THE FINE STRUCTURE OF THE WEB OF INTERSTELLAR FILAMENTS IN THE GOULD BELT CLOUDS

ALEXANDER MEN'SHCHIKOV

HERSCHEL Gould Belt Survey HOBYS SPIRE SAG3 cea

Credits

- *Herschel* GBS & HOBYS teams: Ph. André, N. Schneider, V. Könyves, P. Palmeirim, A. Roy, D. Arzoumanian, P. Didelon, F. Motte, A. Zavagno, S. Bontemps, J. di Francesco, M. Griffin, D. Ward-Thompson, A. Marston, G. White, F. Louvet, V. Minier, M. Sauvage, Q. Nguen Luong, N. Peretto, J. Kirk, K. Marsh, S. Pezzuto, A. Gusdorf, M. Hennemann, T. Hill, J.-Ph. Bernard, S. Sadavoy, N. Cox, C. Alves de Oliveira, C. Fallscheer, H. Aussel, H. Roussel, D. Russeil, L. Deharveng, P. Martin, A. Rivera-Ingraham, *et al.*

- Thanks to all those involved in *Herschel*, who made it great success.

SAG3

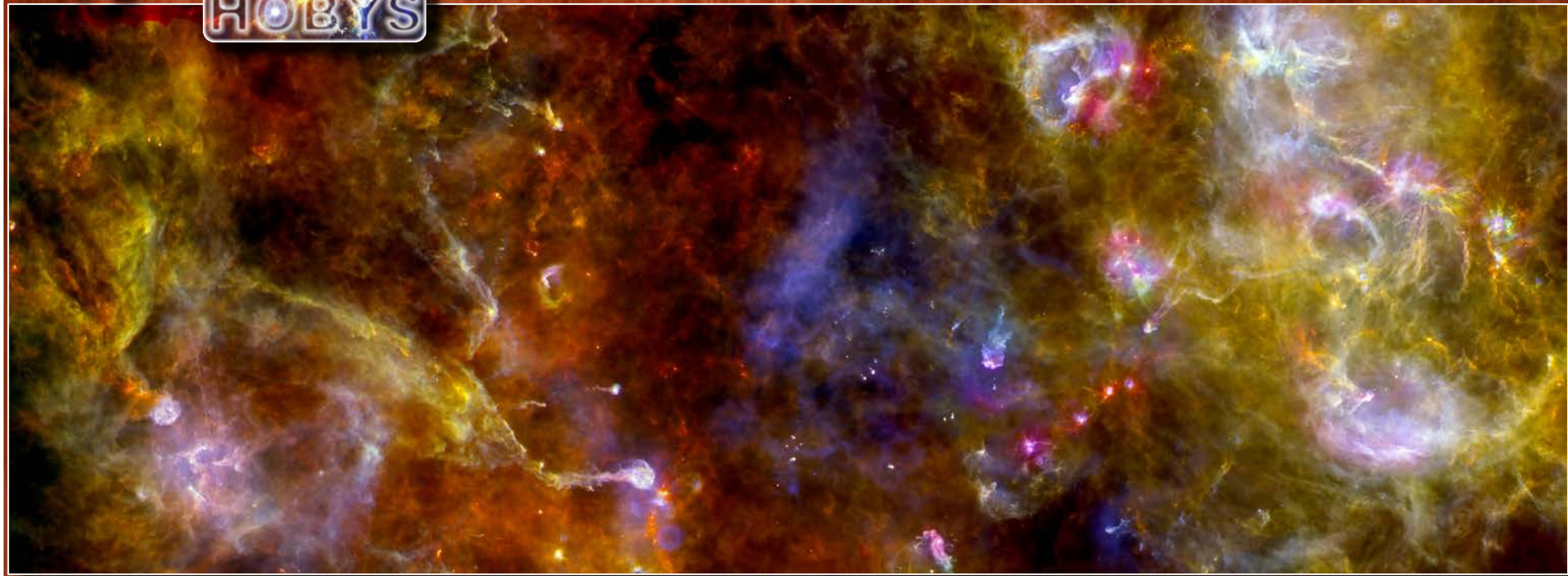
Orion

Ph. André + (2010)

http://oshi.esa.int

Cyg X

F. Motte, A. Zavagno, S. Bontemps + (2010)



http://oshi.esa.int

Questions

- Are all interstellar clouds filamentary?
- Can filaments be considered as simple cylinders?
- Are dense large-scale filaments sub-structured?
- Do stars (prestellar cores) always form in filaments?
- What are the structural properties of filaments?
- Does appearance of filaments depend on distance?
- What can we learn from filamentary *structures*?

Multi-Scale, Multi-Wavelength Source Extraction Method

getsources (Men'shchikov + 2012, A&A 542, A81)

Decompose detection images in (many) spatial scales: $\mathcal{I}_{\lambda\,\mathrm{D}} \rightarrow \mathcal{I}_{\lambda\,\mathrm{D}j}$

↓

Clean single scales by removing noise and background: $\mathcal{I}_{\lambda\,\mathrm{D}j} \rightarrow \mathcal{I}_{\lambda\,\mathrm{D}j\mathrm{C}}$

↓

Combine clean single-scale images over all wavelengths: $\mathcal{I}_{\lambda\,\mathrm{D}j\mathrm{C}} \rightarrow \mathcal{I}_{\mathrm{D}j\mathrm{C}}$

↓

Detect & catalog sources in combined clean single-scale images: $\mathcal{I}_{\mathrm{D}j\mathrm{C}} \rightarrow \mathrm{C}_{\mathrm{D}}$

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Measure & catalog sources properties at all wavelengths: $\mathrm{C}_{\mathrm{D}}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

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Visualize extracted sources: $\mathrm{C}_{\mathrm{M}\,\lambda}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathcal{I}_{\lambda\,\mathrm{E}}, \mathcal{I}_{\lambda\,i}$

Successive unsharp masking:
$\mathcal{I}_{\lambda j} = G_{j-1} * \mathcal{I}_{\lambda} - G_{j} * \mathcal{I}_{\lambda}$ ($j = 1, 2, \ldots, N_{\mathrm{S}}$);
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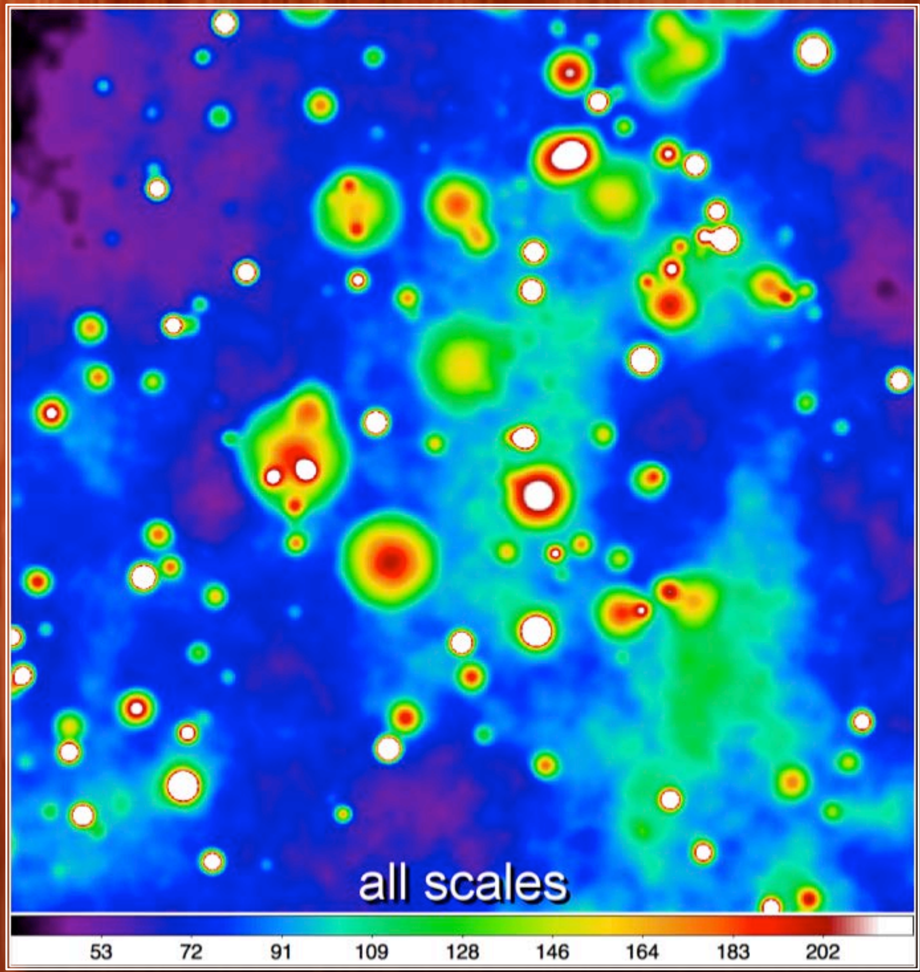
Visualize extracted sources: $\mathrm{C}_{\mathrm{M}\,\lambda}, I_{\lambda\,\mathrm{O}} \rightarrow I_{\lambda\,\mathrm{E}}, I_{\lambda\,i}$



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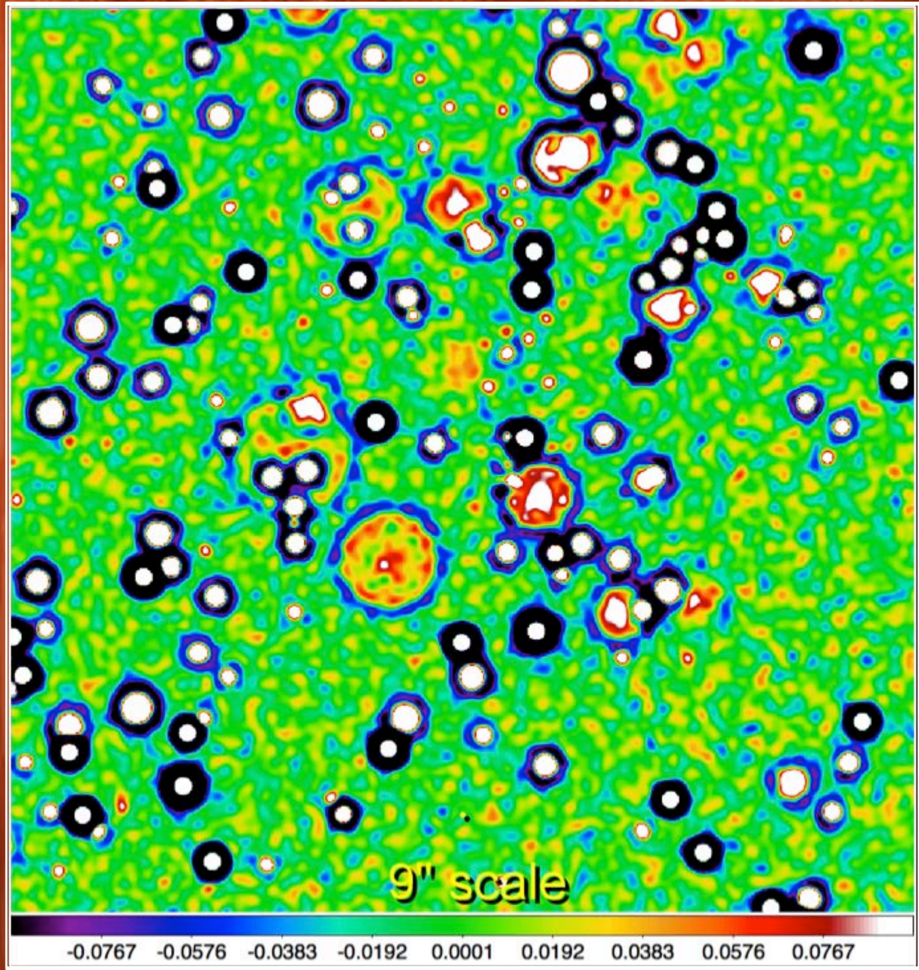

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Detect & catalog sources in combined clean single-scale images: $I_{\mathrm{D}j\mathrm{C}} \rightarrow \mathrm{C_D}$

Measure & catalog sources properties at all wavelengths: $\mathrm{C_D}, I_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

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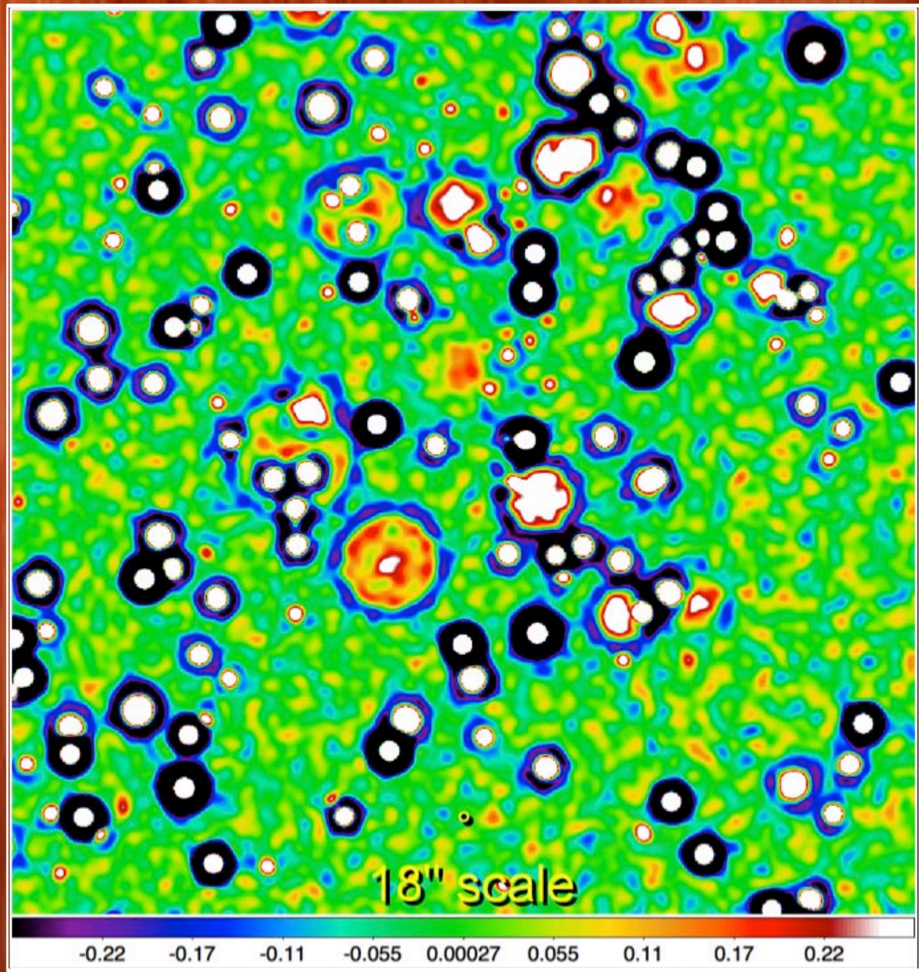

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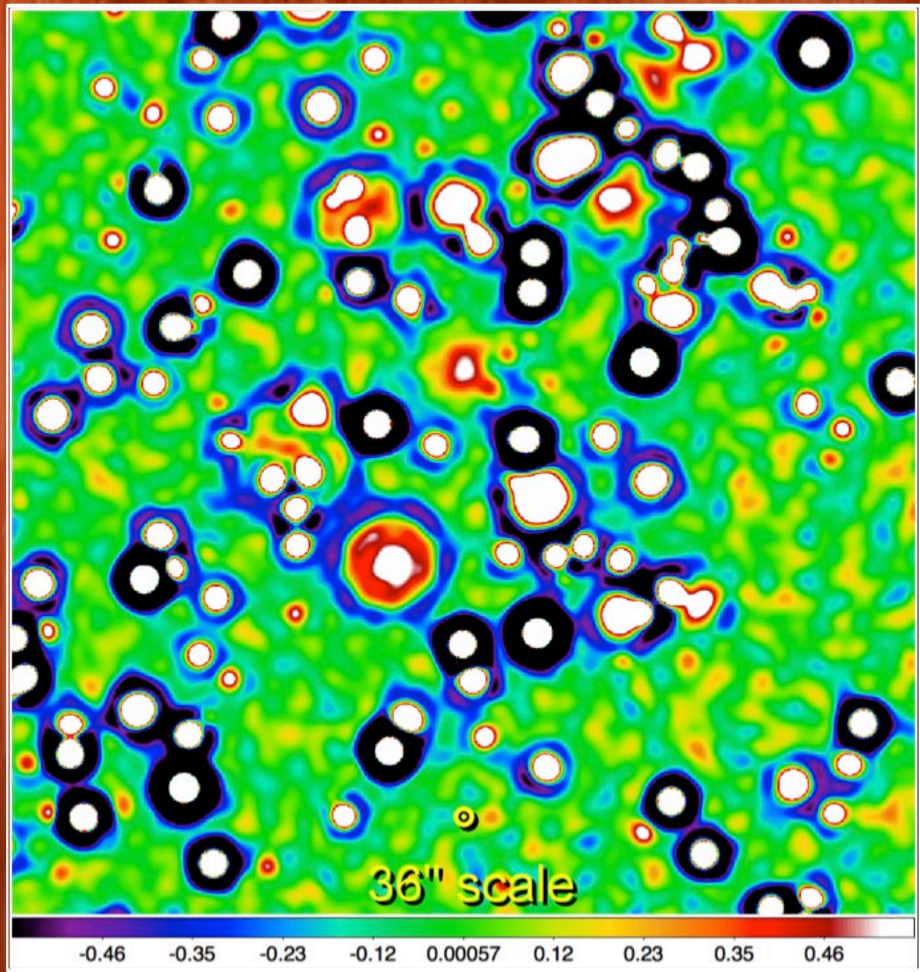

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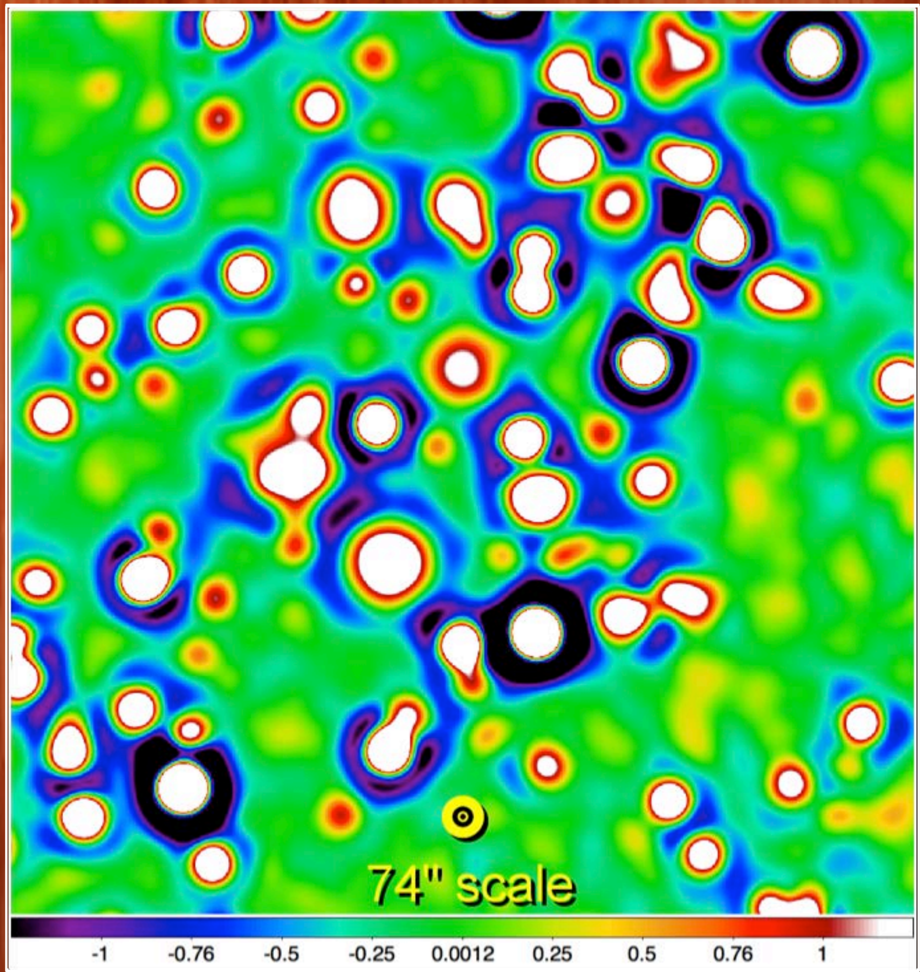

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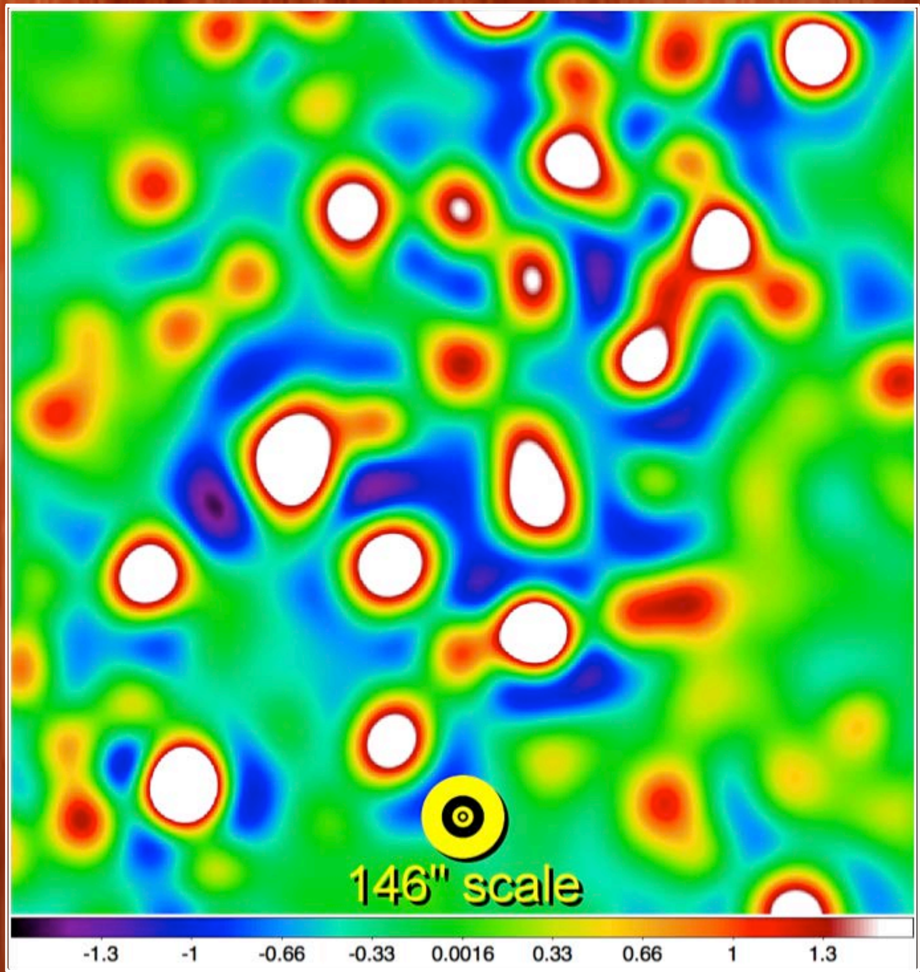

HERSCHEL Gould Belt Survey

HOBYS

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Detect & catalog sources in combined clean single-scale images: $I_{\mathrm{D}j\mathrm{C}} \rightarrow \mathrm{C_D}$

Measure & catalog sources properties at all wavelengths: $\mathrm{C_D}, I_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

Visualize extracted sources: $\mathrm{C}_{\mathrm{M}\,\lambda}, I_{\lambda\,\mathrm{O}} \rightarrow I_{\lambda\,\mathrm{E}}, I_{\lambda\,i}$

Successive unsharp masking:
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originals recoverable by $I_{\lambda} = \mathrm{sum}\,\{ I_{\lambda j} \}$

Find cleaning thresholds (3-6) $\sigma_{\lambda j}$ outside of sources and filaments and set all fainter pixels to zero

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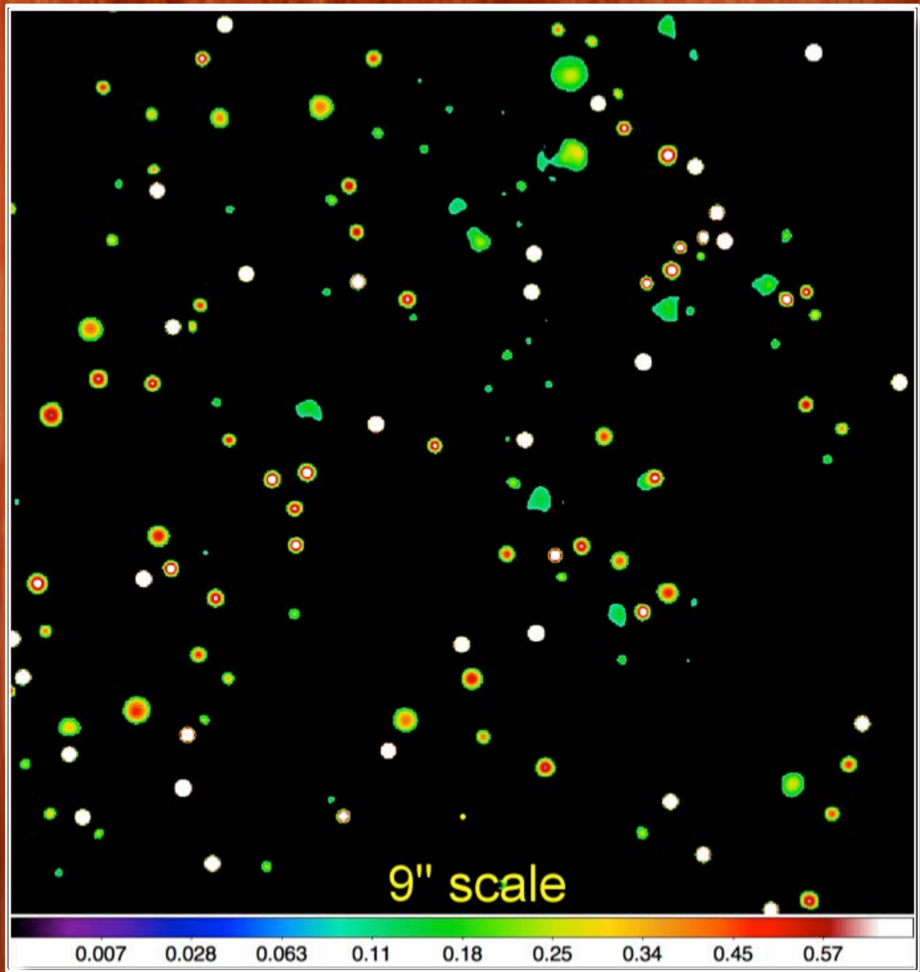

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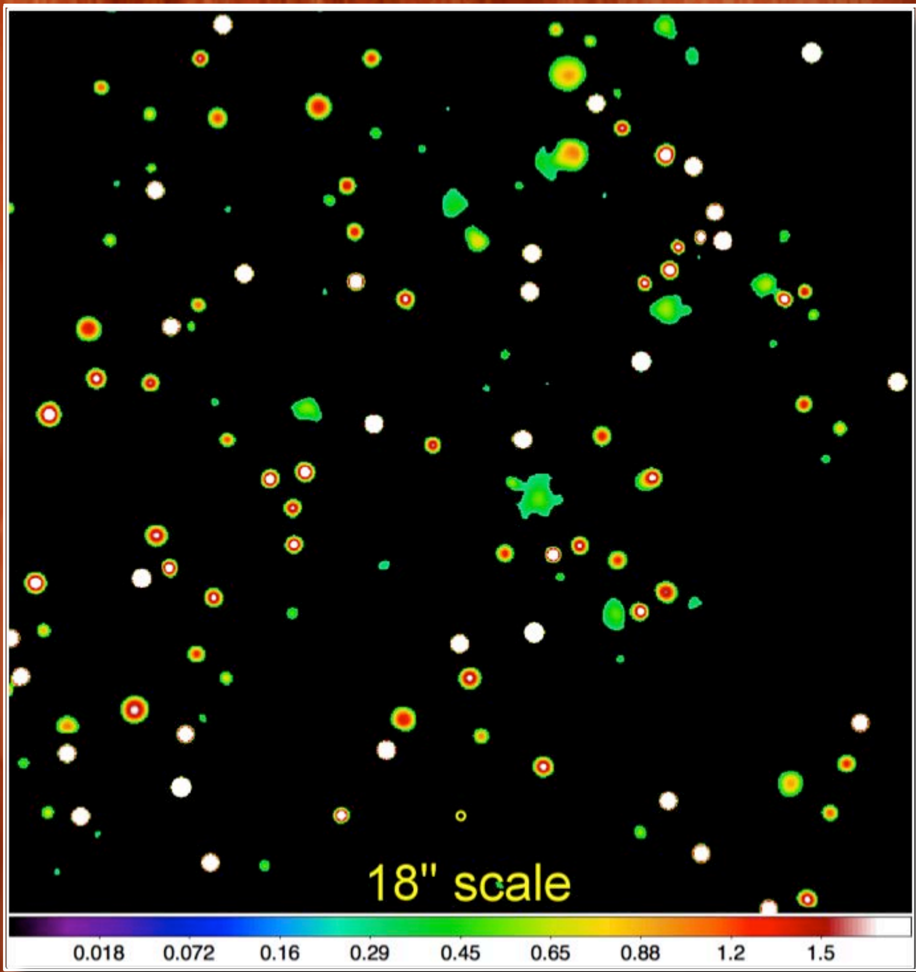
Clean single scales by removing noise and background: $I_{\lambda\,Dj} \rightarrow I_{\lambda\,DjC}$

Combine clean single-scale images over all wavelengths: $I_{\lambda\,DjC} \rightarrow I_{DjC}$

Detect & catalog sources in combined clean single-scale images: $I_{DjC} \rightarrow C_D$

Measure & catalog sources properties at all wavelengths: $C_D, I_{\lambda\,O} \rightarrow C_{M\lambda}$

Visualize extracted sources: $C_{M\lambda}, I_{\lambda\,O} \rightarrow I_{\lambda\,E}, I_{\lambda\,i}$



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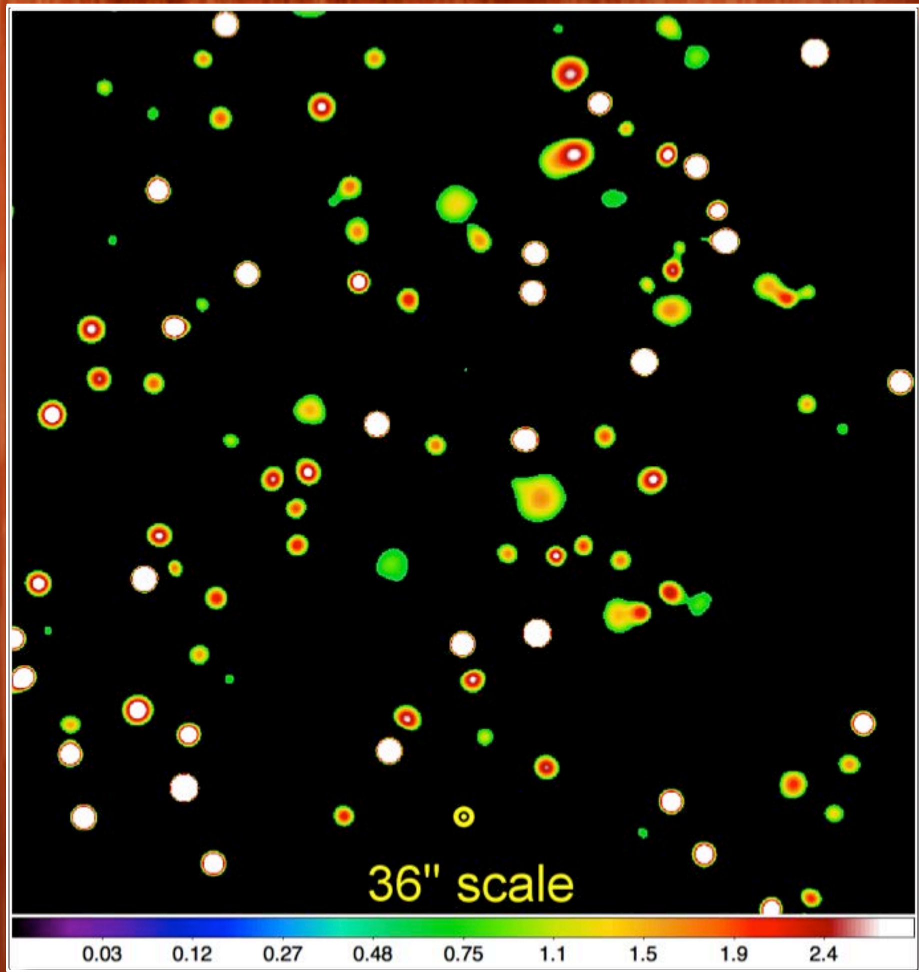

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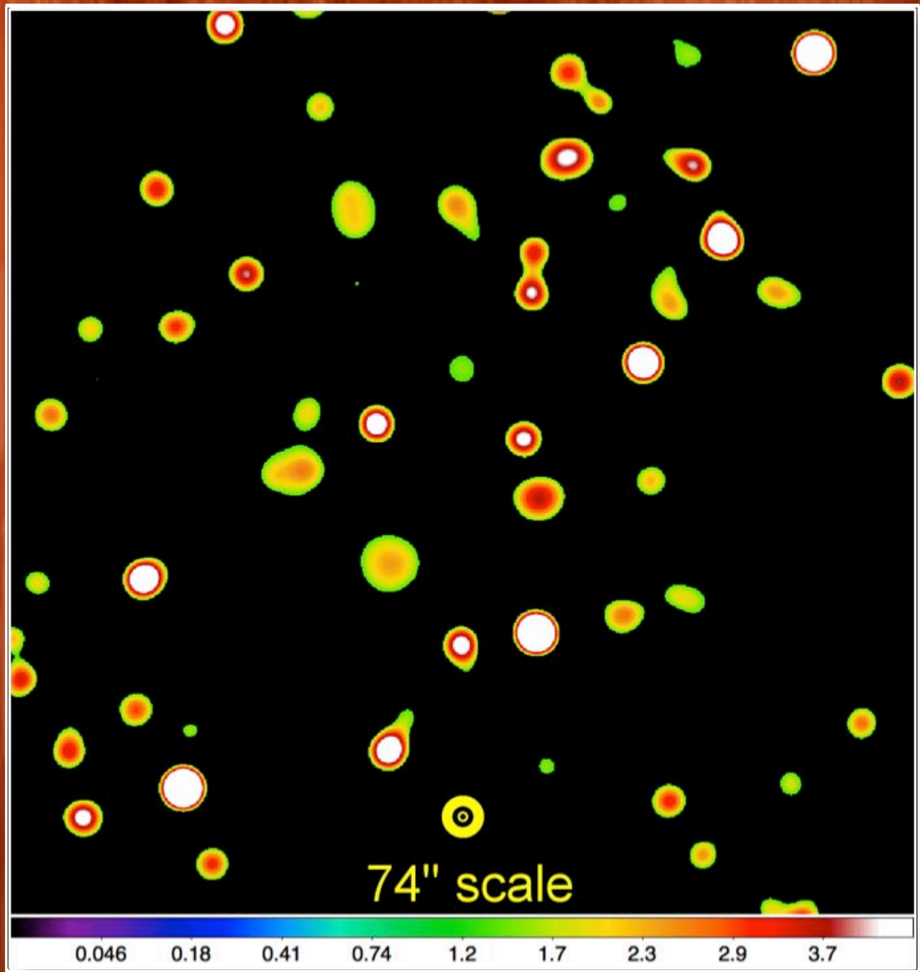

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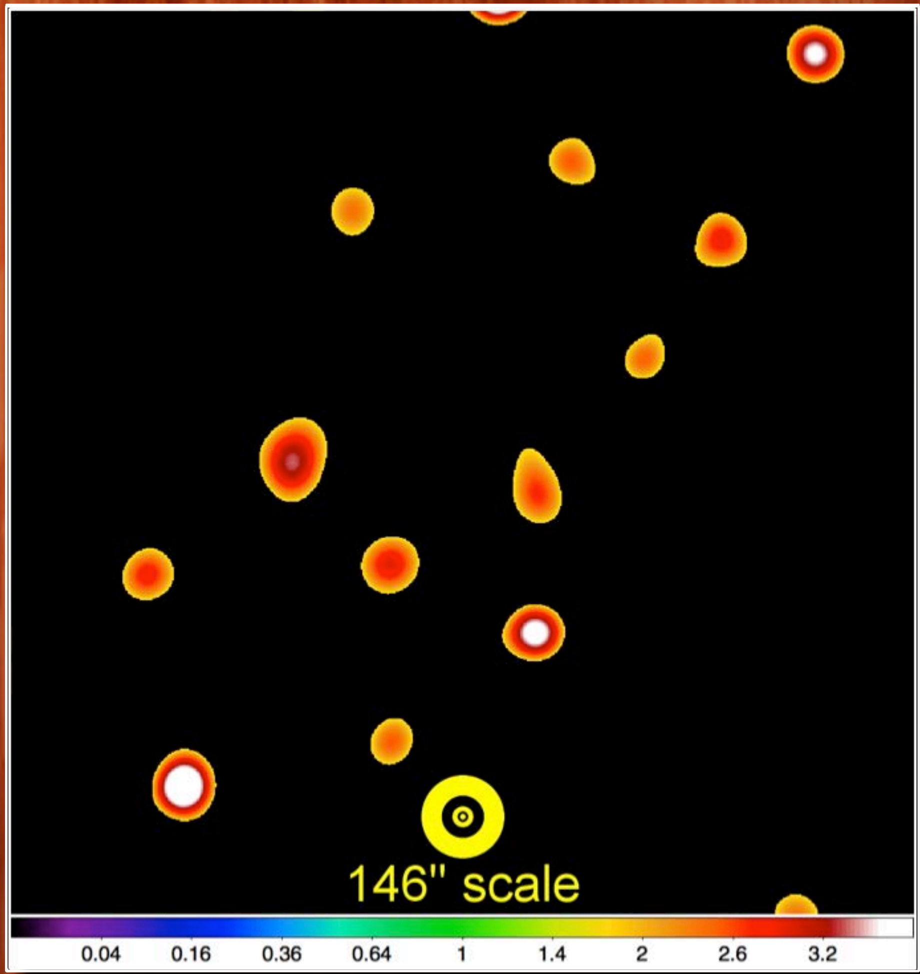

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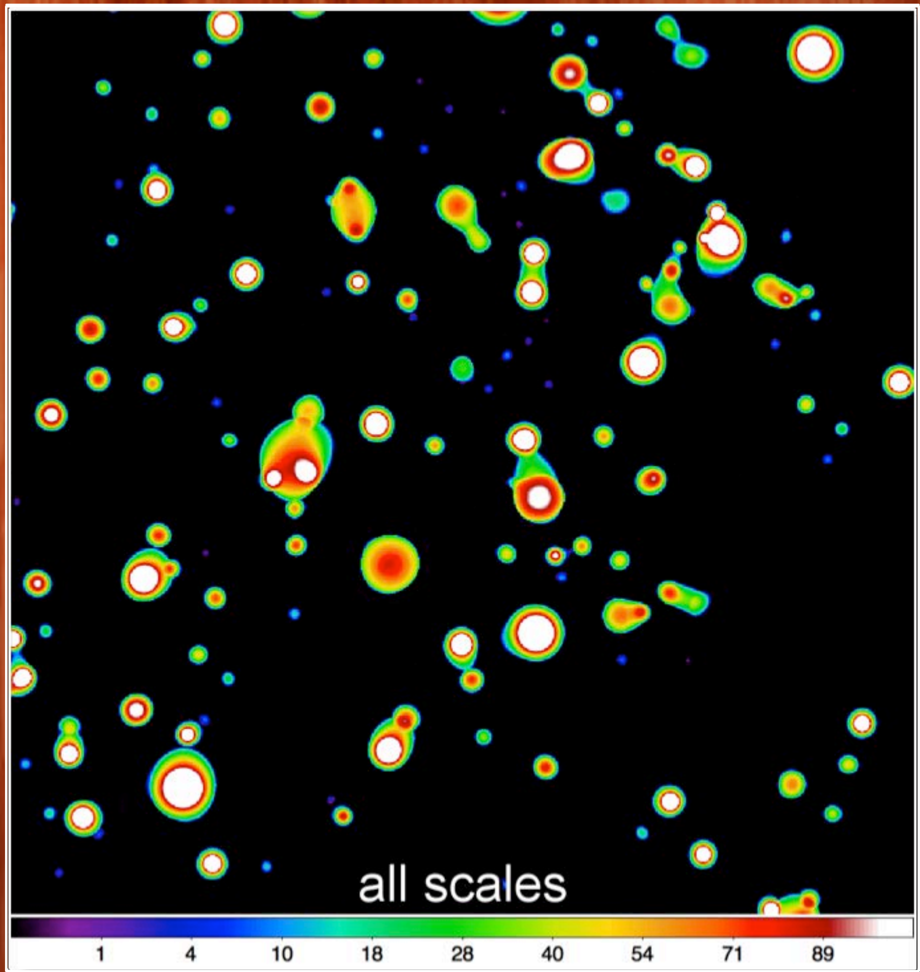

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Measure & catalog sources properties at all wavelengths: $\mathrm{C}_{\mathrm{D}}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

Visualize extracted sources: $\mathrm{C}_{\mathrm{M}\,\lambda}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathcal{I}_{\lambda\,\mathrm{E}}, \mathcal{I}_{\lambda\,i}$

Successive unsharp masking: $\mathcal{I}_{\lambda j} = \mathcal{G}_{j-1} * \mathcal{I}_{\lambda} - \mathcal{G}_{j} * \mathcal{I}_{\lambda}$ ($j = 1, 2, \ldots, N_{\mathrm{S}}$); originals recoverable by $\mathcal{I}_{\lambda} = \mathrm{sum}\{\,\mathcal{I}_{\lambda j}\,\}$

Find cleaning thresholds (3-6) $\sigma_{\lambda j}$ outside of sources and filaments and set all fainter pixels to zero

Create wavelength-independent set of clean single-scale detection images

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Clean single scales by removing noise and background: $\mathcal{I}_{\lambda\,\mathrm{D}j} \rightarrow \mathcal{I}_{\lambda\,\mathrm{D}j\mathrm{C}}$

Find cleaning thresholds (3-6) $\sigma_{\lambda j}$ outside of sources and filaments and set all fainter pixels to zero

Combine clean single-scale images over all wavelengths: $\mathcal{I}_{\lambda\,\mathrm{D}j\mathrm{C}} \rightarrow \mathcal{I}_{\mathrm{D}j\mathrm{C}}$

Create wavelength-independent set of clean single-scale detection images

Detect & catalog sources in combined clean single-scale images: $\mathcal{I}_{\mathrm{D}j\mathrm{C}} \rightarrow \mathrm{C}_{\mathrm{D}}$

Measure & catalog sources properties at all wavelengths: $\mathrm{C}_{\mathrm{D}}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

Visualize extracted sources: $\mathrm{C}_{\mathrm{M}\,\lambda}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathcal{I}_{\lambda\,\mathrm{E}}, \mathcal{I}_{\lambda\,i}$

The method detects sources in filament-subtracted single-scale images and it measures sources in the observed (but also) filament-subtracted image.

