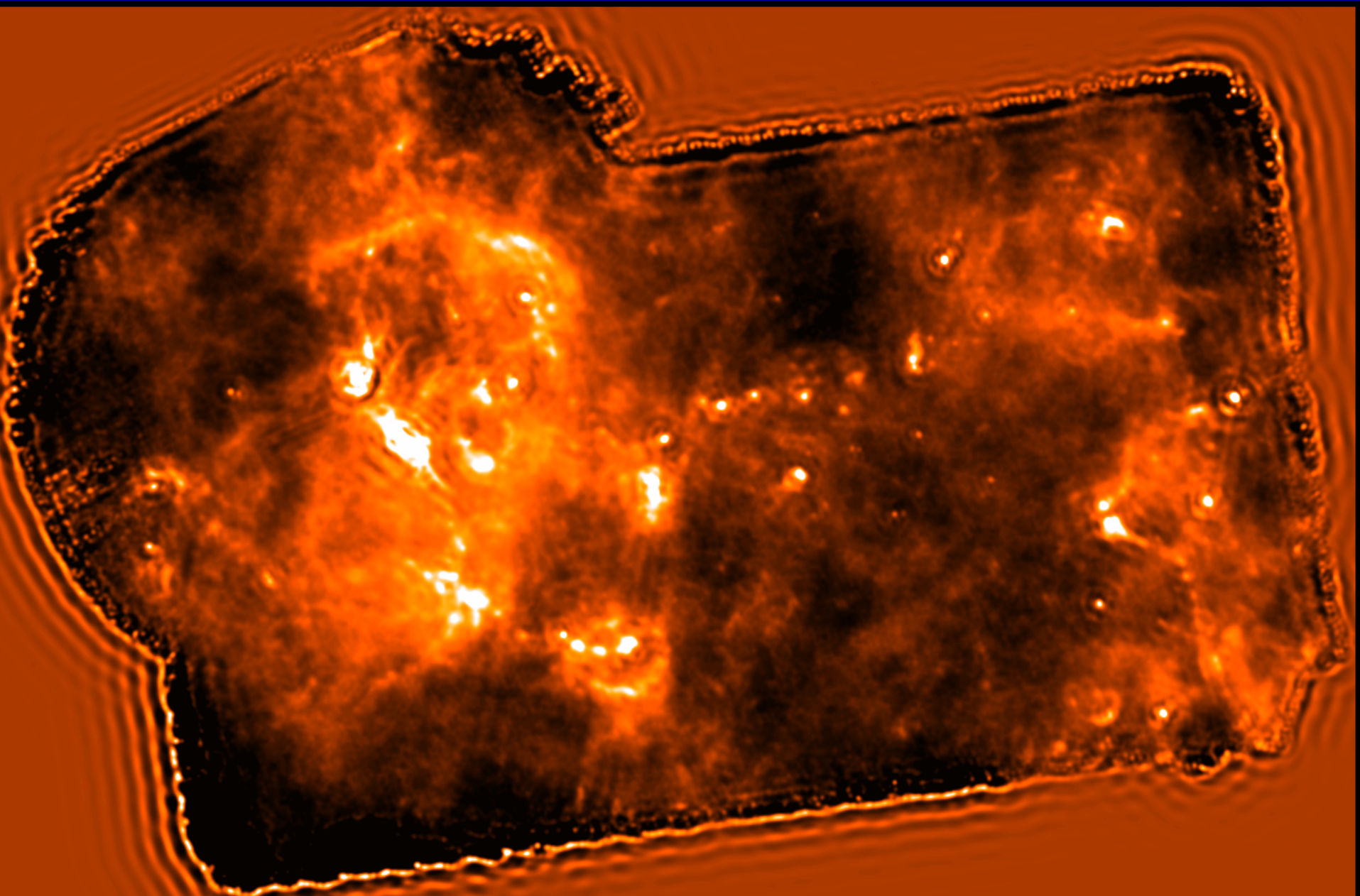
100 micron IRAS (HIRES)



100 micron – IRIS (original)



250 micron – BLAST



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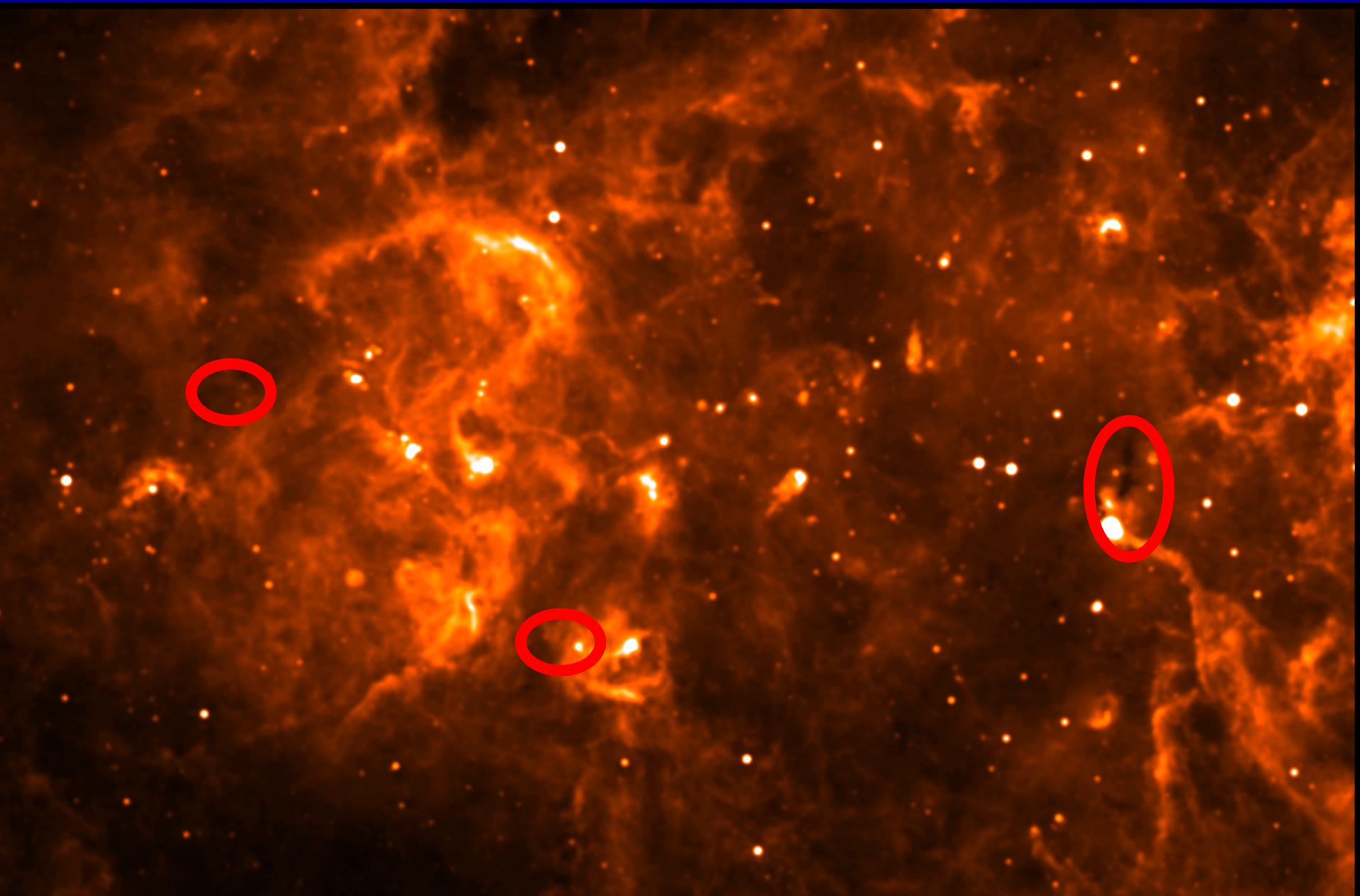
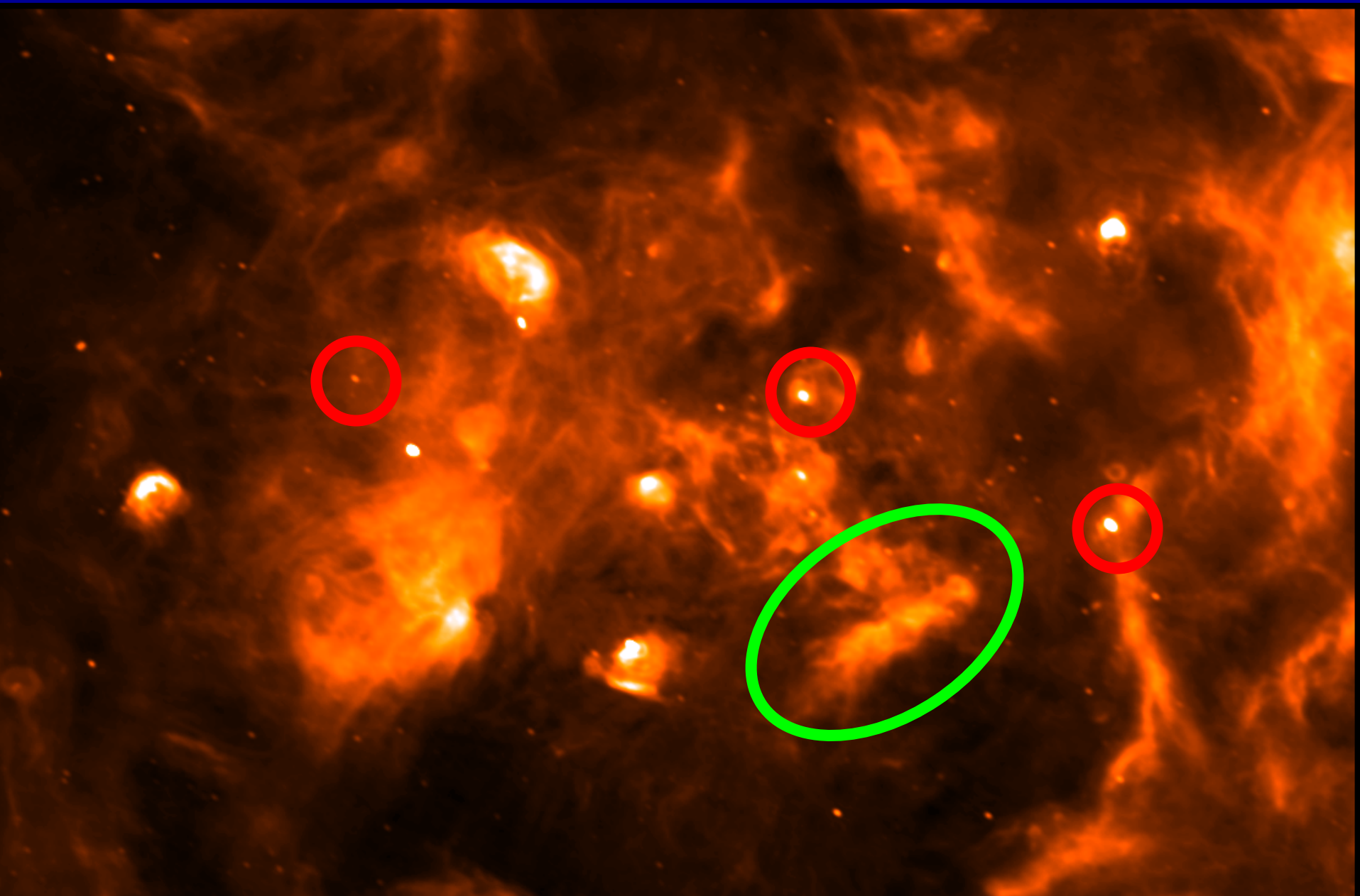
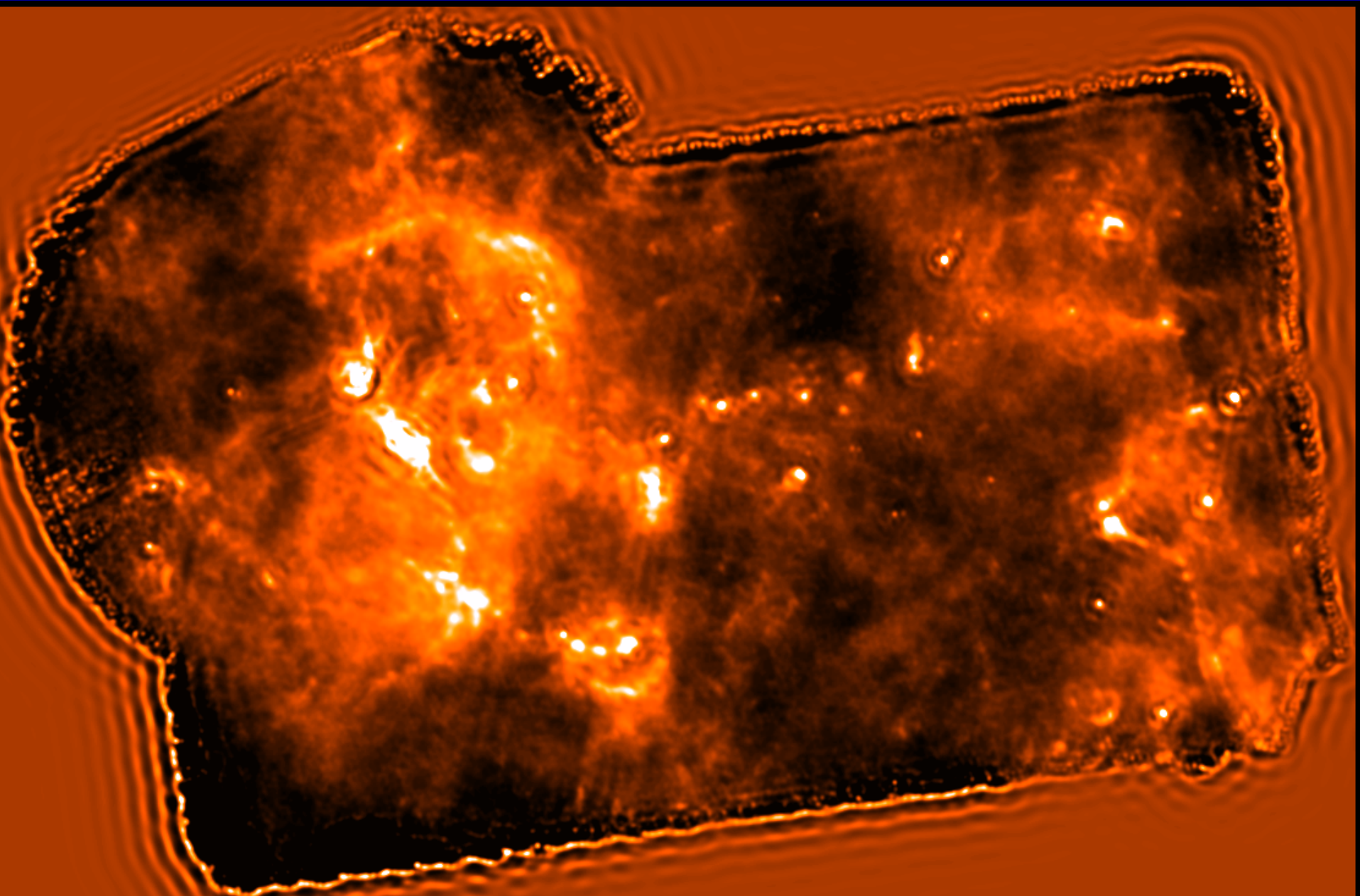