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Multi-Scale Filament Extraction Method

getfilaments (Men'shchikov 2013, A&A 560, A63)

Decompose detection images in (many) spatial scales: $\mathcal{I}_{\lambda\,\mathrm{D}} \rightarrow \mathcal{I}_{\lambda\,\mathrm{D}j}$

↓

Clean single scales of sources, noise, and background: $\mathcal{I}_{\lambda\,\mathrm{D}j} \rightarrow \mathcal{I}_{\lambda\,\mathrm{D}j\mathrm{C}}$

↓

Measure & catalog properties of filaments at all waves: $\mathrm{C}_{\mathrm{D}}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

↓

Visualize extracted filaments: $\mathrm{C}_{\mathrm{M}\,\lambda}, \mathcal{I}_{\lambda\,\mathrm{O}} \rightarrow \mathcal{I}_{\lambda\,\mathrm{E}}, \mathcal{I}_{\lambda\,i}$

Successive unsharp masking:
$\mathcal{I}_{\lambda j} = G_{j-1} * \mathcal{I}_{\lambda} - G_{j} * \mathcal{I}_{\lambda}$ ($j = 1, 2, \ldots, N_{\mathrm{S}}$);
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Multi-Scale Filament Extraction Method

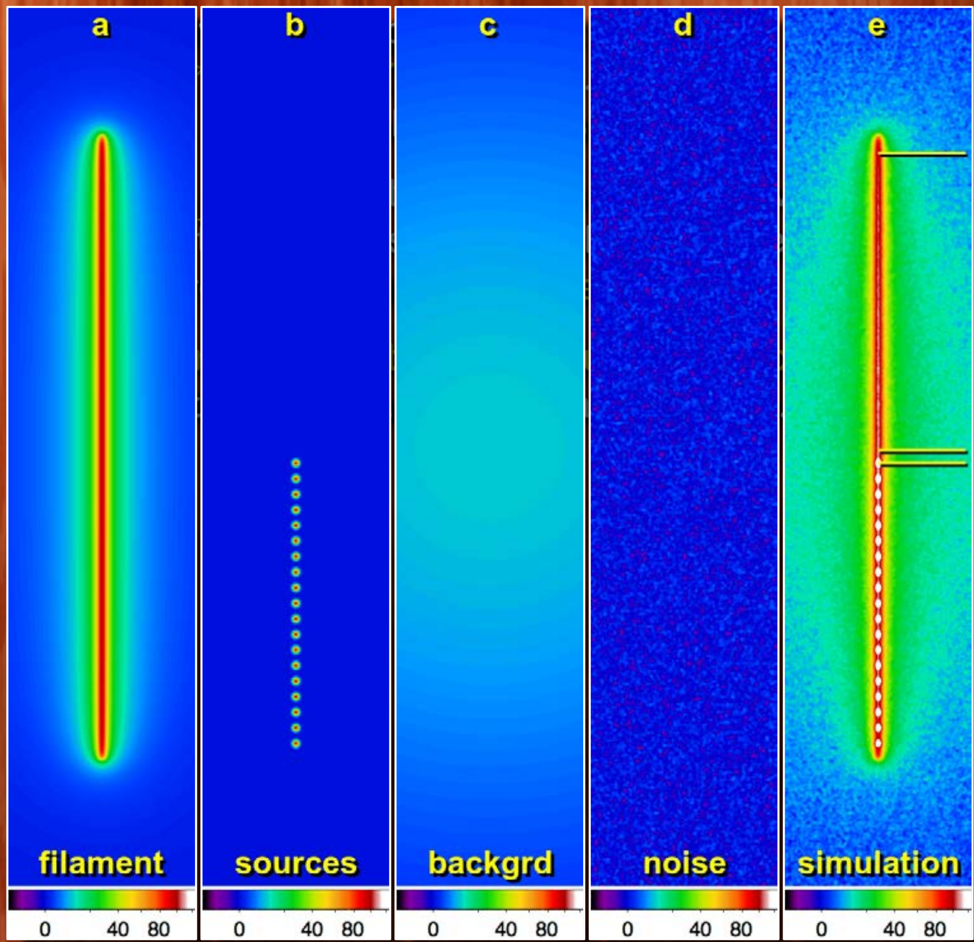
getfilaments (Men'shchikov 2013, A&A 560, A63)

Decompose detection images in (many) spatial scales: $I_{\lambda\,\mathrm{D}} \rightarrow I_{\lambda\,\mathrm{D}j}$

Clean single scales of sources, noise, and background: $I_{\lambda\,\mathrm{D}j} \rightarrow I_{\lambda\,\mathrm{D}j\mathrm{C}}$

Measure & catalog properties of filaments at all waves: $\mathrm{C_D}, I_{\lambda\,\mathrm{O}} \rightarrow \mathrm{C}_{\mathrm{M}\,\lambda}$

Visualize extracted filaments: $\mathrm{C}_{\mathrm{M}\,\lambda}, I_{\lambda\,\mathrm{O}} \rightarrow I_{\lambda\,\mathrm{E}}, I_{\lambda\,i}$



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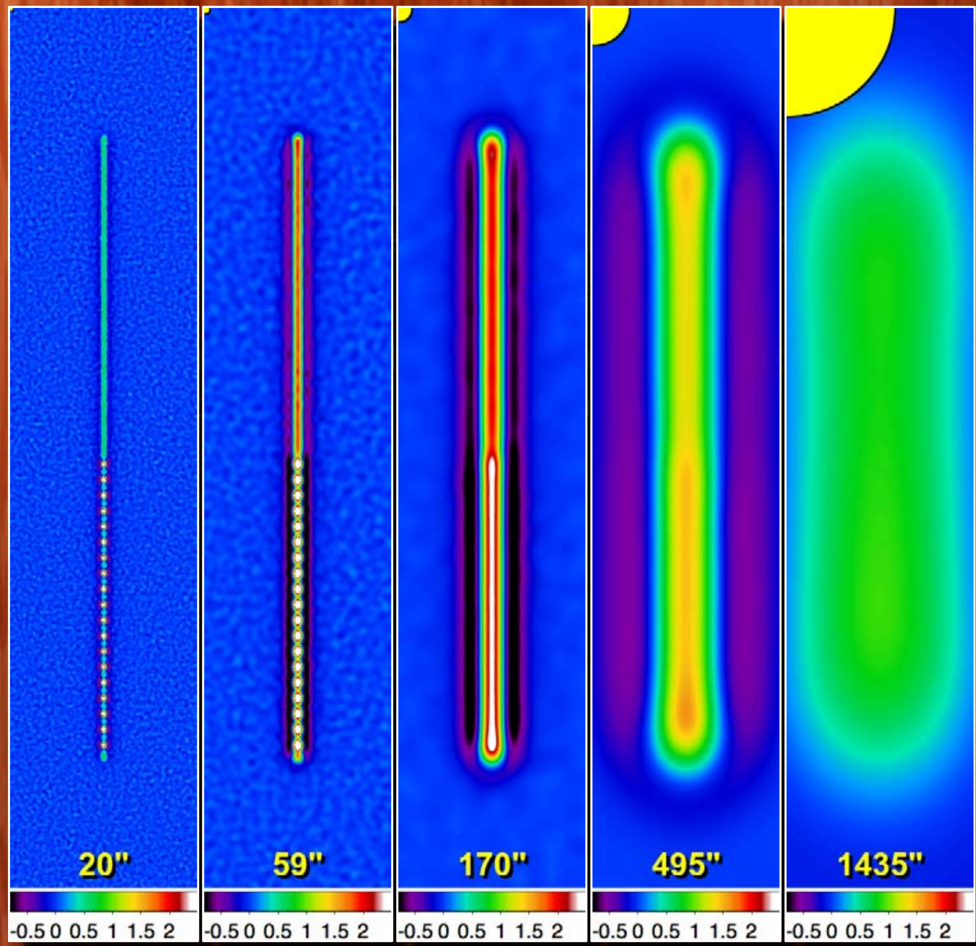

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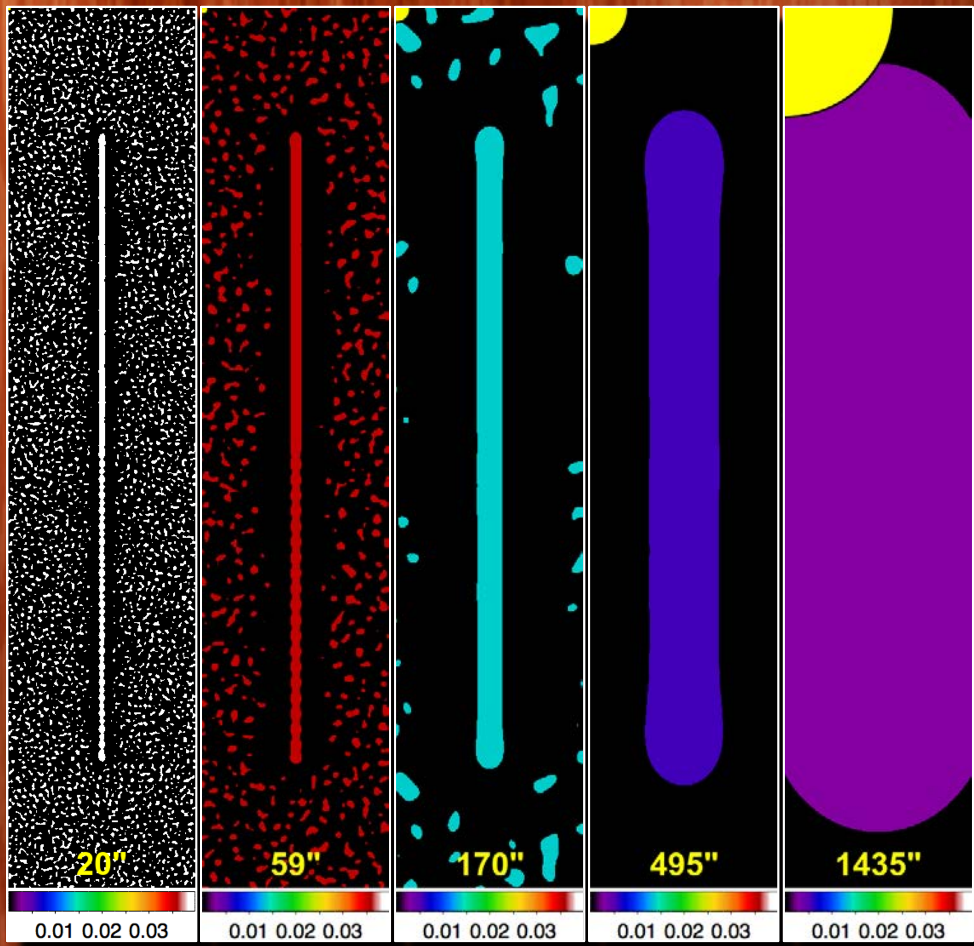

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HERSCHEL Gould Belt Survey

HOBYS

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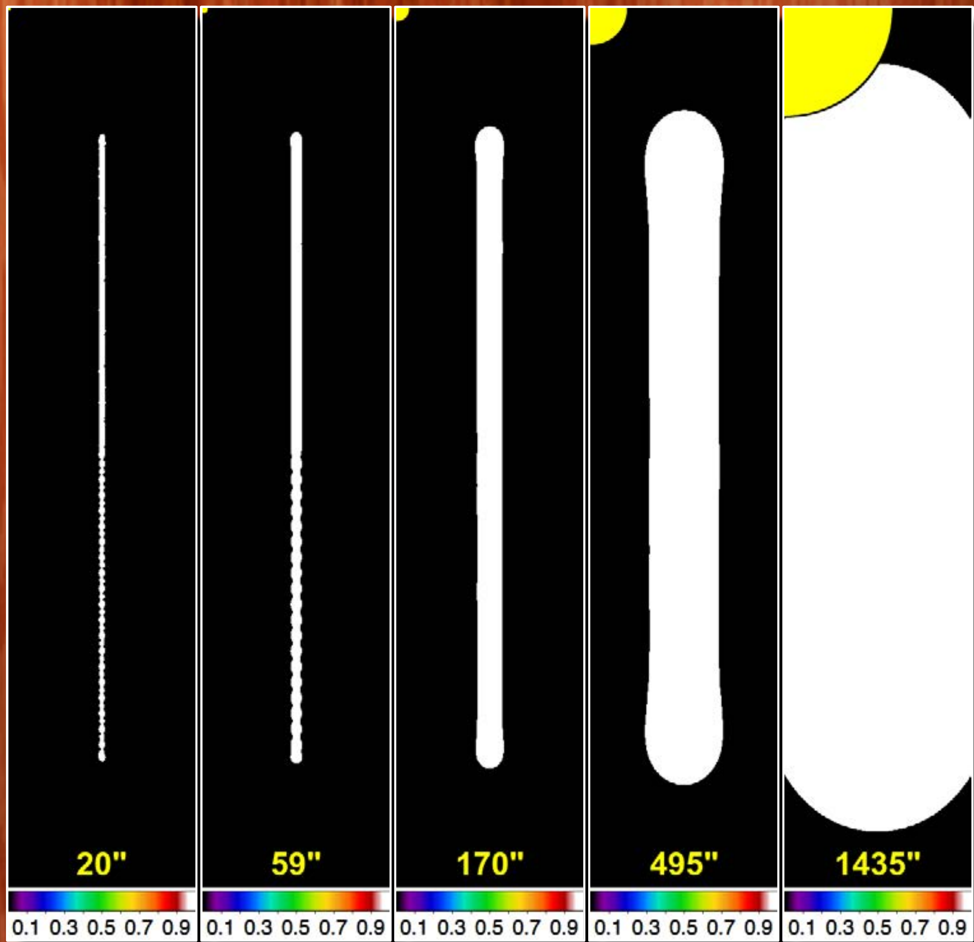

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Multi-Scale Filament Extraction Method

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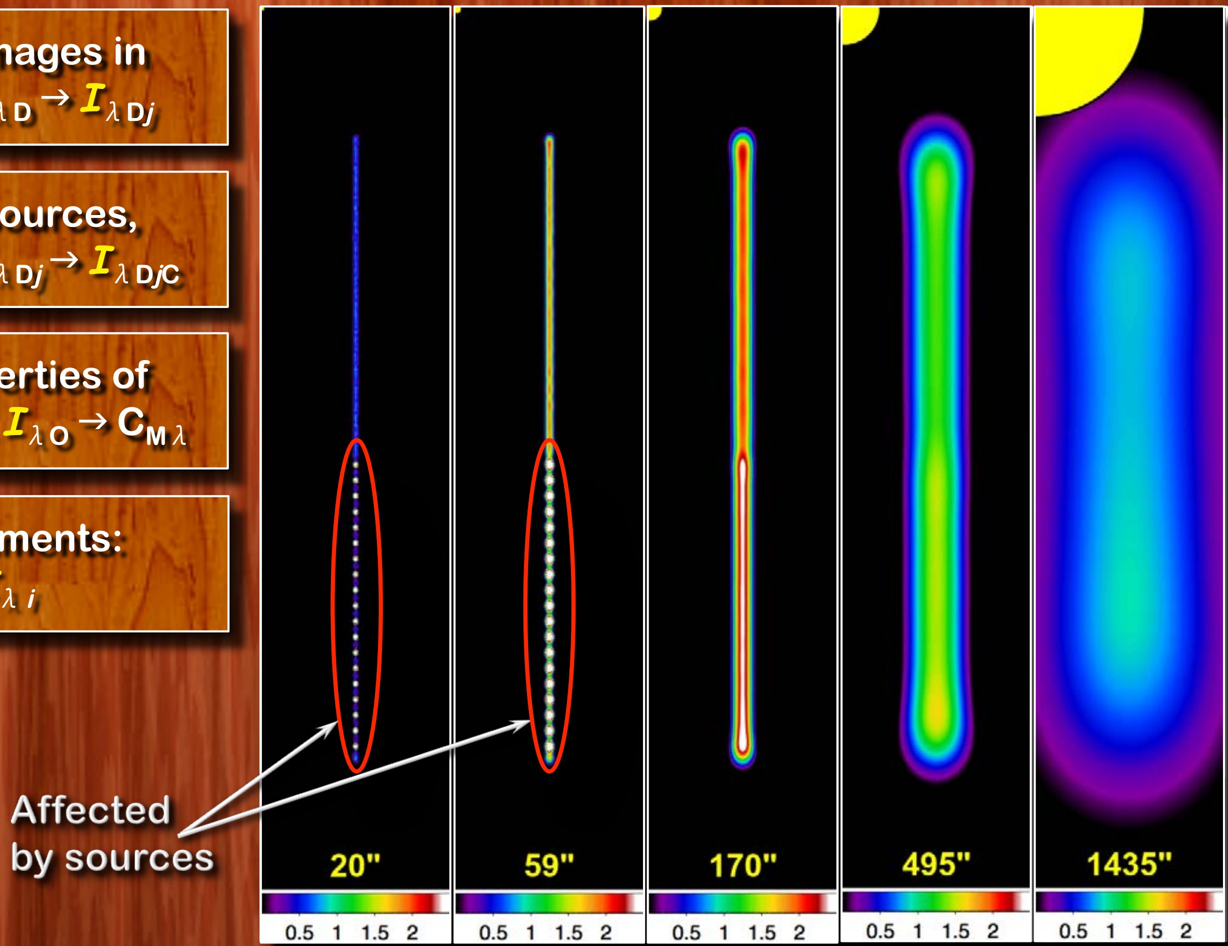
Clean single scales of sources, noise, and background: $I_{\lambda Dj} \rightarrow I_{\lambda DjC}$

Measure & catalog properties of filaments at all waves: $C_D, I_{\lambda O} \rightarrow C_{M\lambda}$

Visualize extracted filaments: $C_{M\lambda}, I_{\lambda O} \rightarrow I_{\lambda E}, I_{\lambda i}$



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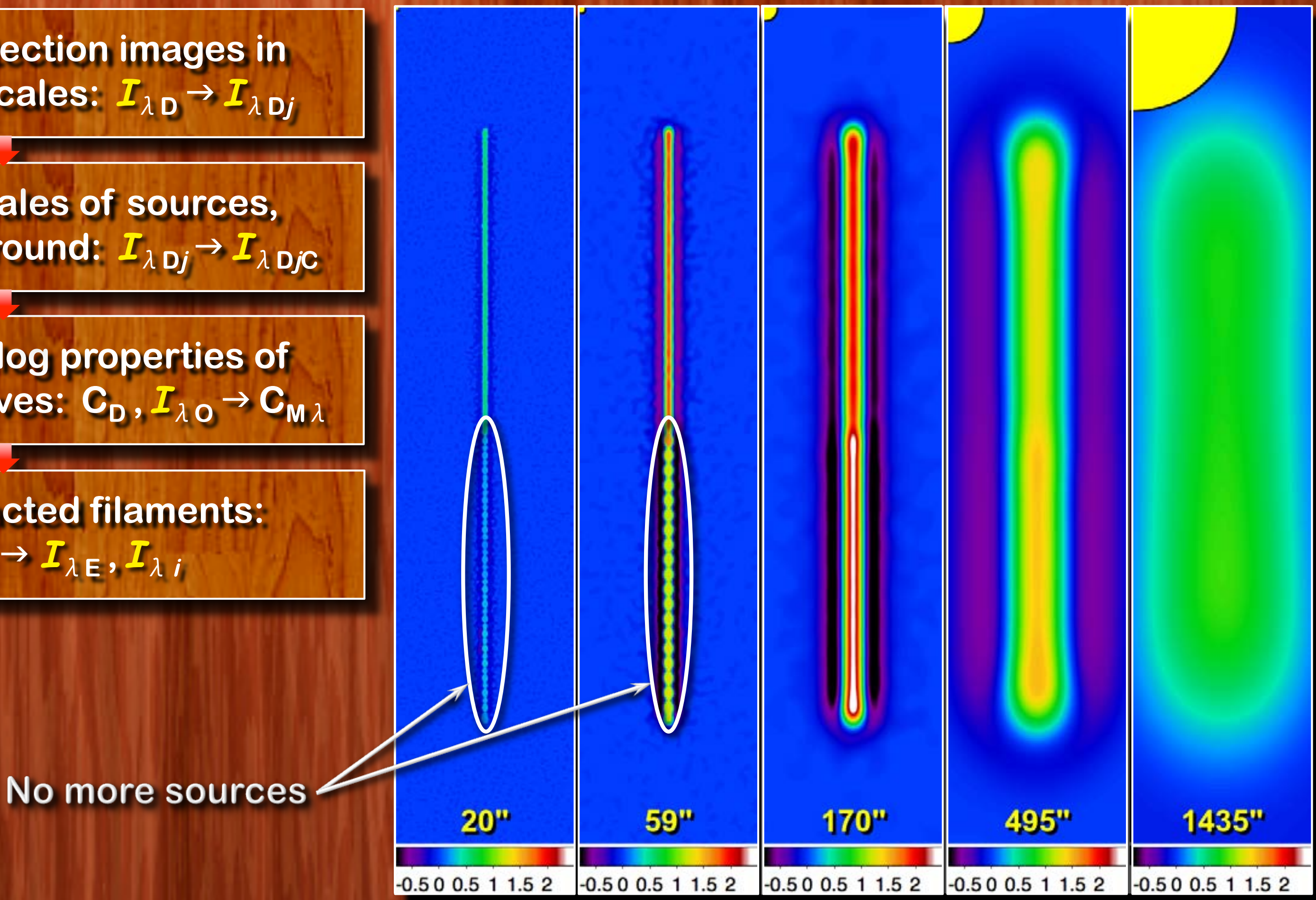

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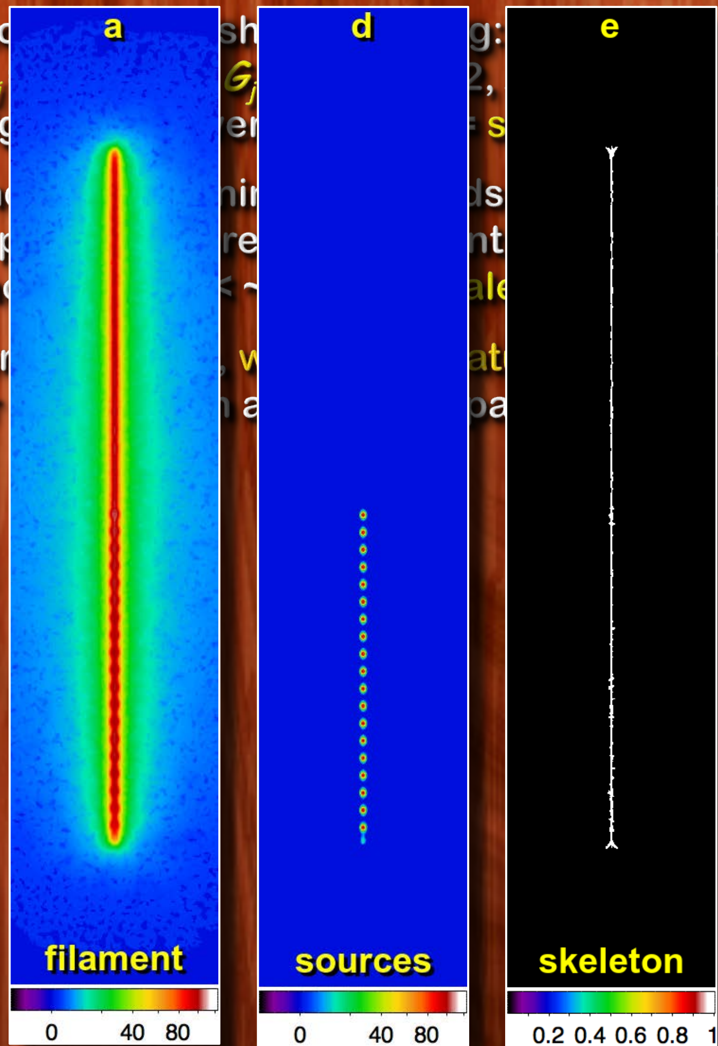
Suc … sh … g:
$I_{\lambda j}$ … G_j … 2,
orig … en … s

Fin … ni … ds … e clusters
of p … re … nt … d – those
wh … < ~ … ale

De … w … at … rofiles
for … a … pa



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HERSCHEL Gould Belt Survey

HOBYS

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Derive lengths, widths, curvatures, and profiles for skeletons in a range of spatial scales.

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The method reconstructs *intrinsic* intensities of filaments: contributions of sources, noise, and background fluctuations are carefully removed from each spatial scale by the cleaning algorithm.

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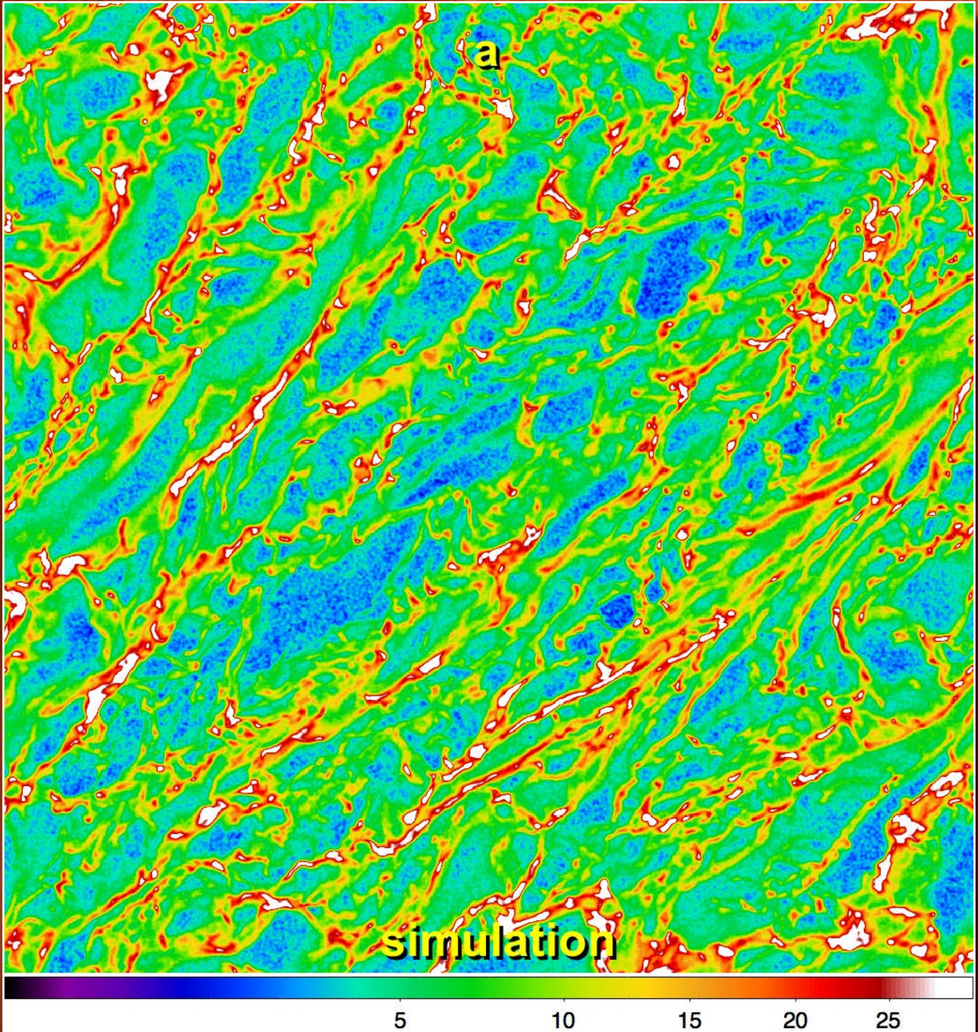
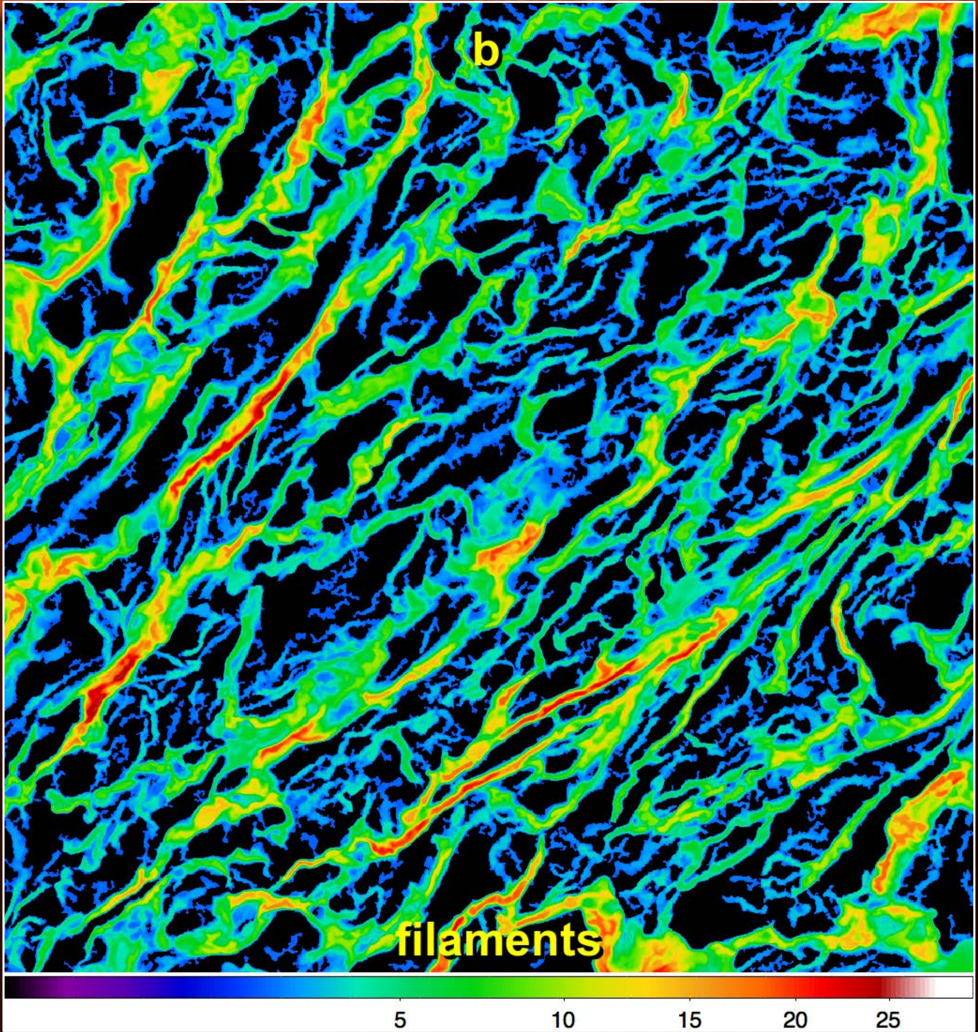
Filaments Extracted from MHD Simulations

Colliding flows of warm diffuse gas (Hennebelle + 2008)

Simulations from: `http://starformat.obspm.fr/starformat/projects`

Column densities





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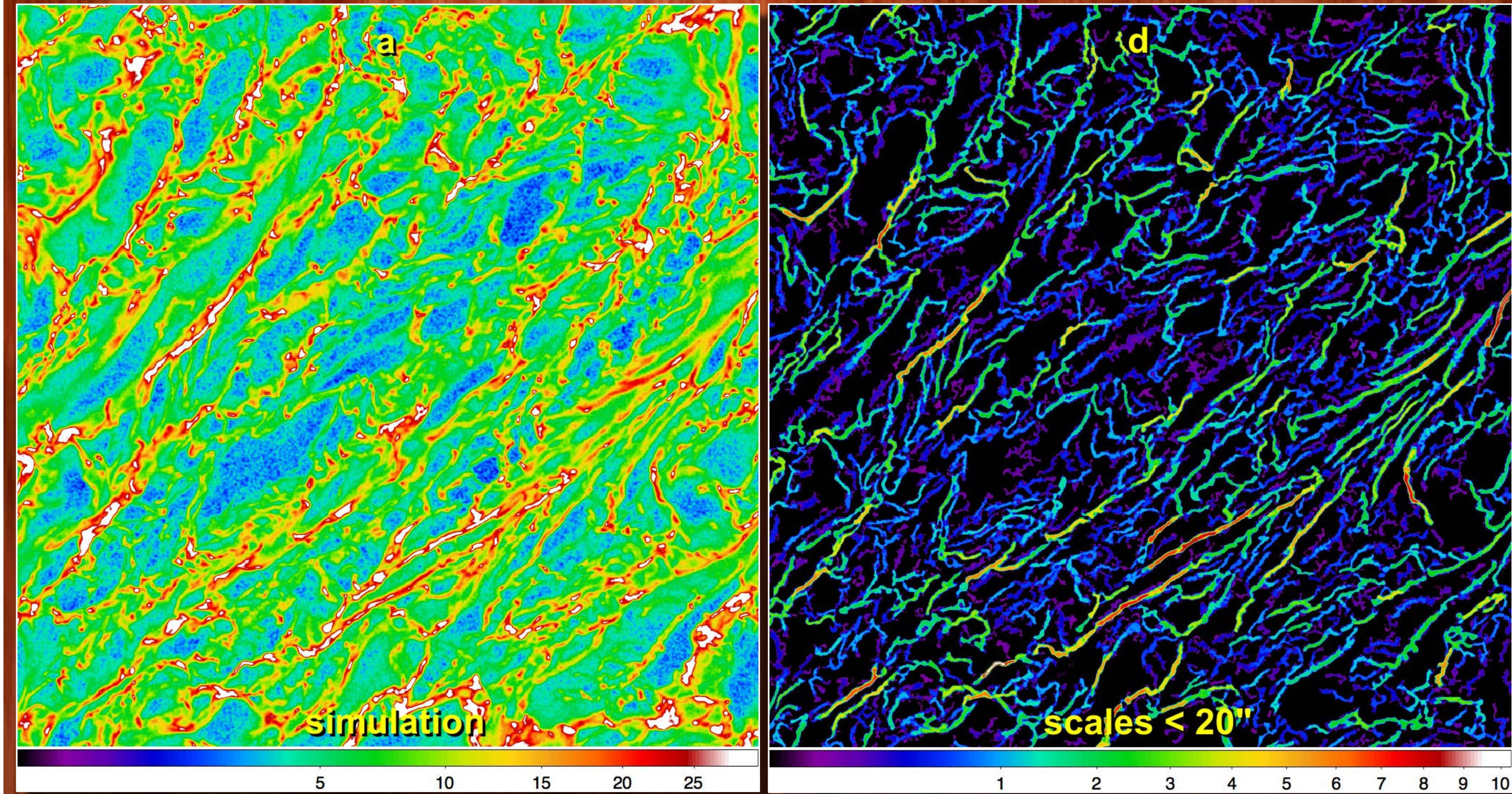

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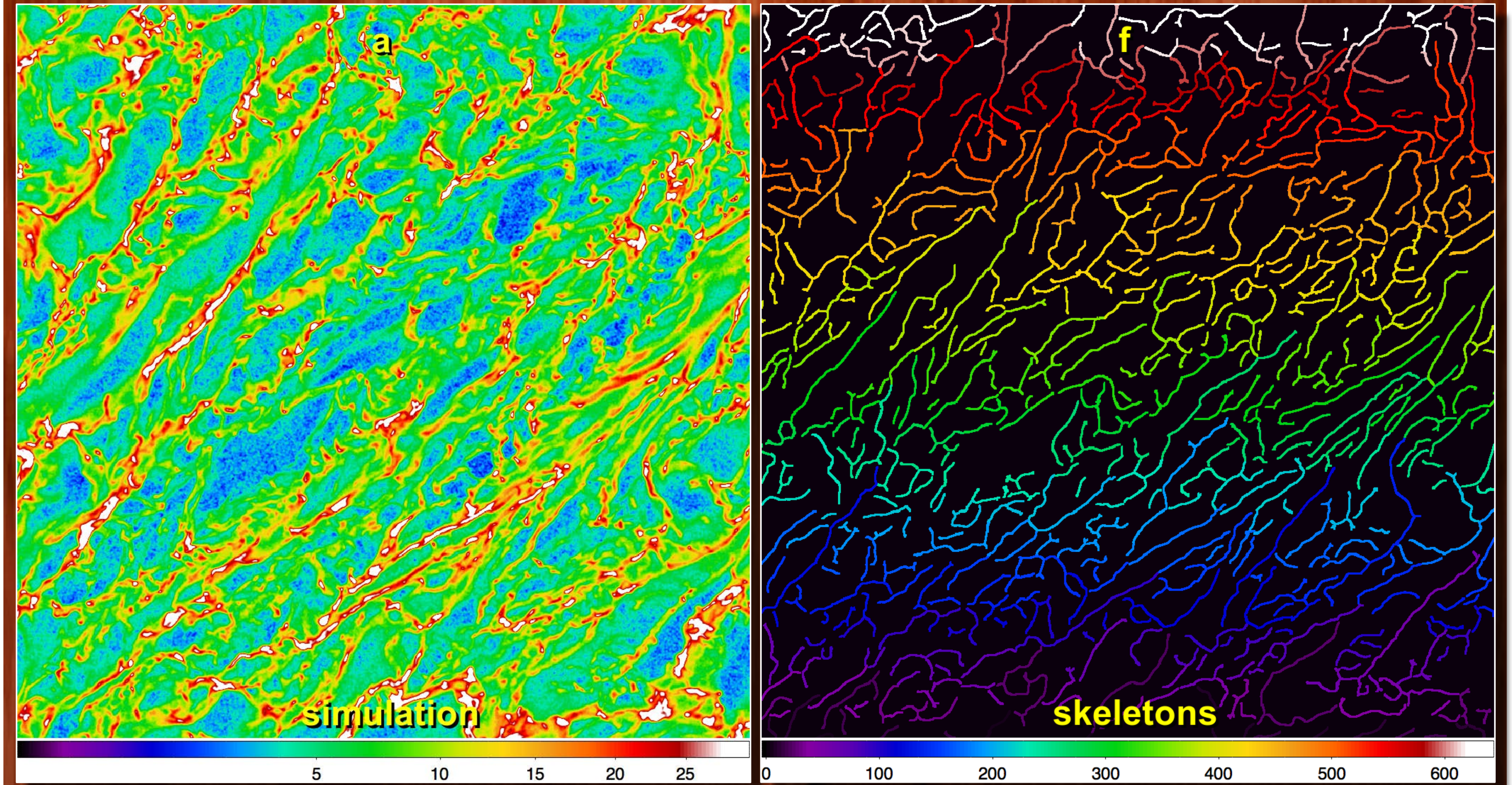

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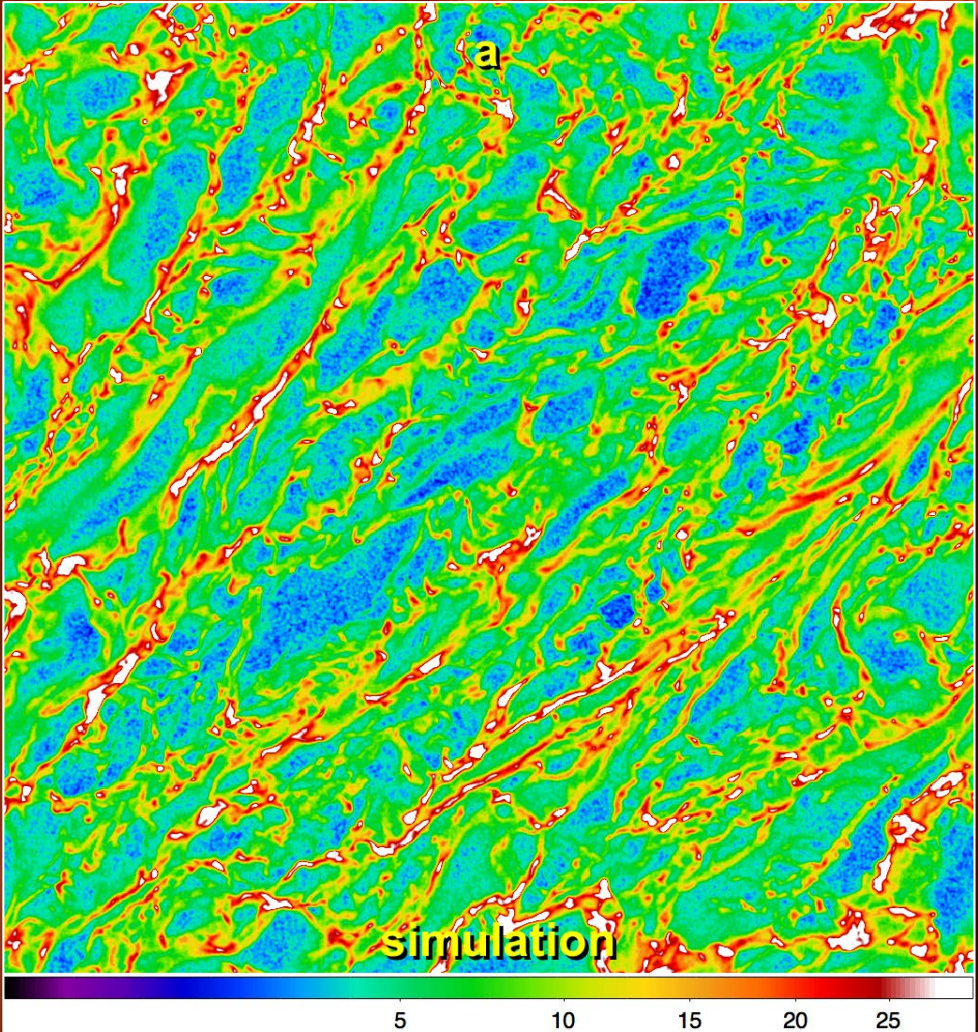
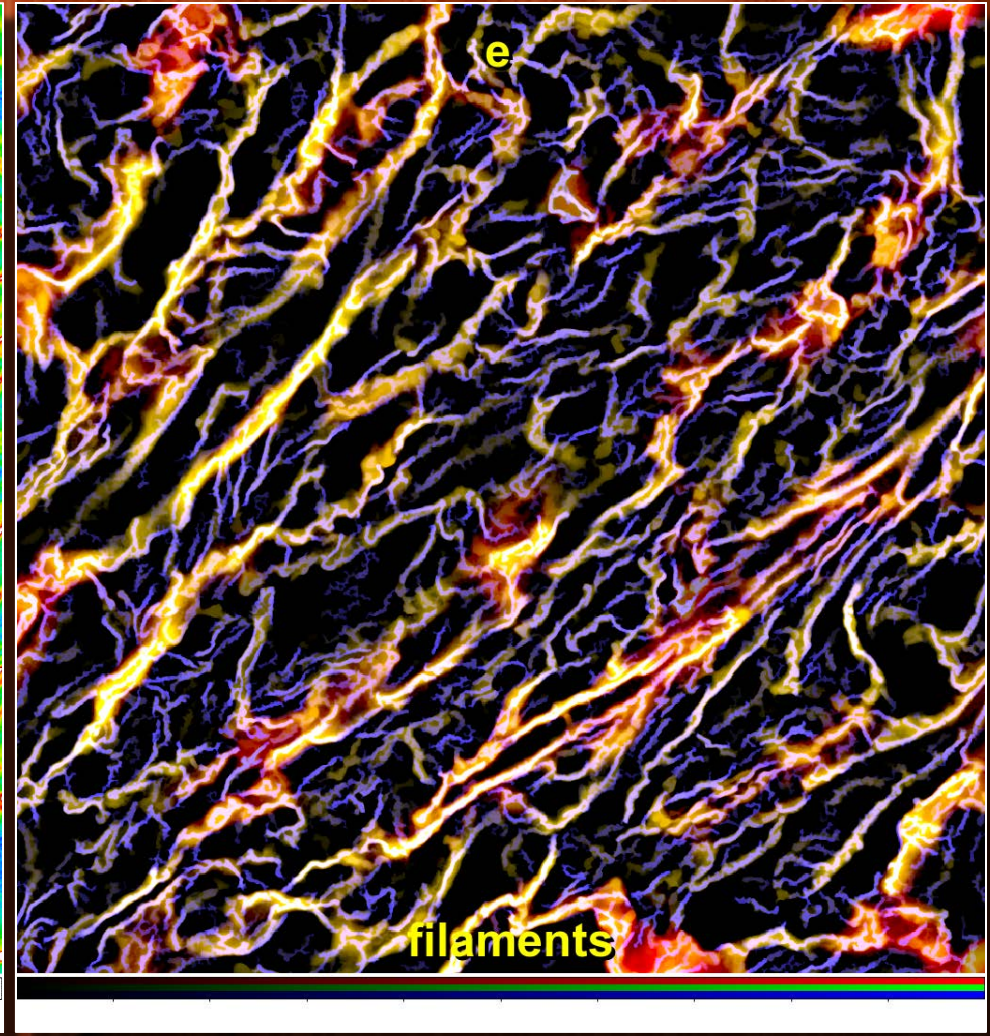


R < 2000” G < 160” B < 10”



Filaments in the *Horizon MareNostrum* Simulation

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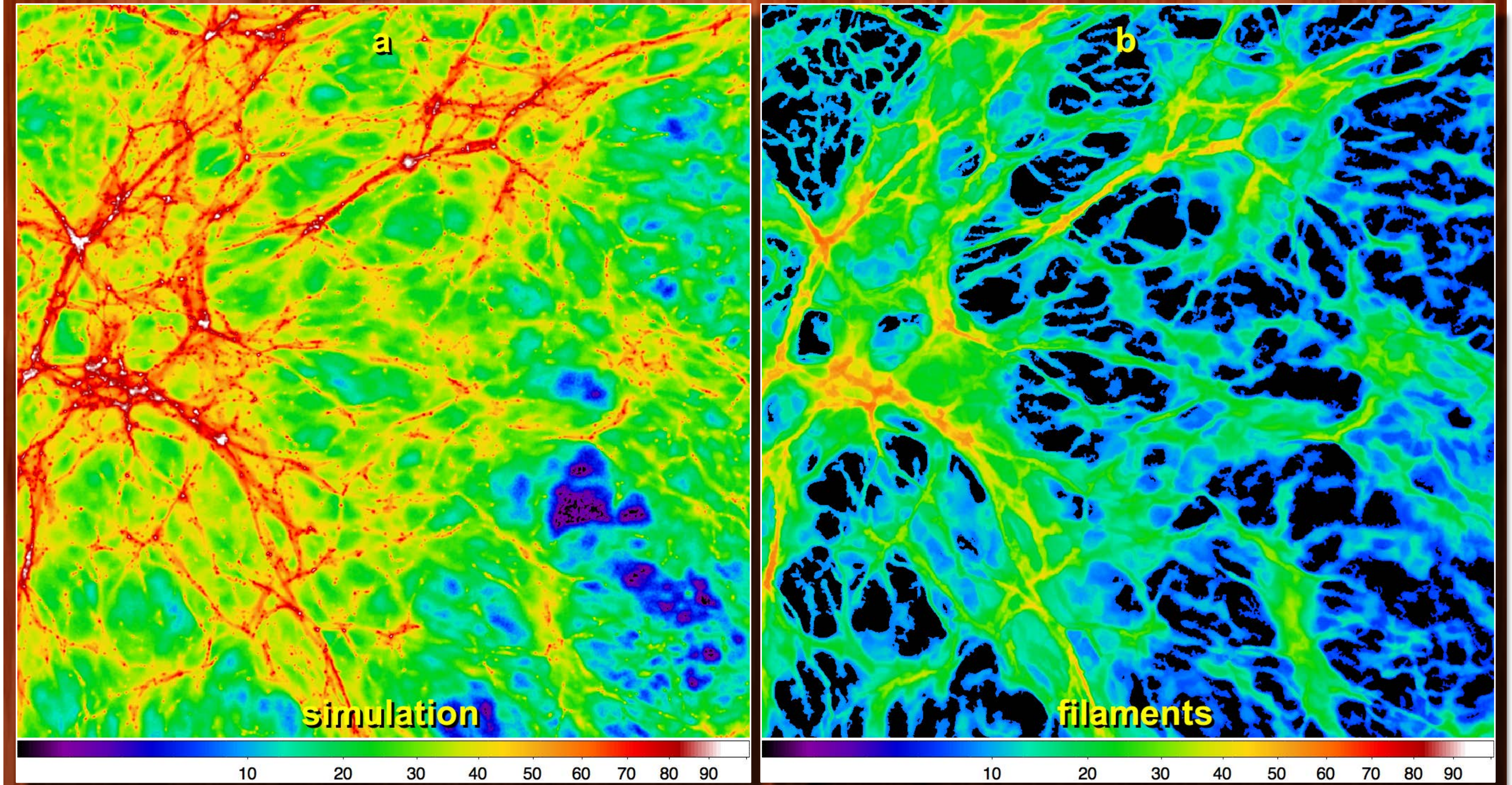
Slice of gas densities



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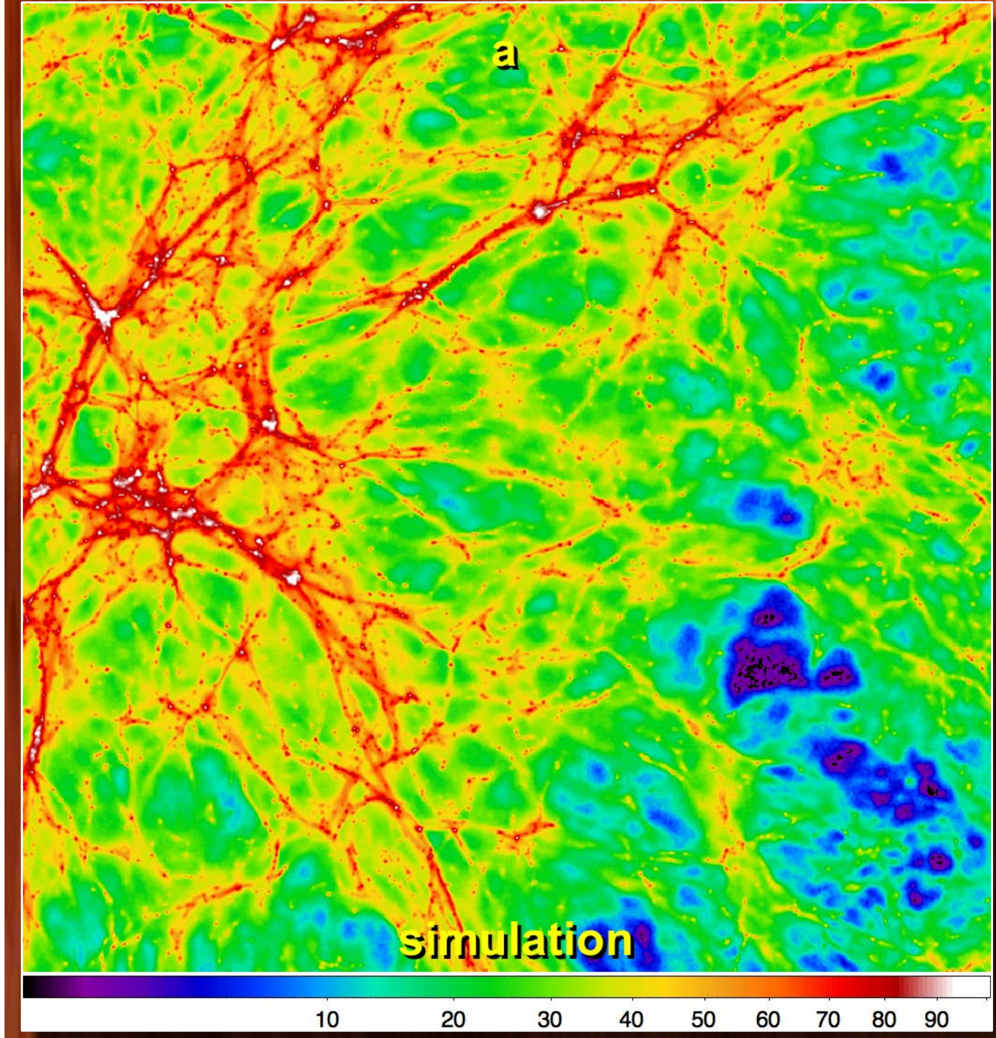

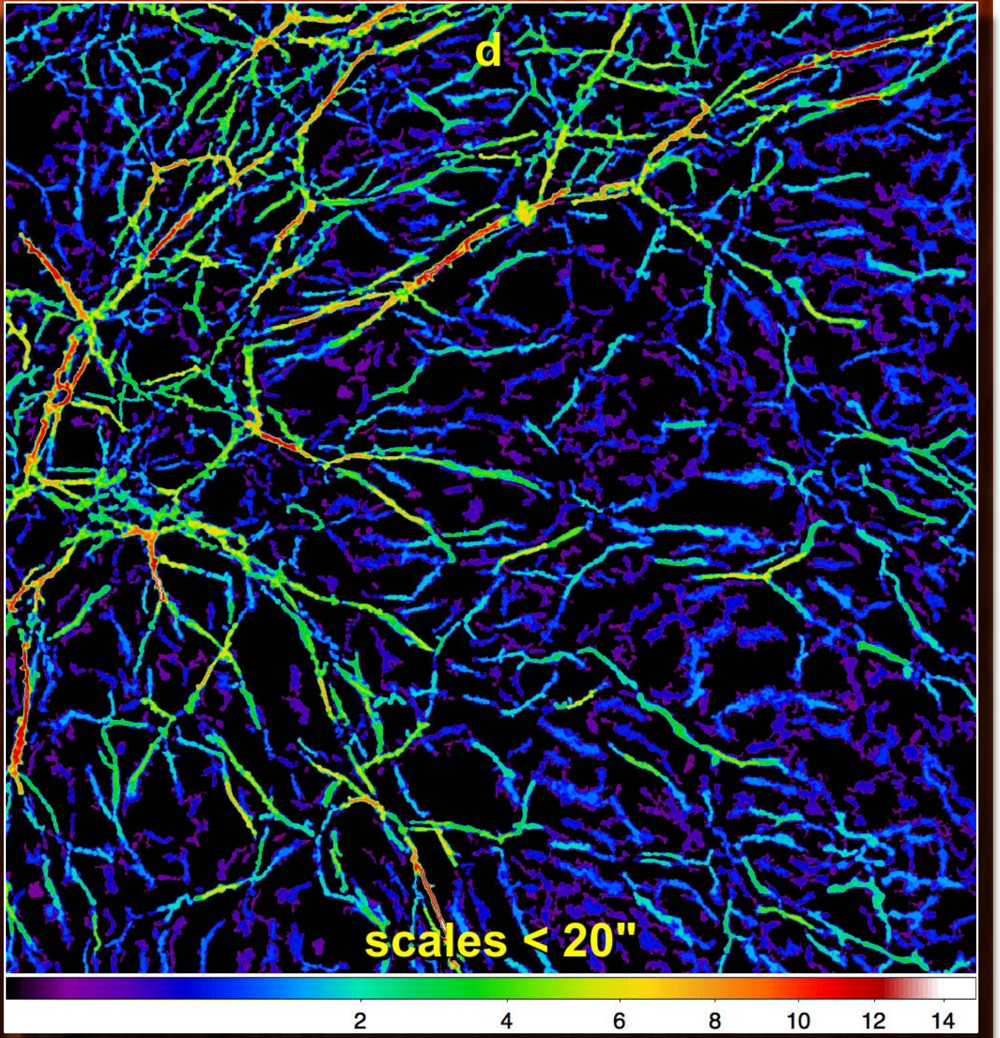

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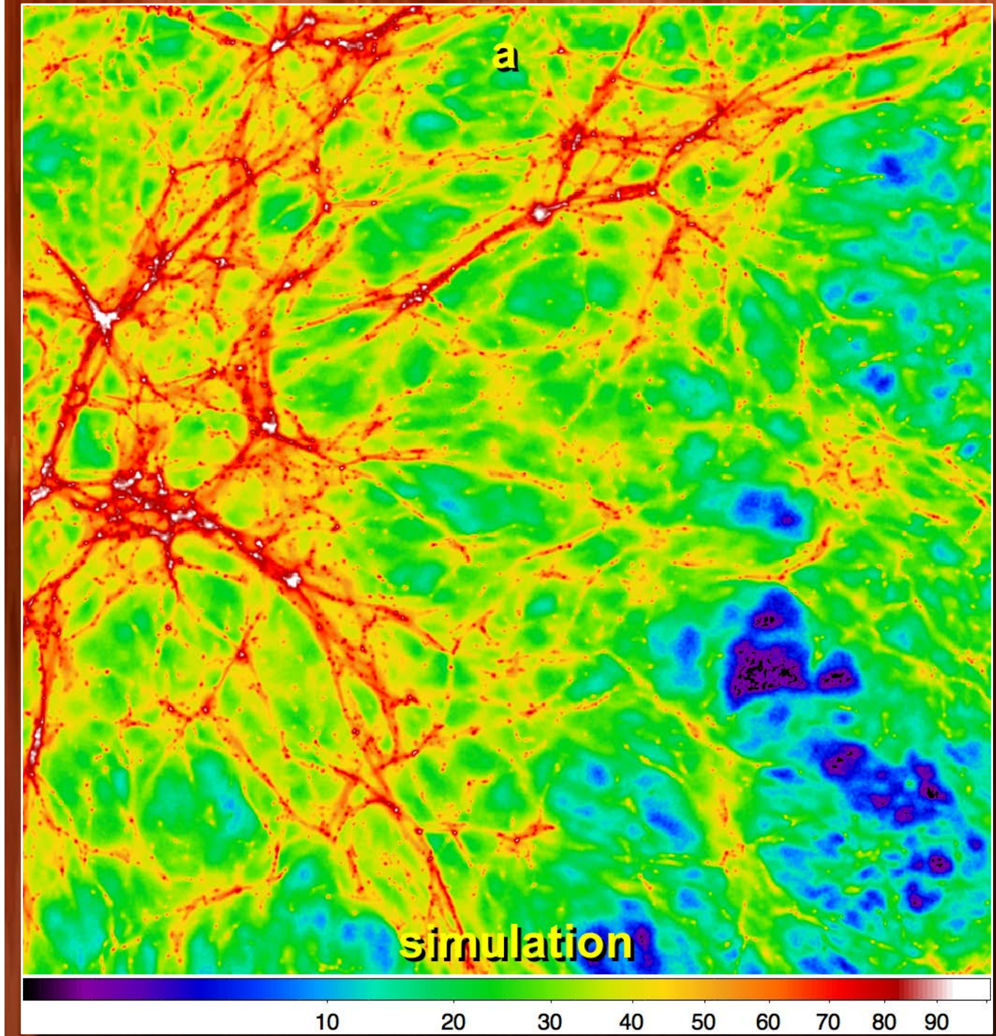

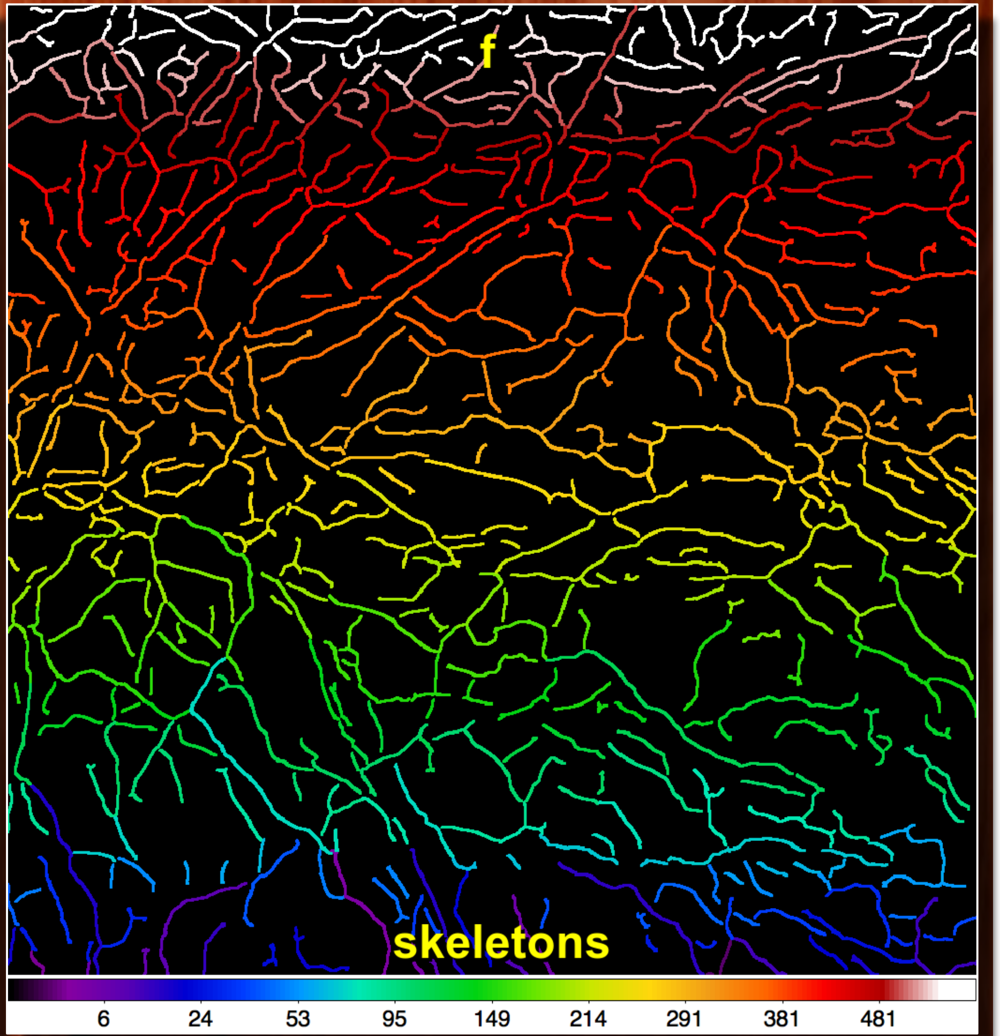

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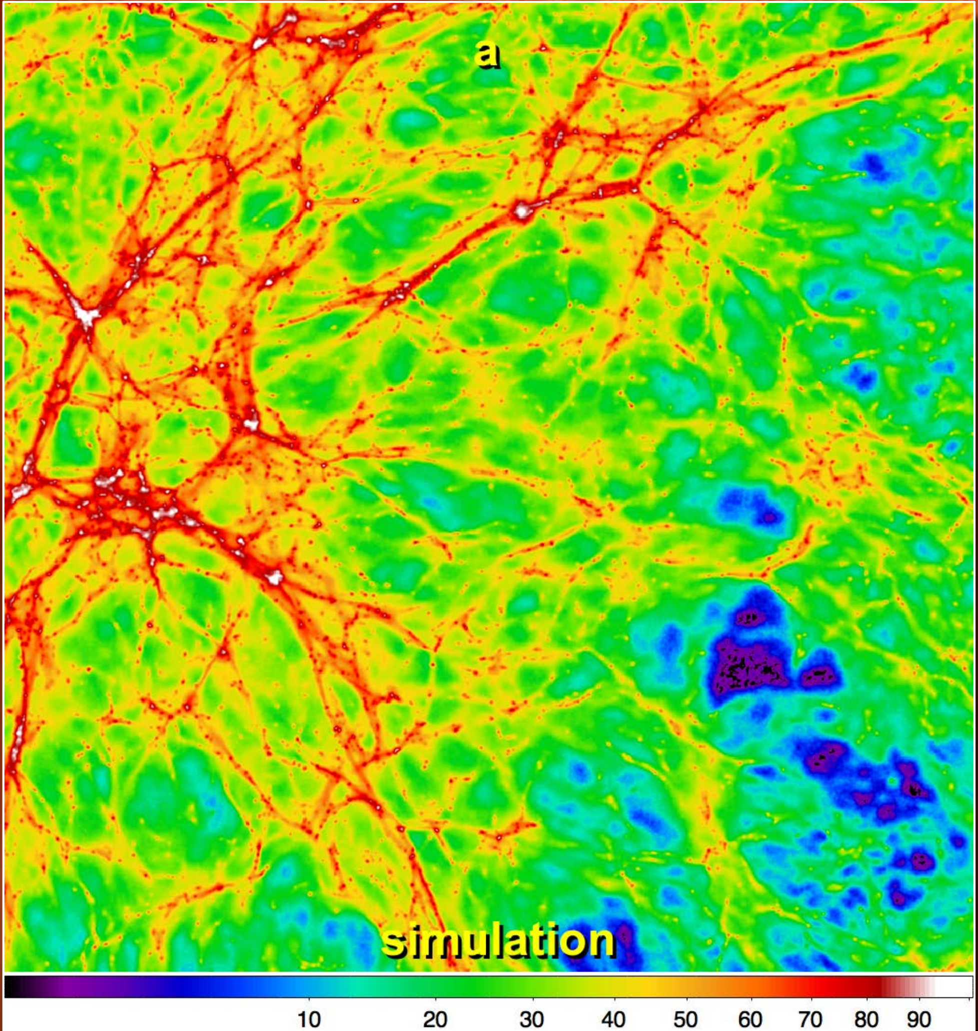

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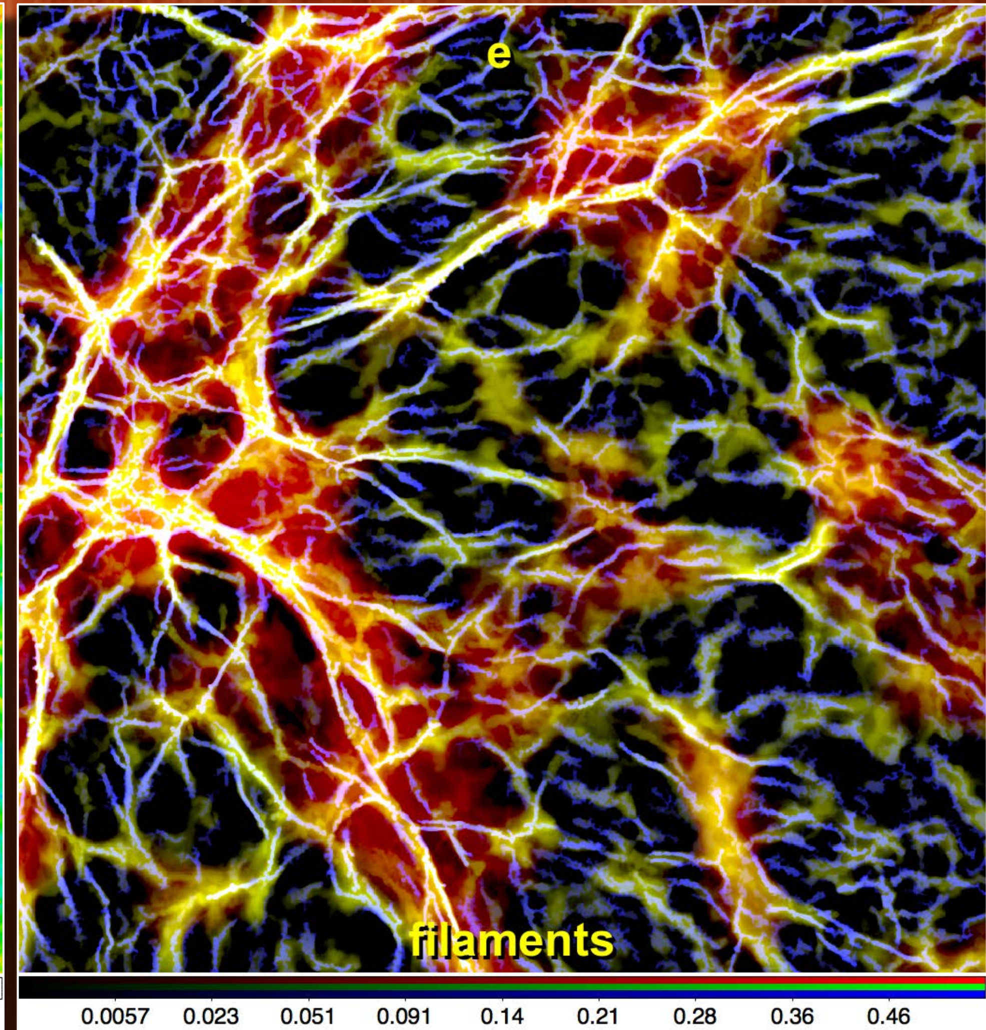

Taurus SPIRE 250 μm 5.3×2.6° = 13×6.5 pc *D* = 140 pc

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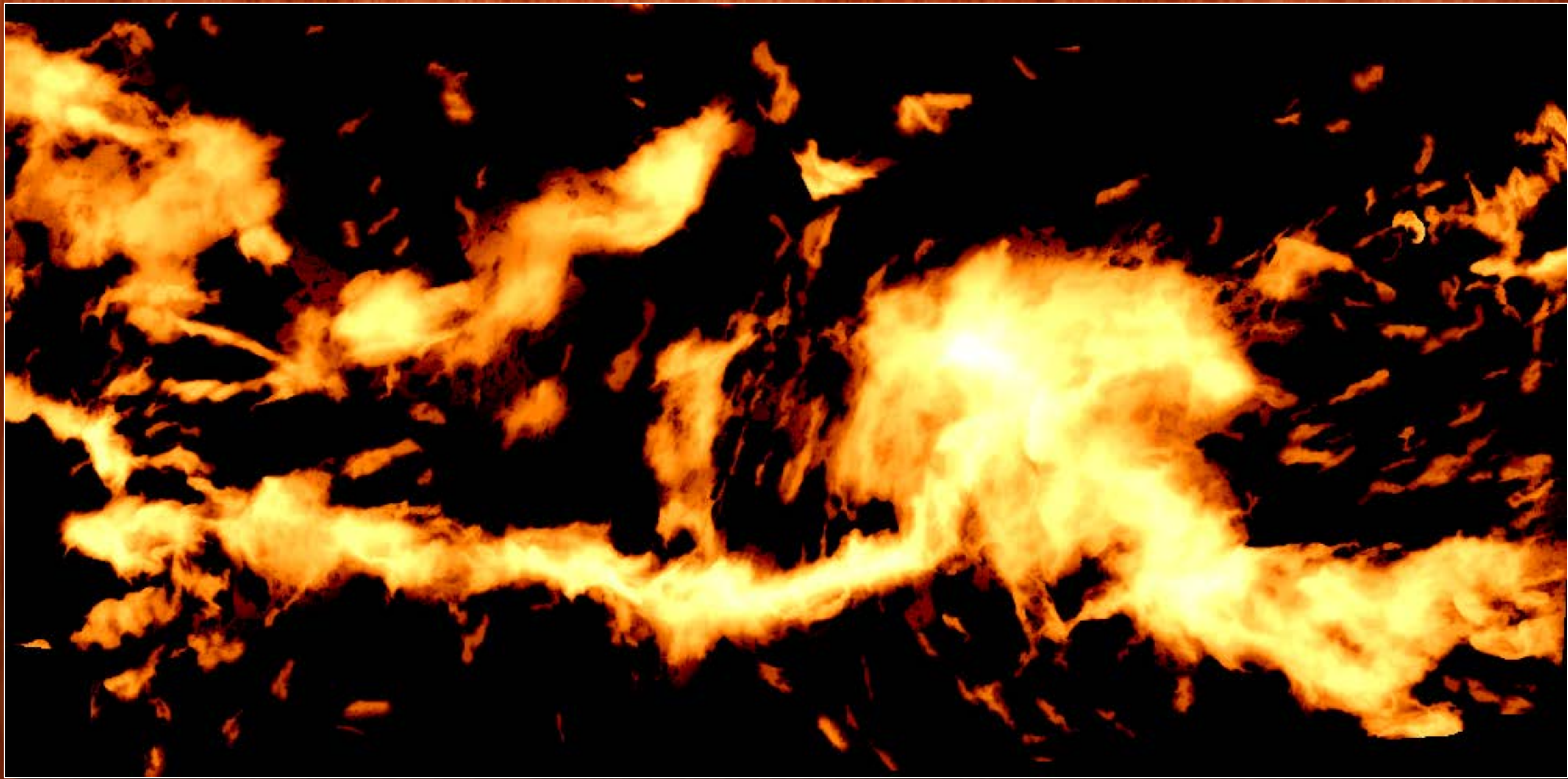

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HERSCHEL Gould Belt Survey SPIRE SAG3

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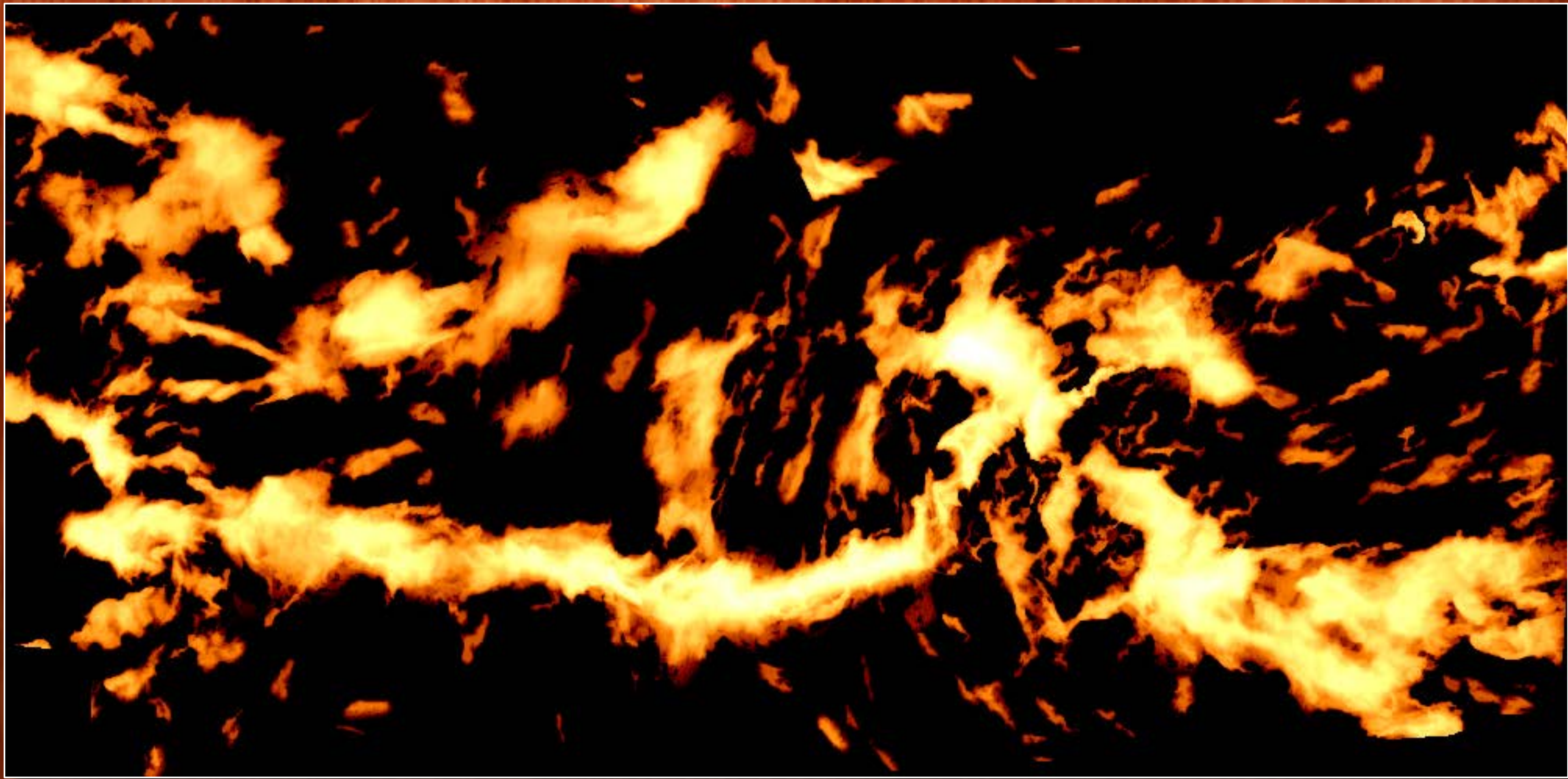

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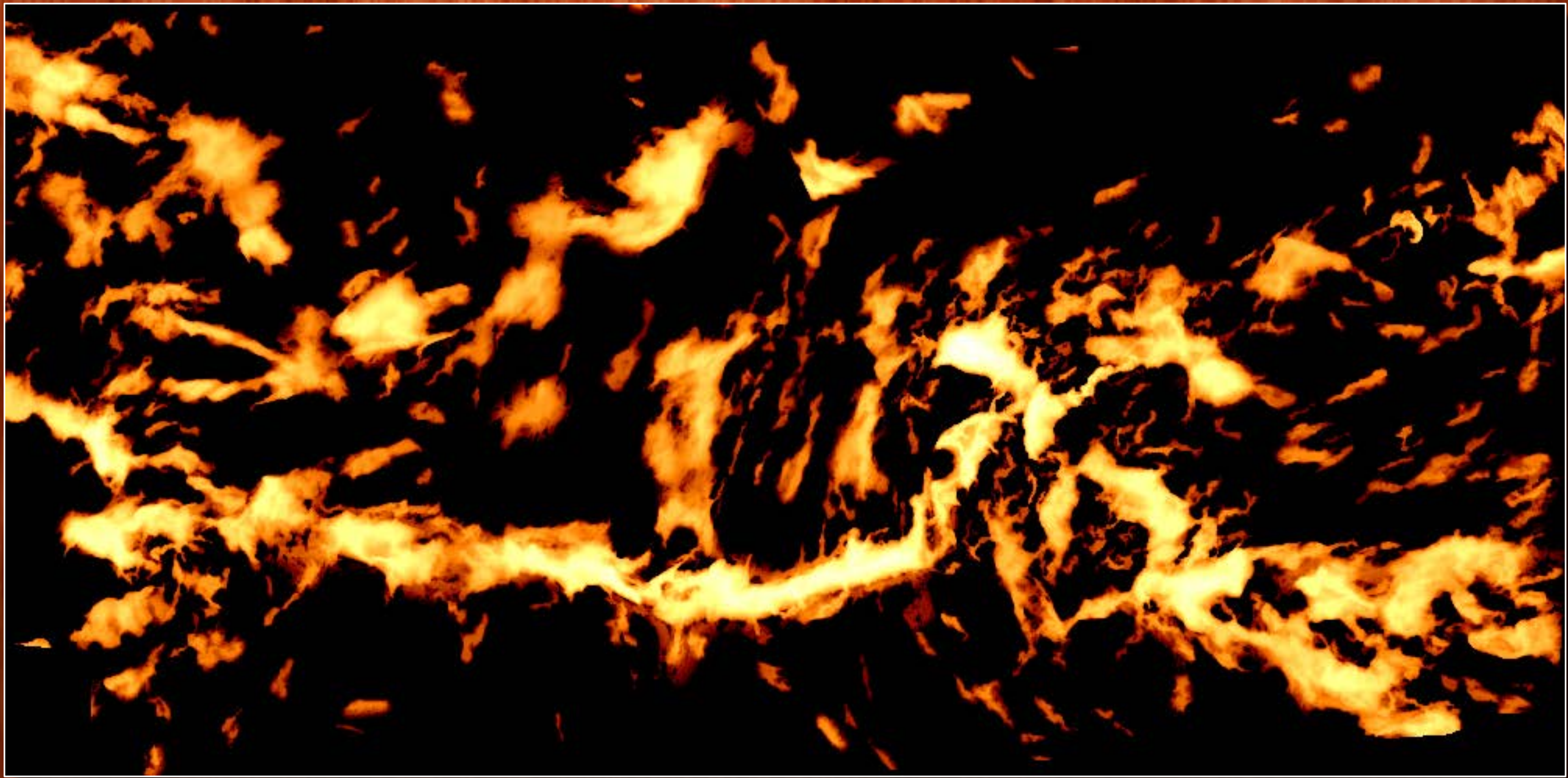

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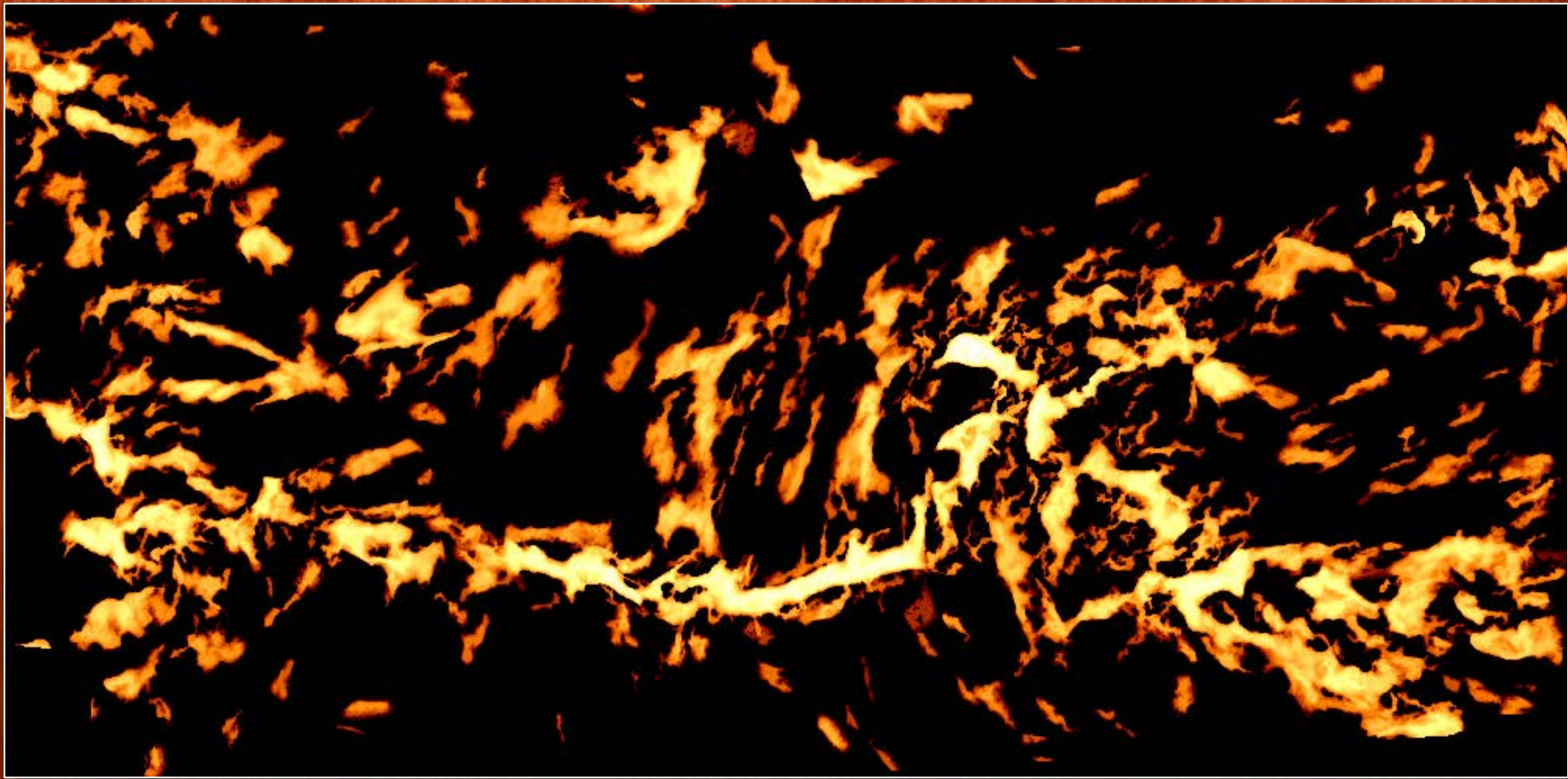

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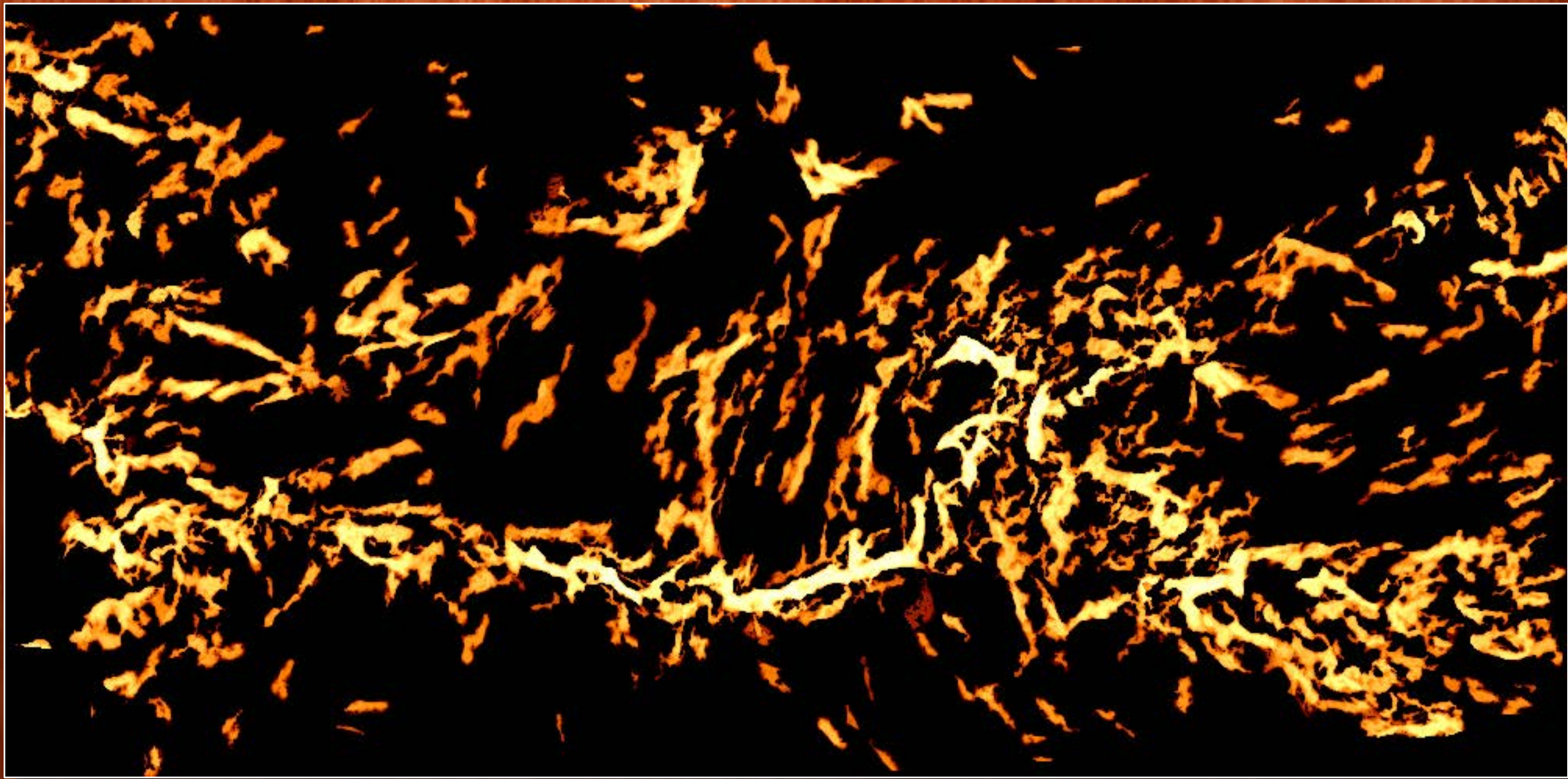

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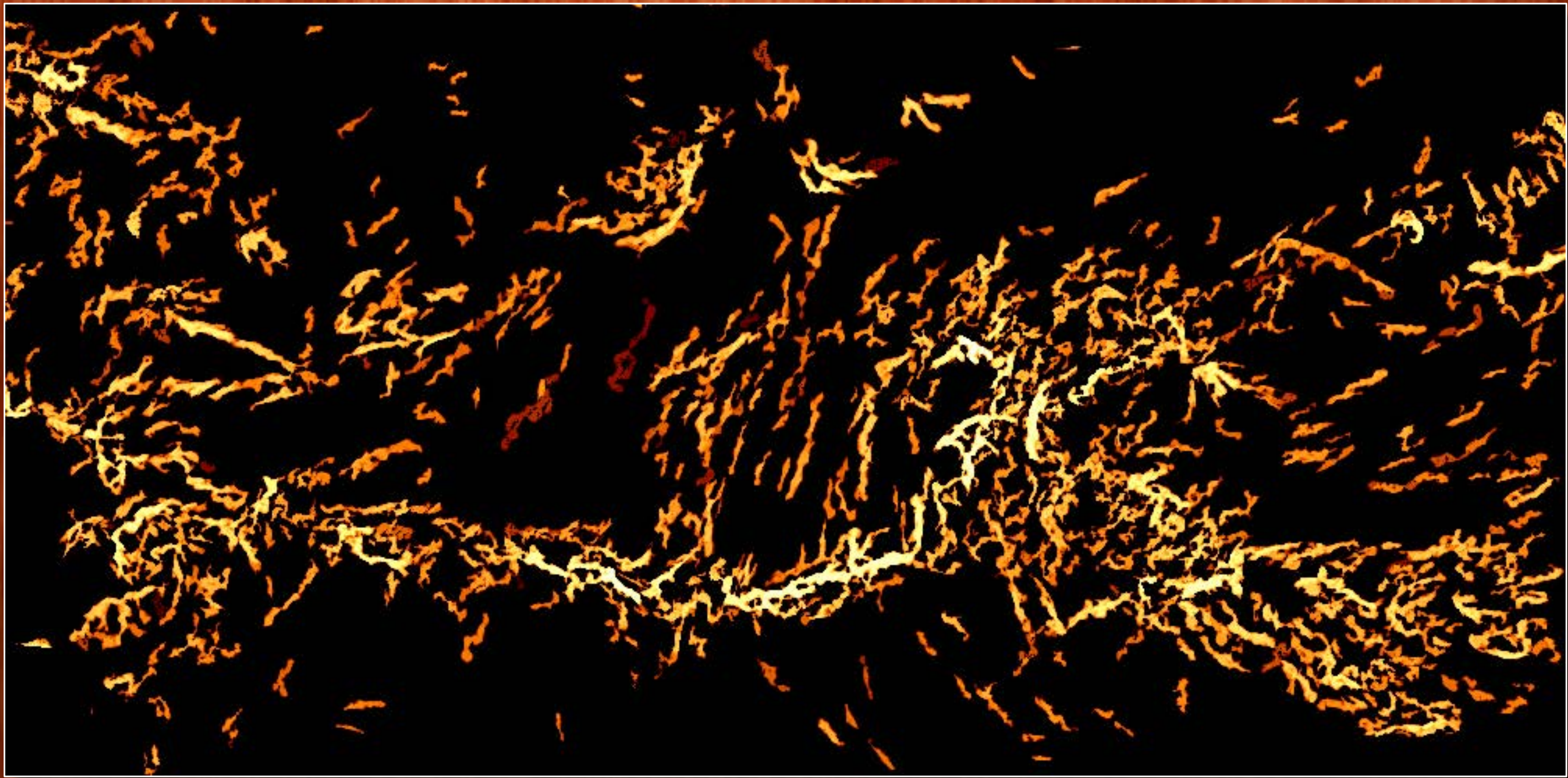