Radio continuum 21 cm



250 micron – BLAST



Measures of Column Density

Dust emission measures column density of dust, modulated by dust temperature T:

$I_\nu = \kappa_\nu B_\nu(T)$ Dust/Gas $\mu m_H N_H = \tau_\nu B_\nu(T)$.

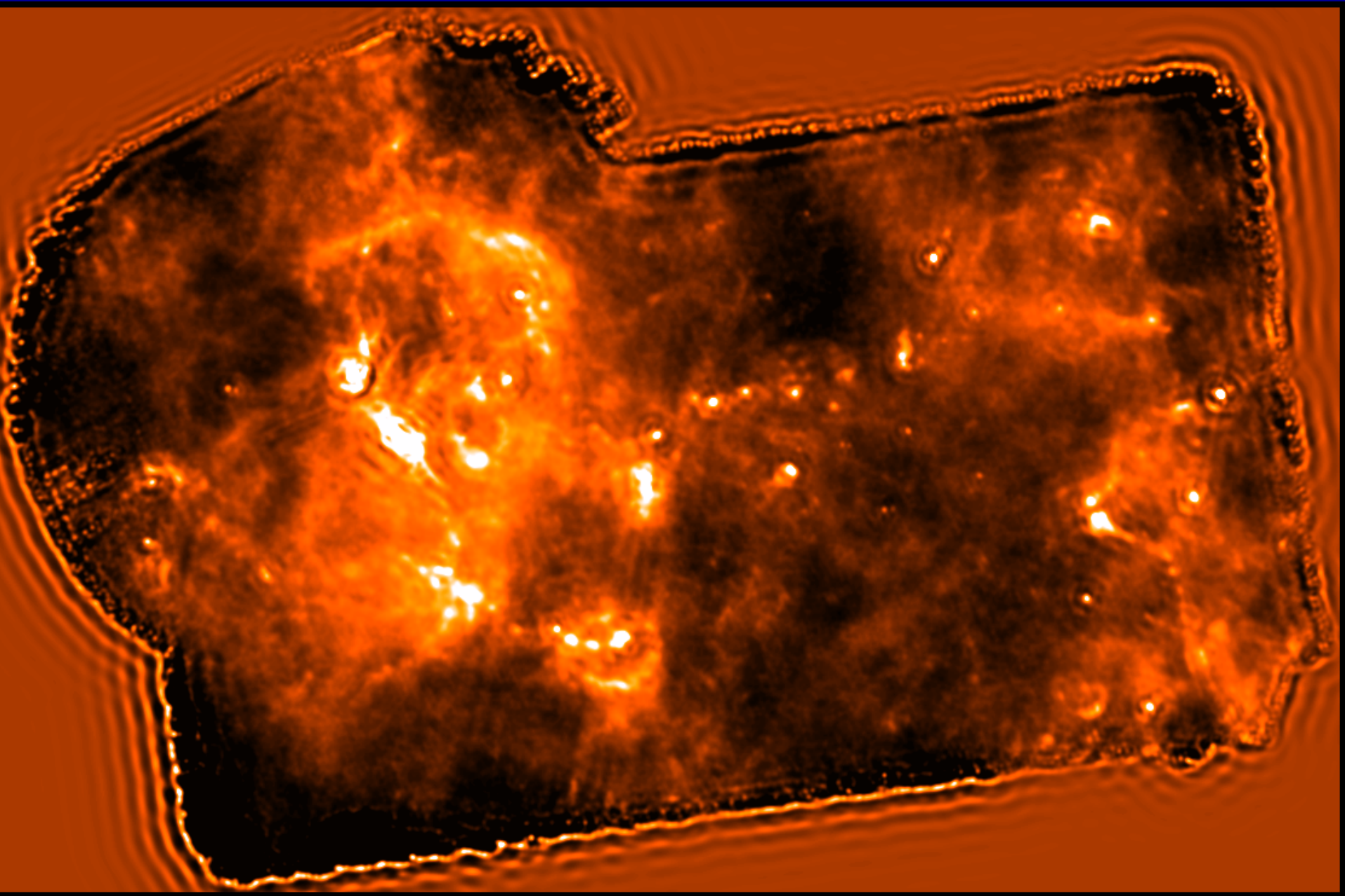
Extinction also measures column density:

$A_V = (A_V/N_H) N_H$,

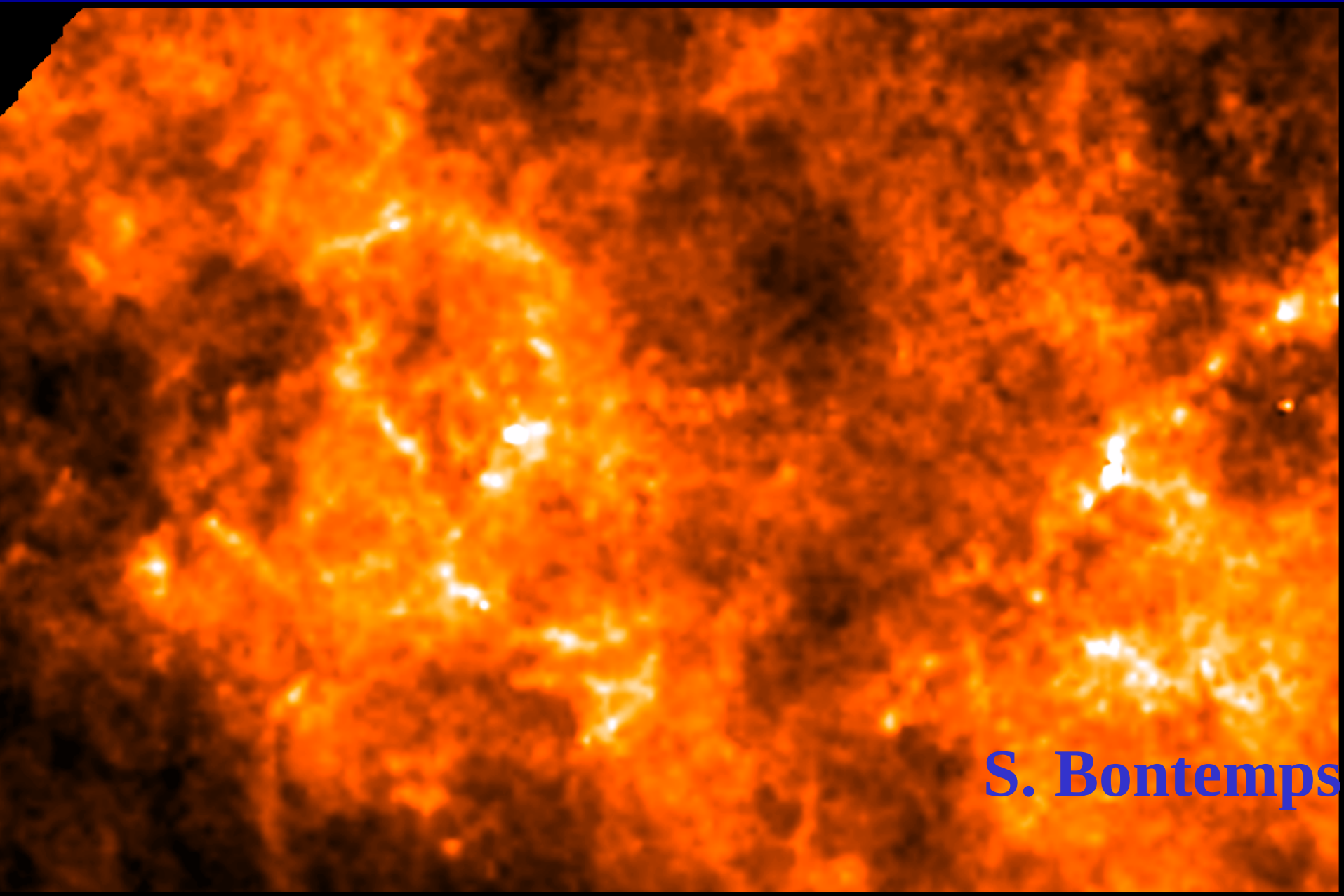
as does the integrated line intensity of CO:

$W(CO) = (2X)^{-1} N_H$.