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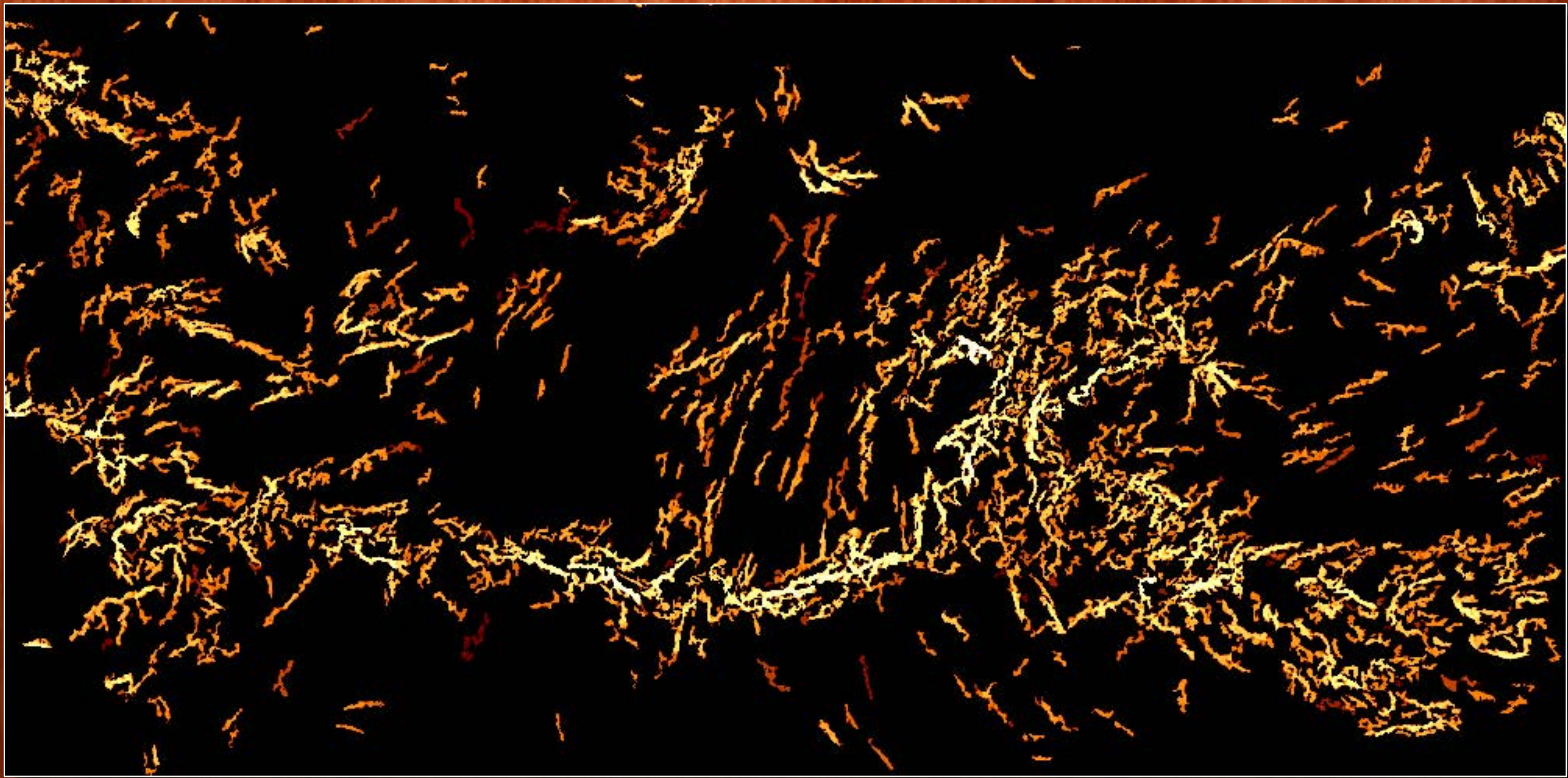

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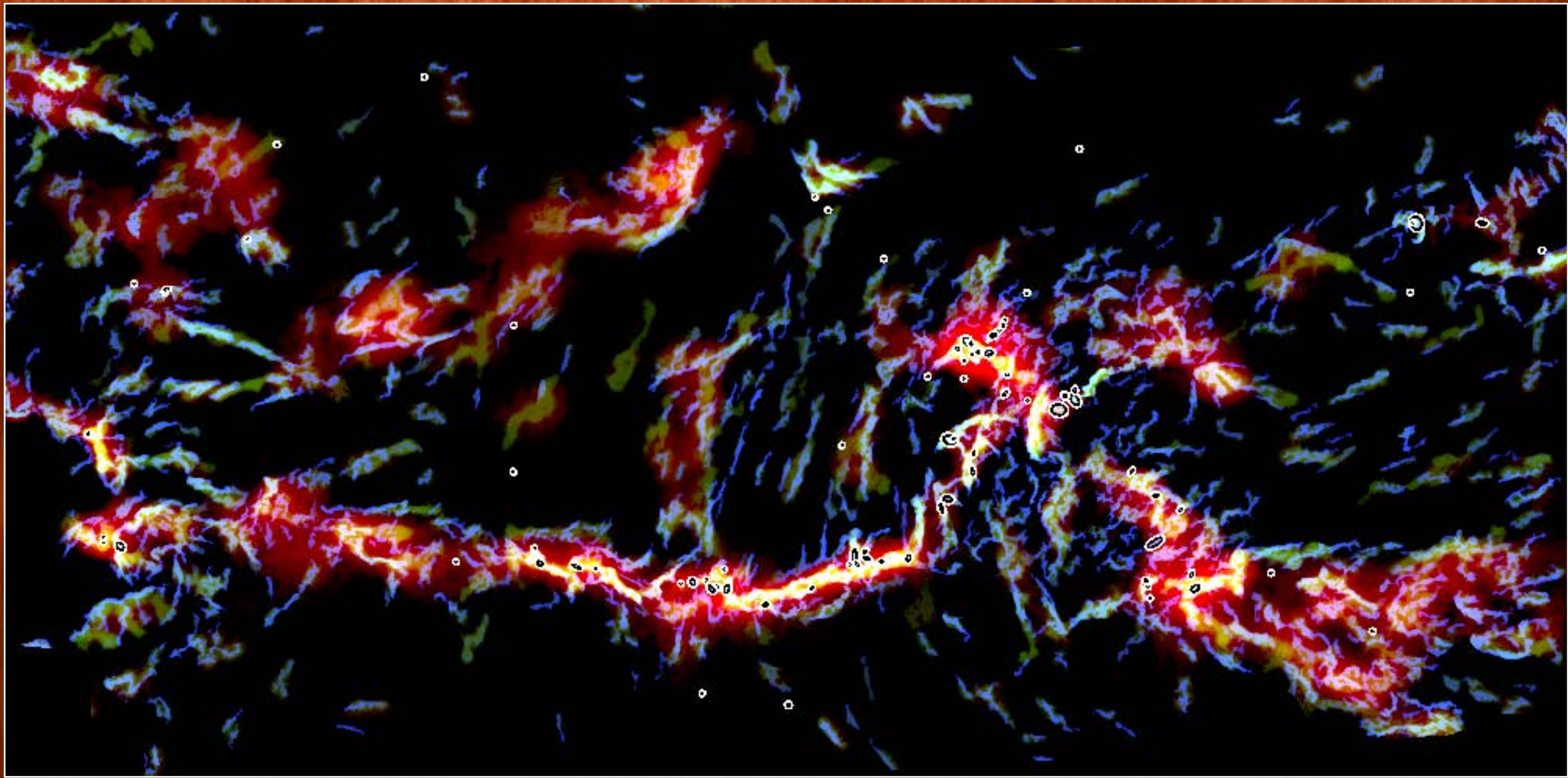

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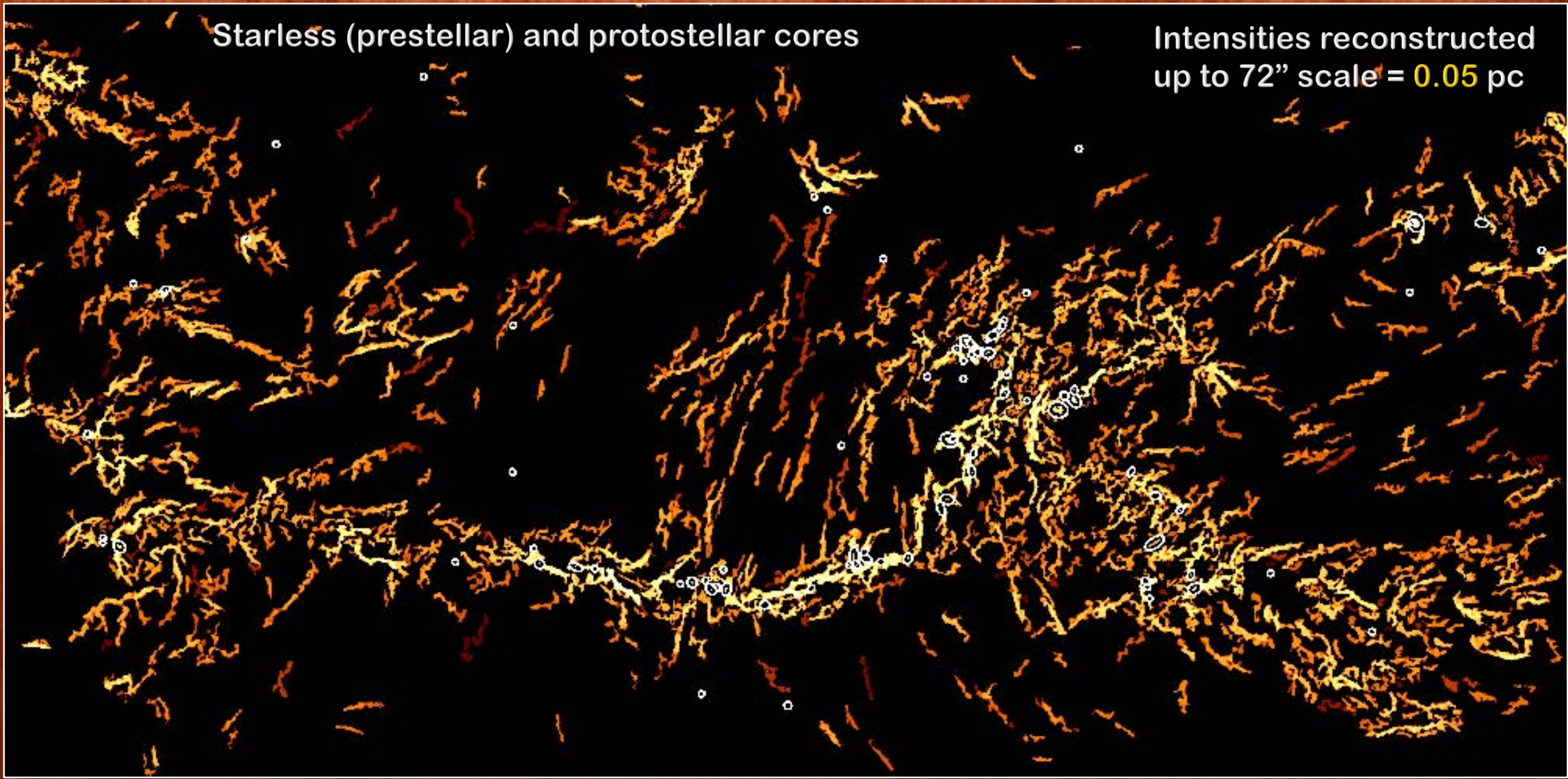

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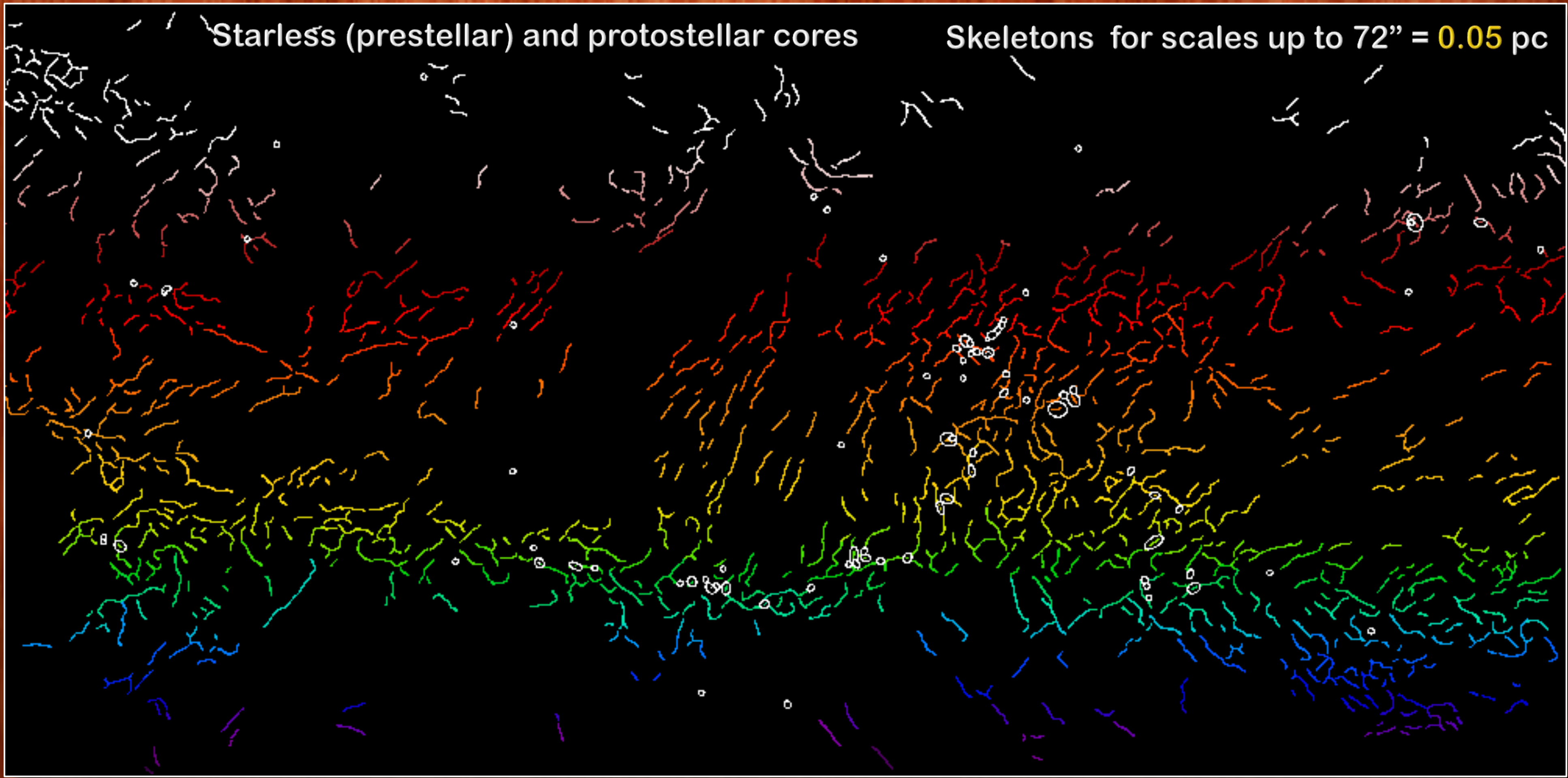

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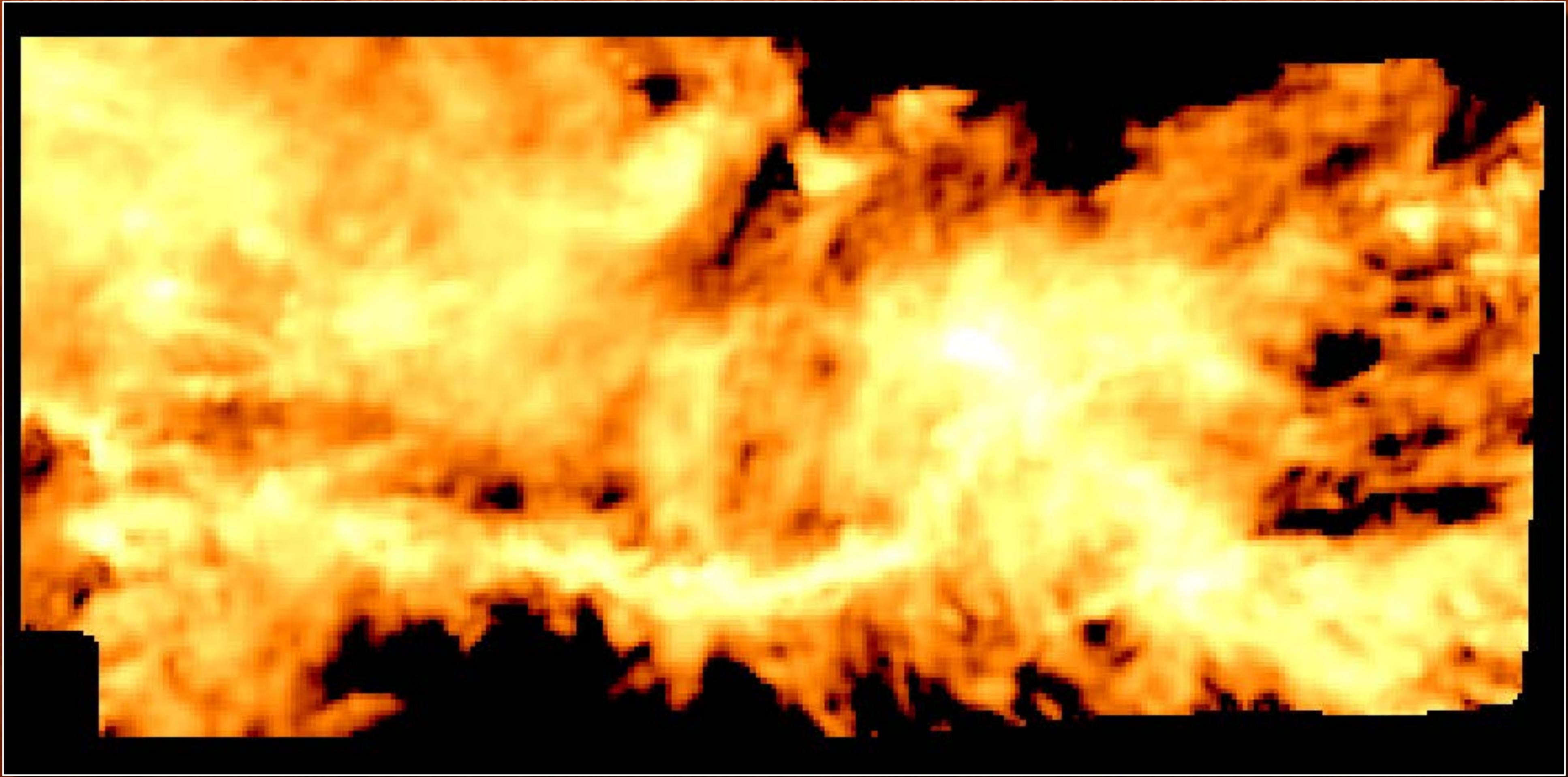
HERSCHEL Gould Belt Survey
SPIRE SAG3

Taurus SPIRE 250 μm 0.25×0.12° = 13×6.5 pc D↗3000 pc



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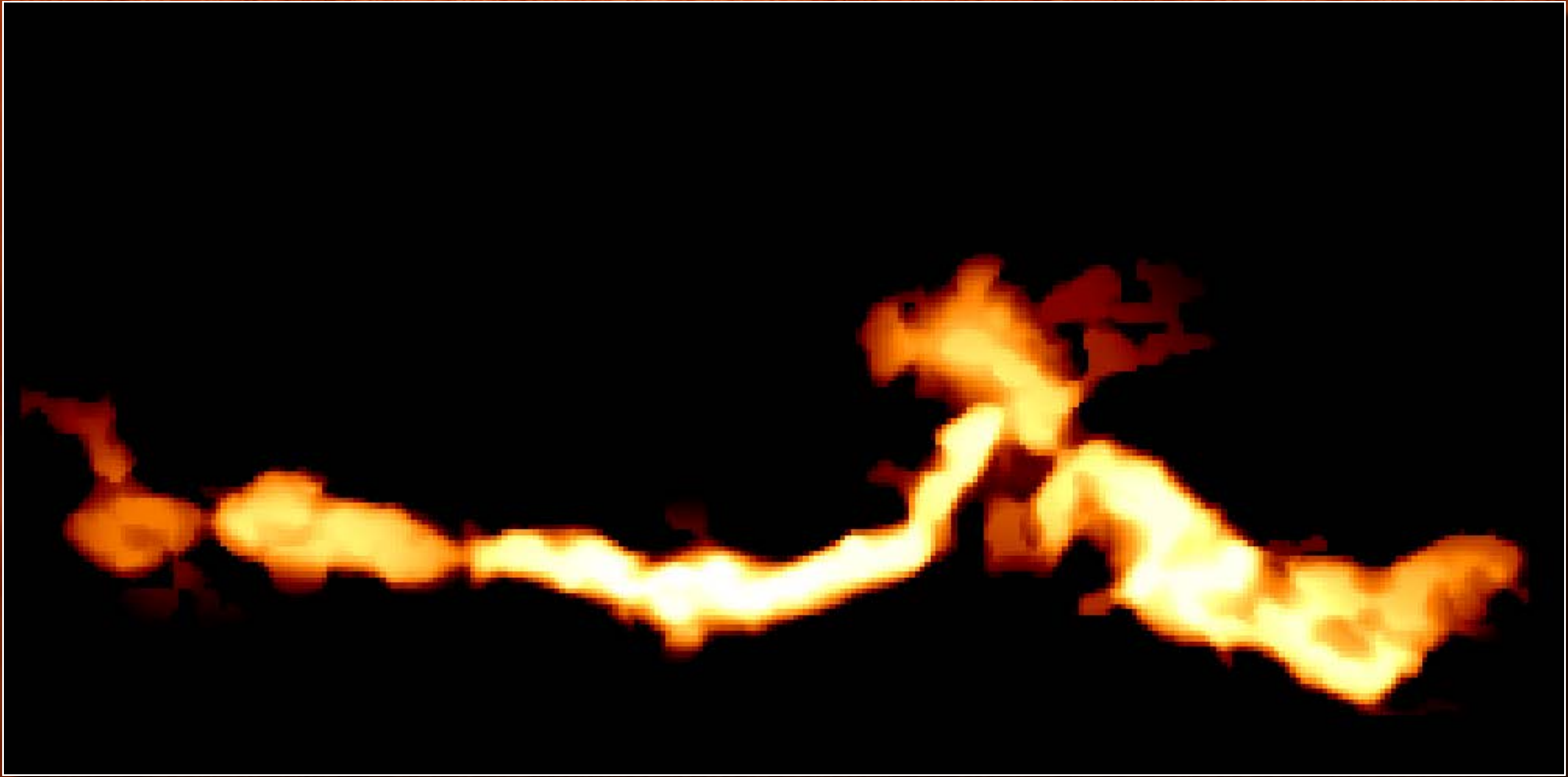

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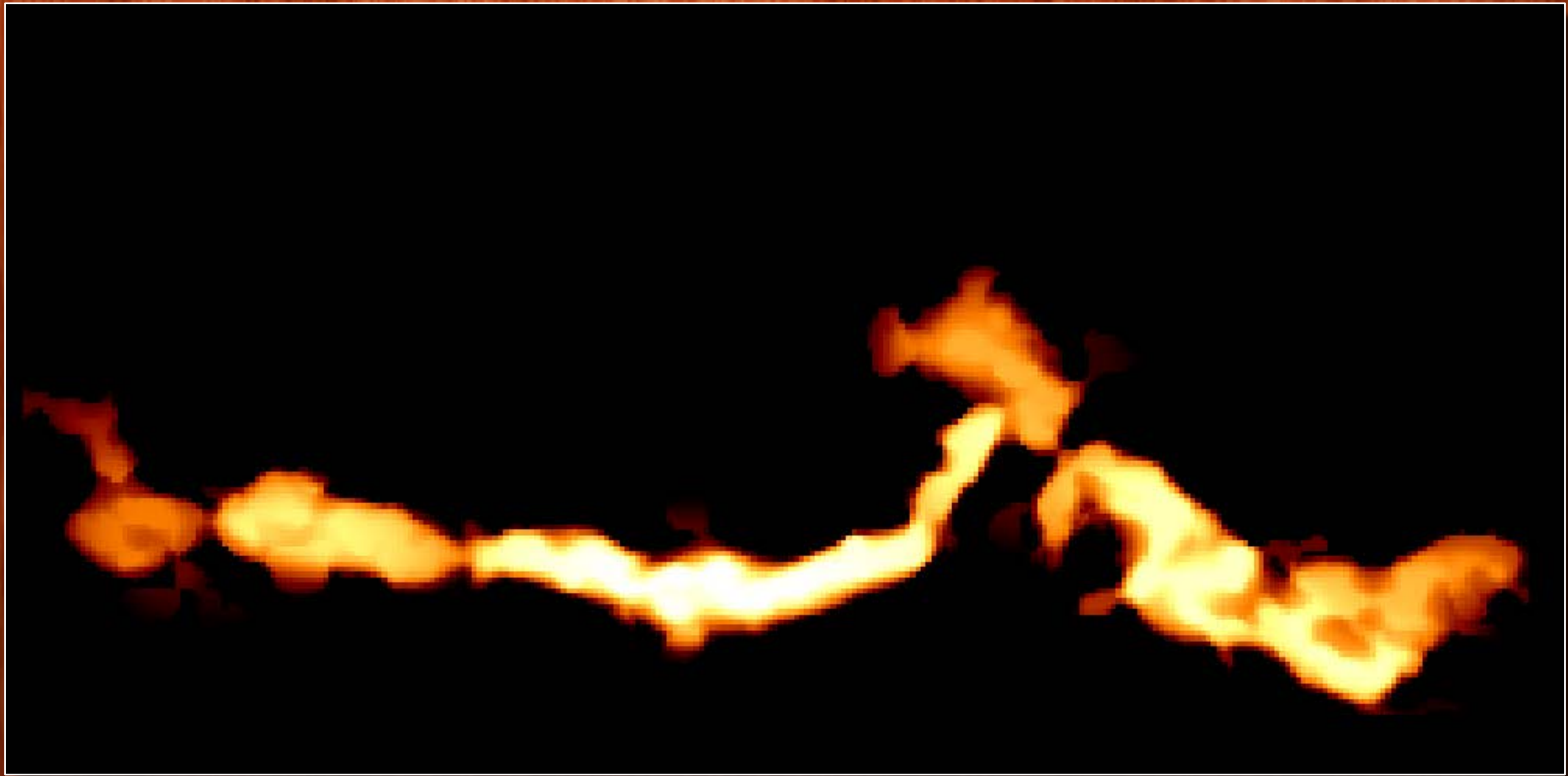

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SAG3

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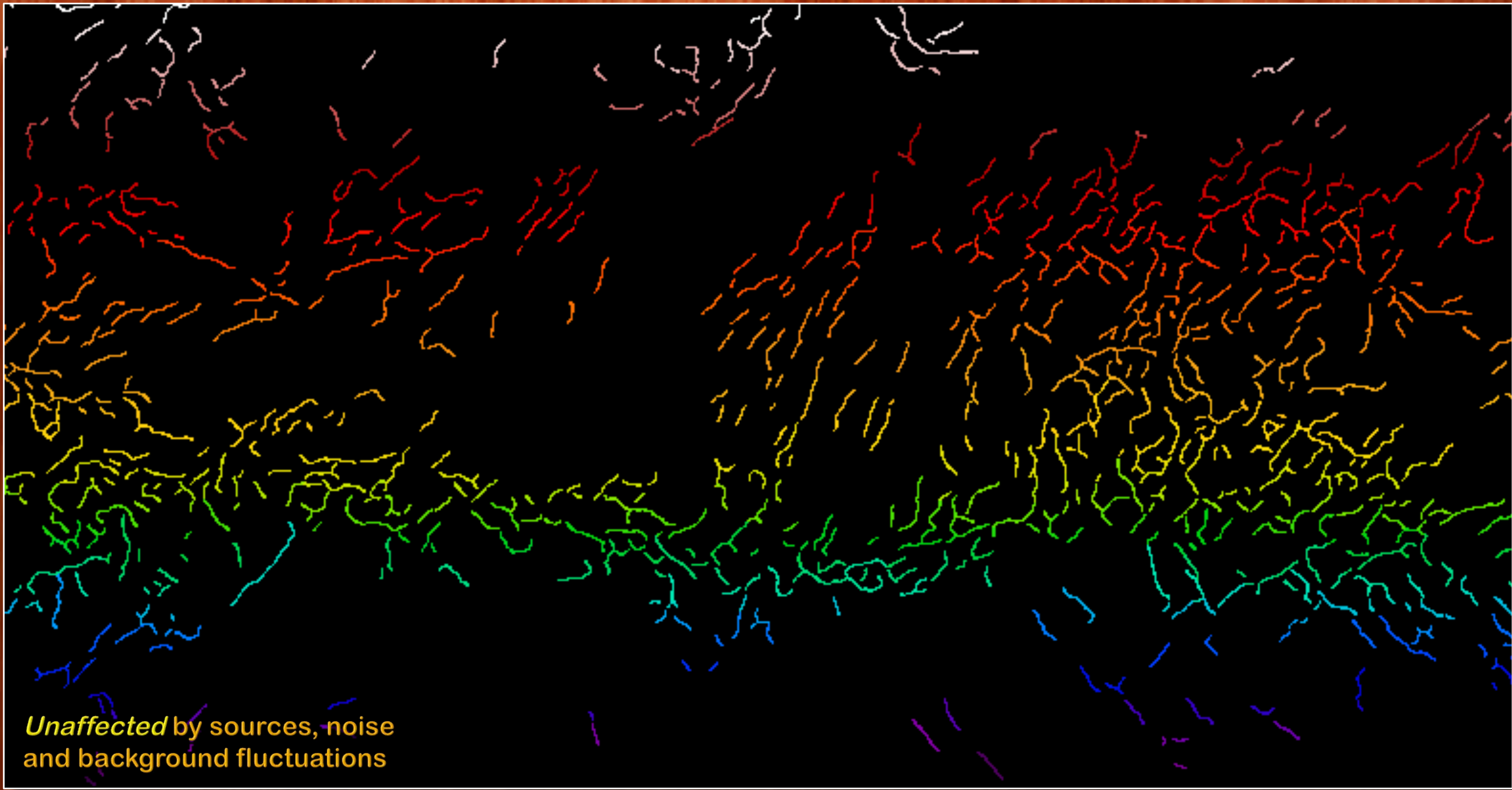


Skeletons by *getfilaments* for scales up to 72” = 0.05 pc

HERSCHEL Gould Belt Survey
SPIRE
SAG3

Taurus SPIRE 250 μm 5.3×2.6° = 13×6.5 pc *D* = 140 pc

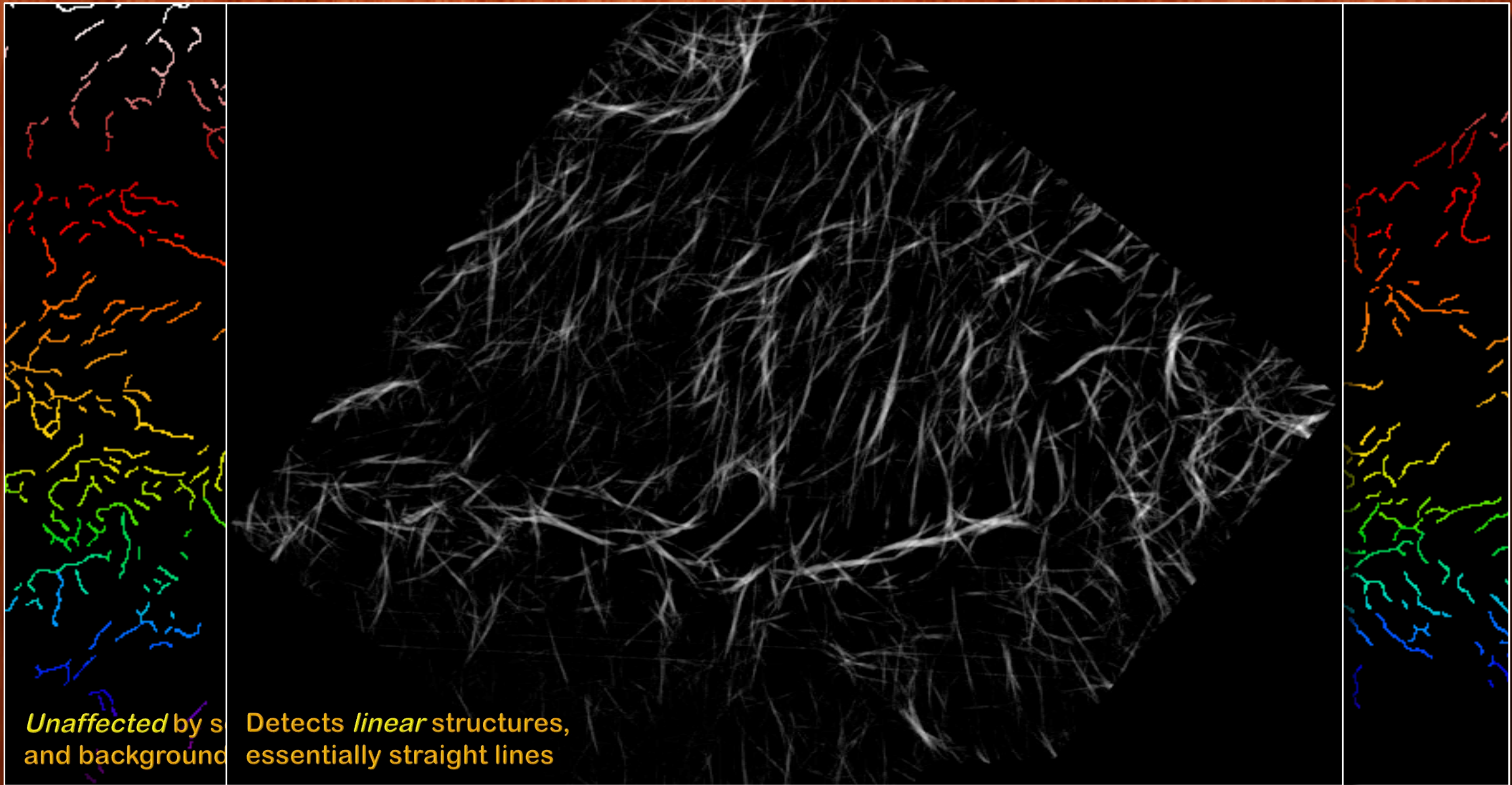


Image from the talk of J. Peek at *Filaments 2014* (Charlottesville):
filaments traced by RHT (Rolling Hough Transform, S. Clark + 2014)

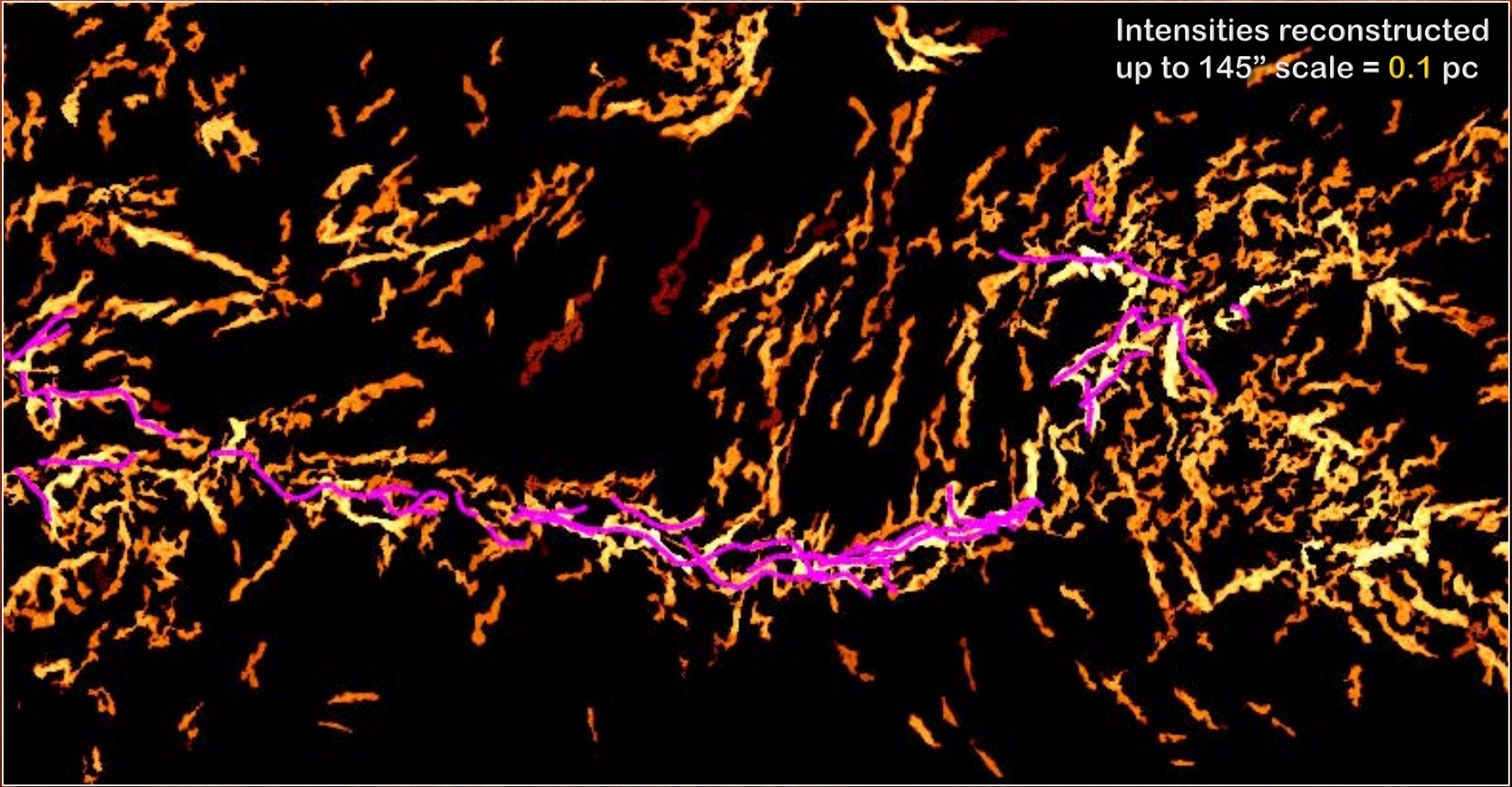
HERSCHEL Gould Belt Survey
SPIRE SAG3

Taurus SPIRE 250 μm 5.3×2.6° = 13×6.5 pc *D* = 140 pc

Skeletons obtained by P. Palmeirim + (2013)
using DisPerSE (T. Sousbie + 2011)

HERSCHEL Gould Belt Survey
SPIRE SAG3

Taurus SPIRE 250 μm 5.3×2.6° = 13×6.5 pc *D* = 140 pc

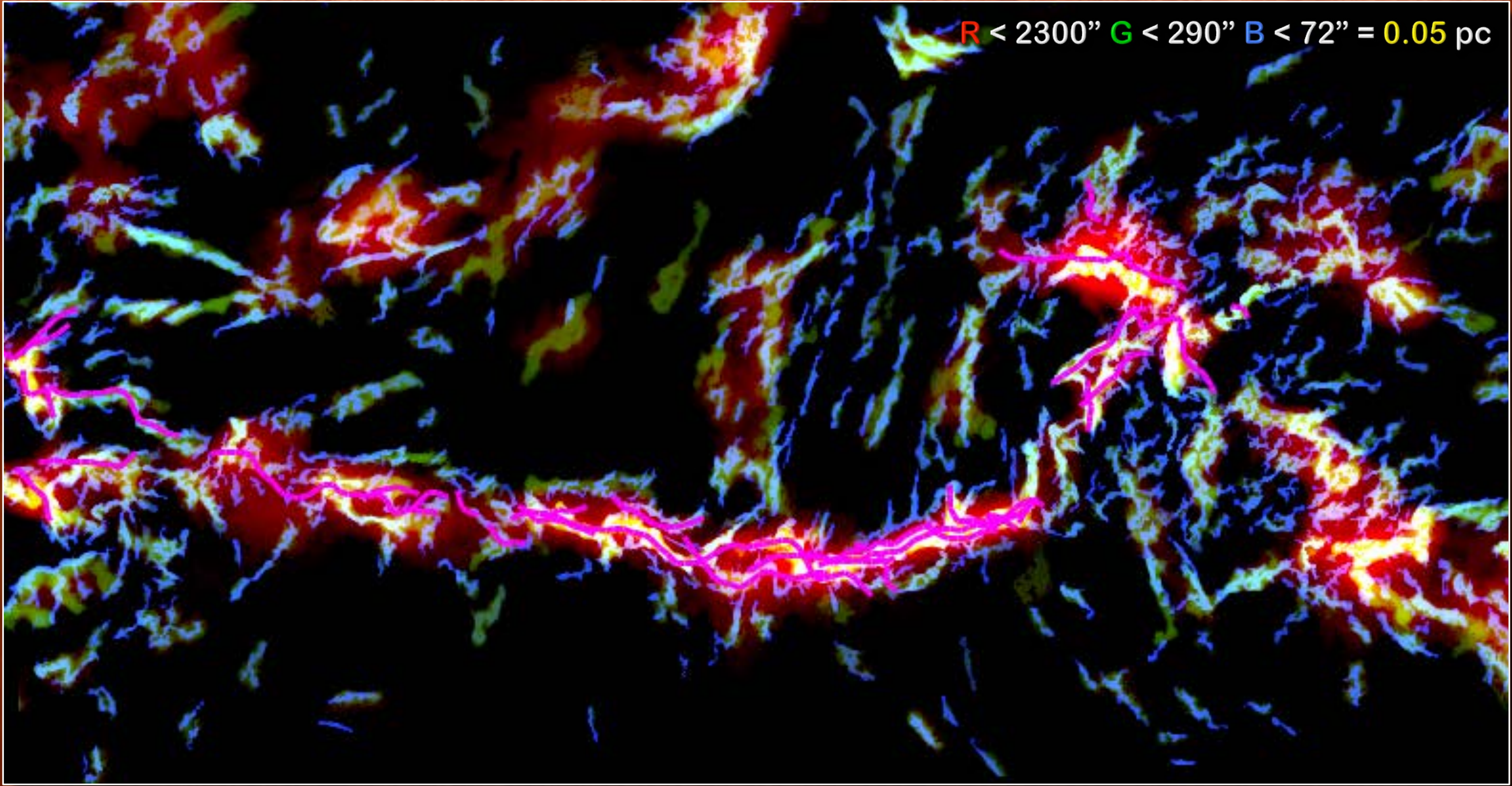


Velocity-coherent fibers from A. Hacar + (2013)

See also: Figure 2 from Ph. André + (Protostars & Planets VI, 2014)

HERSCHEL Gould Belt Survey
SPIRE
SAG3

Taurus SPIRE 250 µm 5.3×2.6° = 13×6.5 pc D = 140 pc



Velocity-coherent fibers from A. Hacar + (2013)

HERSCHEL Gould Belt Survey SPIRE SAG3

Polaris SPIRE 250 μm 4.2×4.2° = 11×11 pc D=150 pc

See also: Ph. André + (2010), A. Men'shchikov + (2010),
M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

HERSCHEL Gould Belt Survey SPIRE SAG3

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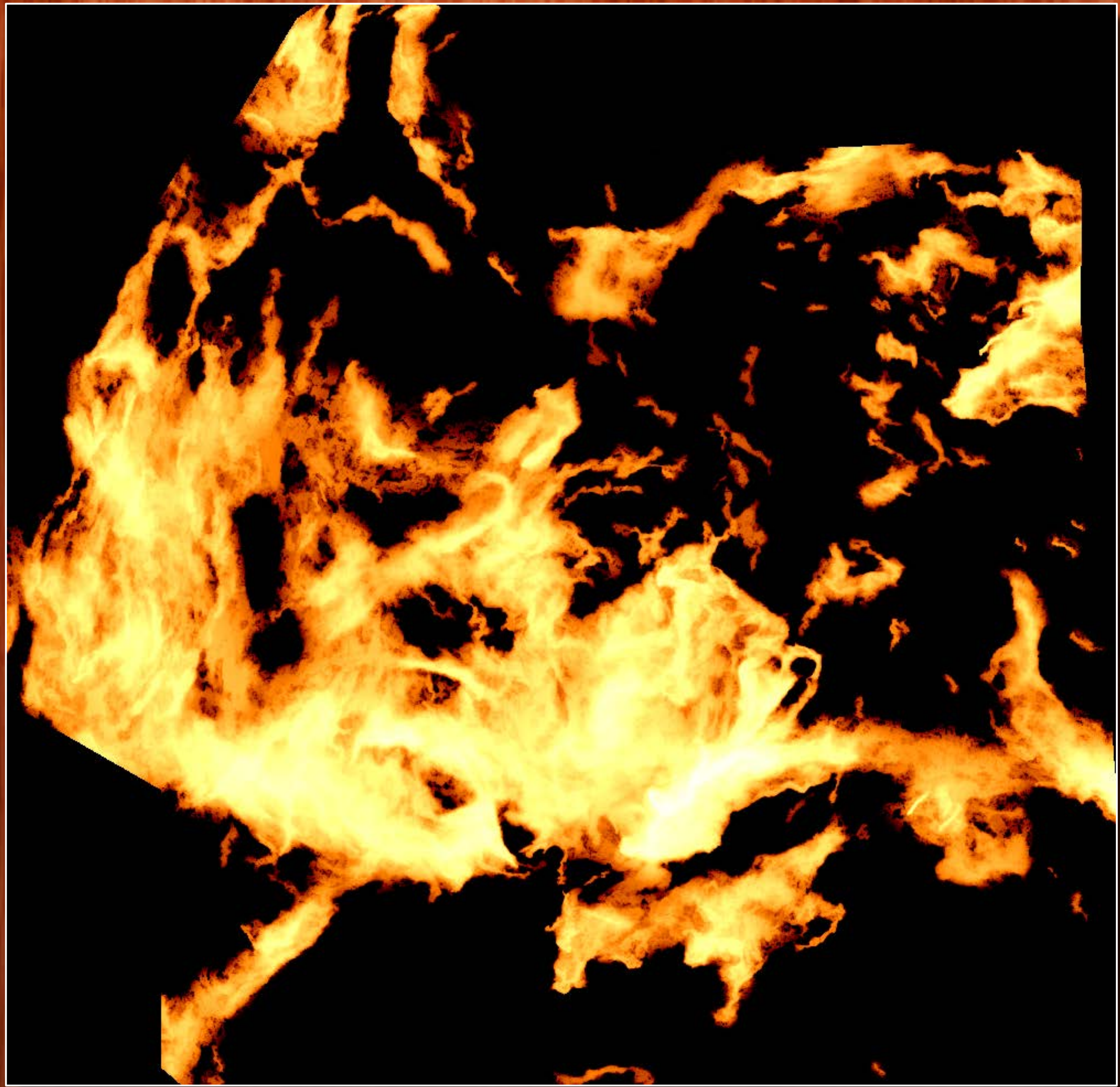

See also: Ph. André + (2010), A. Men'shchikov + (2010),
M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

HERSCHEL Gould Belt Survey
SPIRE
SAG3

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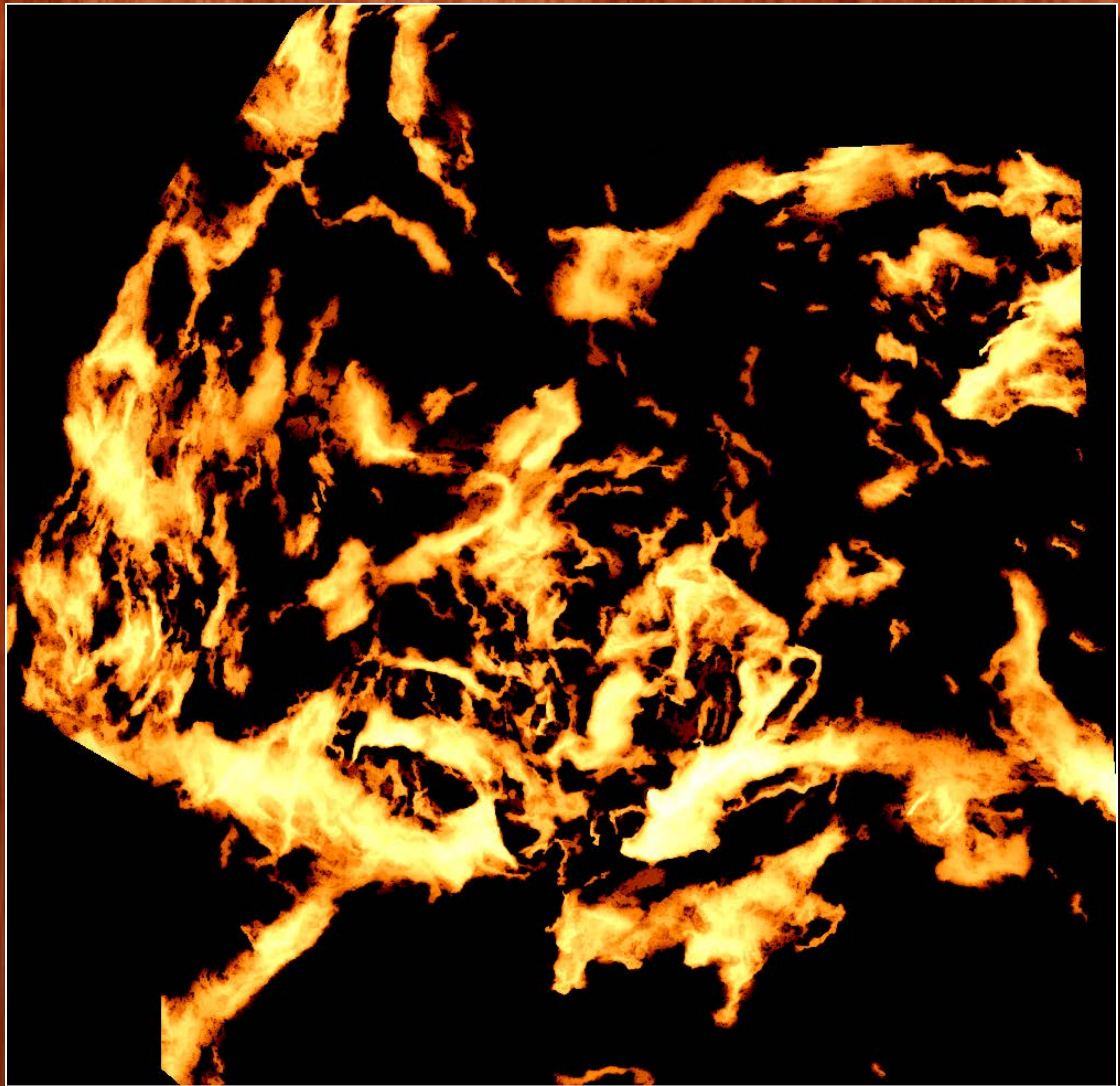

See also: Ph. André + (2010), A. Men'shchikov + (2010), M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

HERSCHEL Gould Belt Survey SPIRE SAG3

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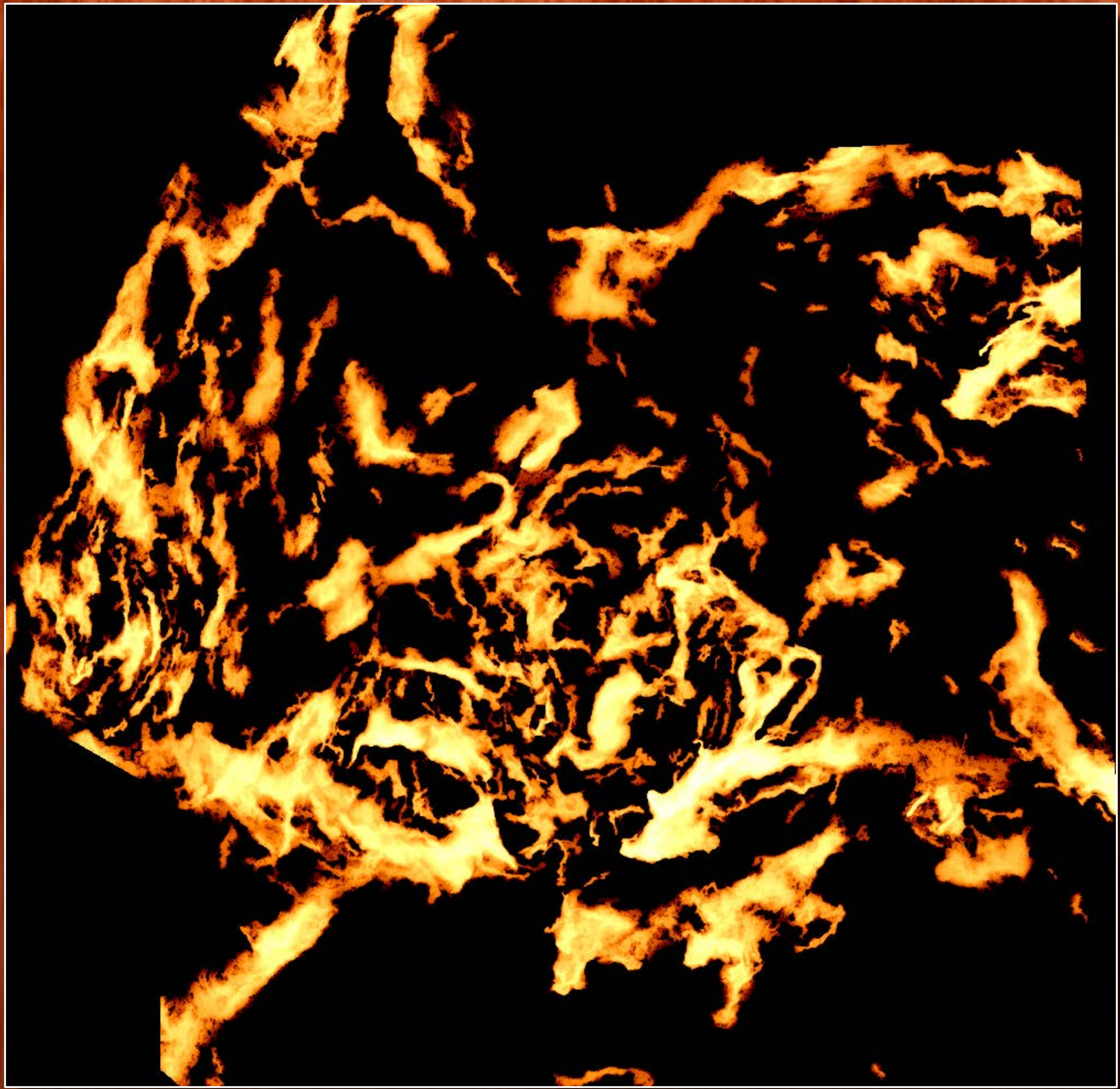

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HERSCHEL Gould Belt Survey SPIRE SAG3

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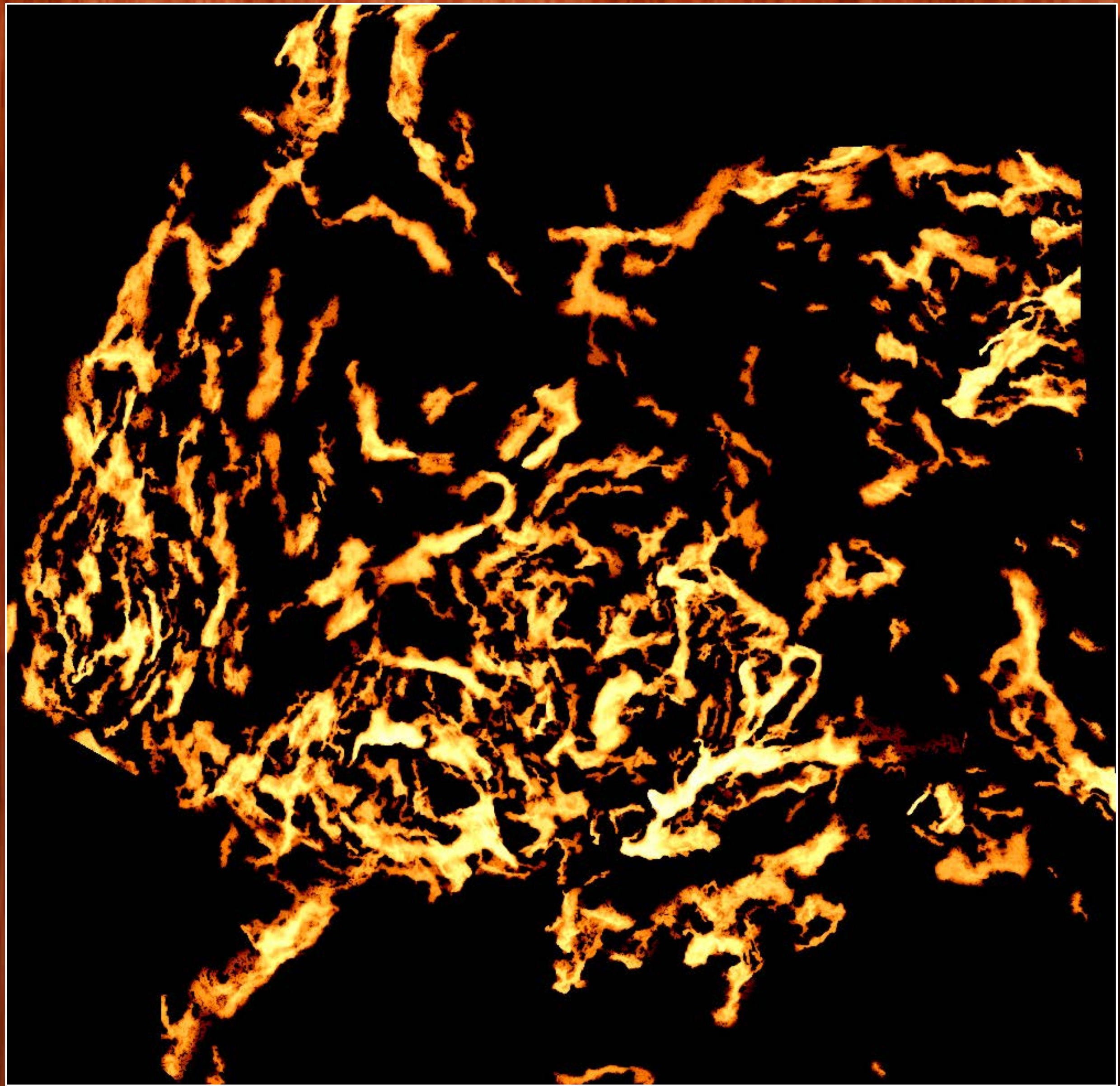

See also: Ph. André + (2010), A. Men'shchikov + (2010),
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HERSCHEL Gould Belt Survey SPIRE SAG3

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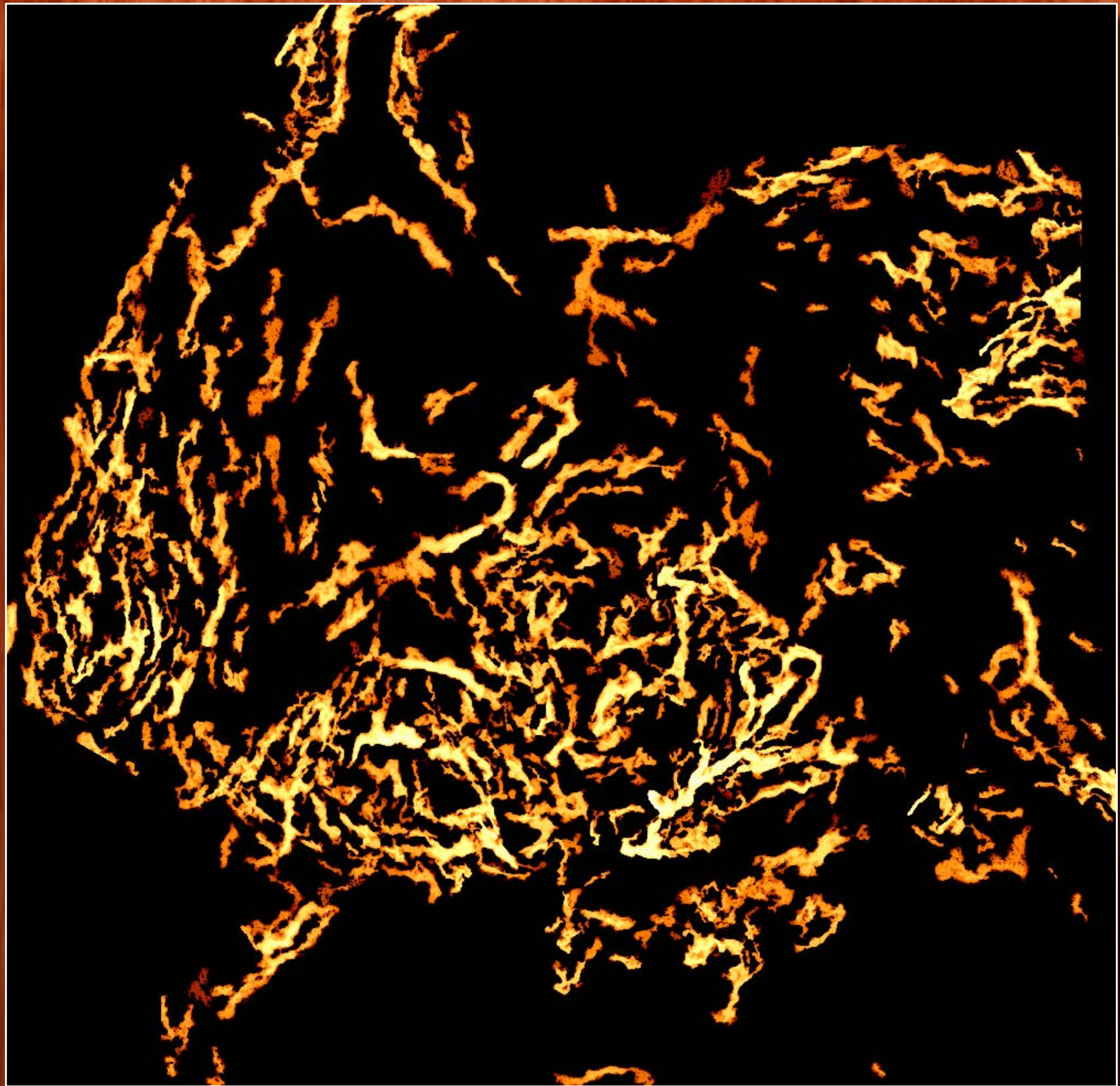

See also: Ph. André + (2010), A. Men'shchikov + (2010),
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HERSCHEL Gould Belt Survey
SPIRE SAG3

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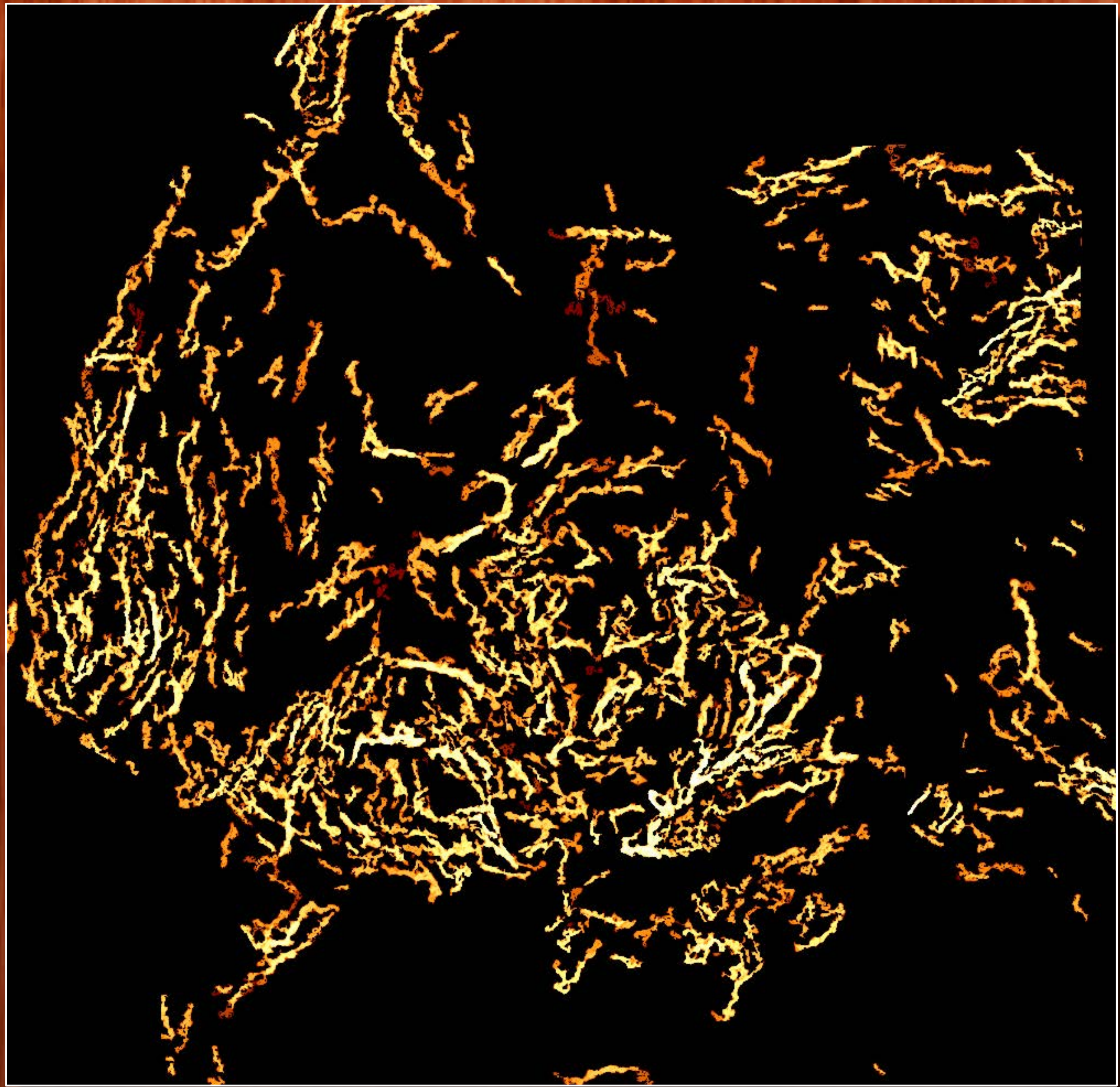

See also: Ph. André + (2010), A. Men'shchikov + (2010),
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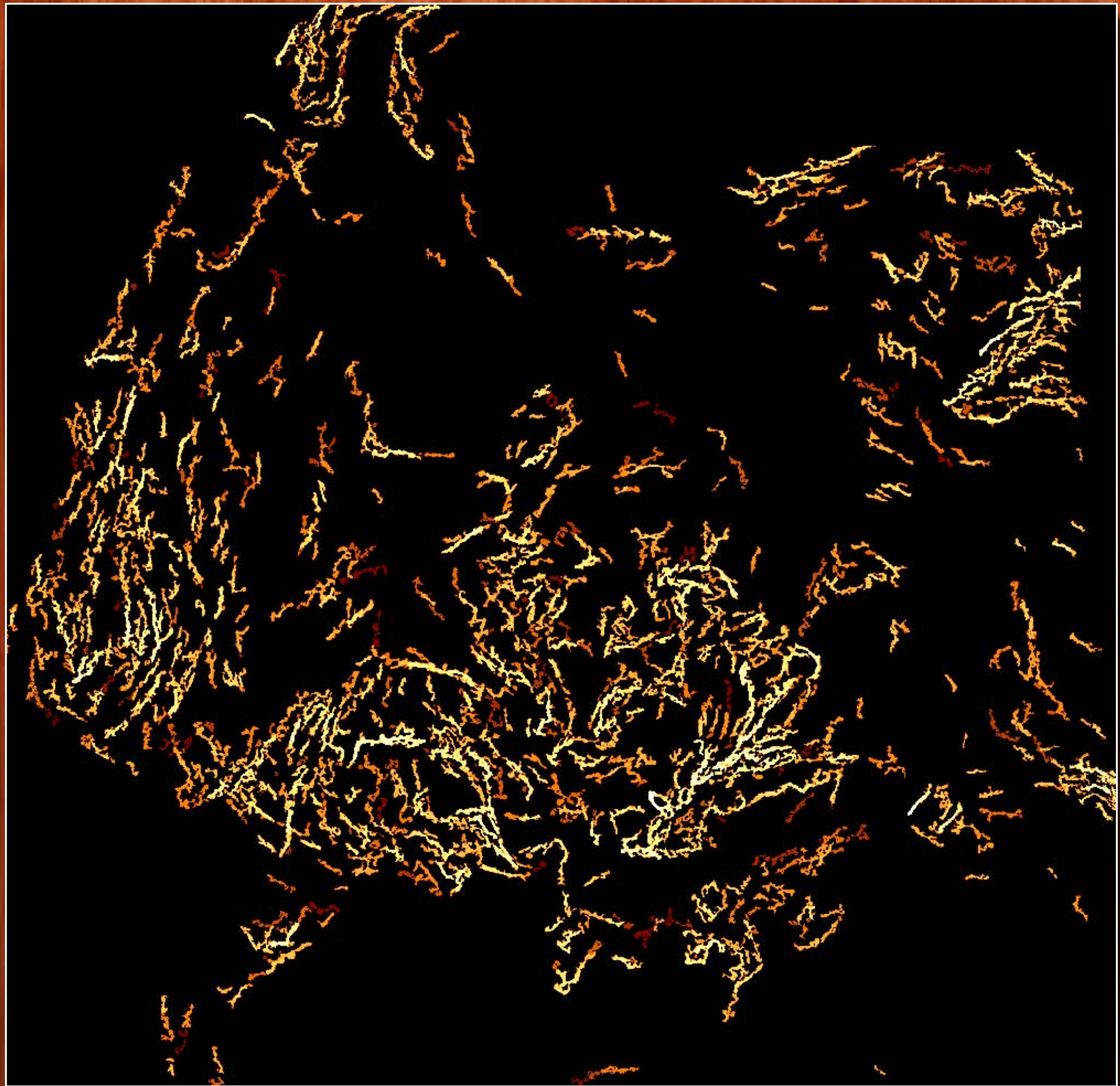

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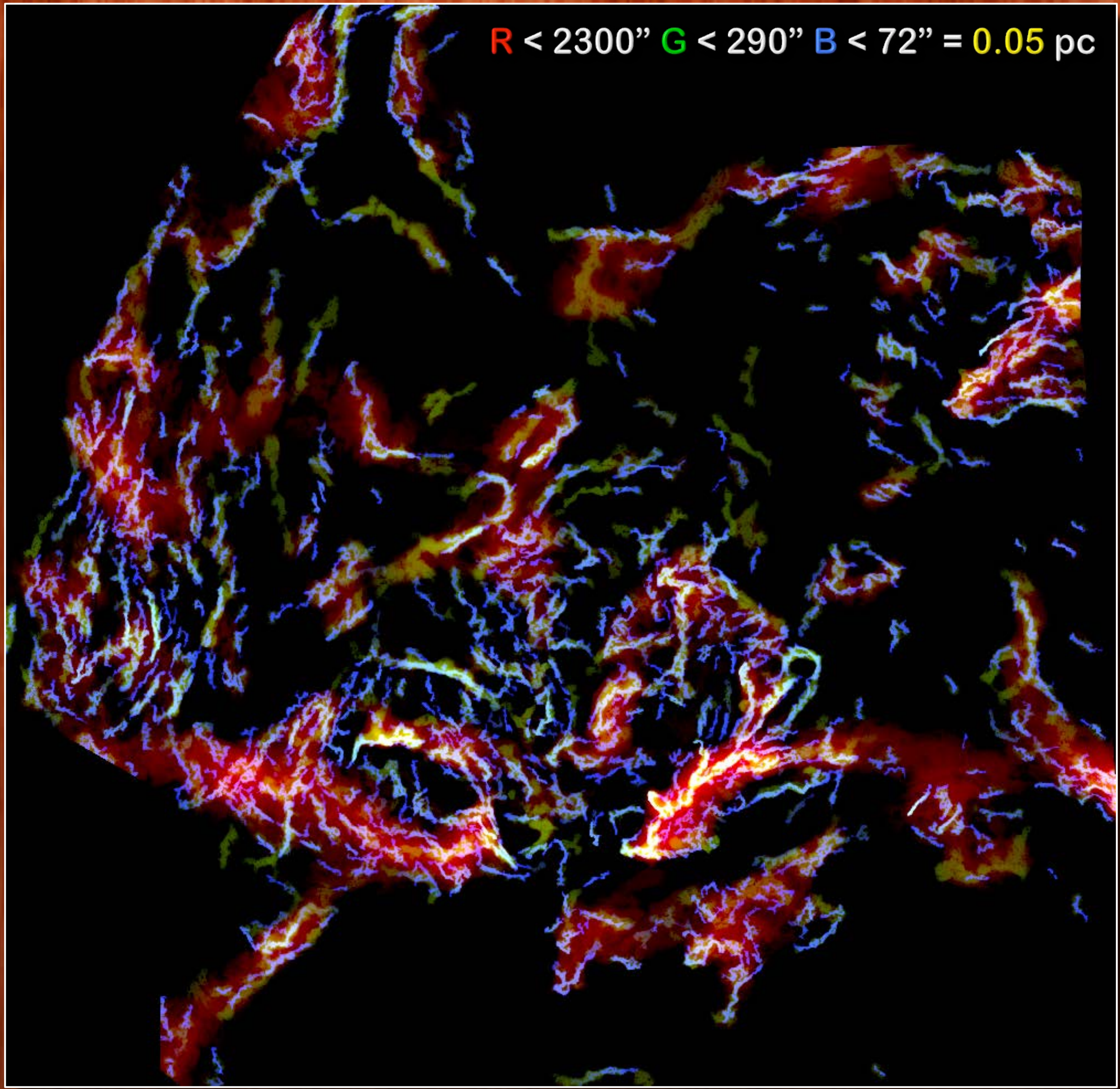

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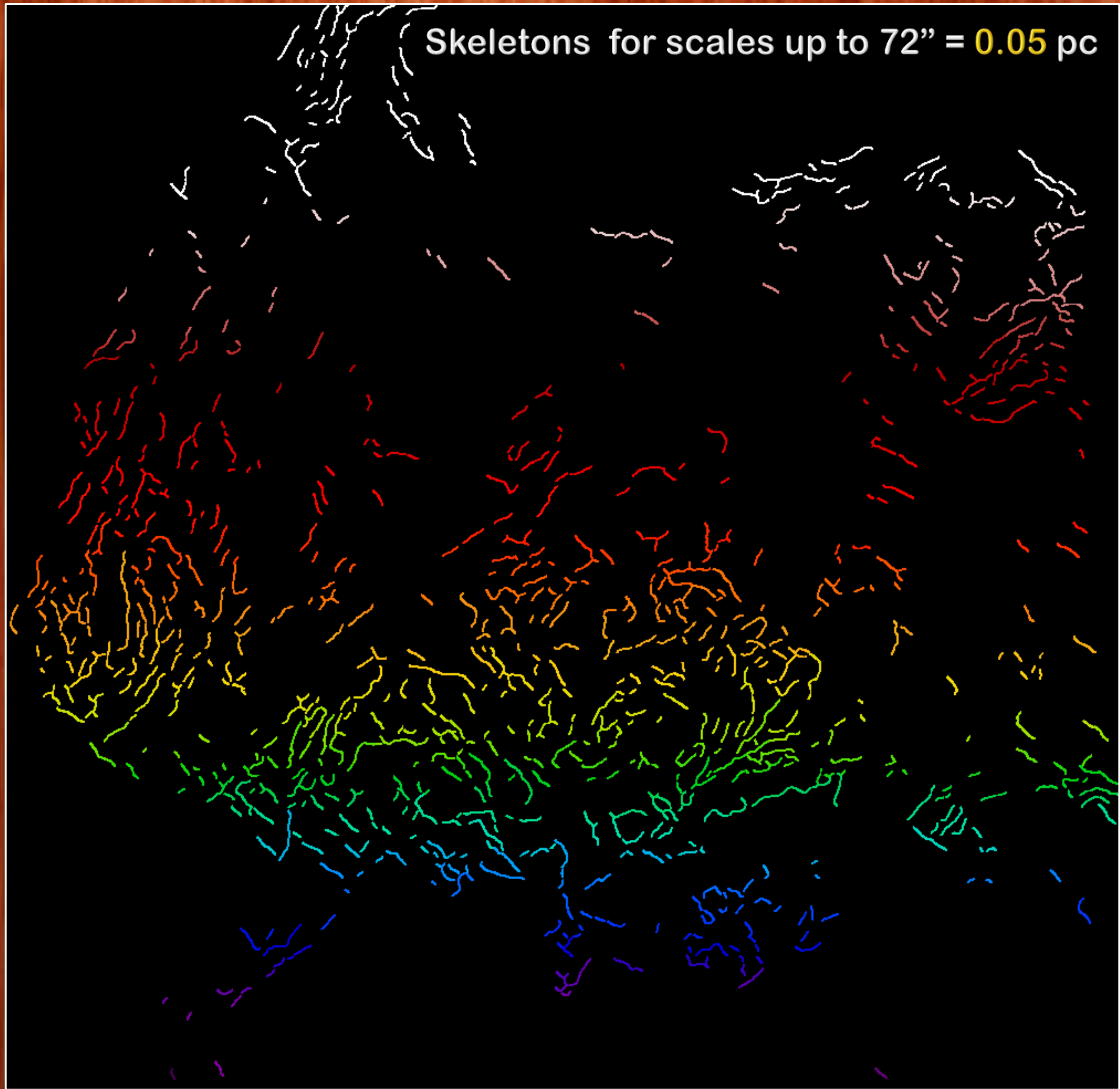
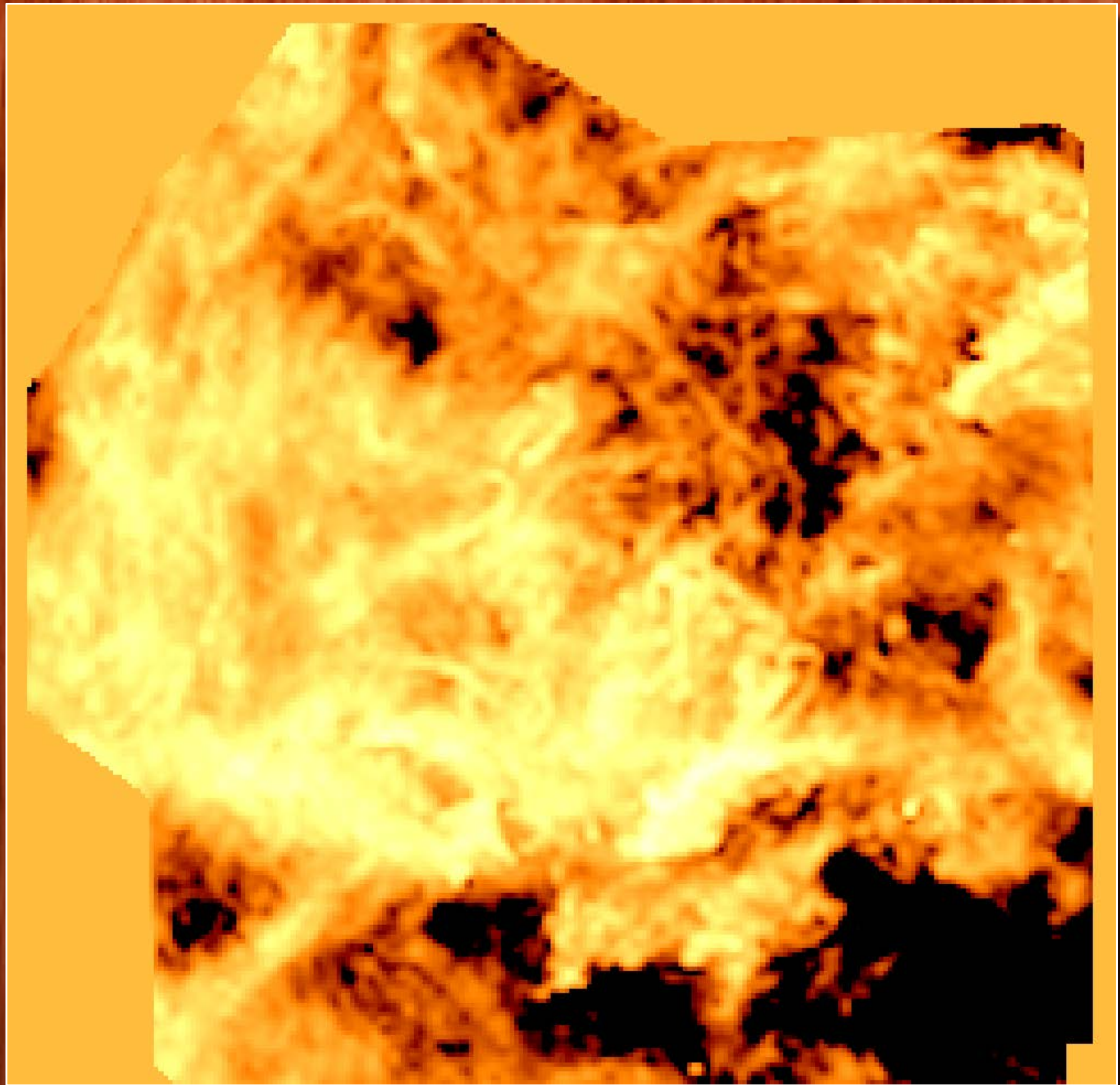


See also: Ph. André + (2010), A. Men’shchikov + (2010),
M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

HERSCHEL Gould Belt Survey SPIRE SAG3

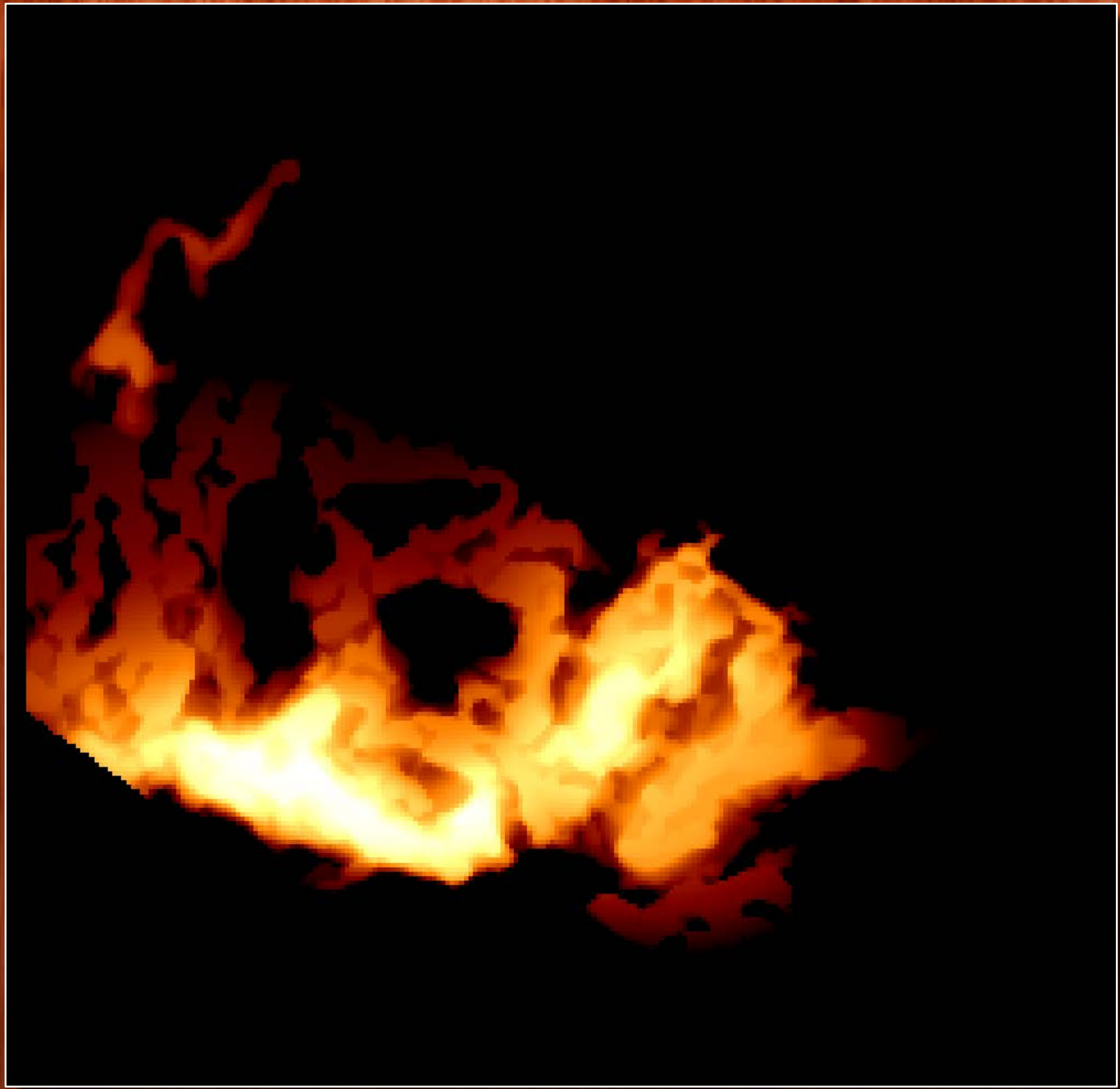
Polaris SPIRE 250 μm 0.21×0.21° = 11×11 pc $D \nearrow 3000$ pc



HERSCHEL Gould Belt Survey SPIRE SAG3

See also: Ph. André + (2010), A. Men'shchikov + (2010),
M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

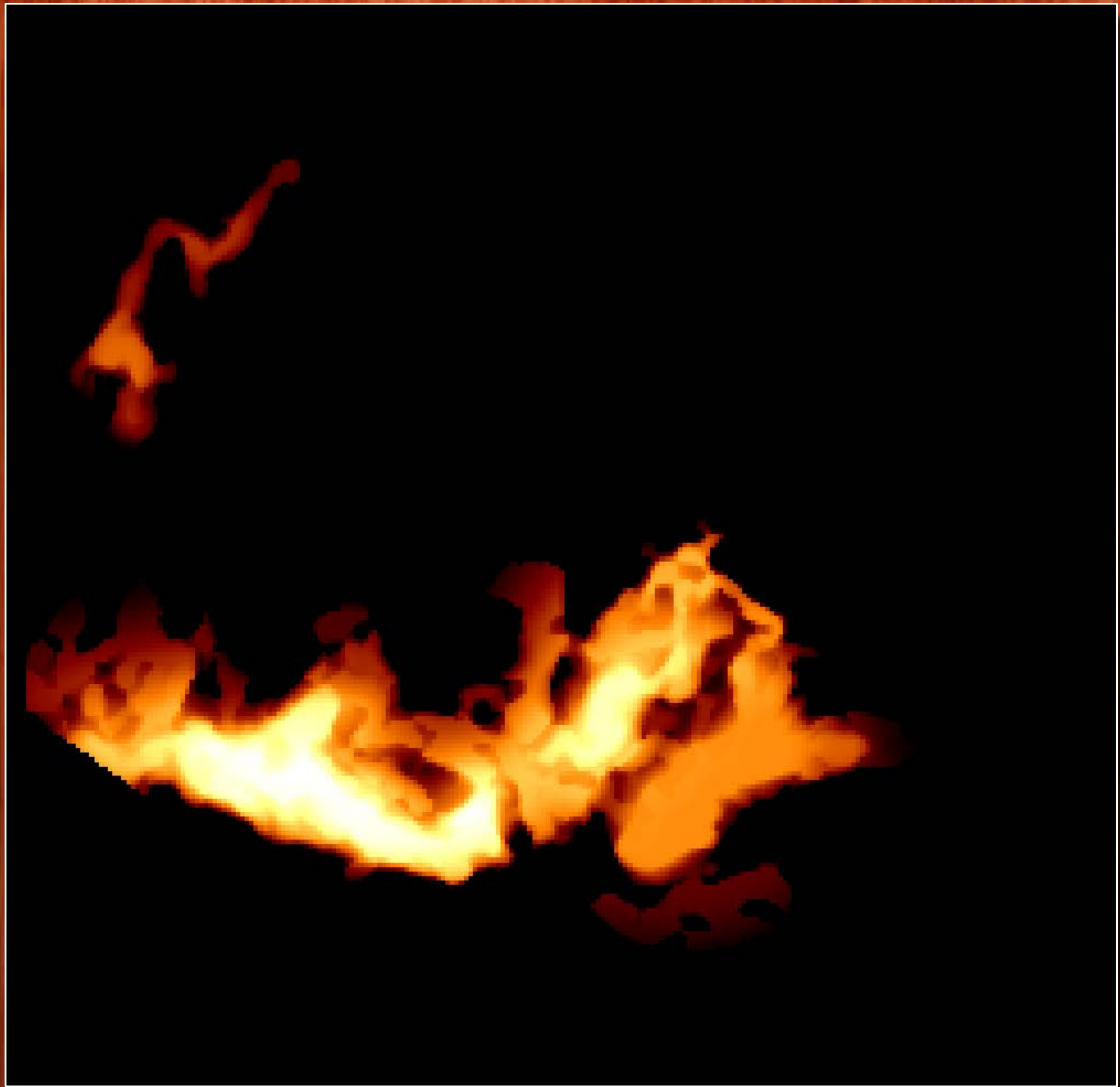
Polaris SPIRE 250 μm 0.21×0.21° = 11×11 pc D↗3000 pc



See also: Ph. André + (2010), A. Men'shchikov + (2010), M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