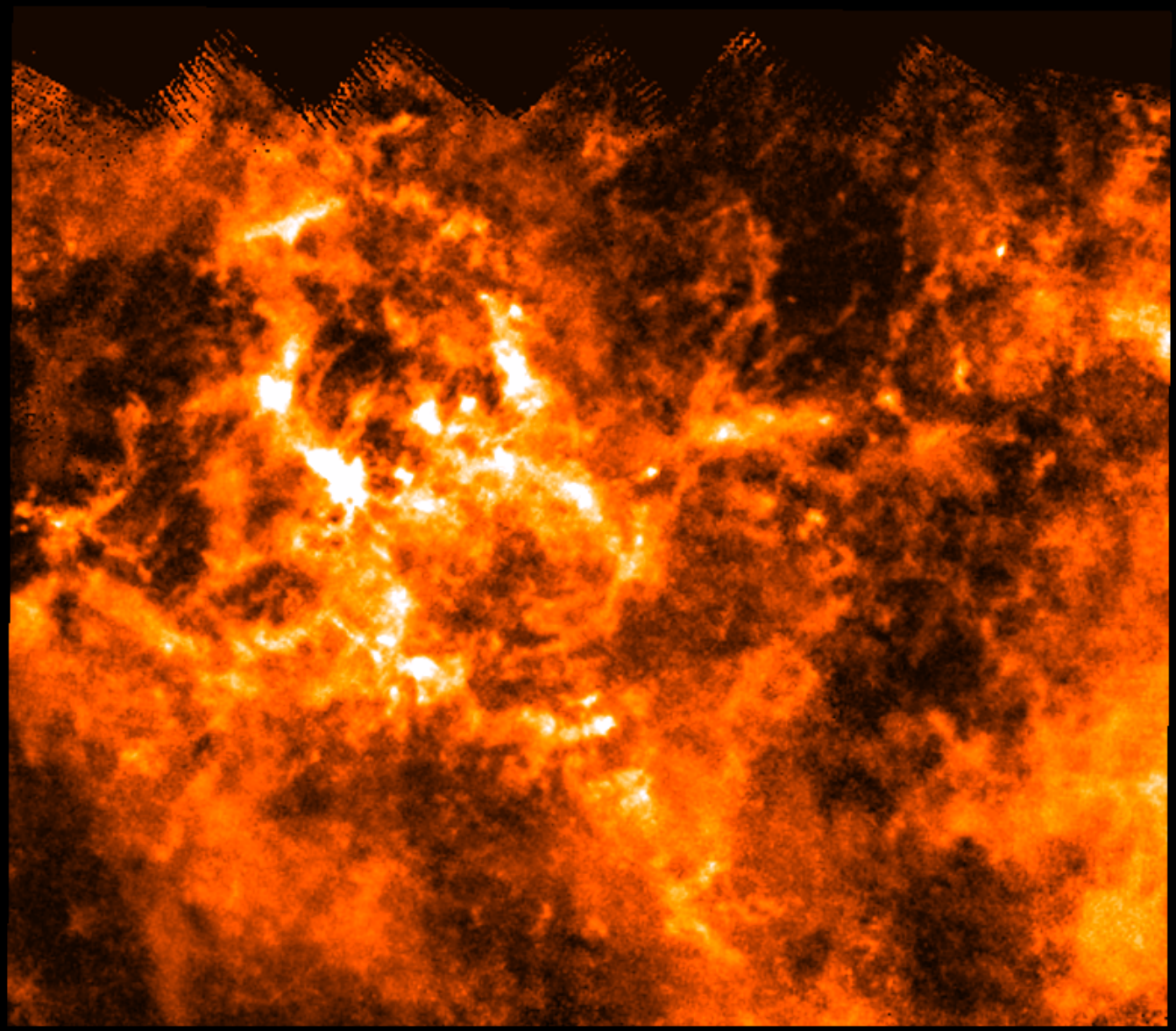
250 micron – BLAST



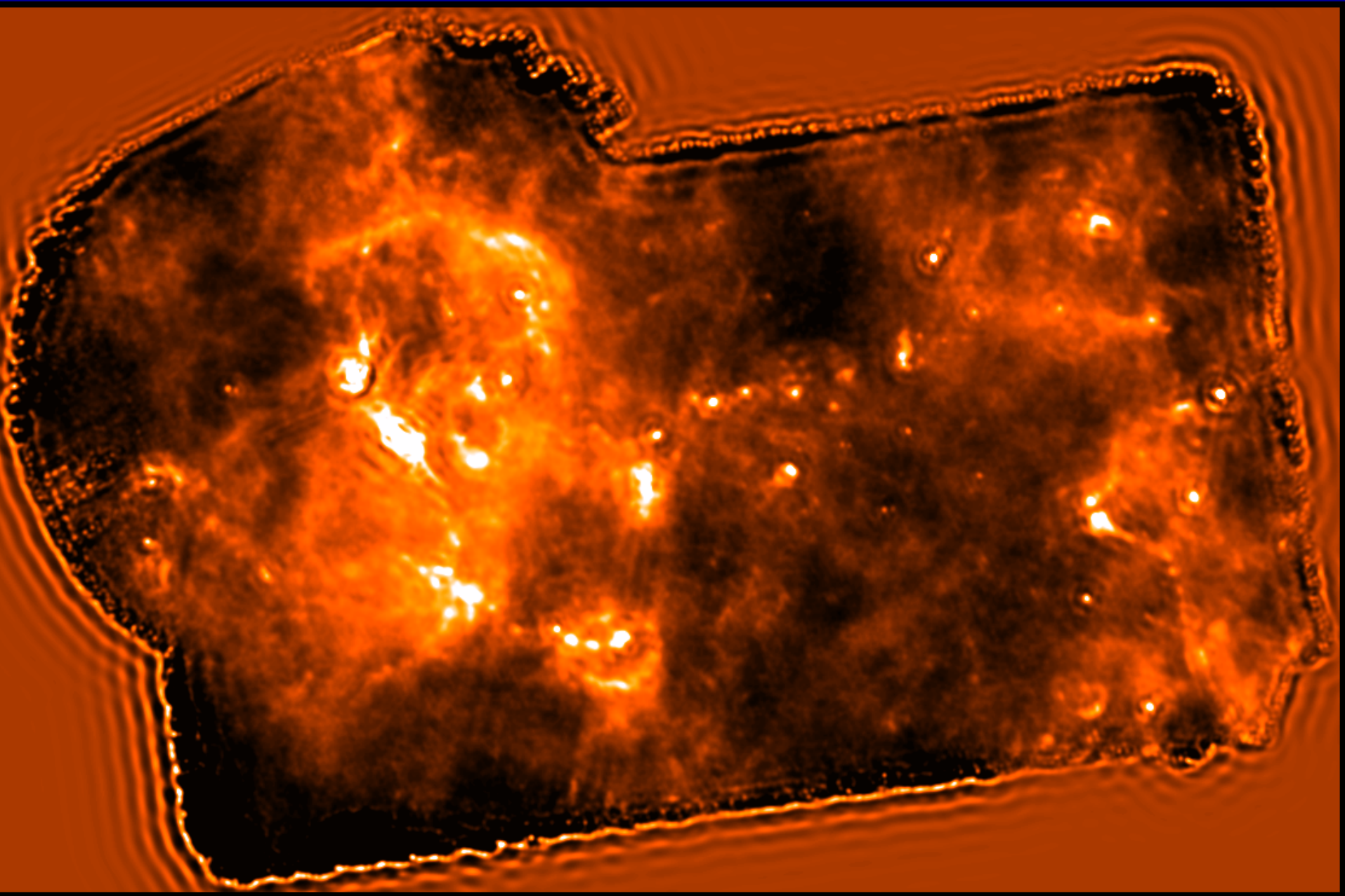
Extinction from HK star counts



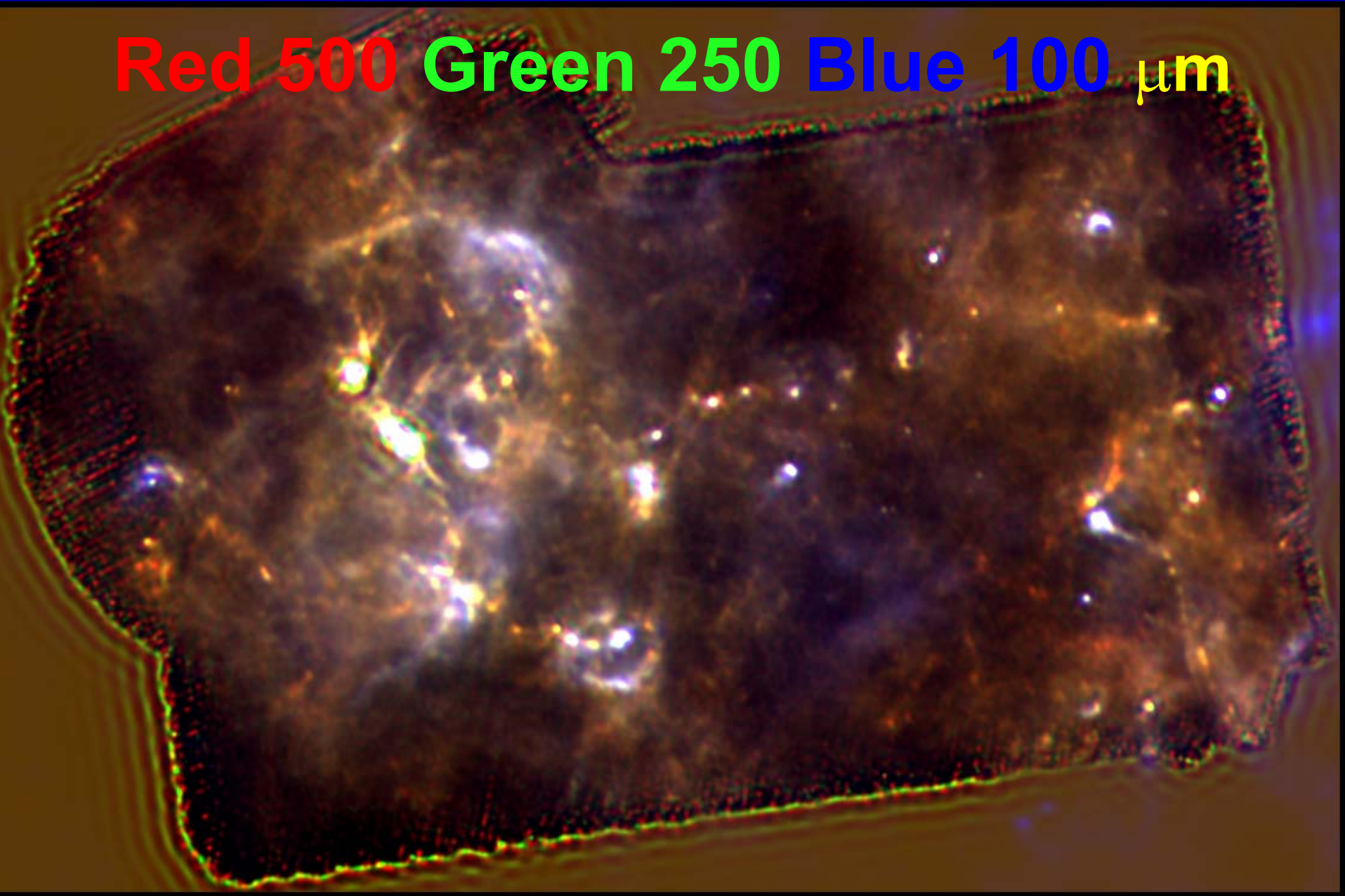
12CO(1--> 0) from FCRAO (Brunt)