SAG3

Polaris SPIRE 250 µm 0.21×0.21° = 11×11 pc D↗3000 pc



See also: Ph. André + (2010), A. Men'shchikov + (2010),
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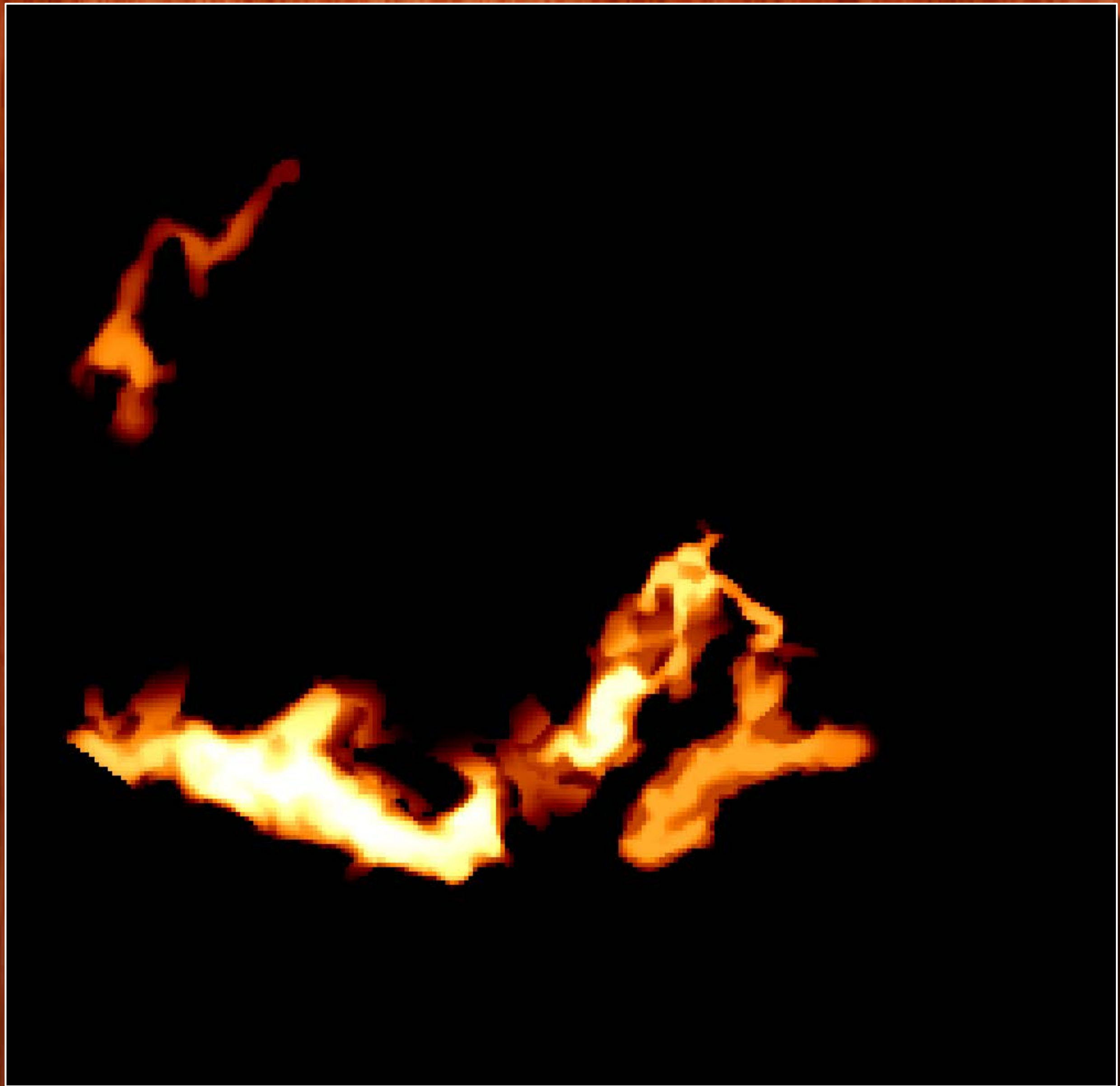
HERSCHEL Gould Belt Survey
SPIRE
SAG3

Polaris SPIRE 250 μm 0.21×0.21° = 11×11 pc D↗3000 pc



SAG3

See also: Ph. André + (2010), A. Men’shchikov + (2010),
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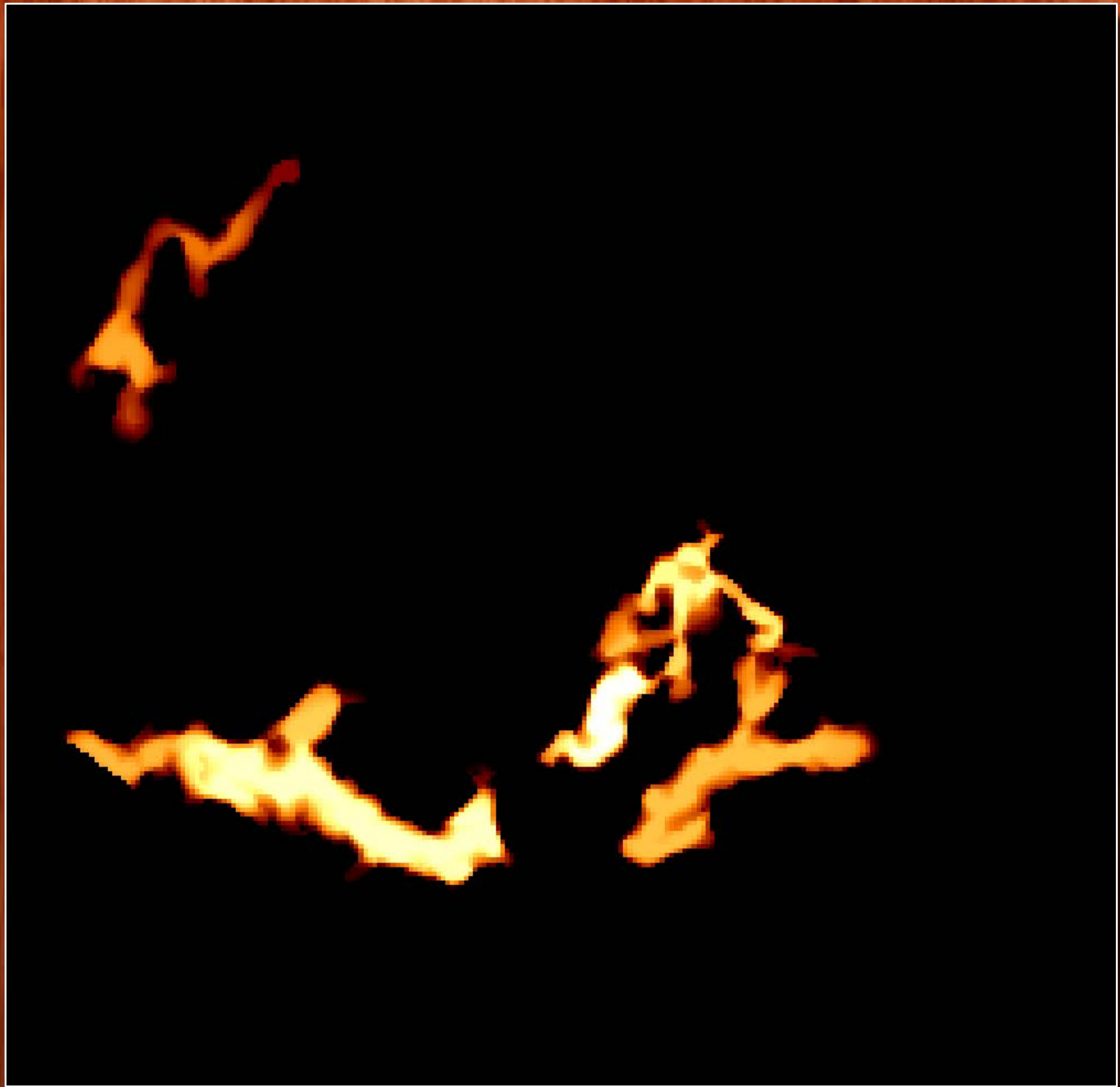

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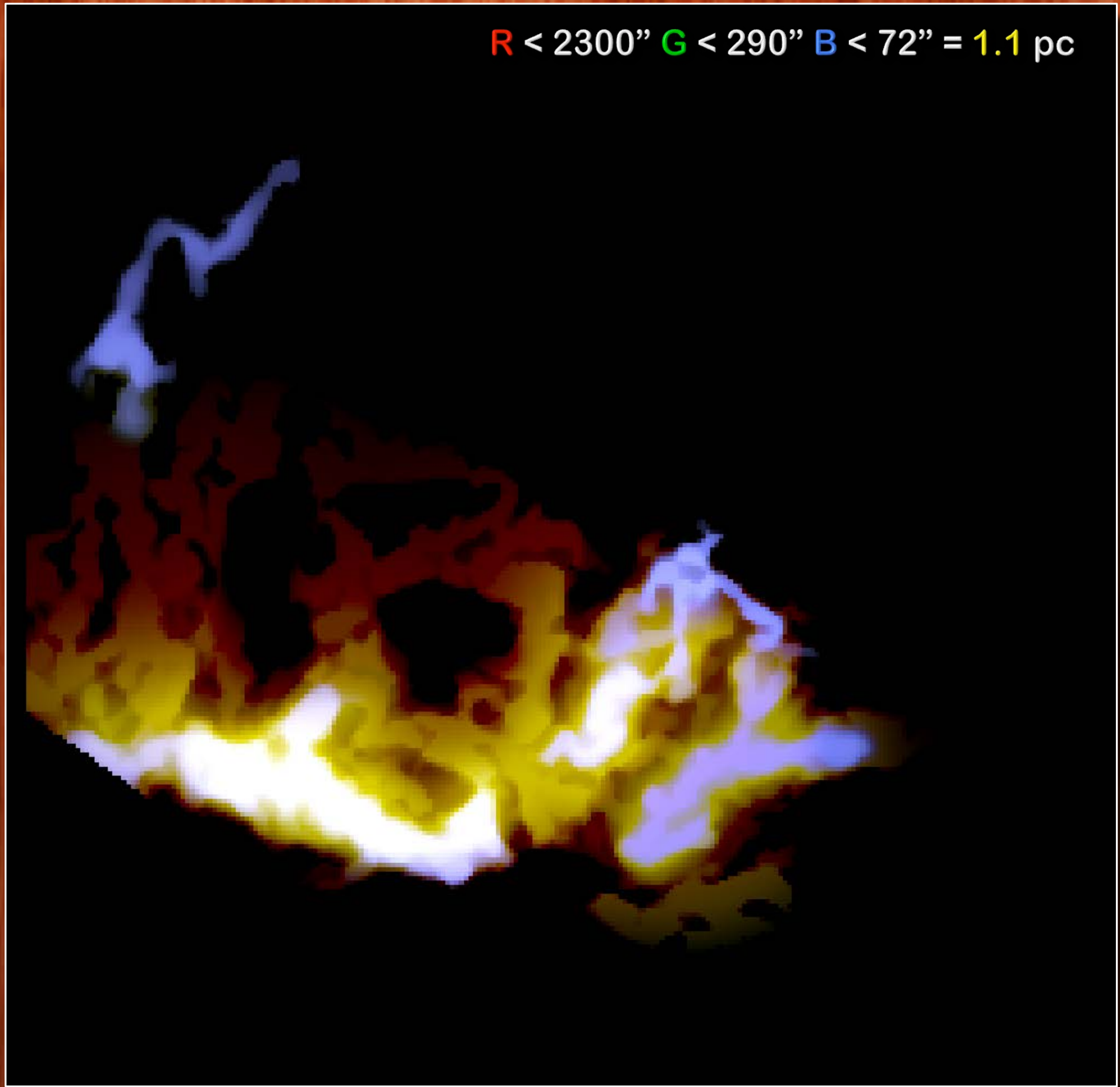
M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

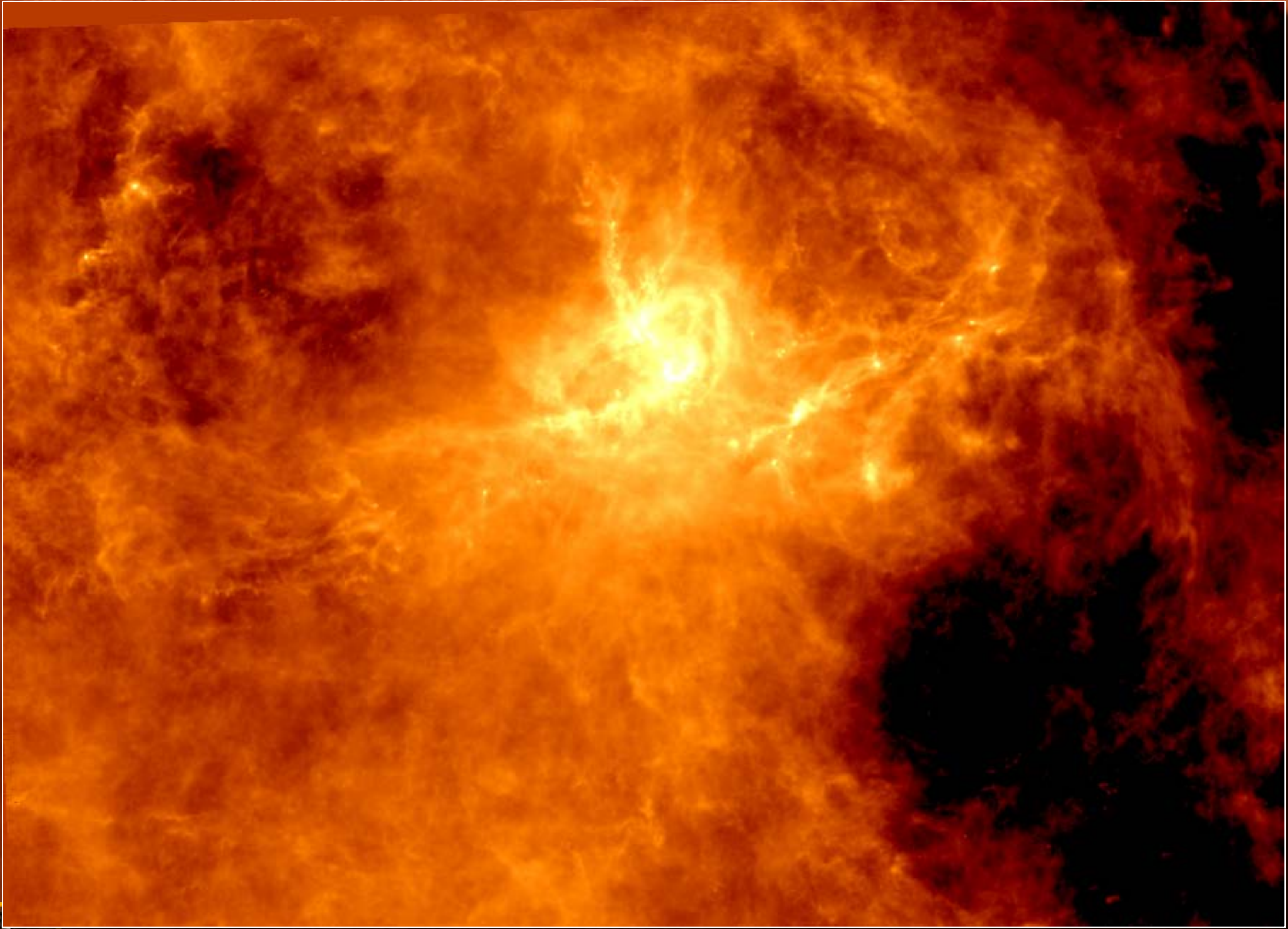
Polaris SPIRE 250 μm 0.21×0.21° = 11×11 pc *D*↗3000 pc



See also: Ph. André + (2010), A. Men'shchikov + (2010),
M.-A. Miville-Dechênes + (2010), Ward-Thompson + (2010)

HERSCHEL Gould Belt Survey SPIRE SAG3

Aquila SPIRE 250 μm 3.0×2.1° = 14×9.8 pc D = 260 pc



See also: Ph. André + (2010), A. Men'shchikov + (2010), S. Bontemps + (2010), V. Könyves + (2010; in prep.; also talk)

HERSCHEL Gould Belt Survey SPIRE SAG3

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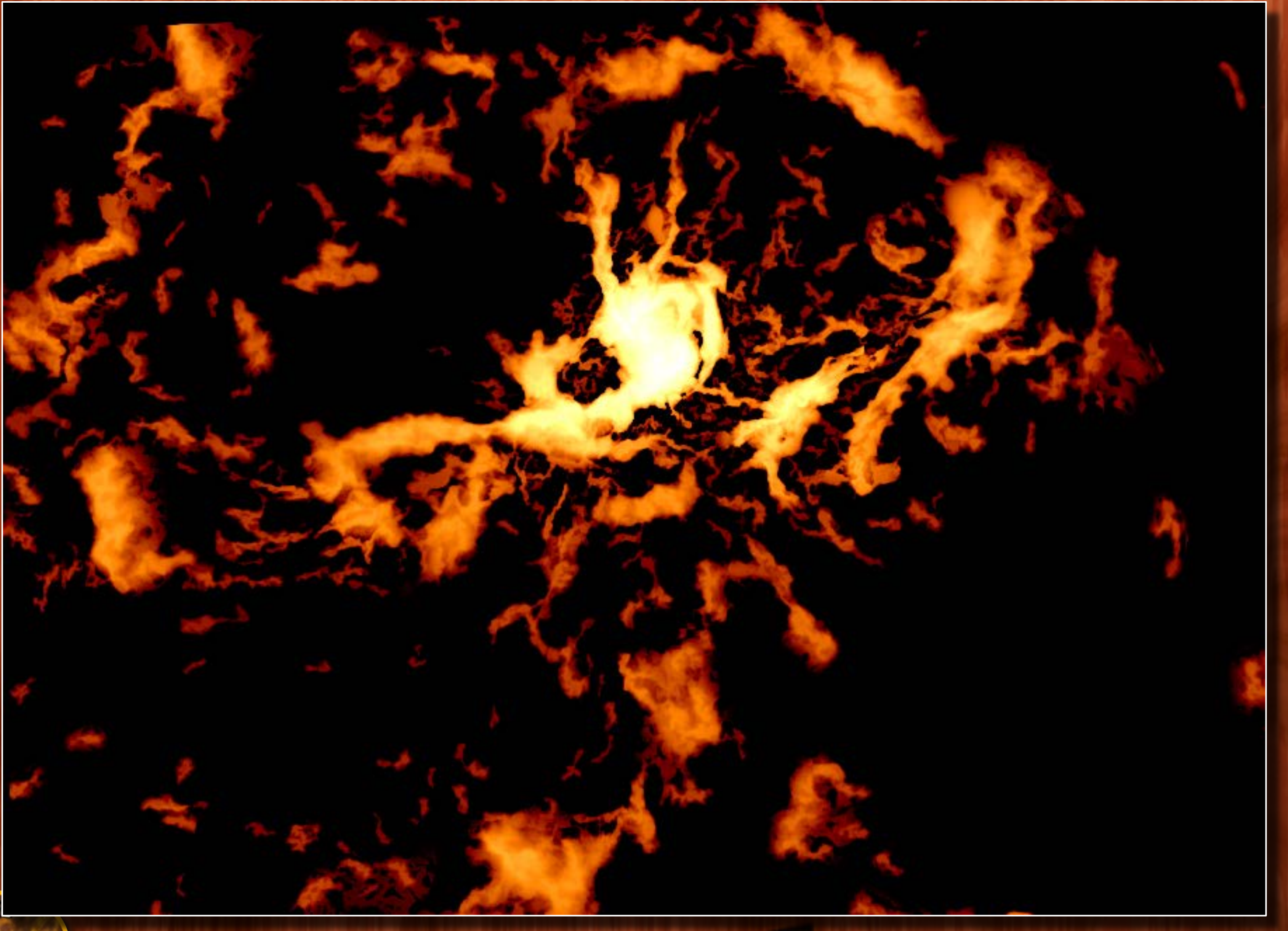

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SAG3

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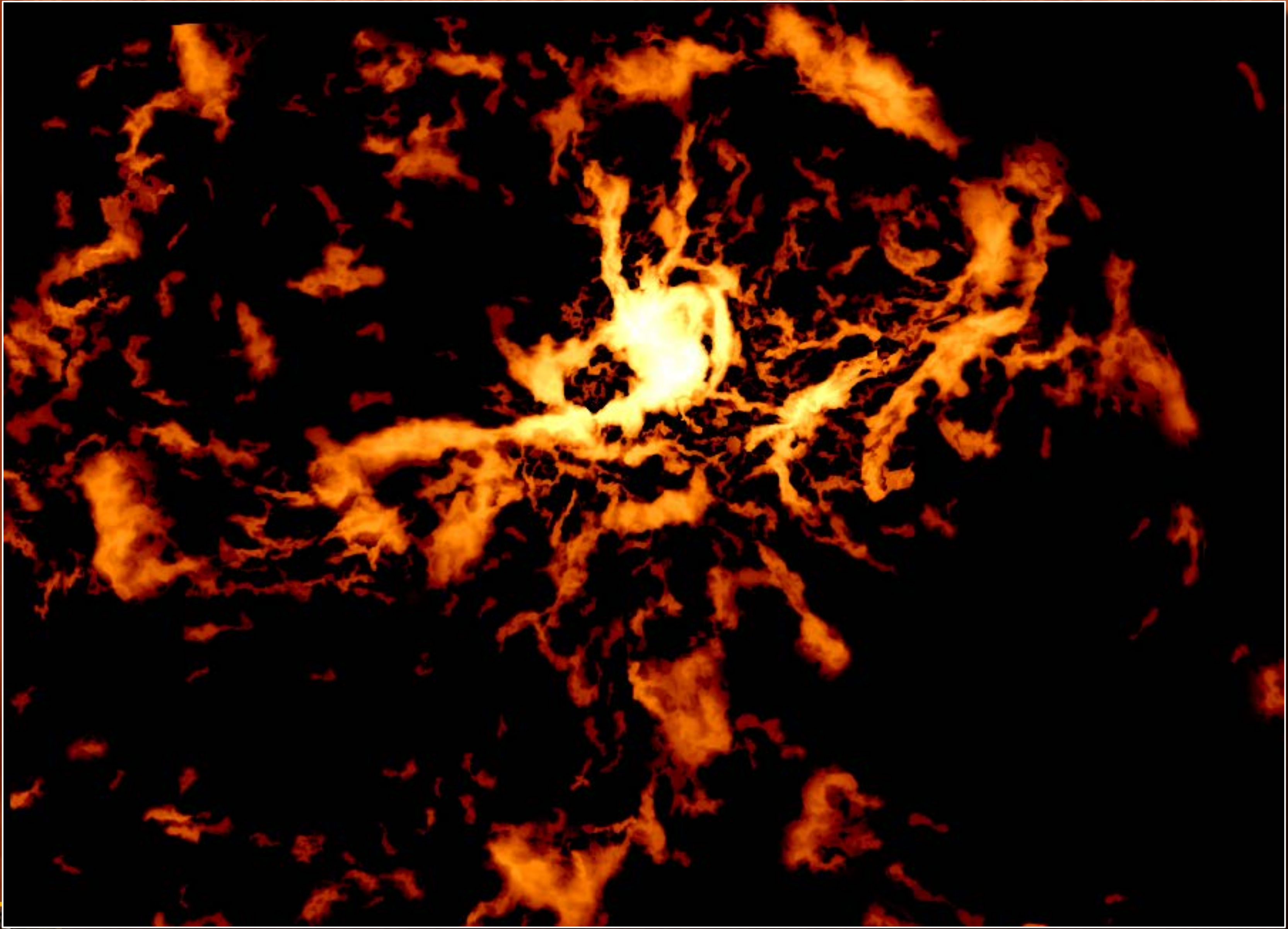

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HERSCHEL Gould Belt Survey SPIRE SAG3

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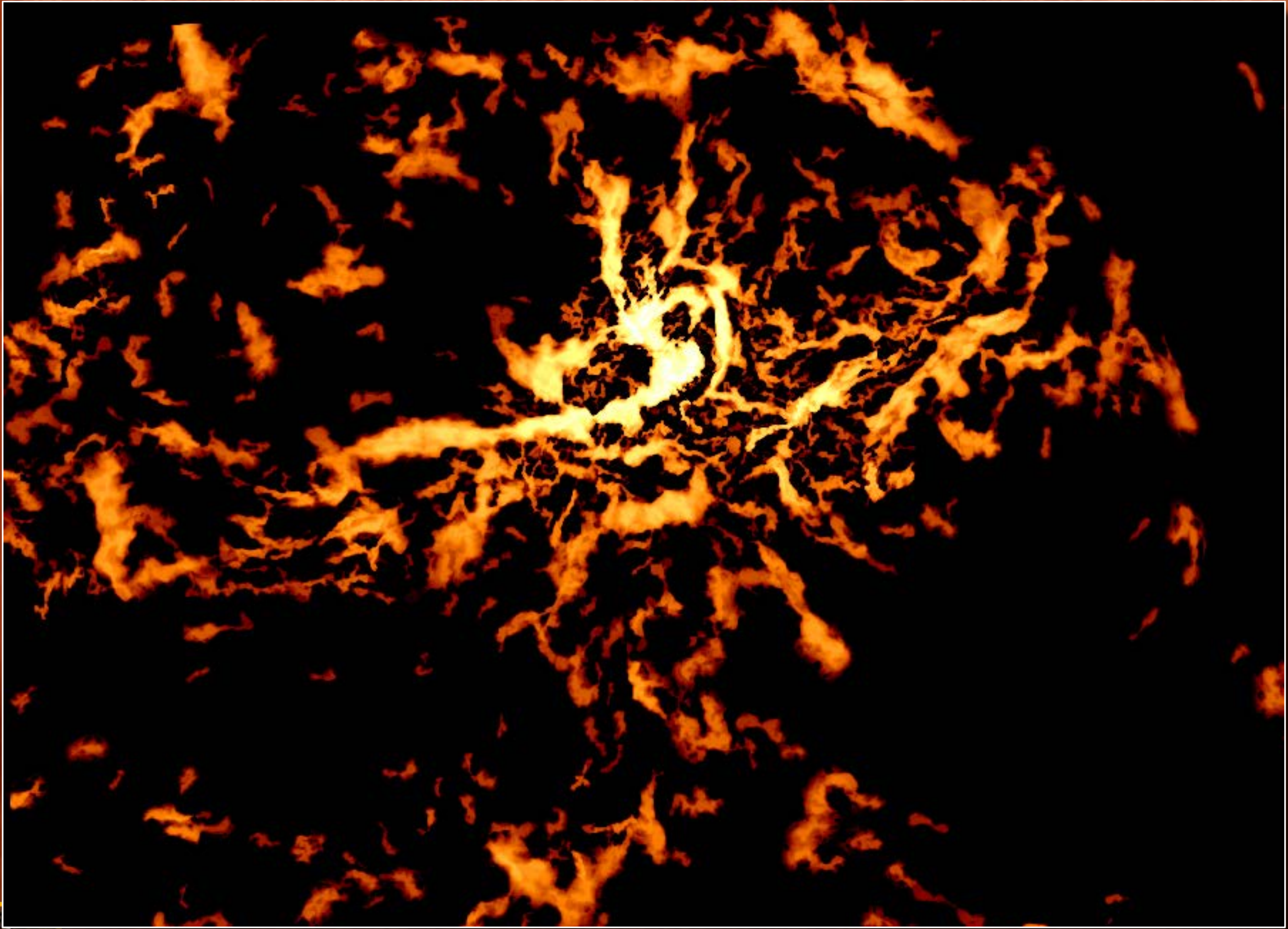

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SAG3

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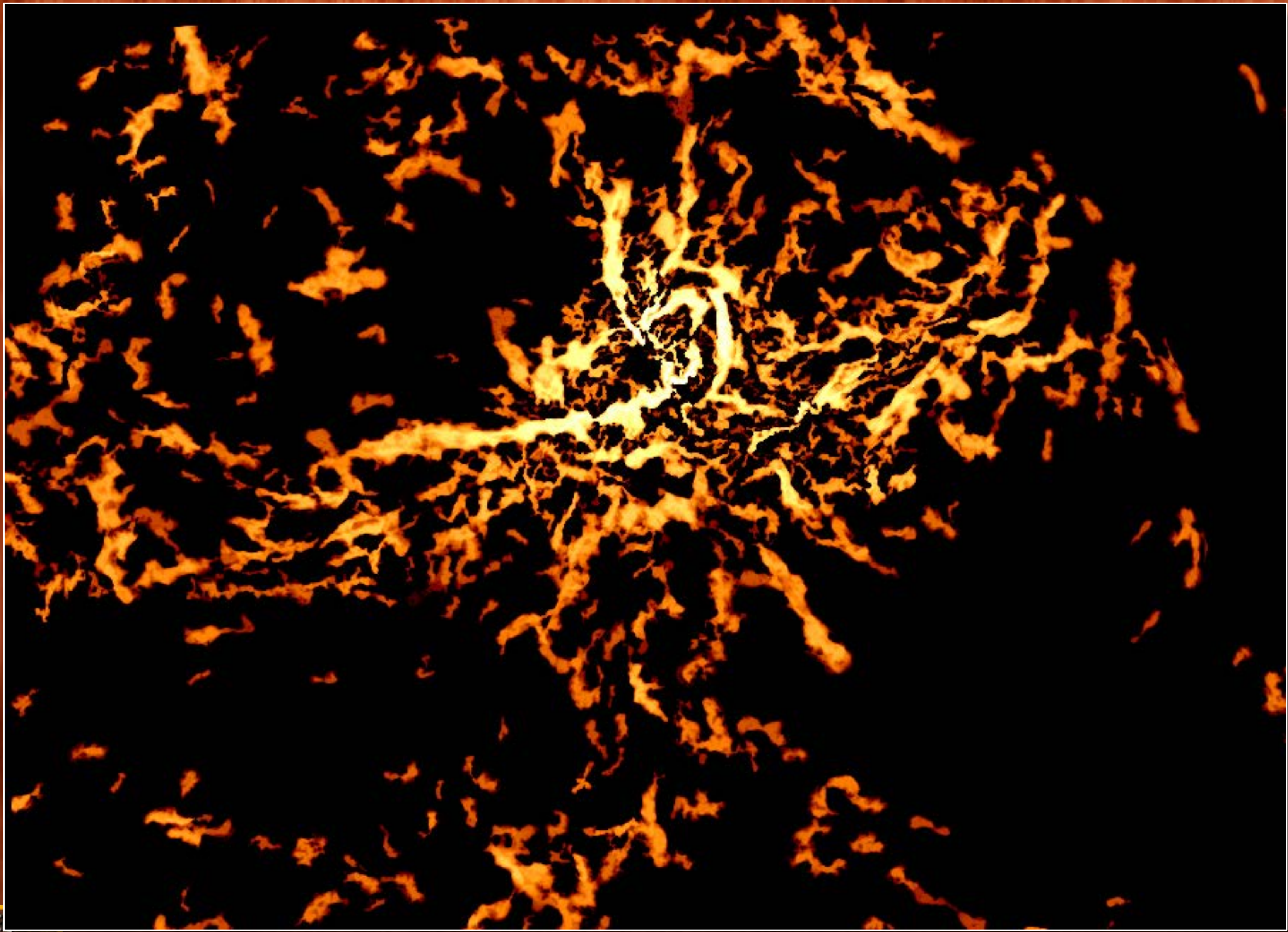

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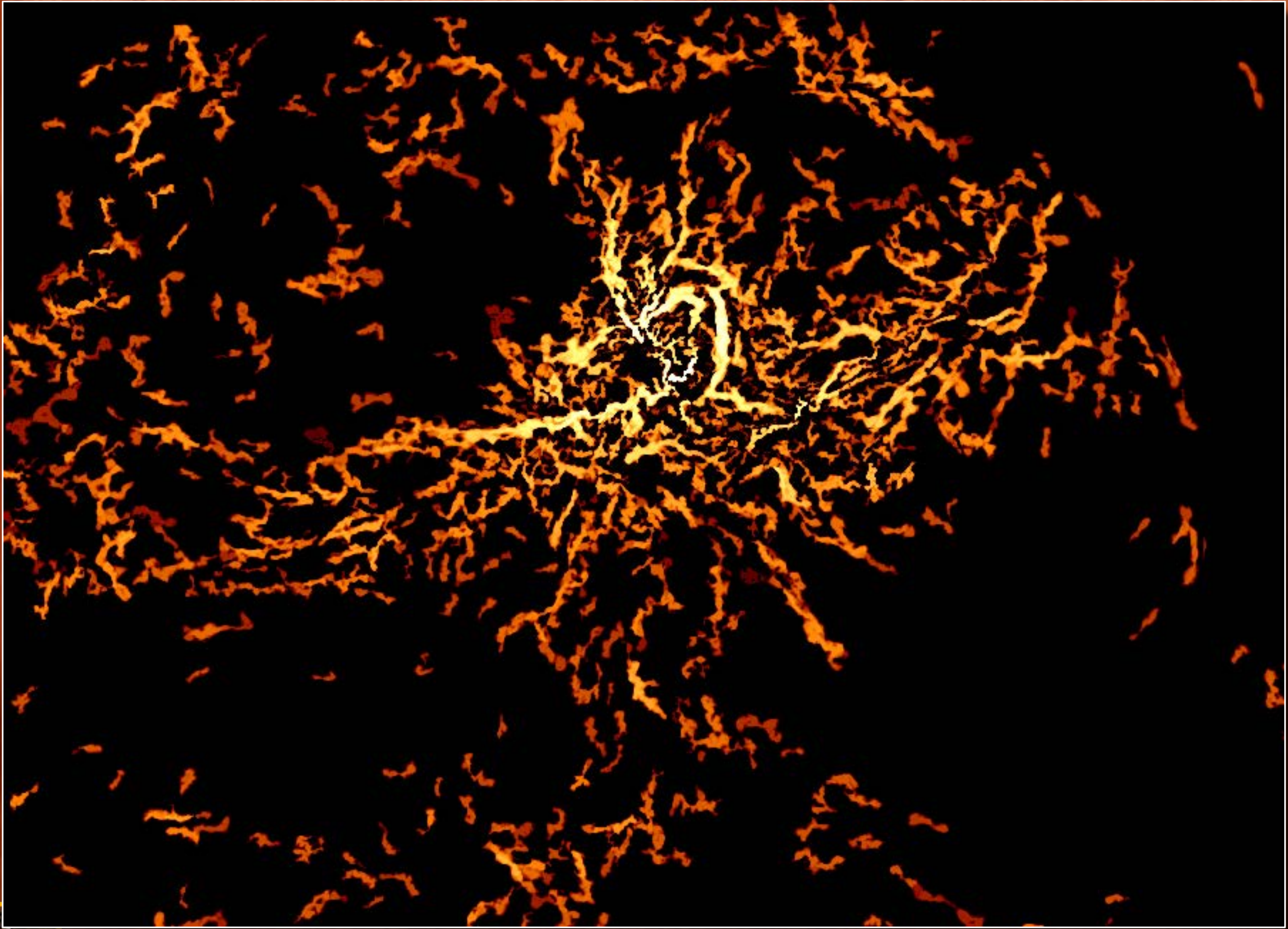

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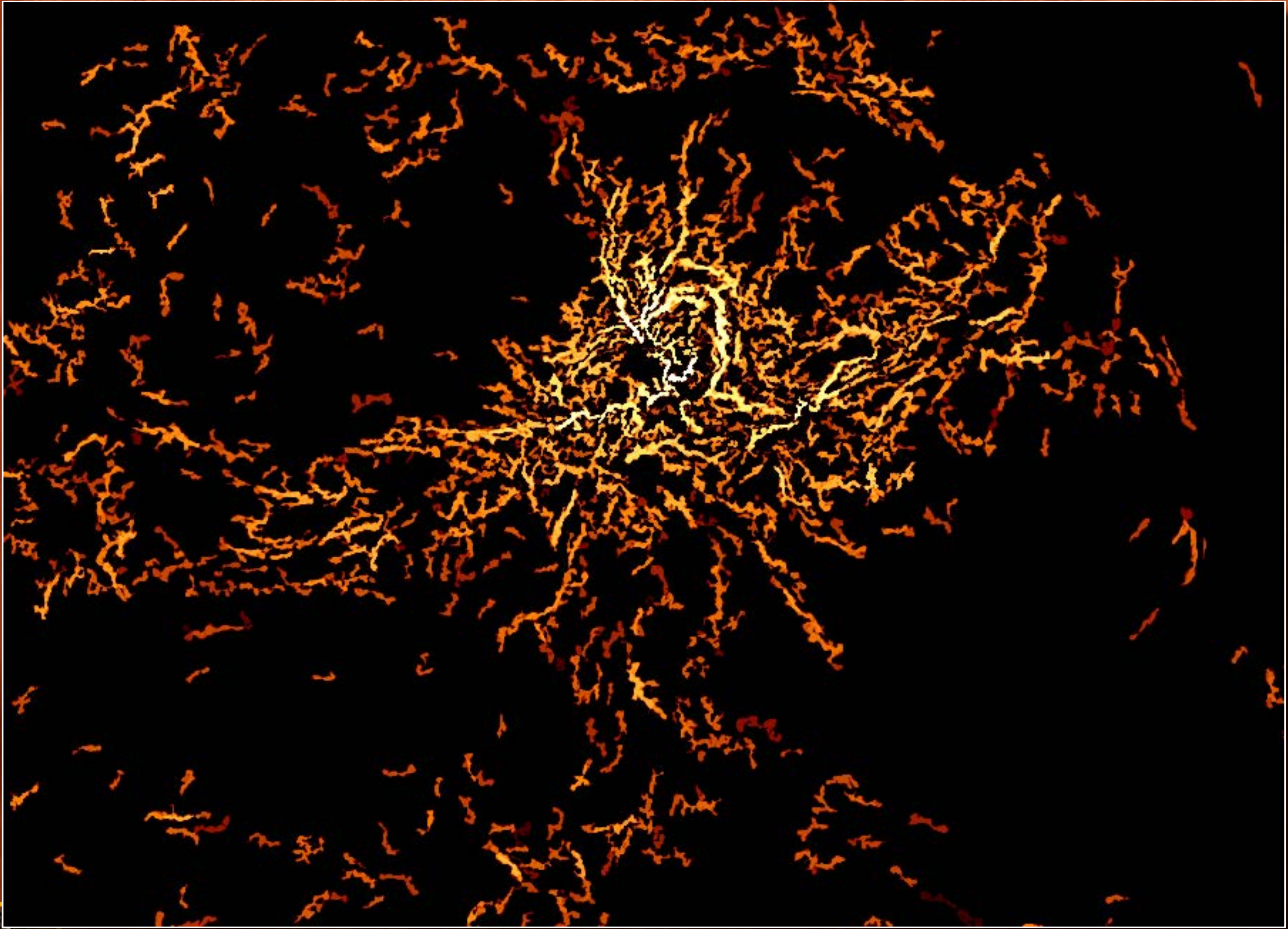

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HERSCHEL Gould Belt Survey SPIRE SAG3

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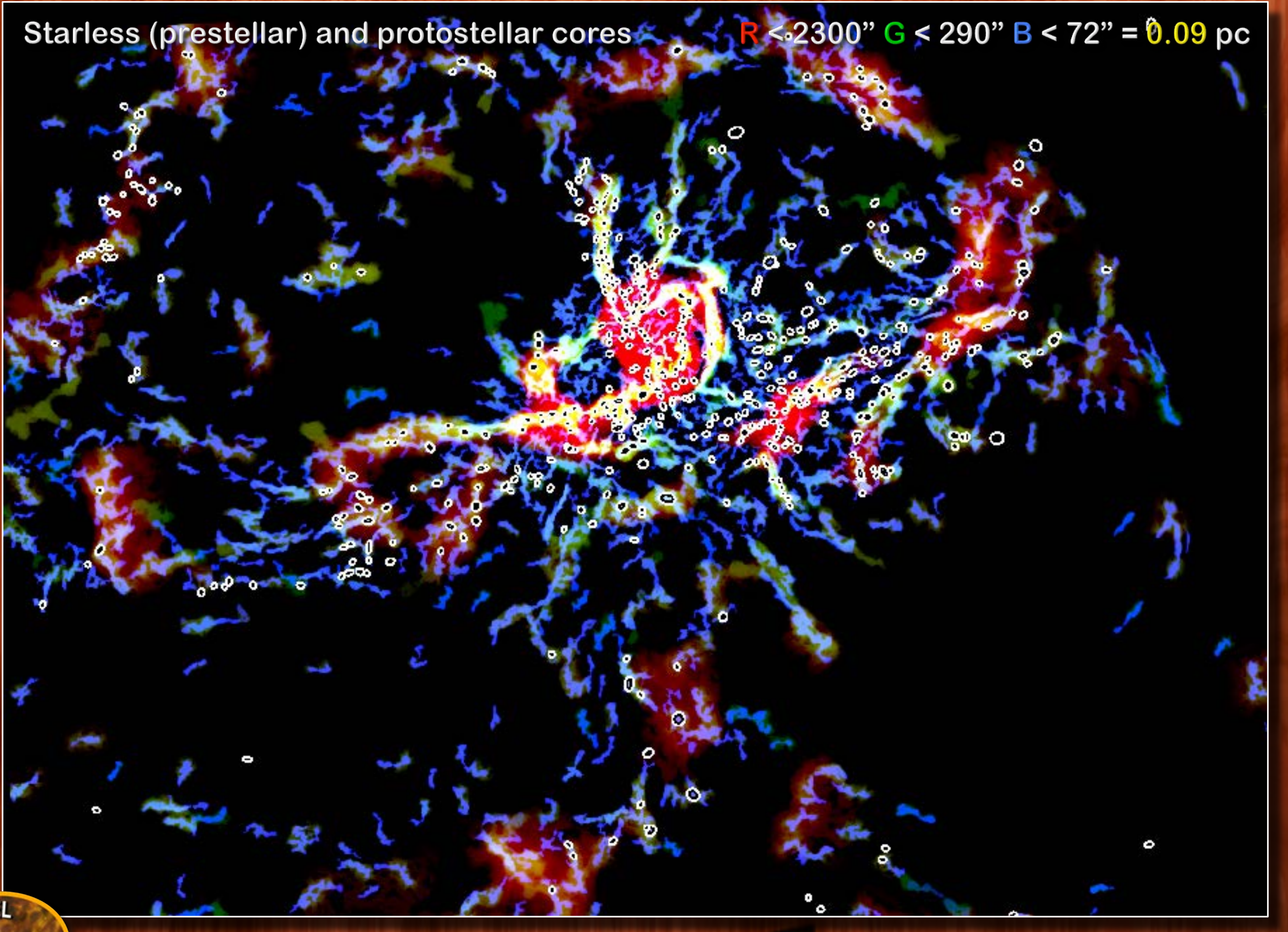

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HERSCHEL Gould Belt Survey SPIRE SAG3

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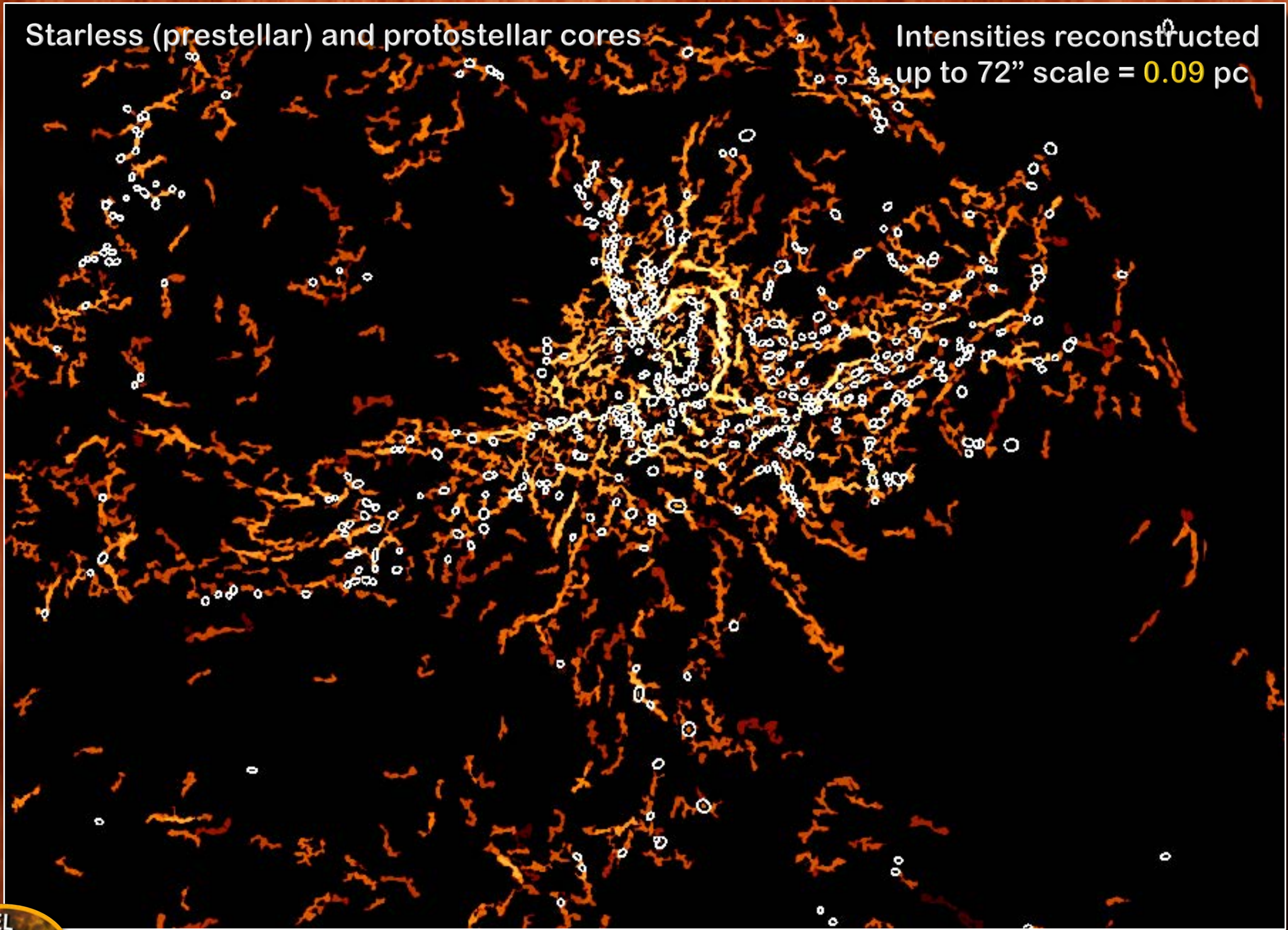