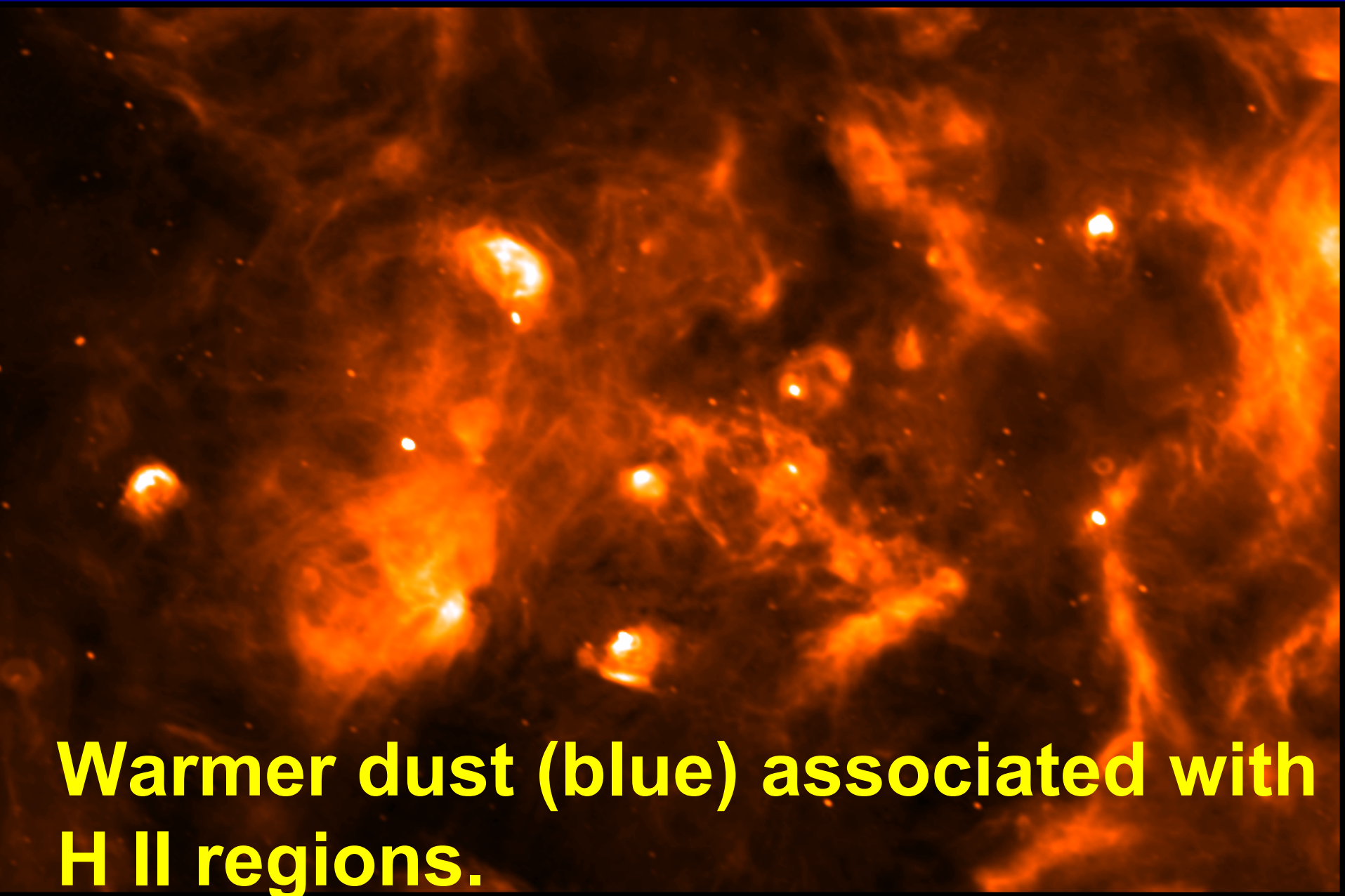
250 micron – BLAST



3 colour – BLAST + IRAS



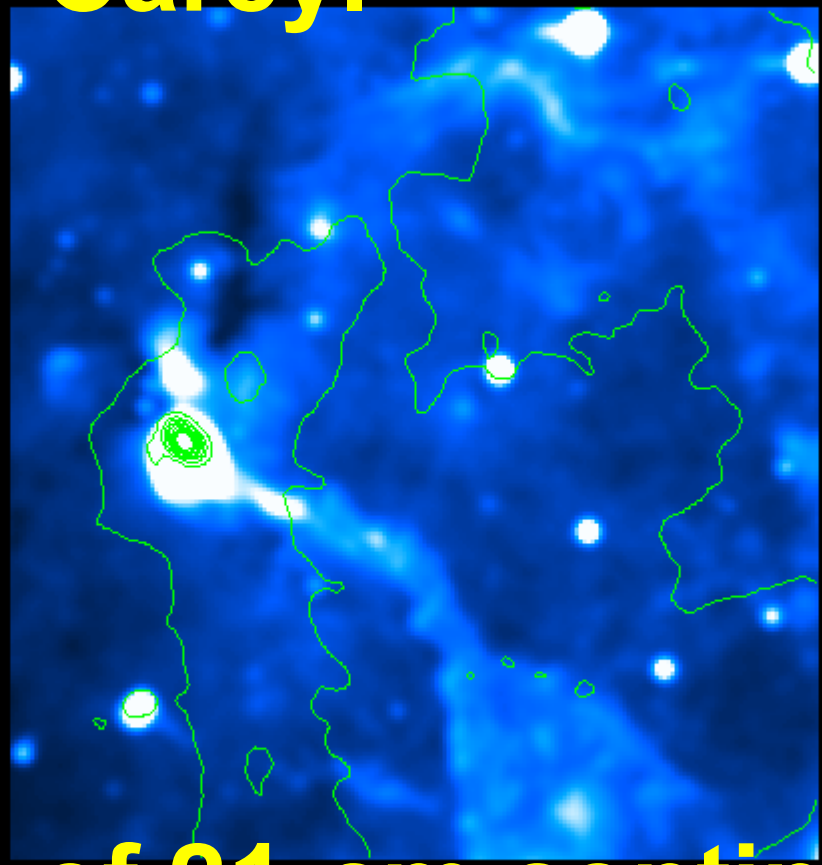
Radio continuum 21 com



Warmer dust (blue) associated with H II regions.

Infrared dark clouds – 8.6 μm MSX

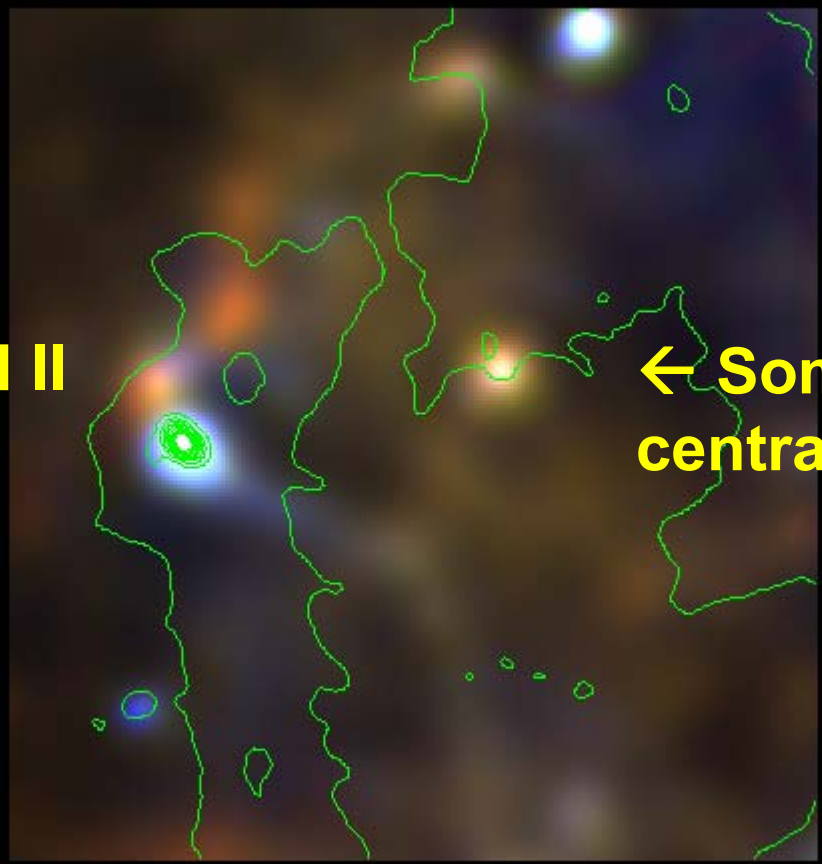
IRDCs can be stellar nurseries – poster by Carey.



Contours of 21-cm continuum: a compact HII region.

Warm and cold dust – BLAST

Cold cores with adjacent stellar activity.



Compact H II region →

← Some with warm central region.