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HERSCHEL Gould Belt Survey SPIRE SAG3

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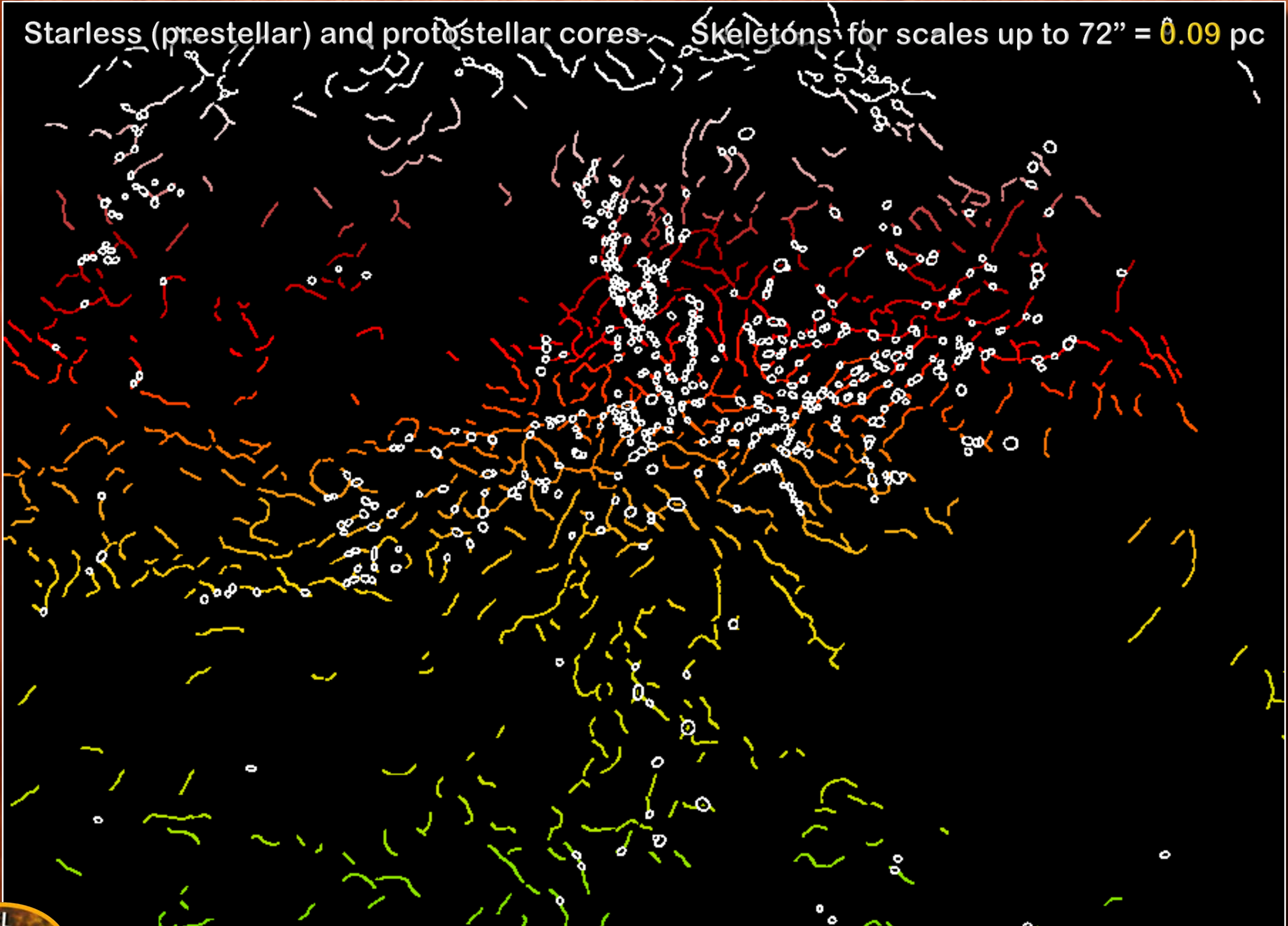

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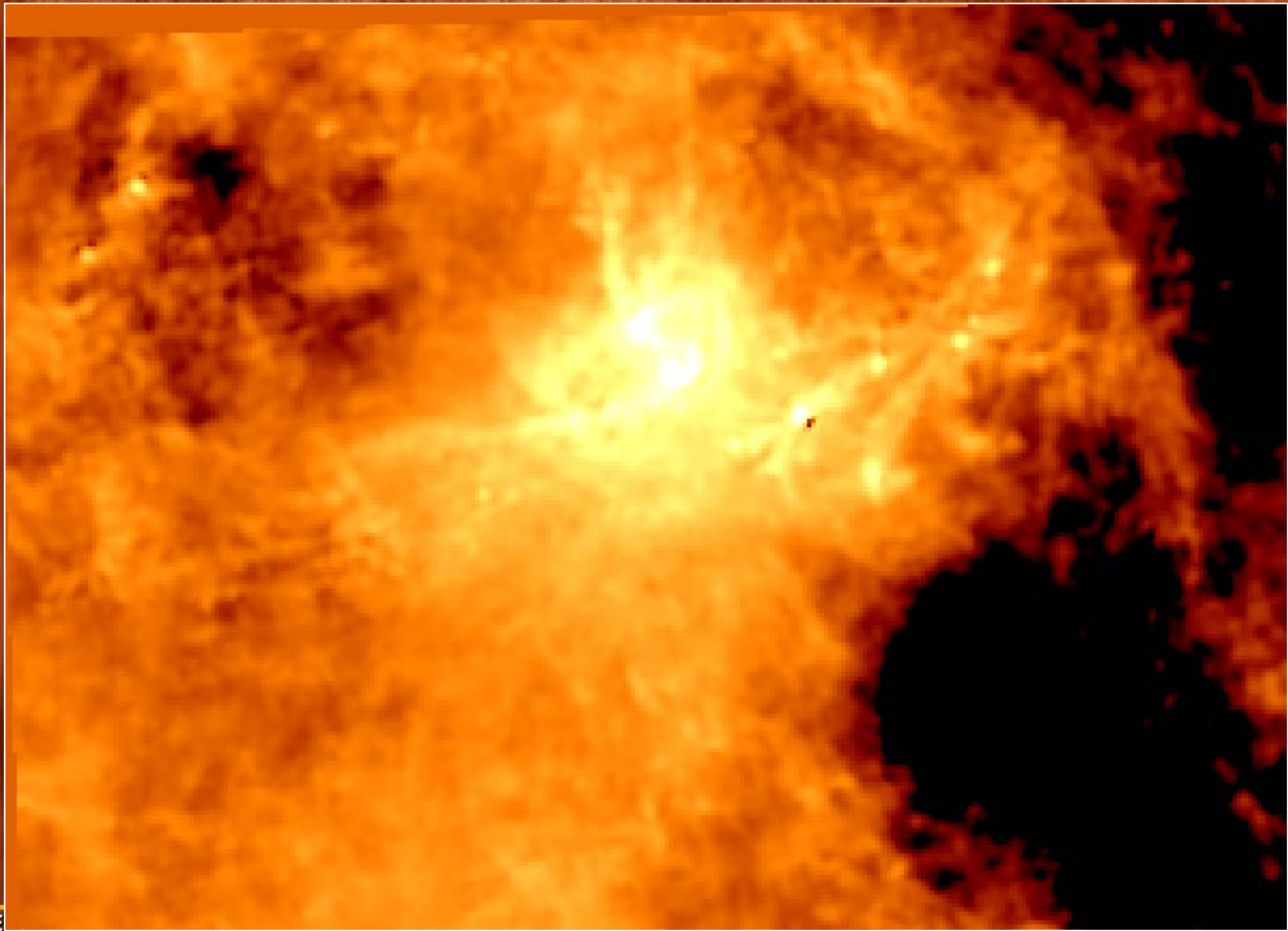
HERSCHEL Gould Belt Survey SPIRE SAG3

Aquila SPIRE 250 μm 0.25×0.18° = 14×9.8 pc *D*↗3000 pc



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HERSCHEL Gould Belt Survey SPIRE SAG3

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HERSCHEL Gould Belt Survey

SPIRE SAG3

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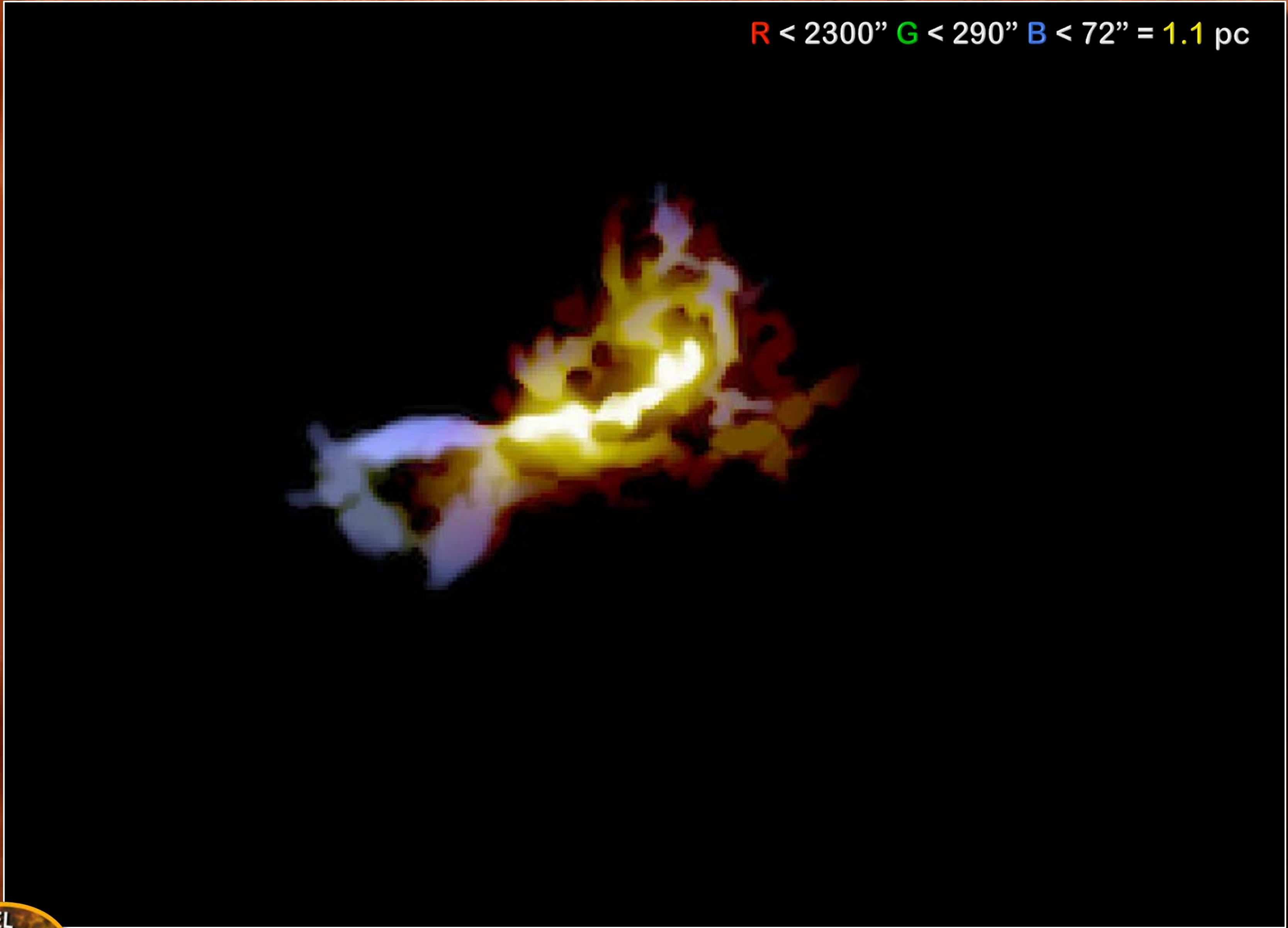
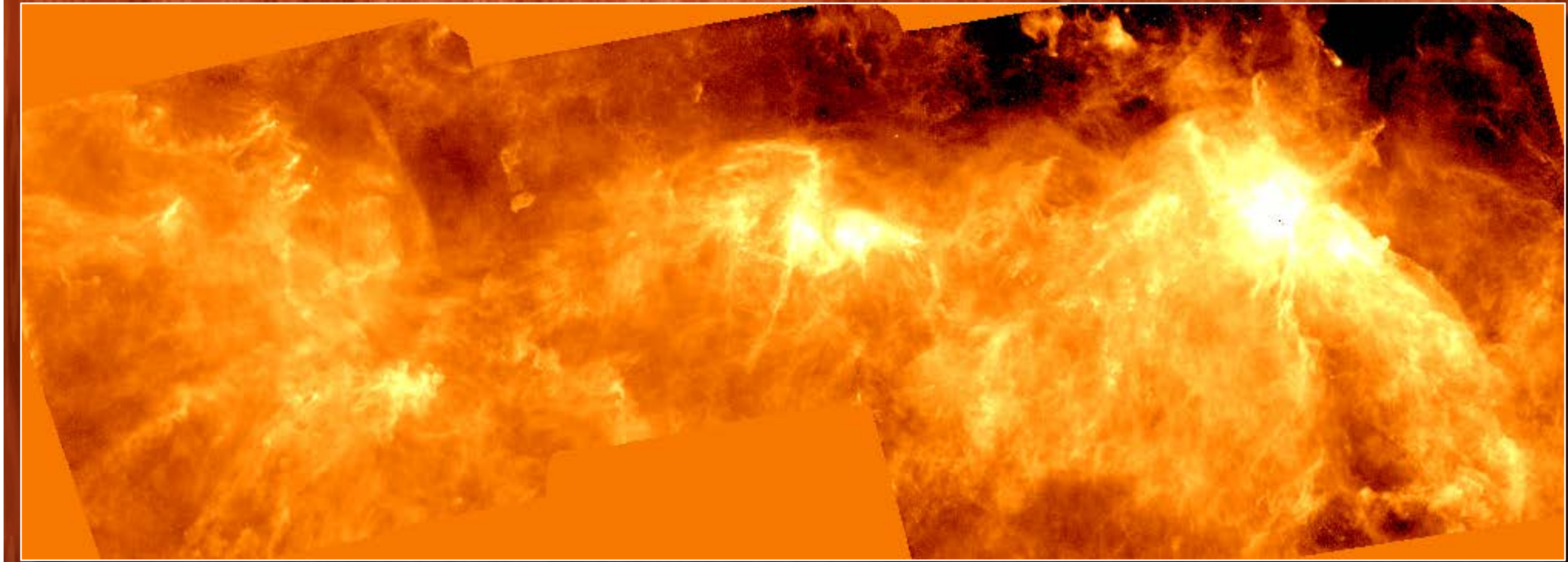


HERSCHEL Gould Belt Survey SPIRE SAG3

See also: Ph. André + (2010), A. Men'shchikov + (2010), S. Bontemps + (2010), V. Könyves + (2010; in prep.; also talk)

Orion B SPIRE 250 μm 8.7×3.7° = 64×27 pc *D* = 410 pc



See also: N. Schneider + (2013)

HERSCHEL Gould Belt Survey SPIRE SAG3

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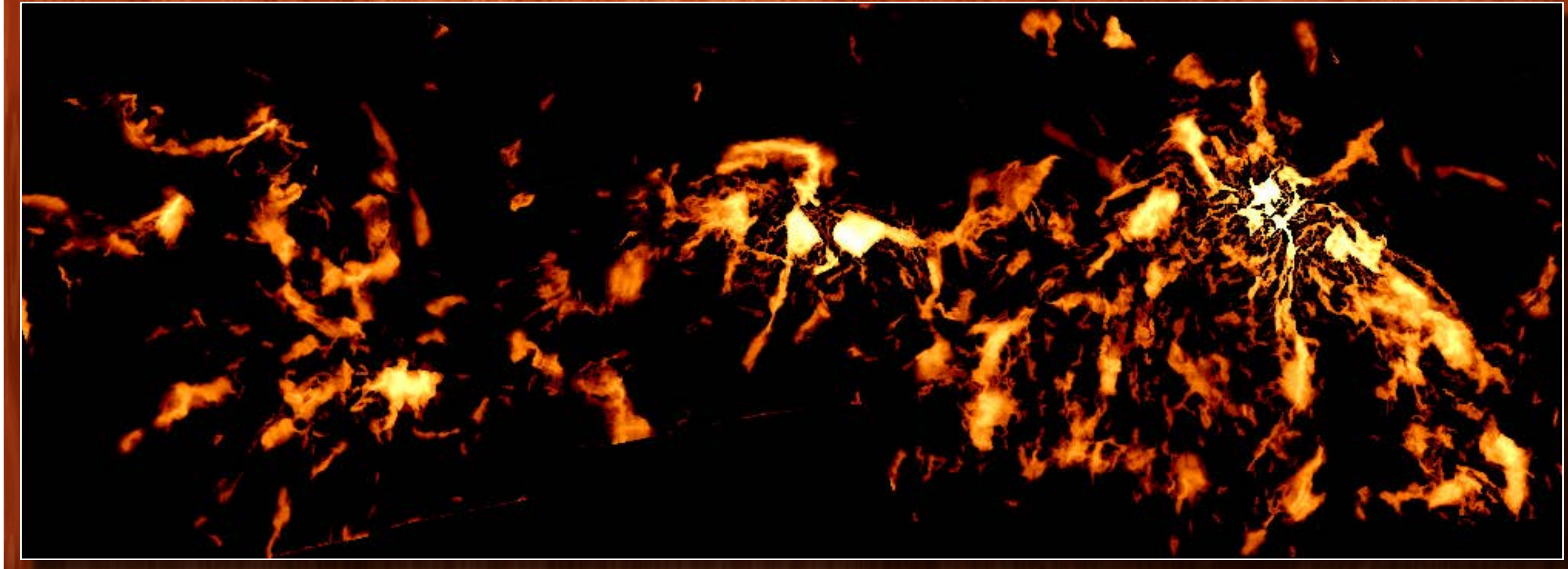

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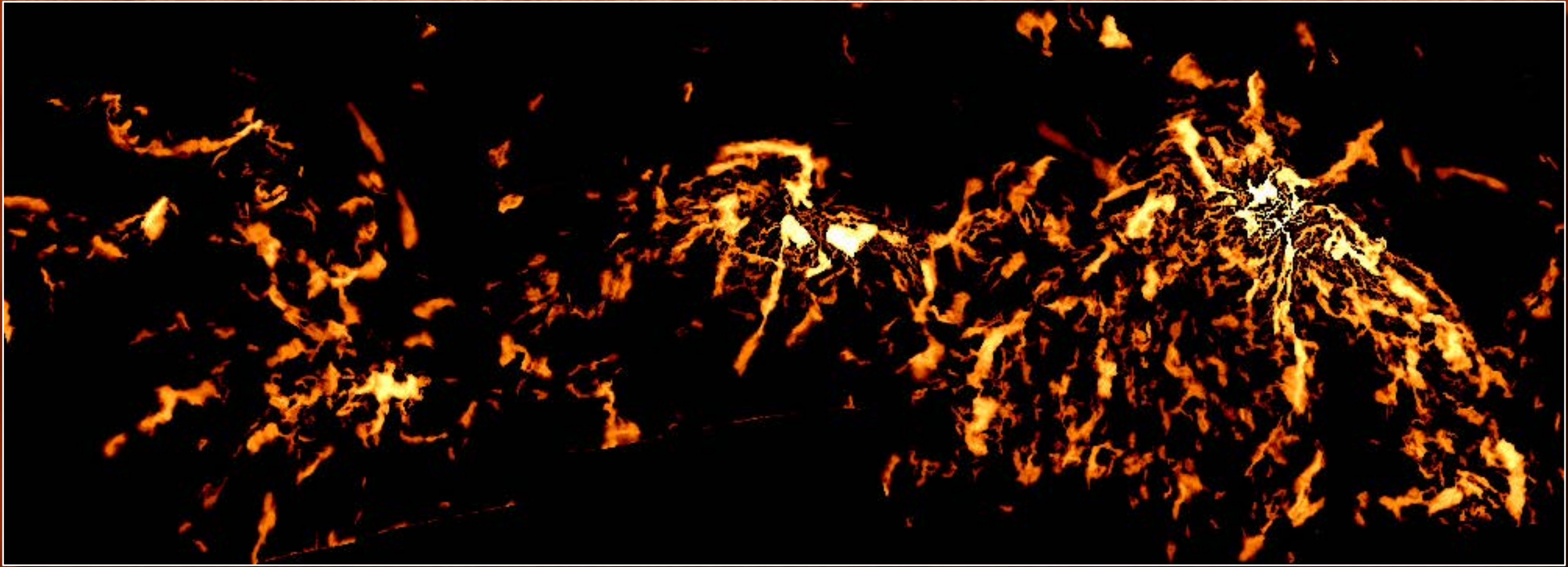

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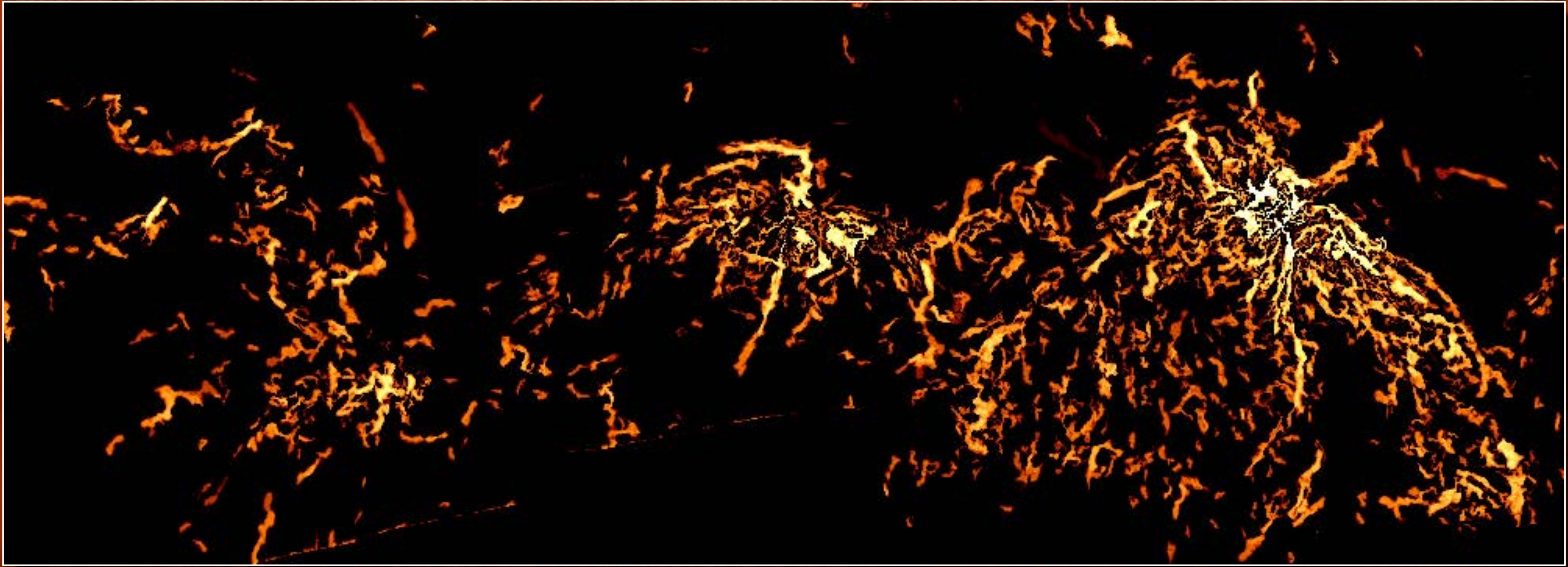

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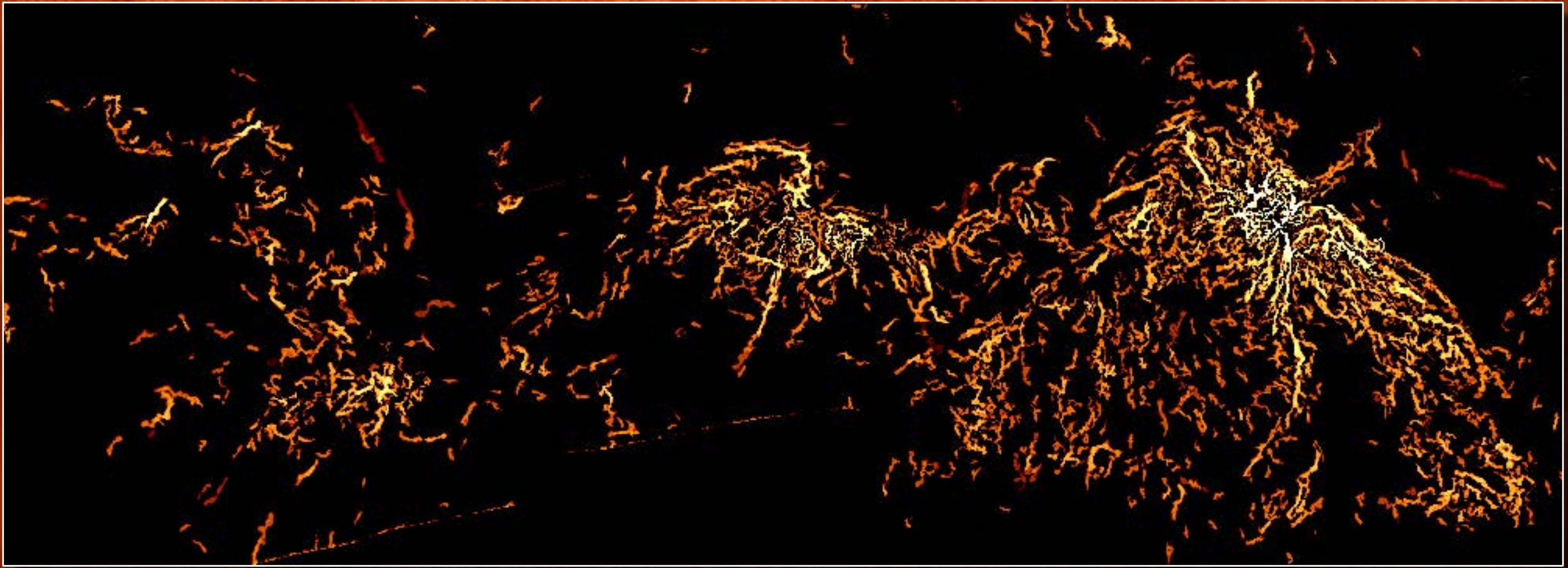

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HERSCHEL Gould Belt Survey SPIRE SAG3

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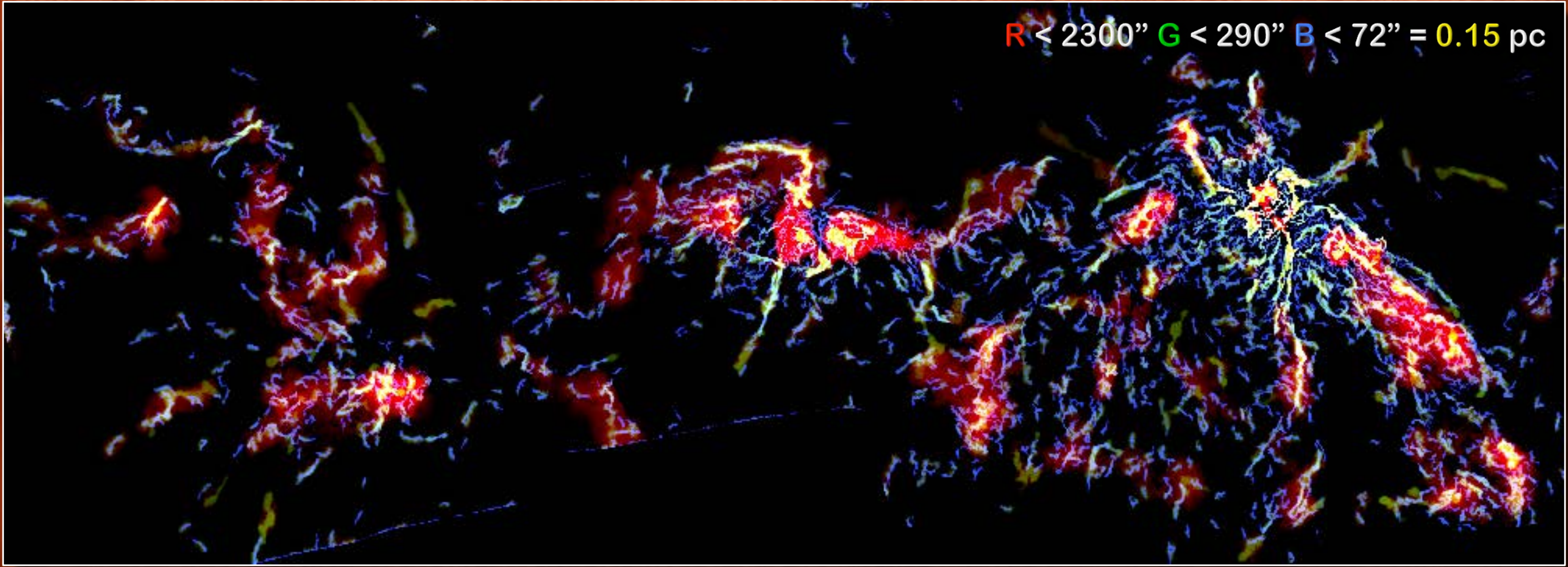

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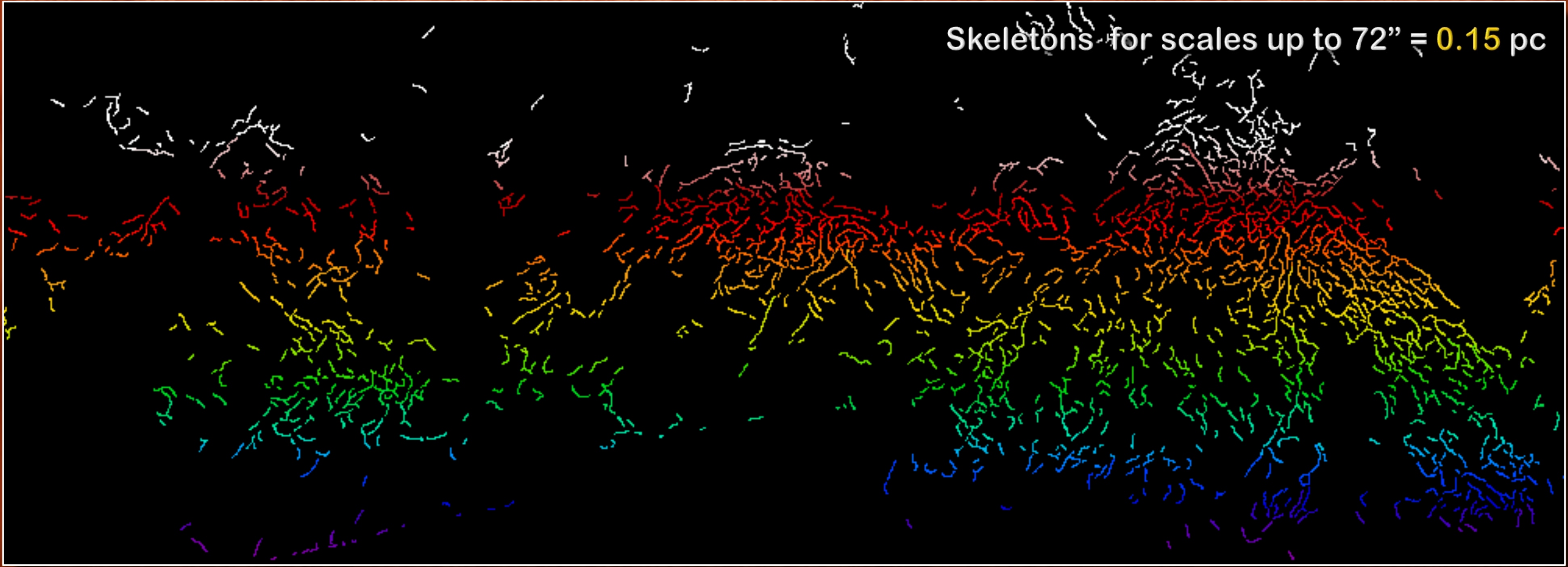
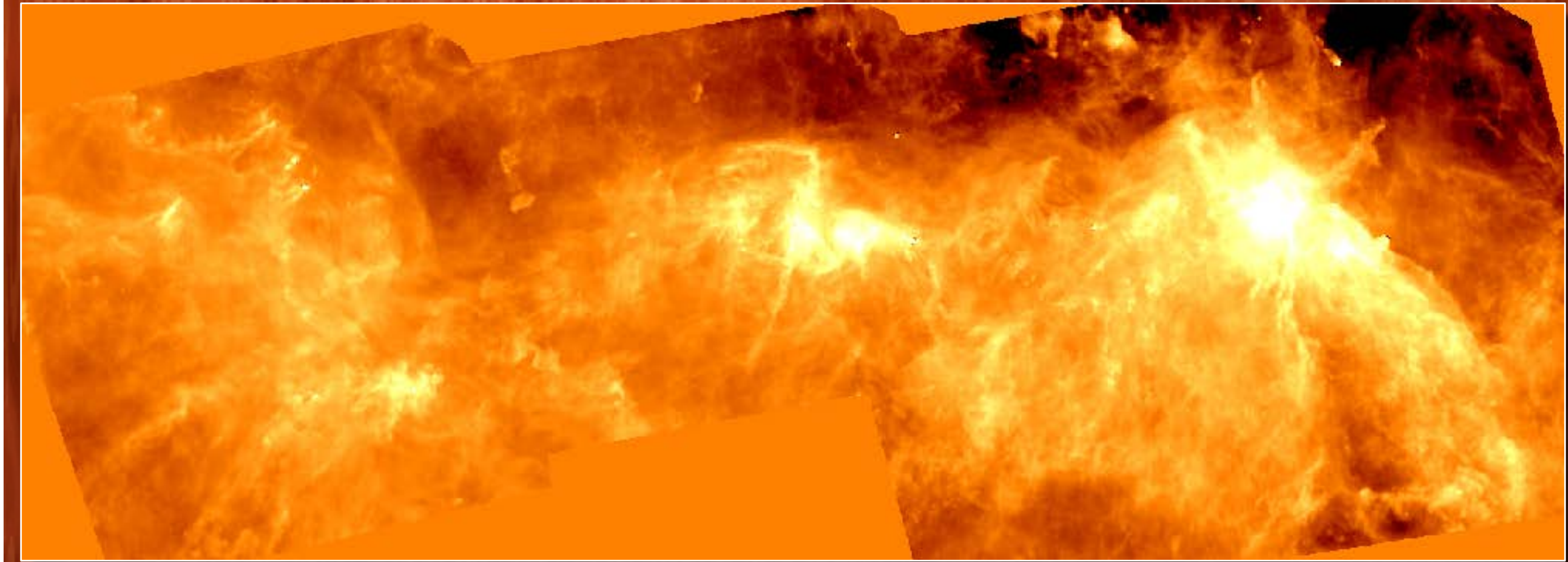


See also: N. Schneider + (2013)

HERSCHEL Gould Belt Survey
SPIRE
SAG3

Orion B SPIRE 250 µm 1.2×0.54° = 64×27 pc D↗3000 pc



See also: N. Schneider + (2013)

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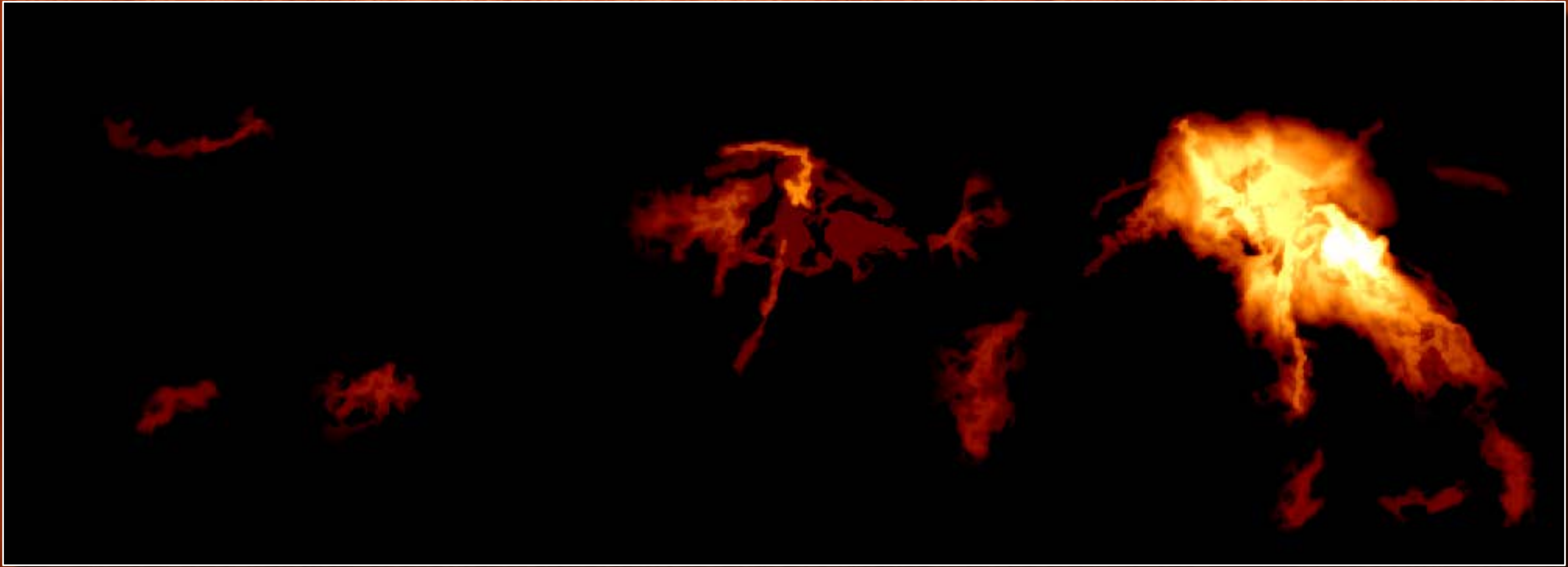

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SPIRE
SAG3

Orion B SPIRE 250 µm 1.2×0.54° = 64×27 pc *D* ↗ 3000 pc

See also: N. Schneider + (2013)

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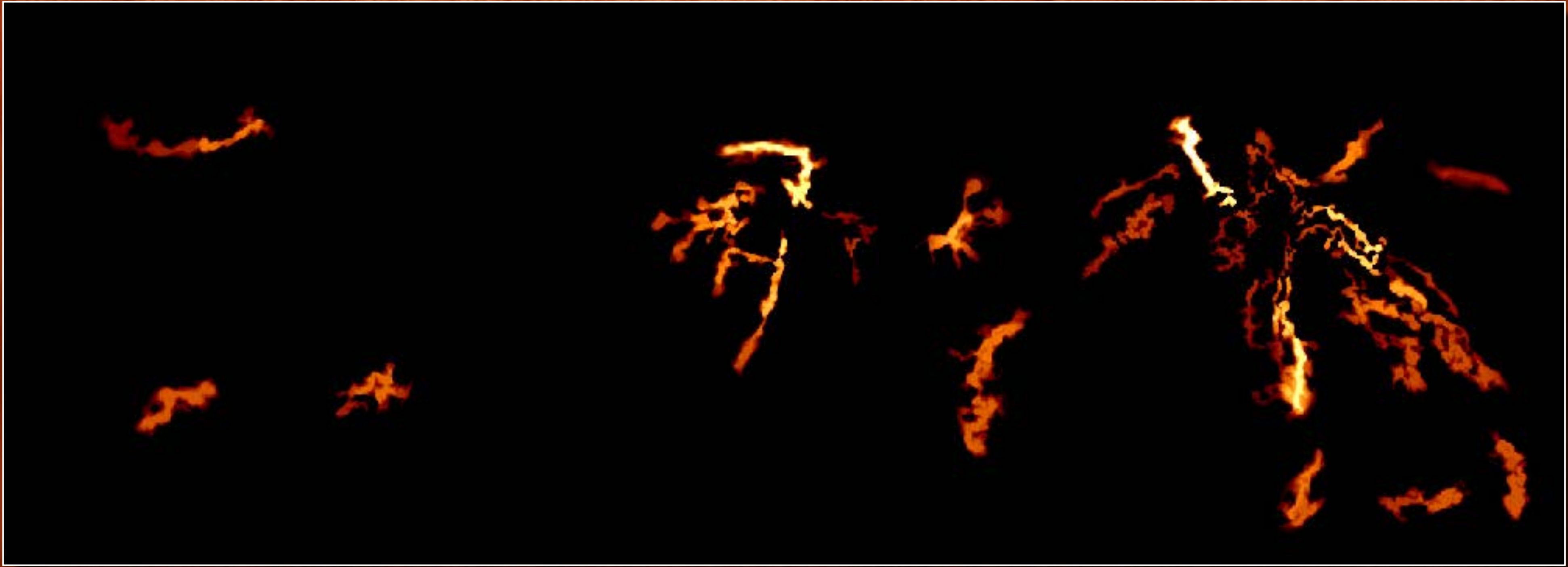