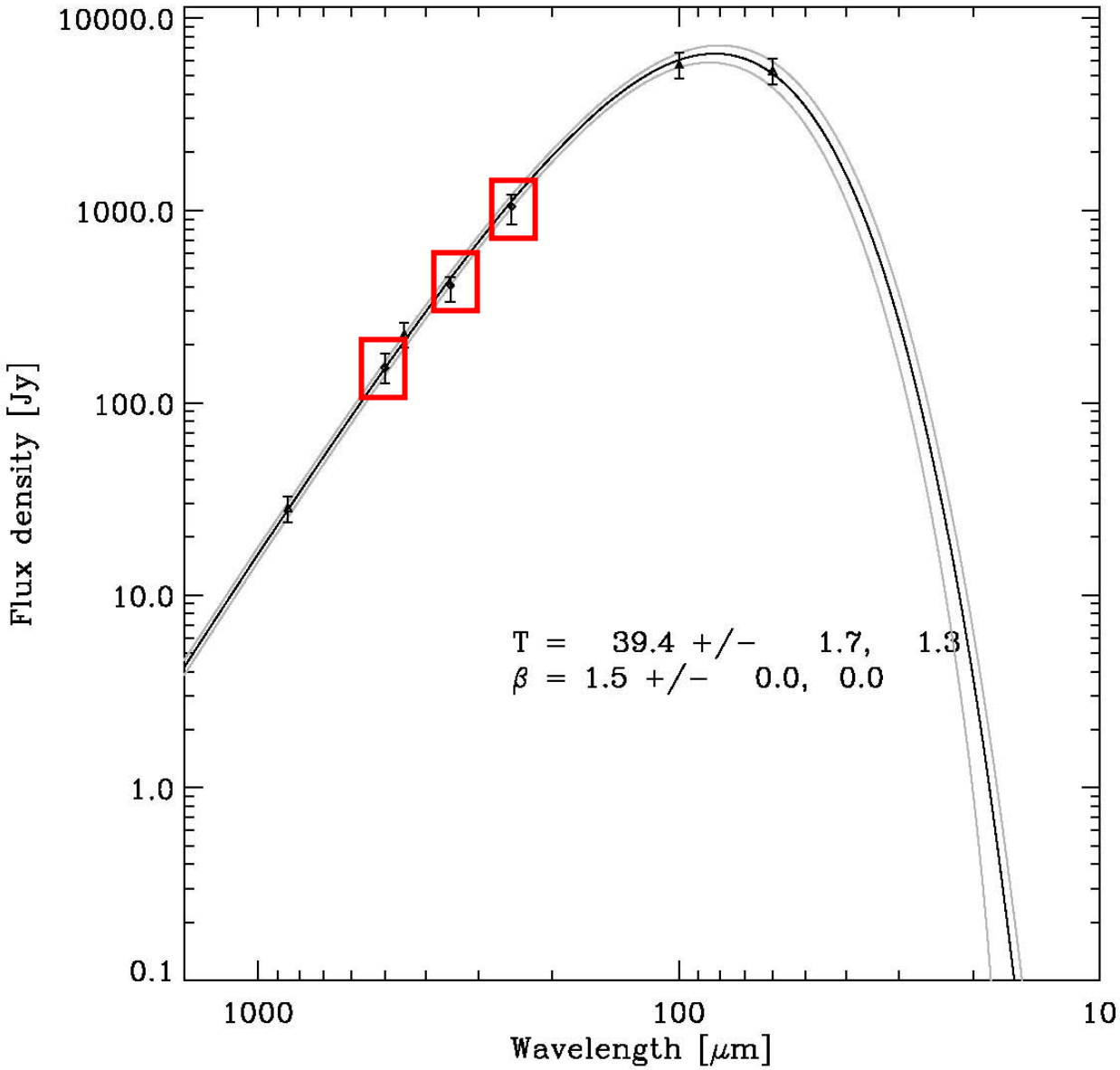
Cyg X Survey – 170 compact sources

To quantify the dust temperature, measure the SED using as many frequencies as possible.
e.g., to BLAST add IRAS on the high side, and SCUBA, Mambo and Bolocam on the low side.

Arabindo Roy

SED

BLAST frequencies are ideally placed to constrain the dust temperature, especially cool dust.



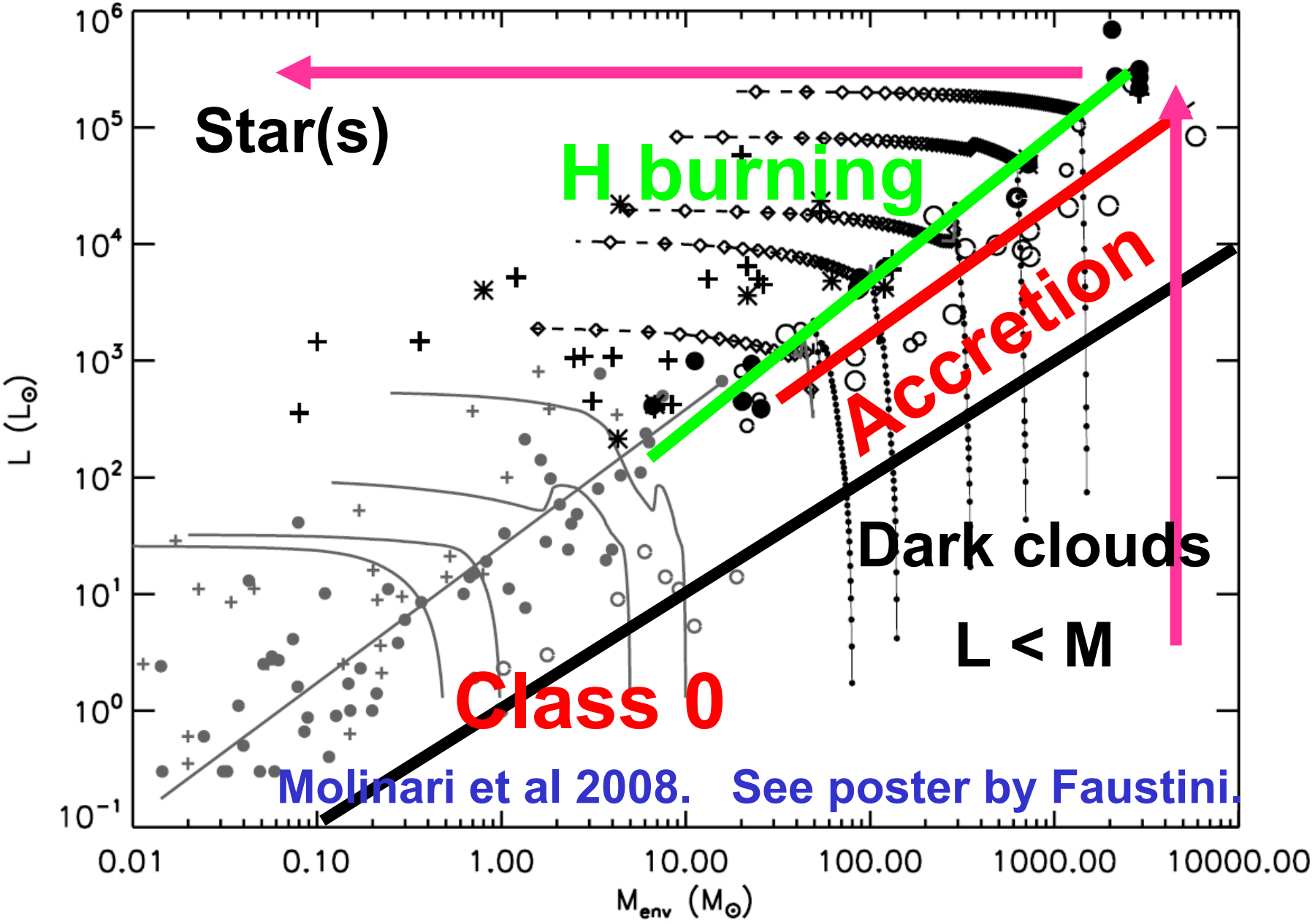
Luminosity and mass

Large range.

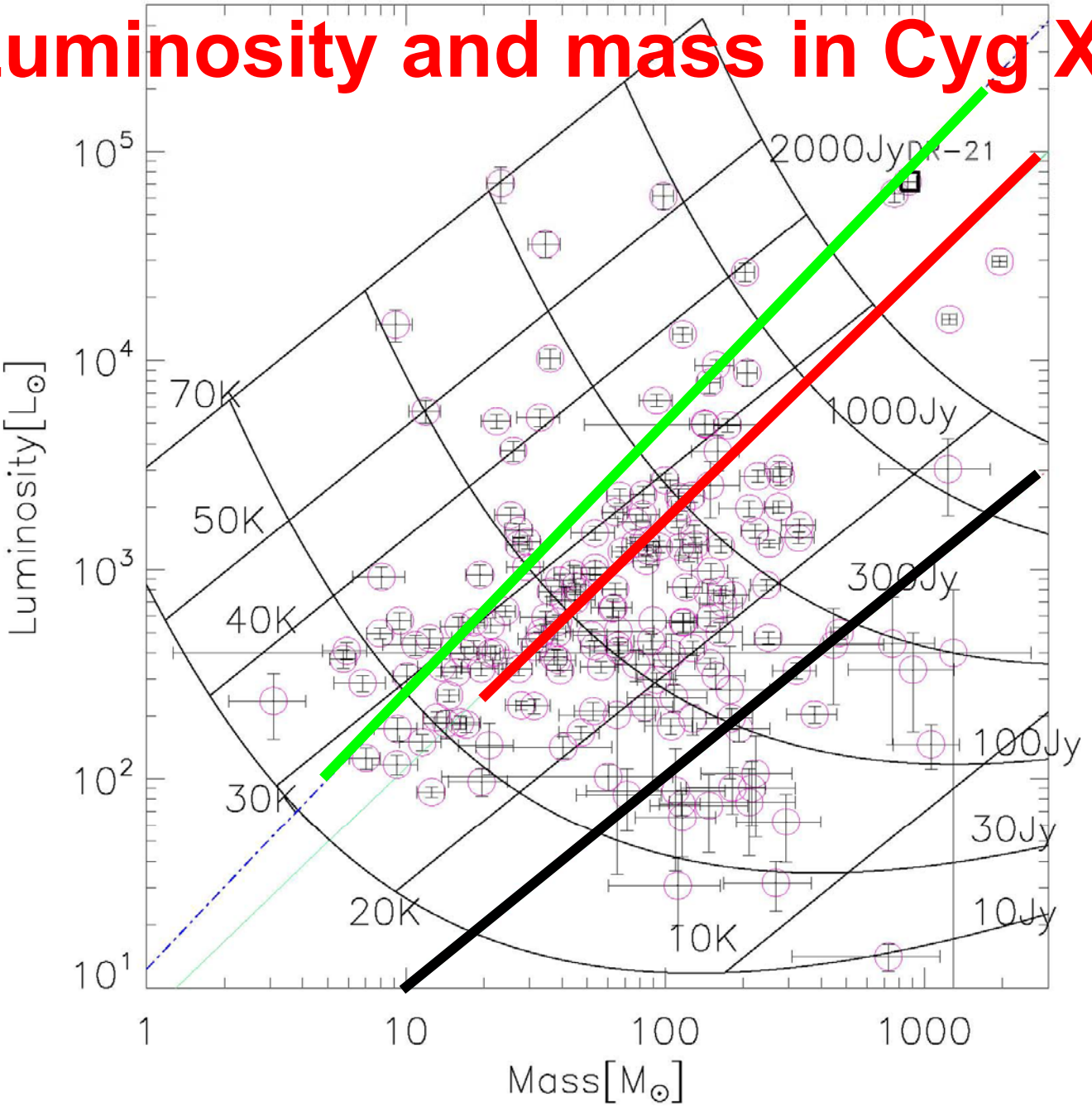
Protostars → warmer dust and higher luminosity.

Cores preceding massive star "formation" are cool and have a low luminosity.

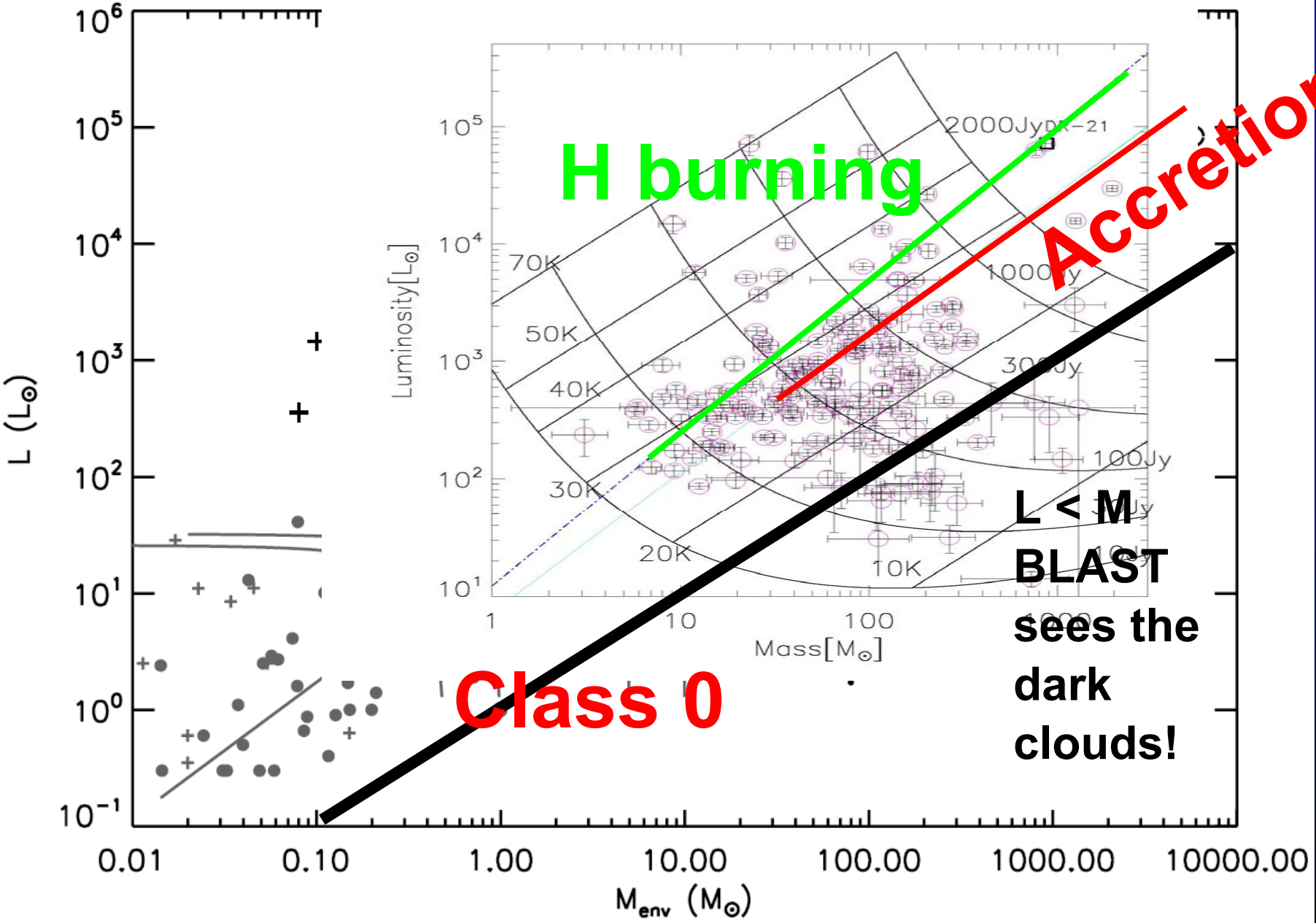
Luminosity and Mass: evolution



Luminosity and mass in Cyg X



Luminosity and Mass in Cyg X



Future

Herschel will have a smaller beam, and will make deeper maps. Some regions will be relatively nearby, allowing probe to lower masses at higher spatial resolution.

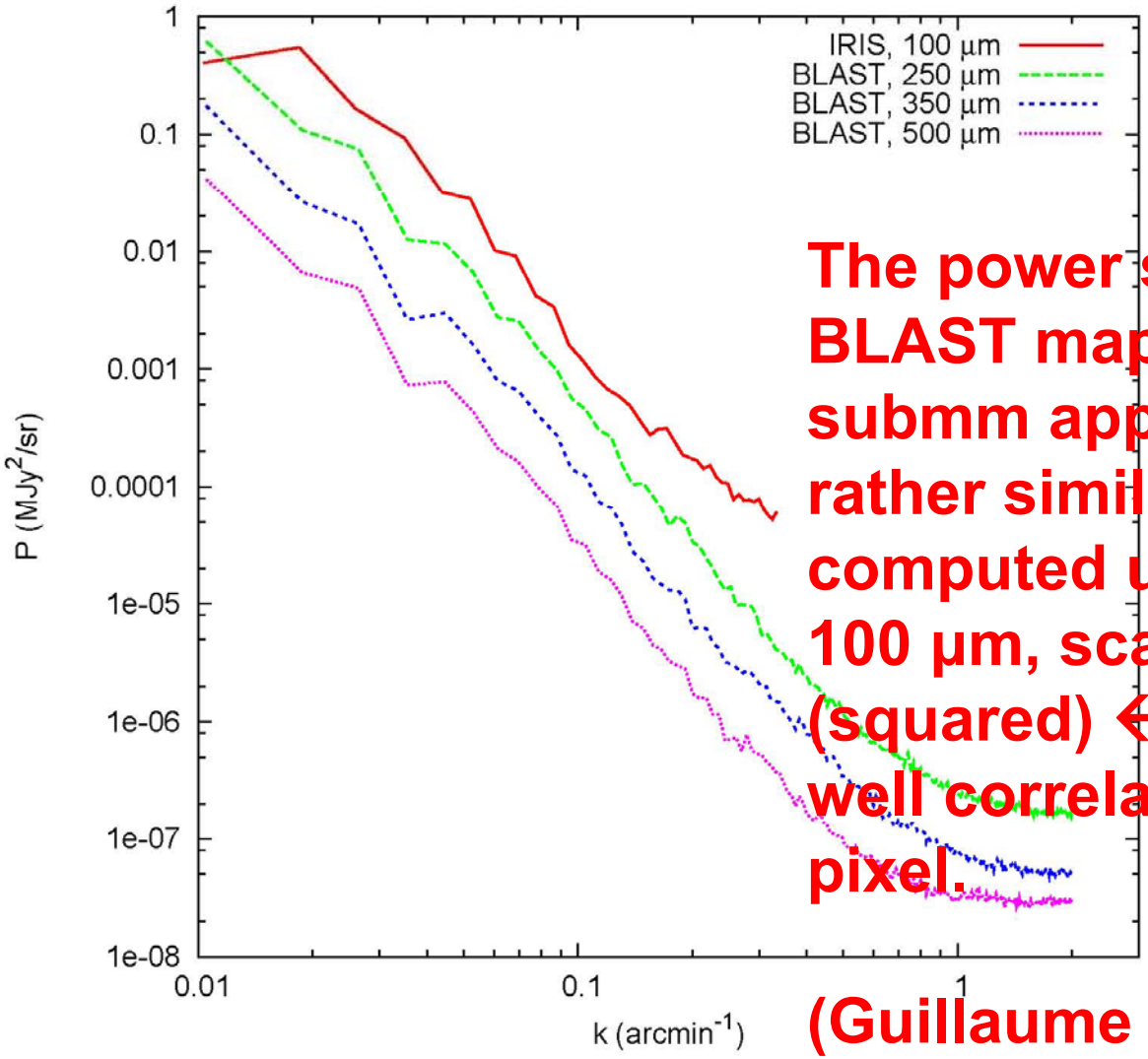
Limiting factors, beyond detector noise

Interstellar "froth" – cirrus confusion. Can estimate using power spectrum.

Source confusion.

Galaxies.

Power spectra in Cyg X



The power spectra from BLAST maps in the submm appear to be rather similar to that computed using IRAS at 100 µm, scaled with SED (squared) ←→ maps are well correlated pixel by pixel.

(Guillaume Rivest)

BLAST06

BLAST06, from Antarctica, had a very successful 11-d flight.

Devoted mostly to extragalactic science (talk by Mark Devlin).

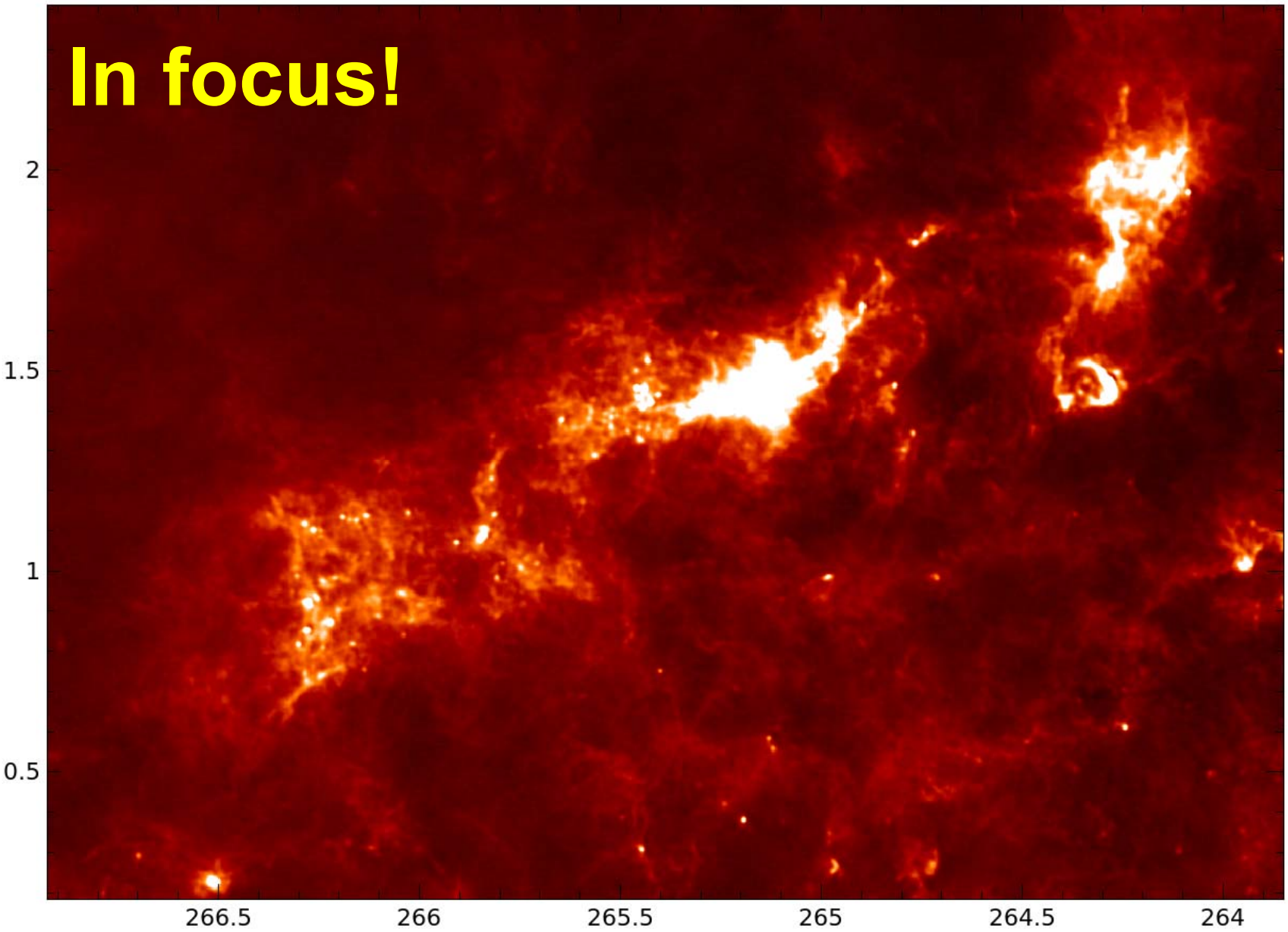
Made some spectacular observations in the Galactic plane.

Vela molecular ridge – 50 sq. deg.

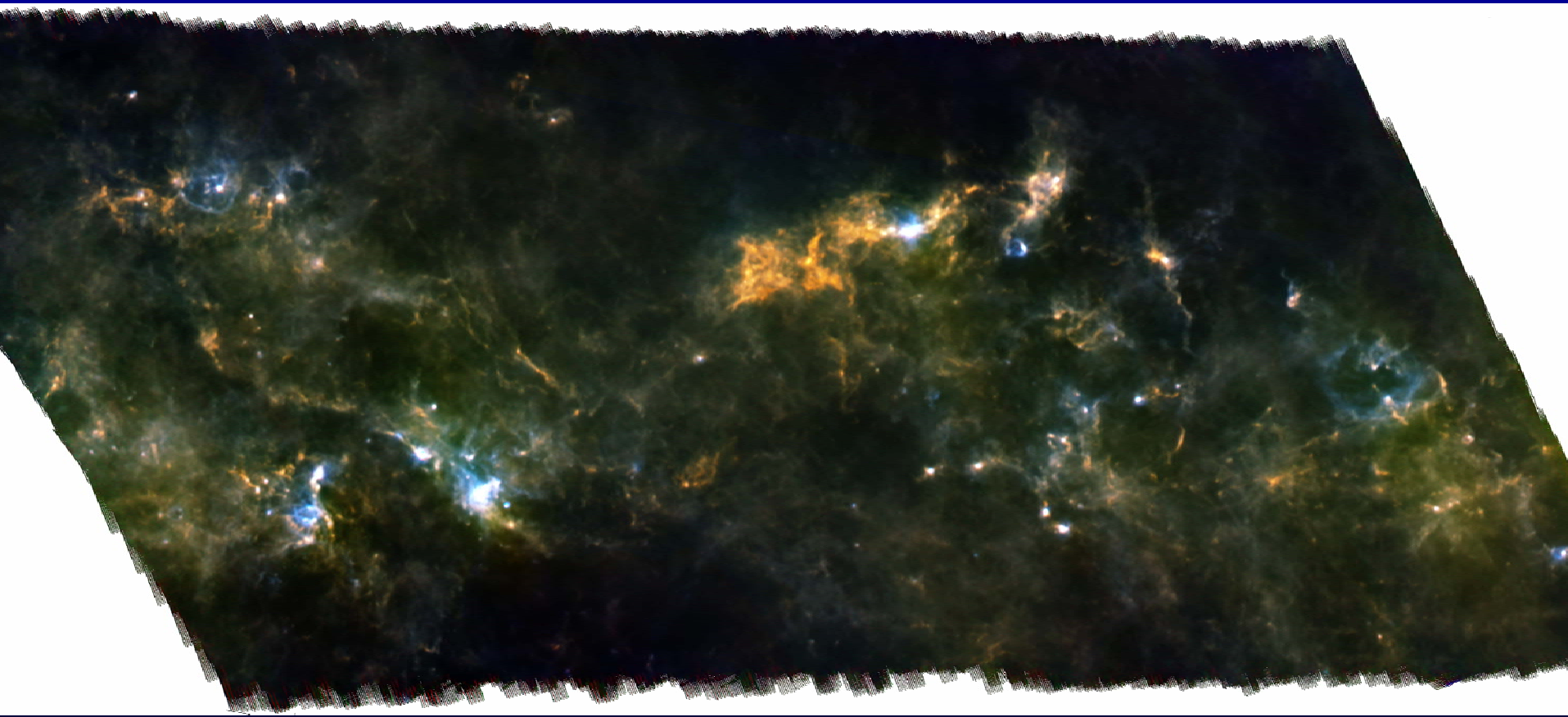
Found a large range of conditions, including a massive molecular cloud (Vela C) in which very little star formation has occurred yet. Yet there are many cold cores.

We can quantify the conditions (size, mass, temperature, even lifetime) that lead to star formation.

Vela C – 250 μm, 3 by 2 deg cutout

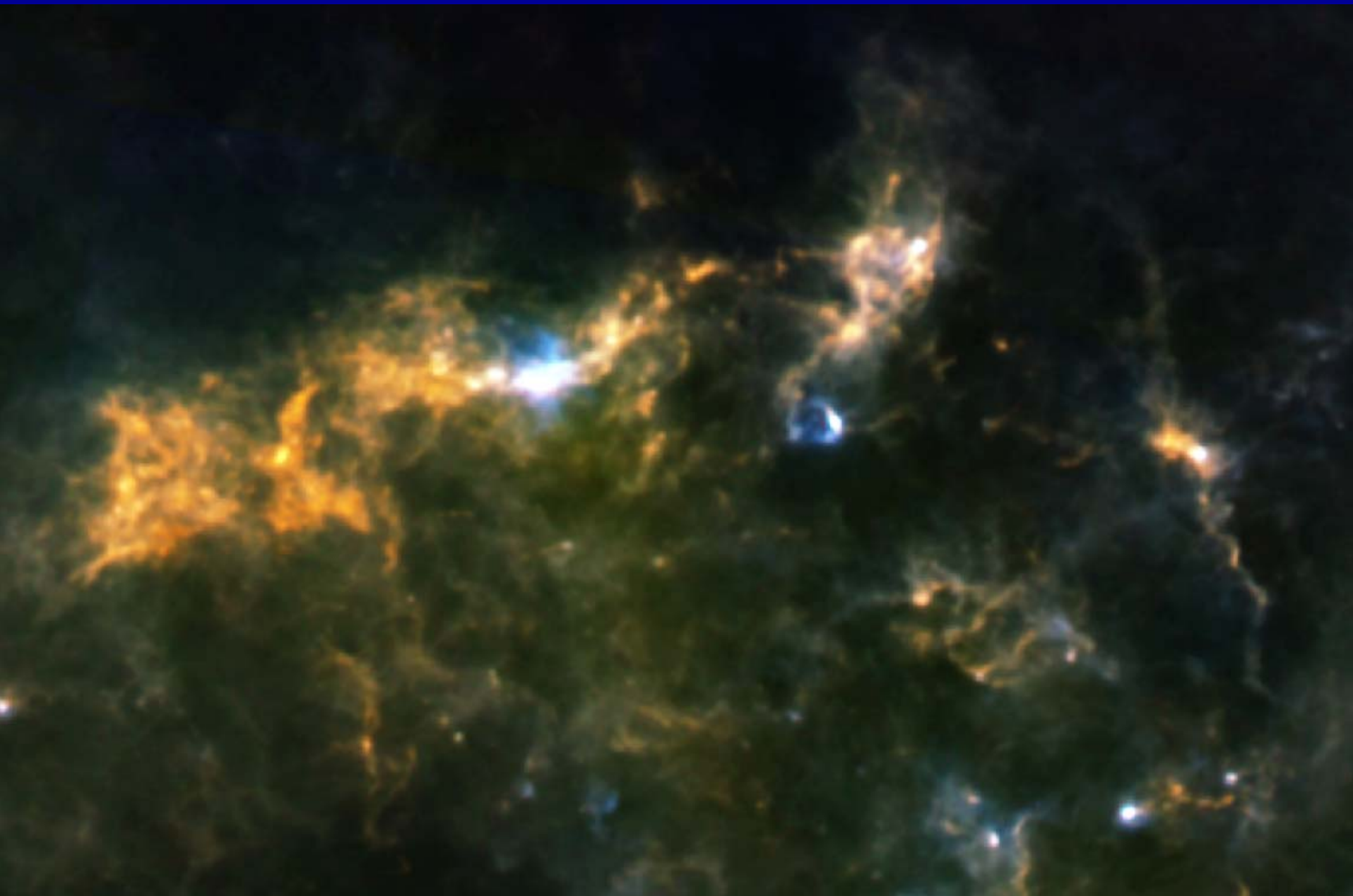


BLAST: 3-colour Vela image, 50 sq. d

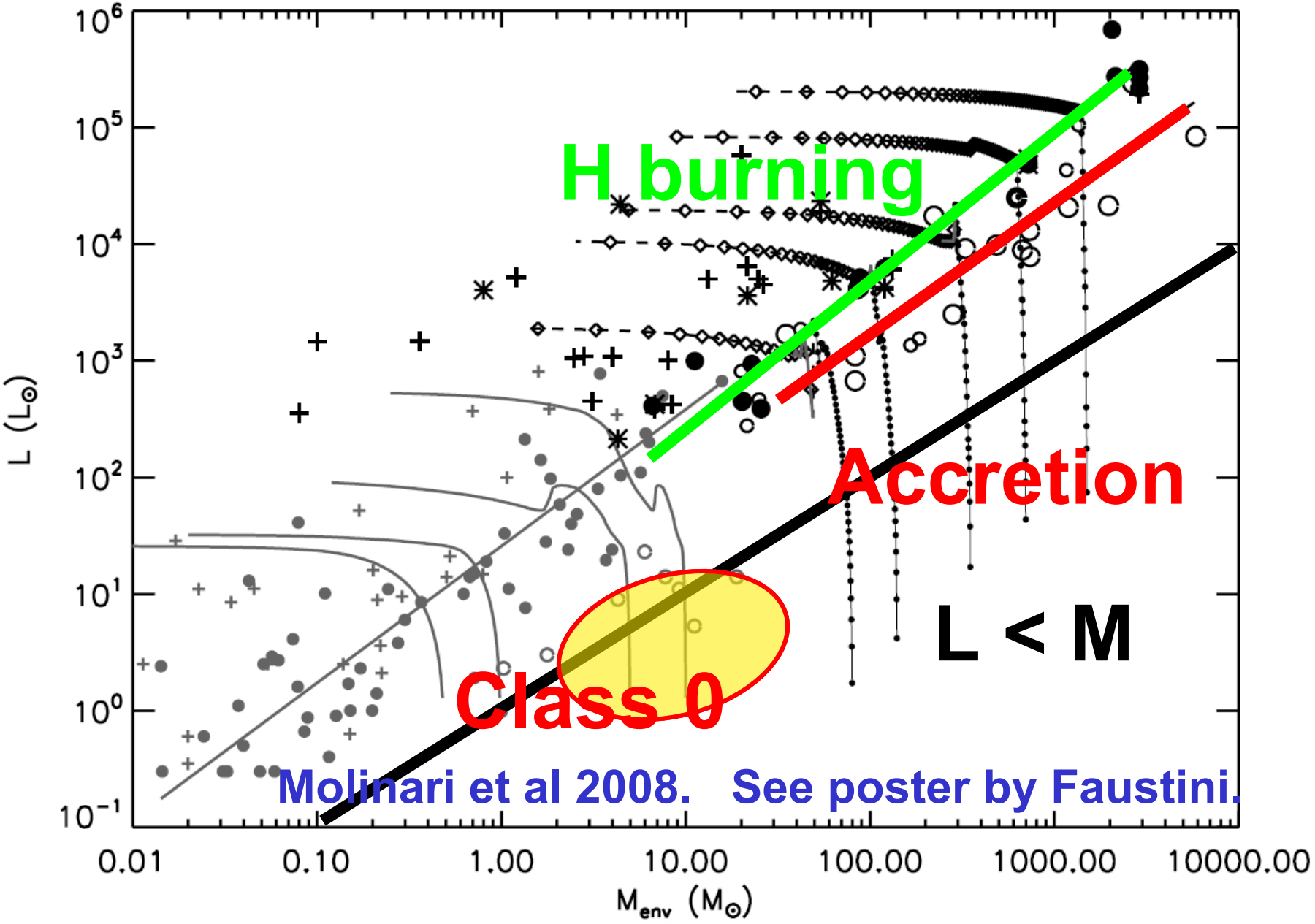


Netterfield et al. (2008) will present some highlights.

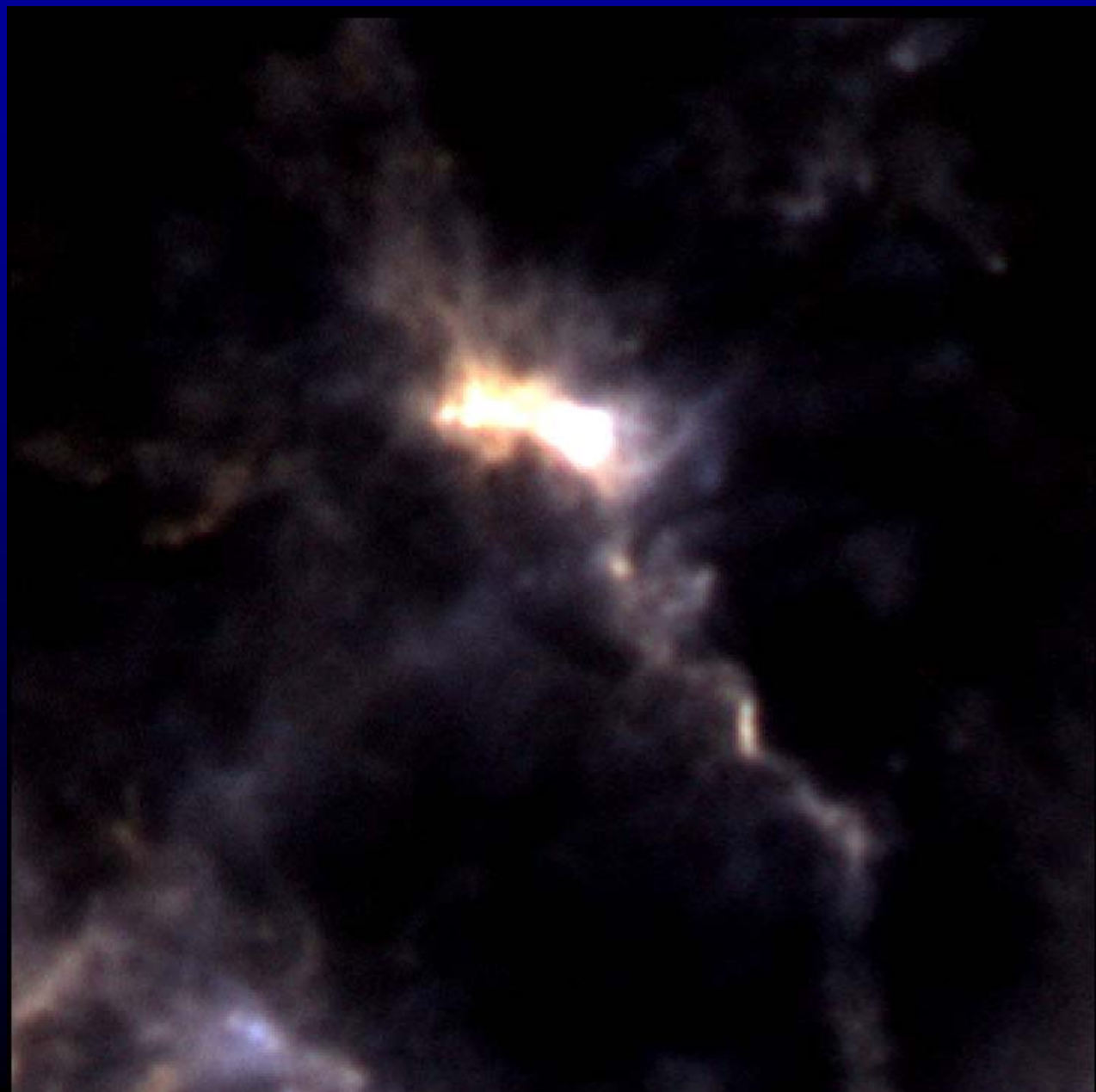
Vela C, 3-colour BLAST image



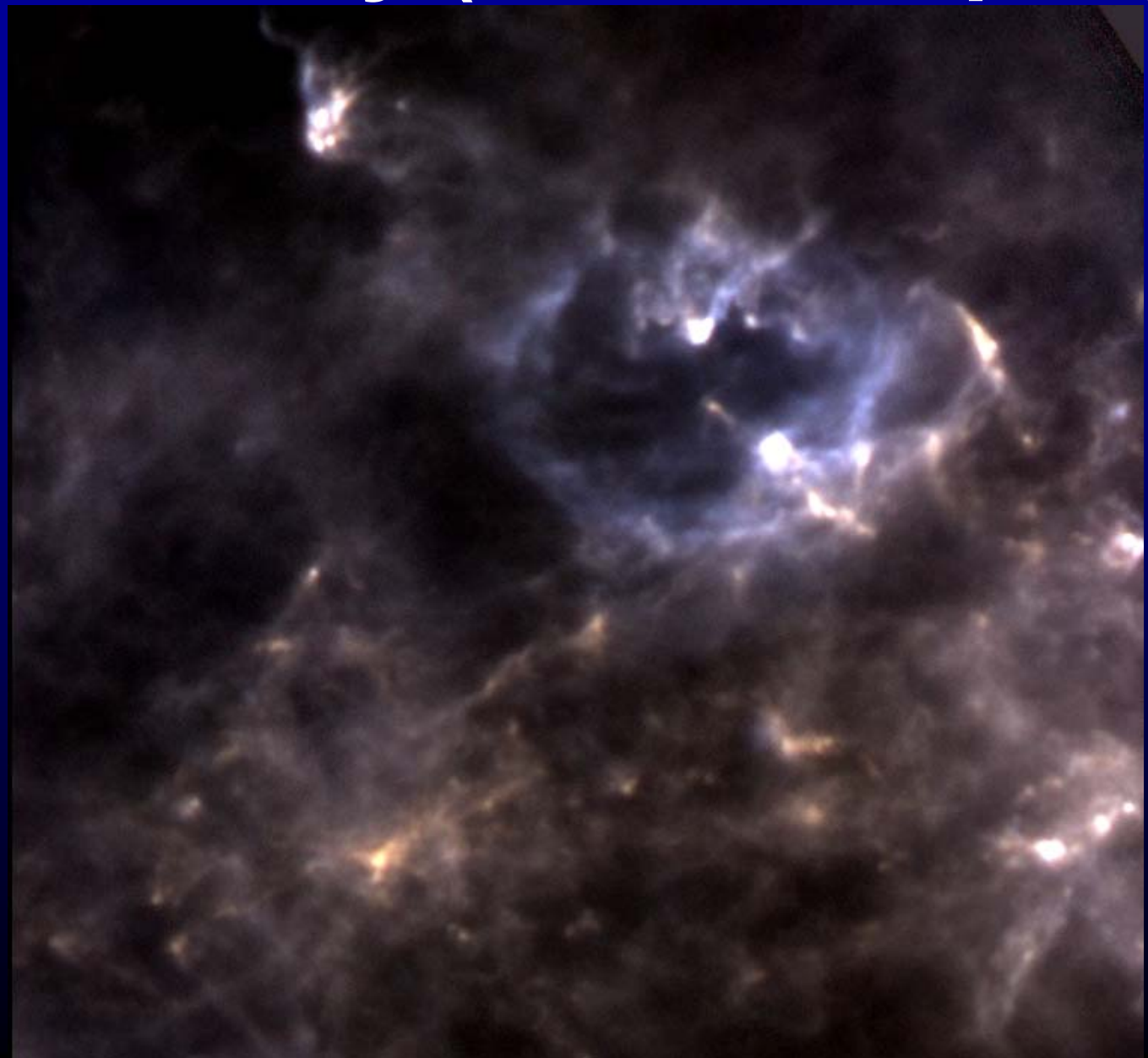
Luminosity and Mass in Vela C



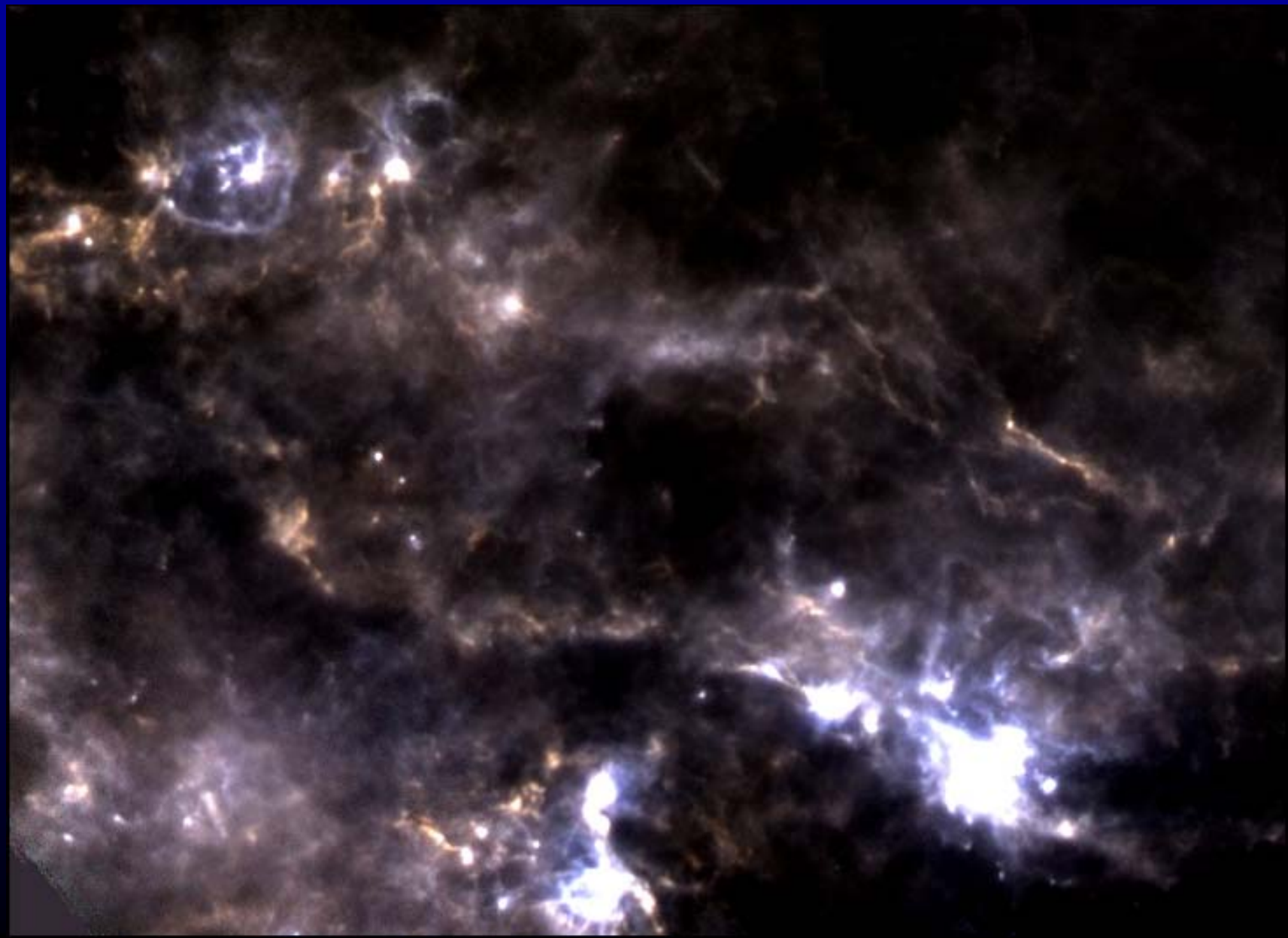
Vela Survey (detail, 1 sq deg)



Vela Survey (detail, 4 sq deg)



Vela Survey (detail, 3 by 4 deg)




Vela 3-colour
BLAST image
The work has
just begun…

END