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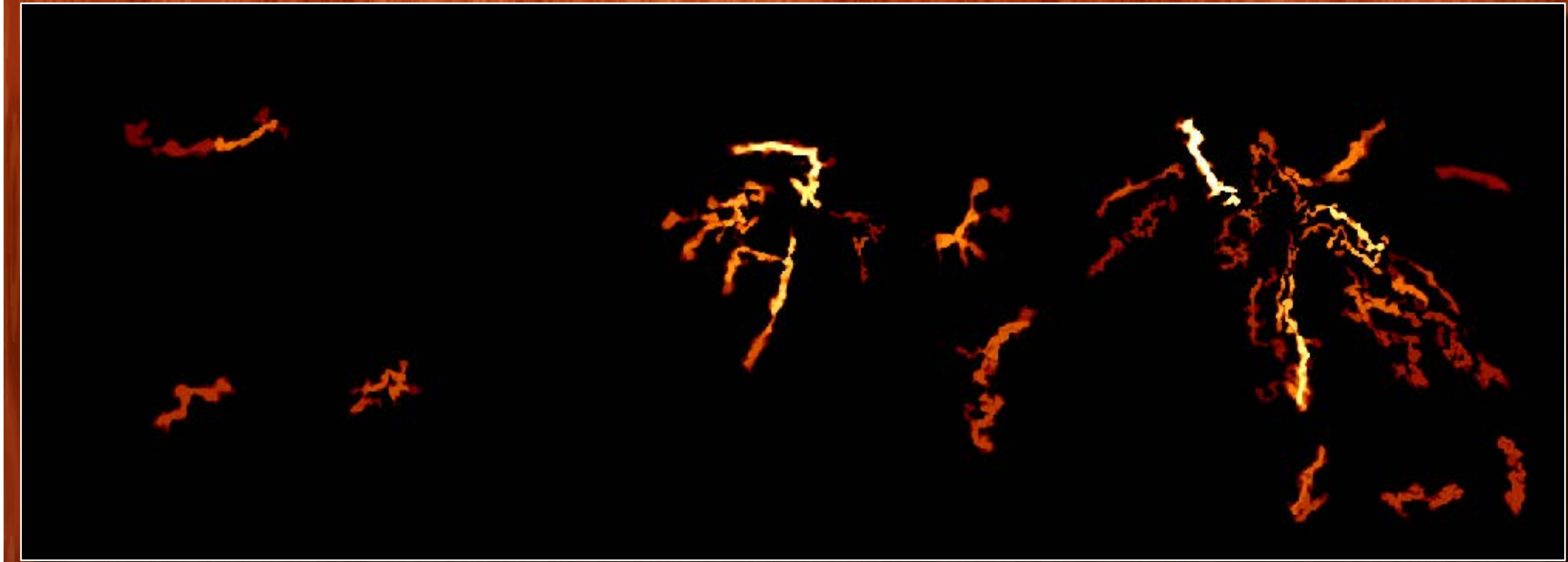
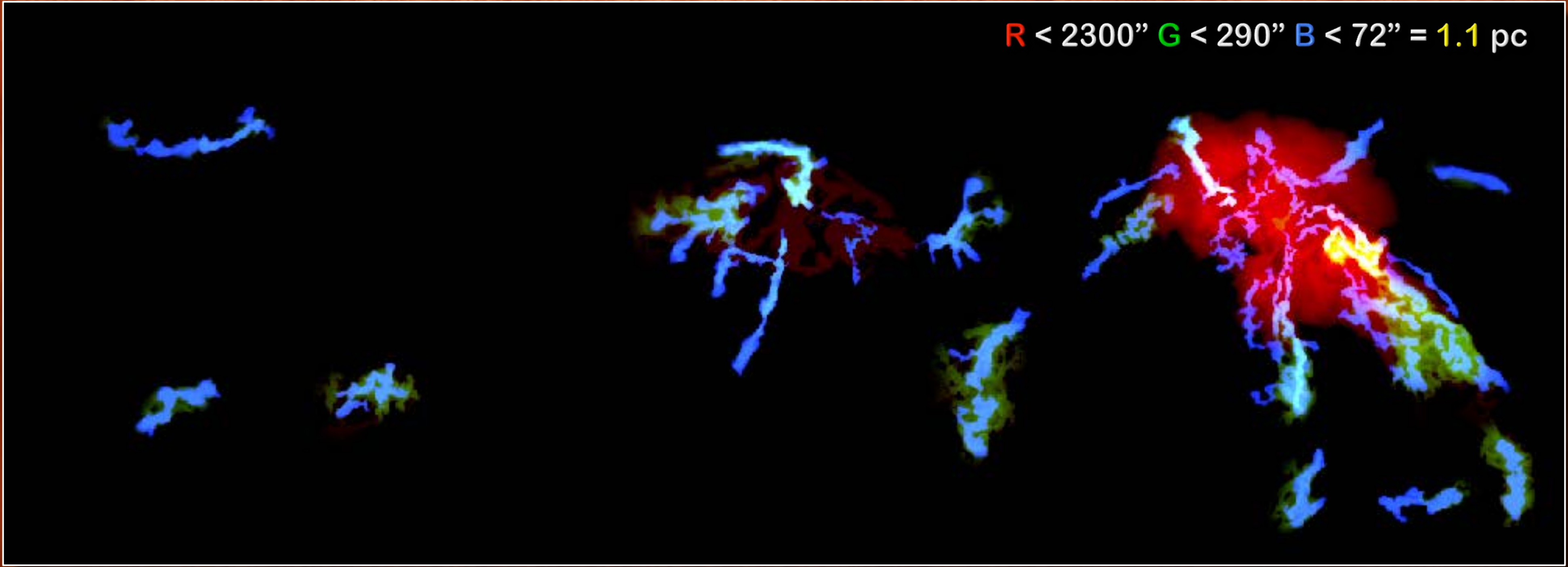


See also: N. Schneider + (2013)

HERSCHEL Gould Belt Survey SPIRE SAG3

Orion B SPIRE 250 µm 1.2×0.54° = 64×27 pc *D* ↗ 3000 pc

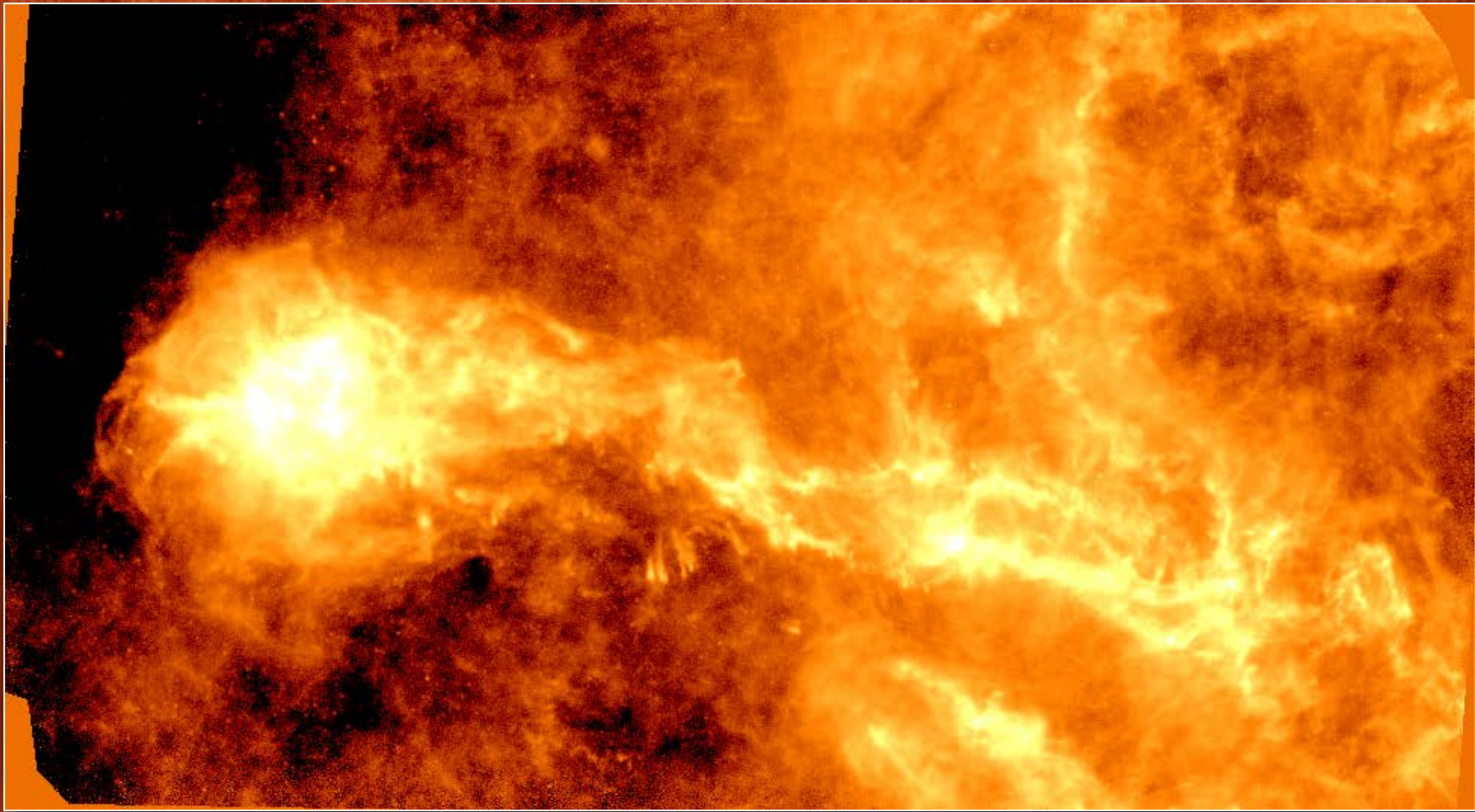


See also: N. Schneider + (2013)

HERSCHEL Gould Belt Survey

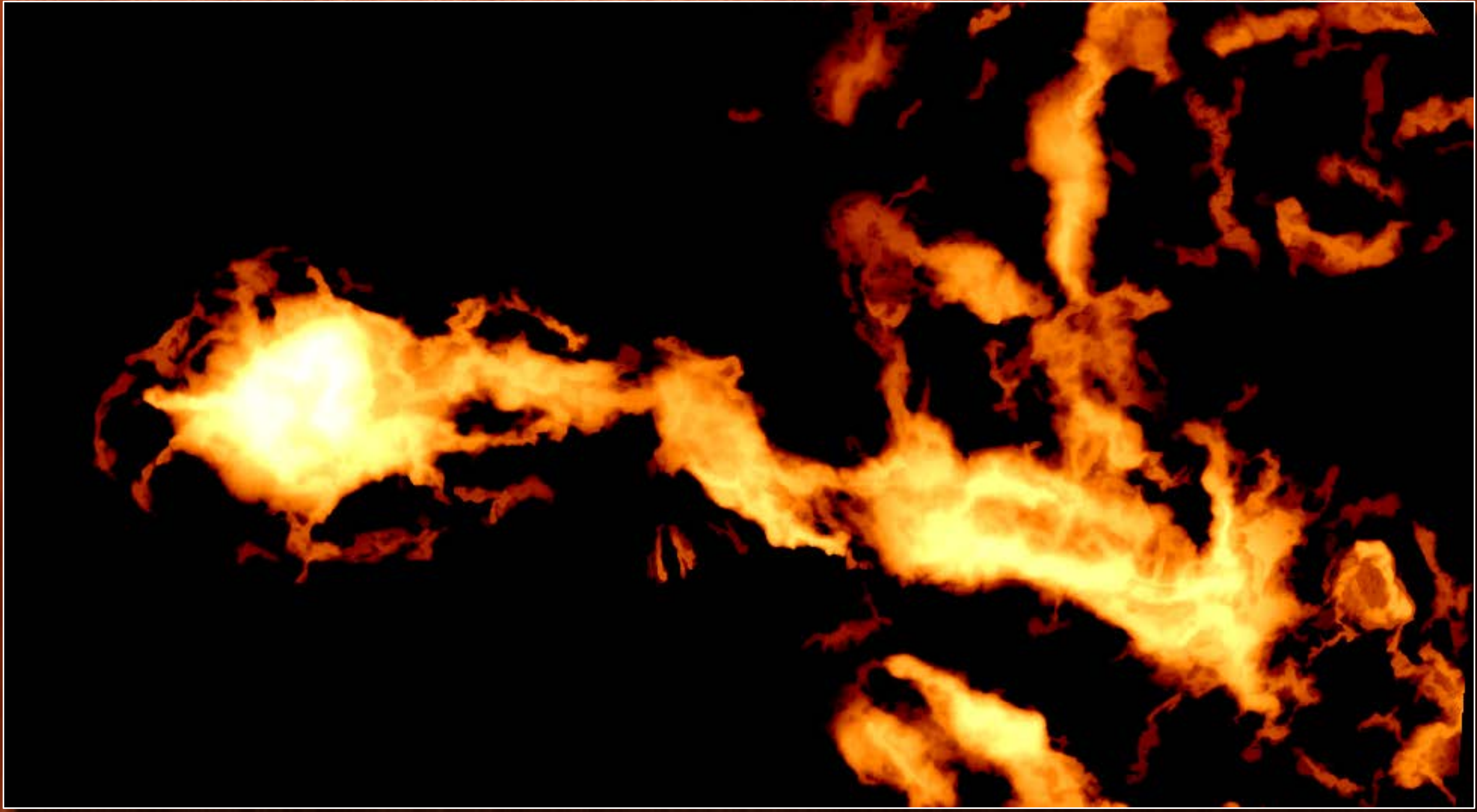
SPIRE SAG3

IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc D = 460 pc



See also: D. Arzoumanian + (2011)

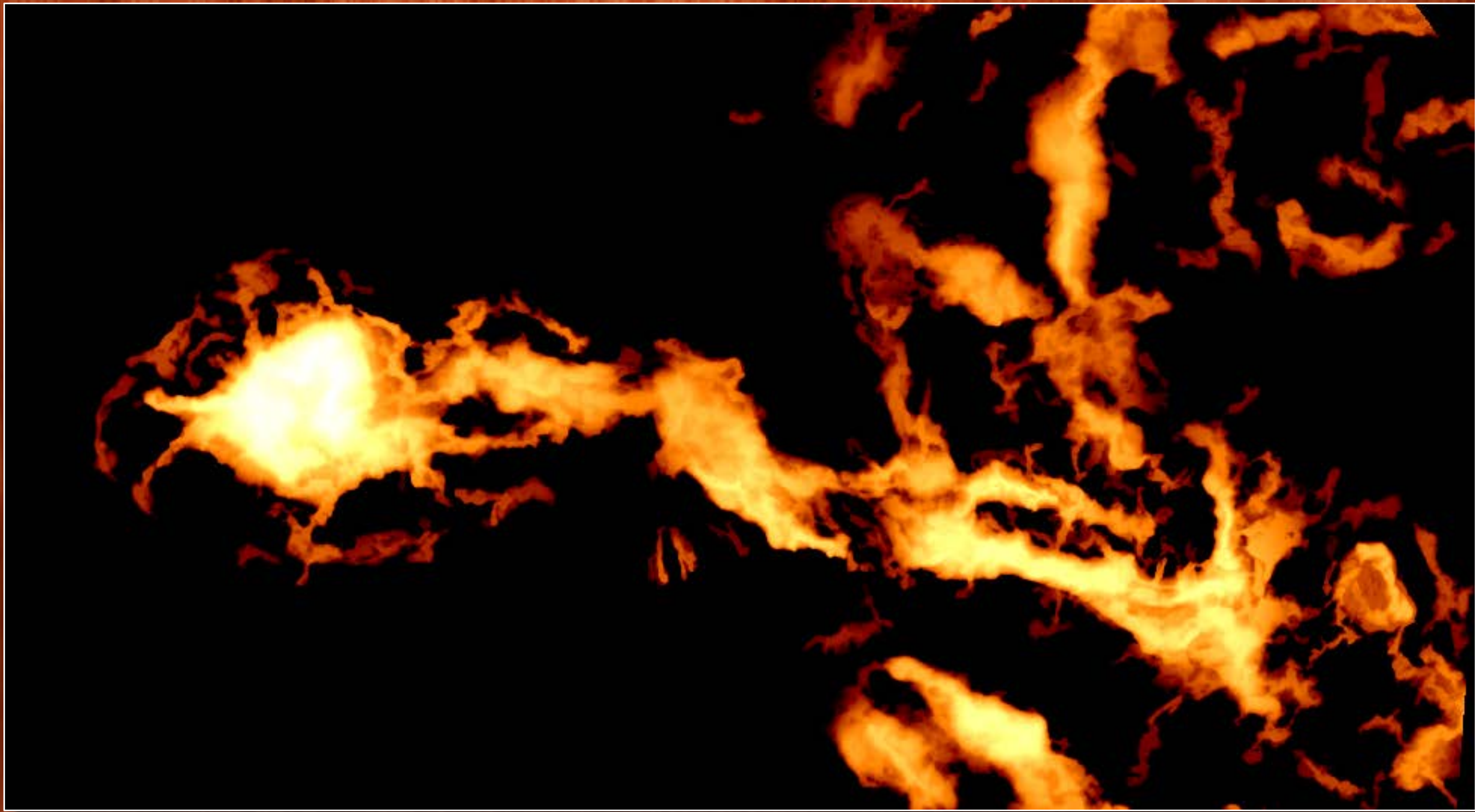
IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc *D* = 460 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

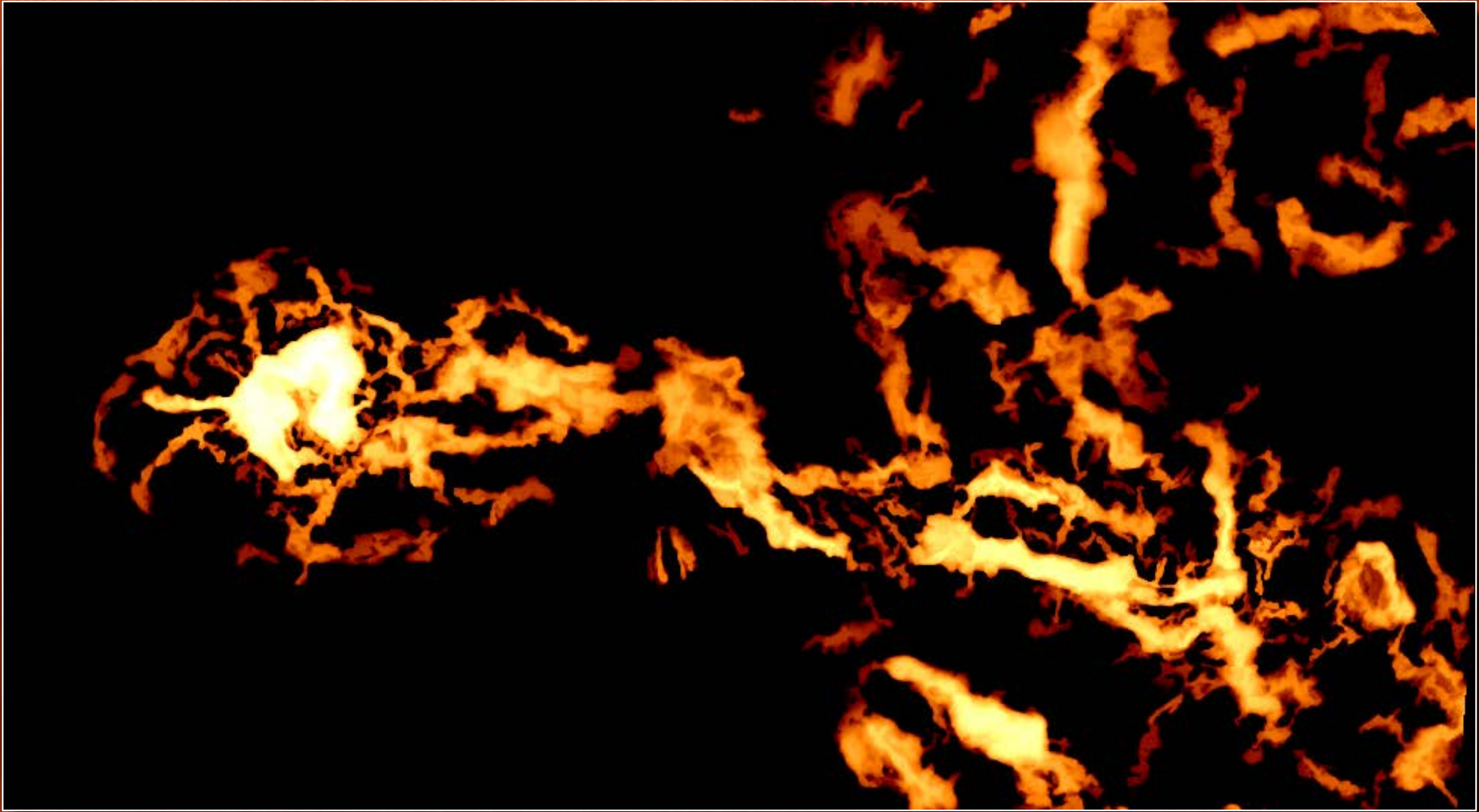
IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc D = 460 pc



See also: D. Arzoumanian + (2011)

SAG3

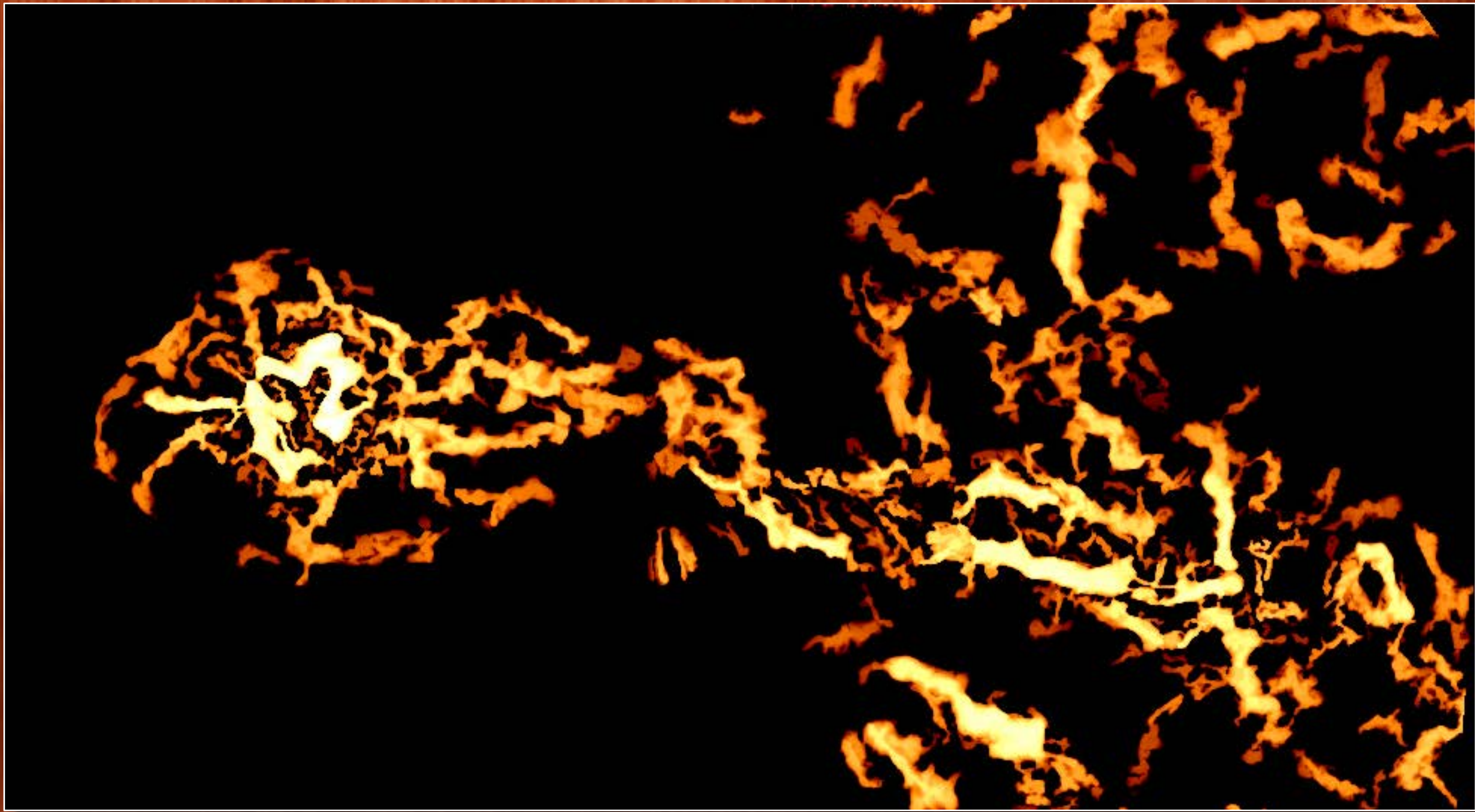
IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc *D* = 460 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

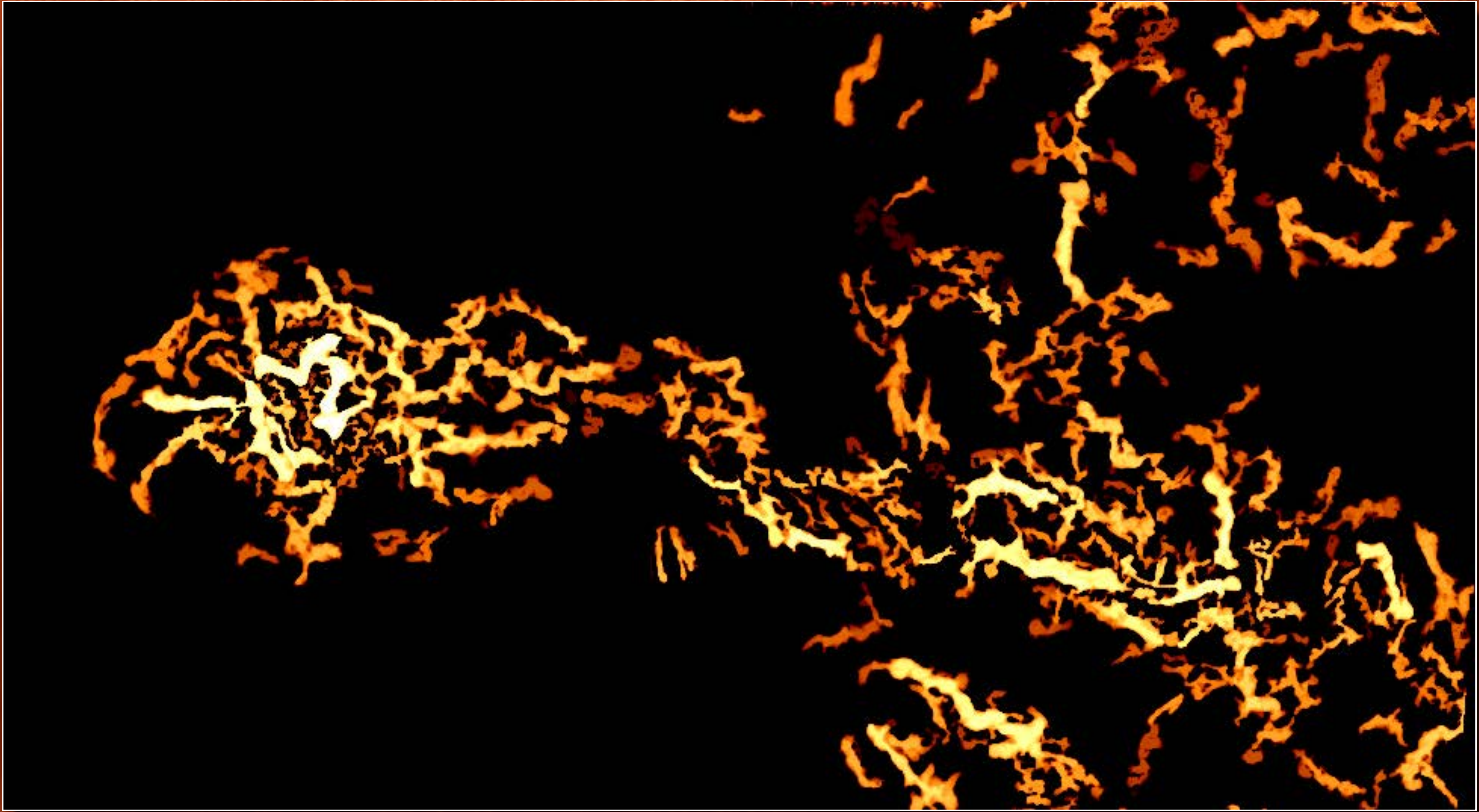
IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc D = 460 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

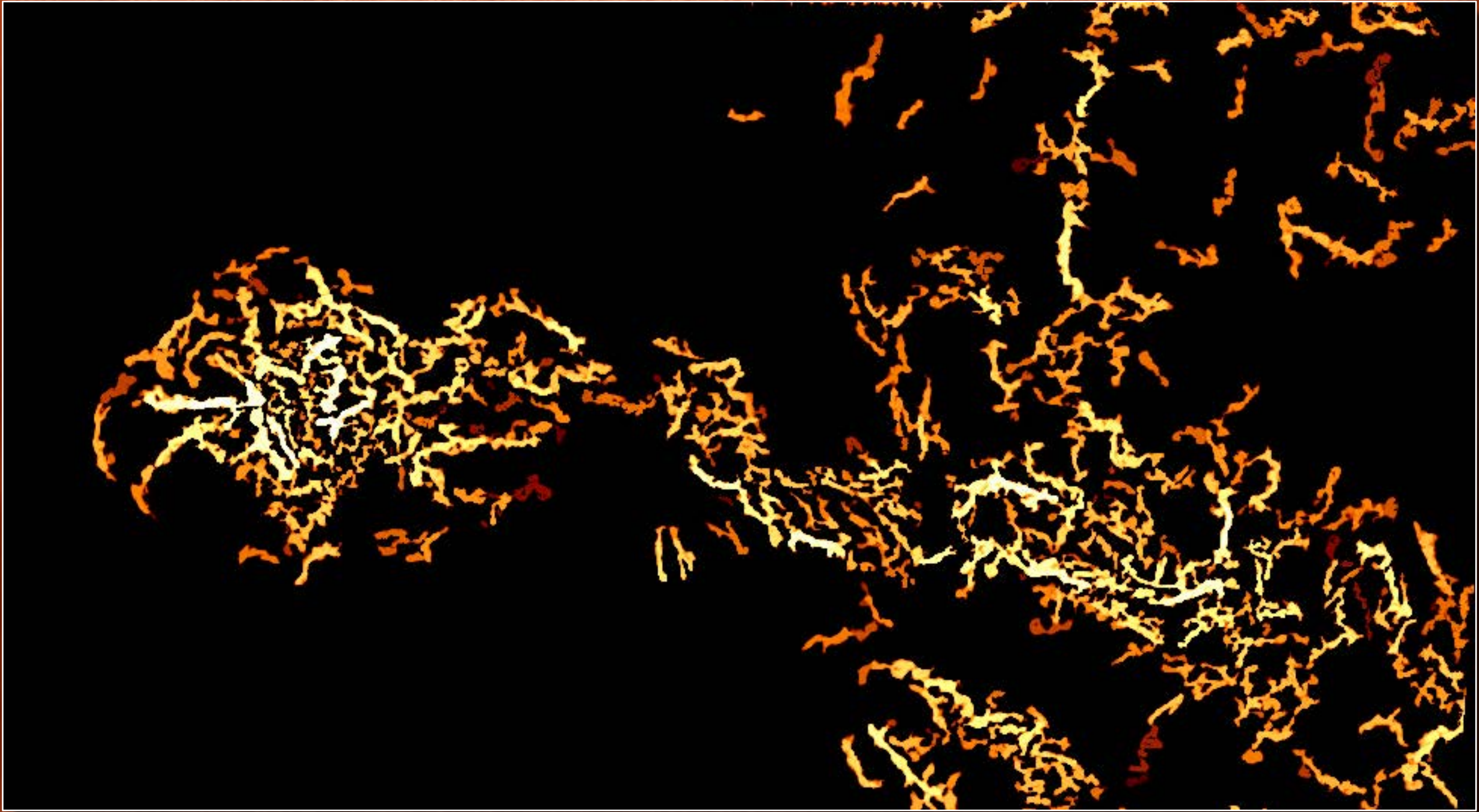
IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc *D* = 460 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

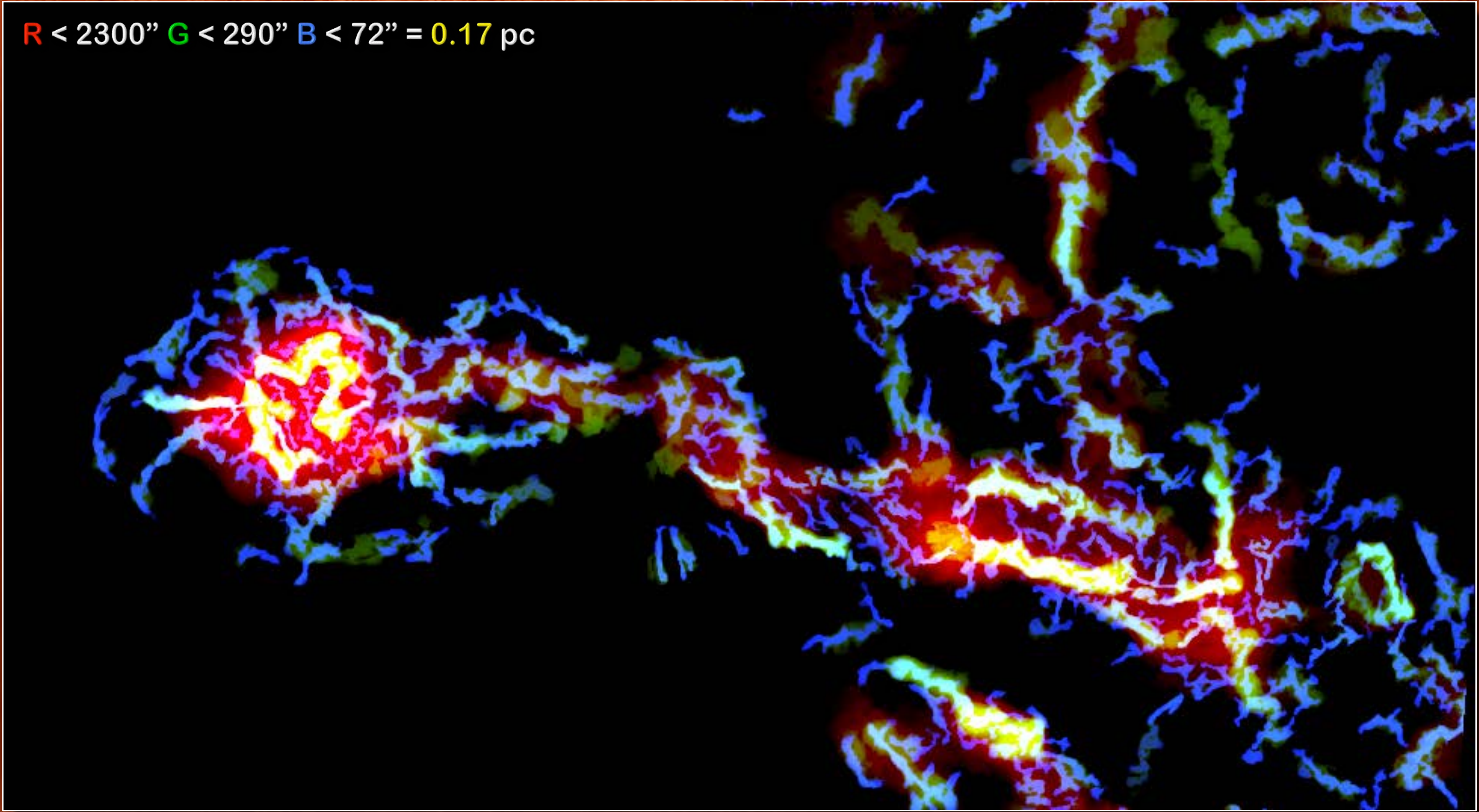
IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc *D* = 460 pc



See also: D. Arzoumanian + (2011)

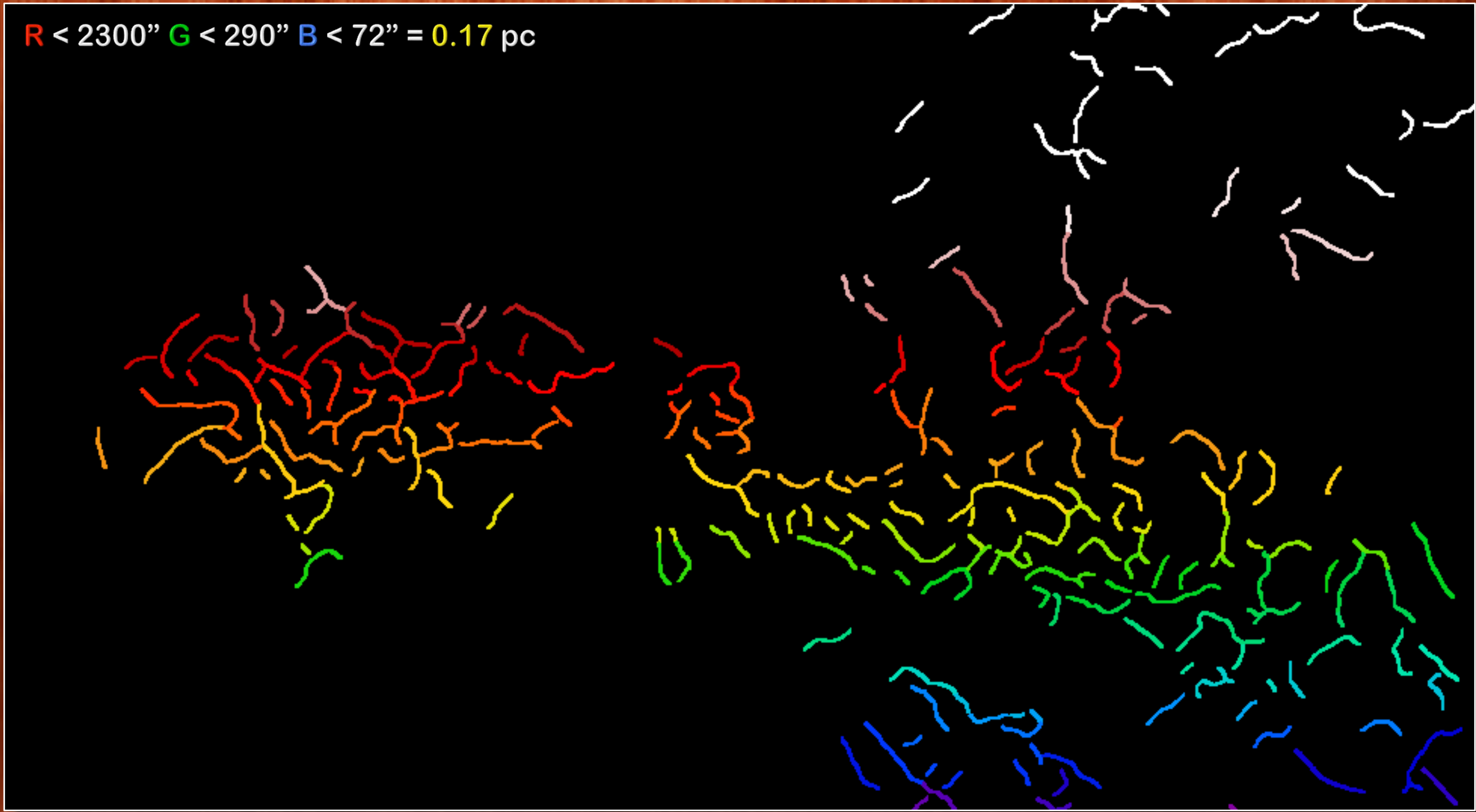
HERSCHEL Gould Belt Survey SPIRE SAG3

IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc *D* = 460 pc



See also: D. Arzoumanian + (2011)

IC 5146 SPIRE 250 μm 2.5×1.4° = 21×12 pc D = 460 pc

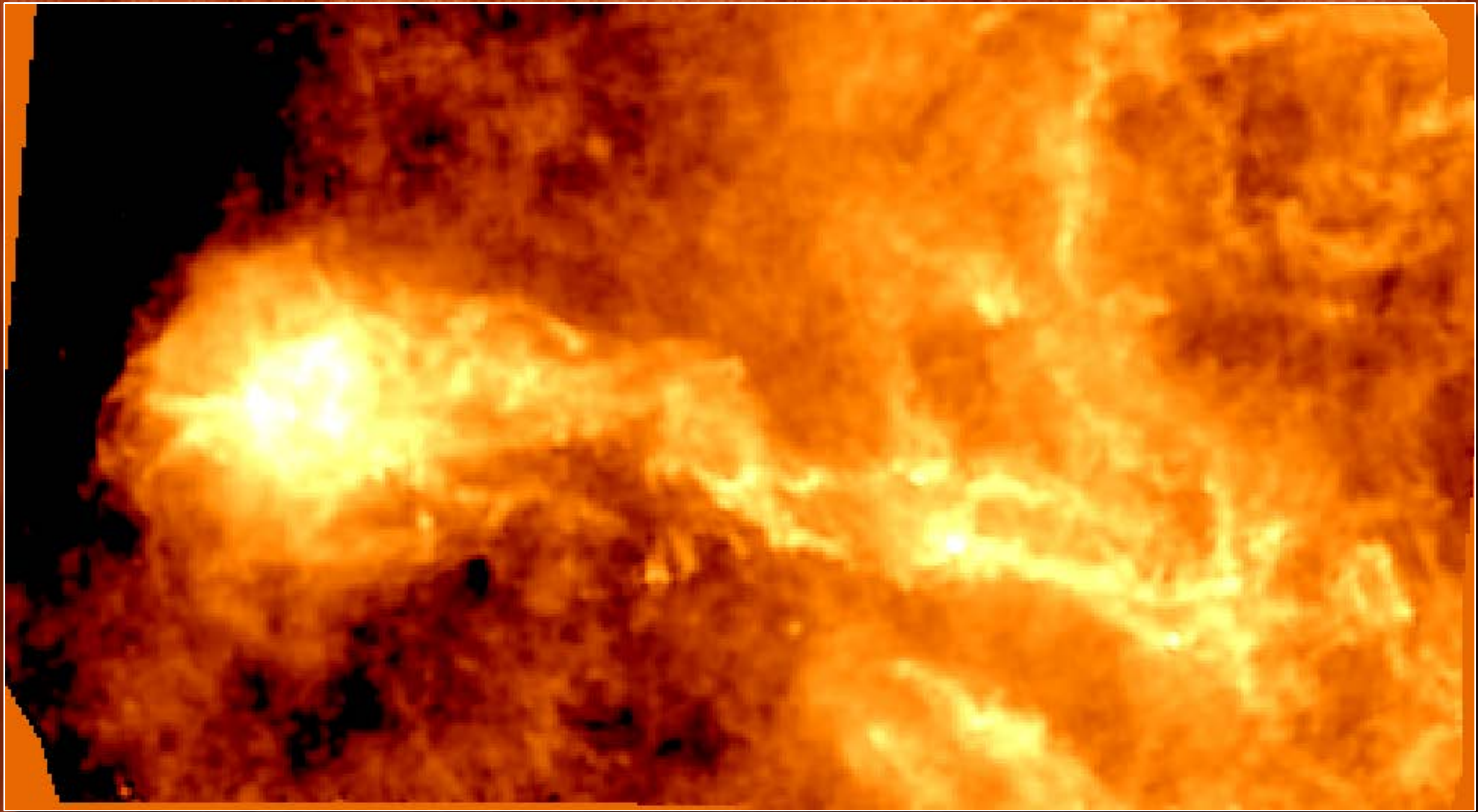


See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey

SPIRE SAG3

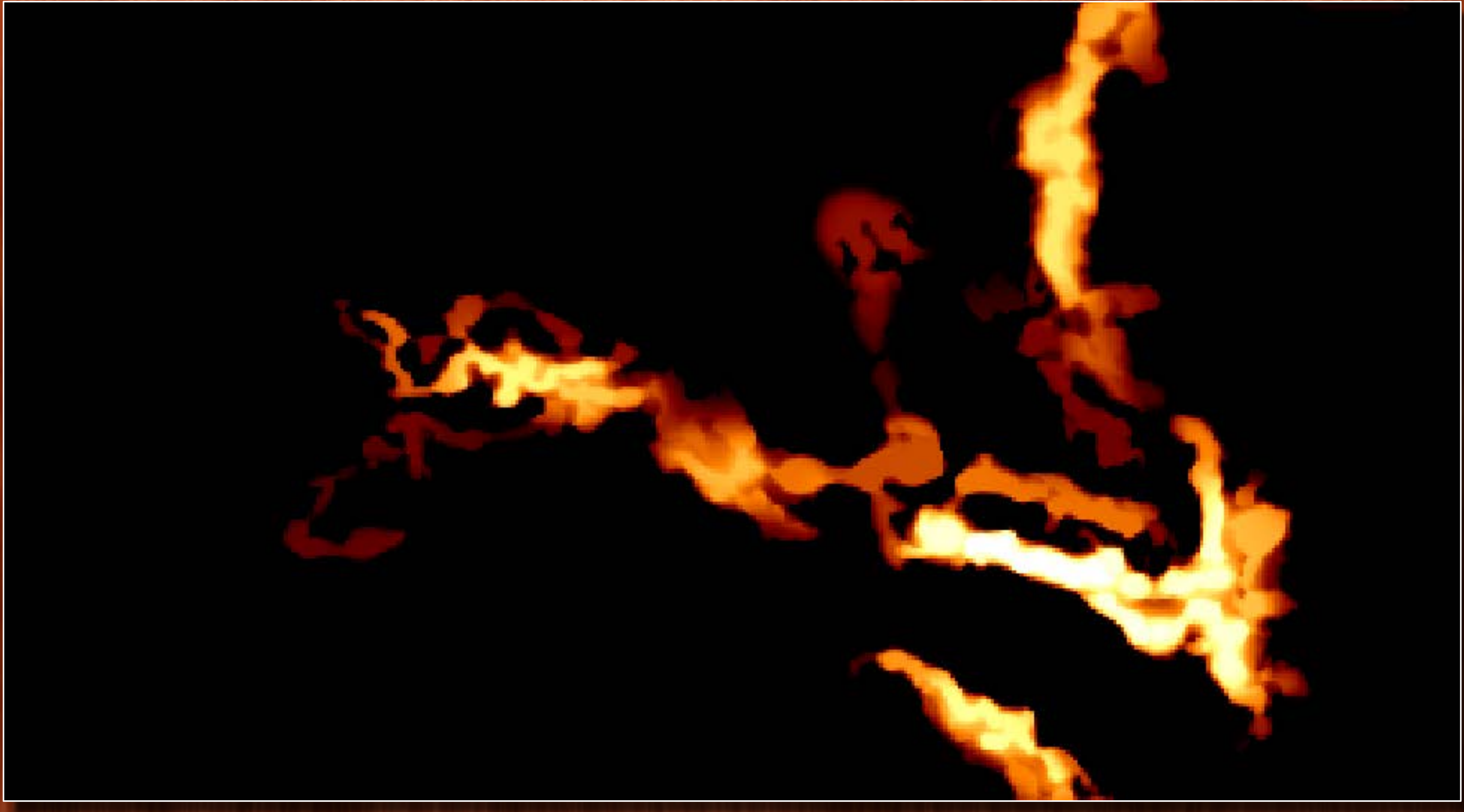
IC 5146 SPIRE 250 µm 0.36×0.20° = 21×12 pc D↗3000 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

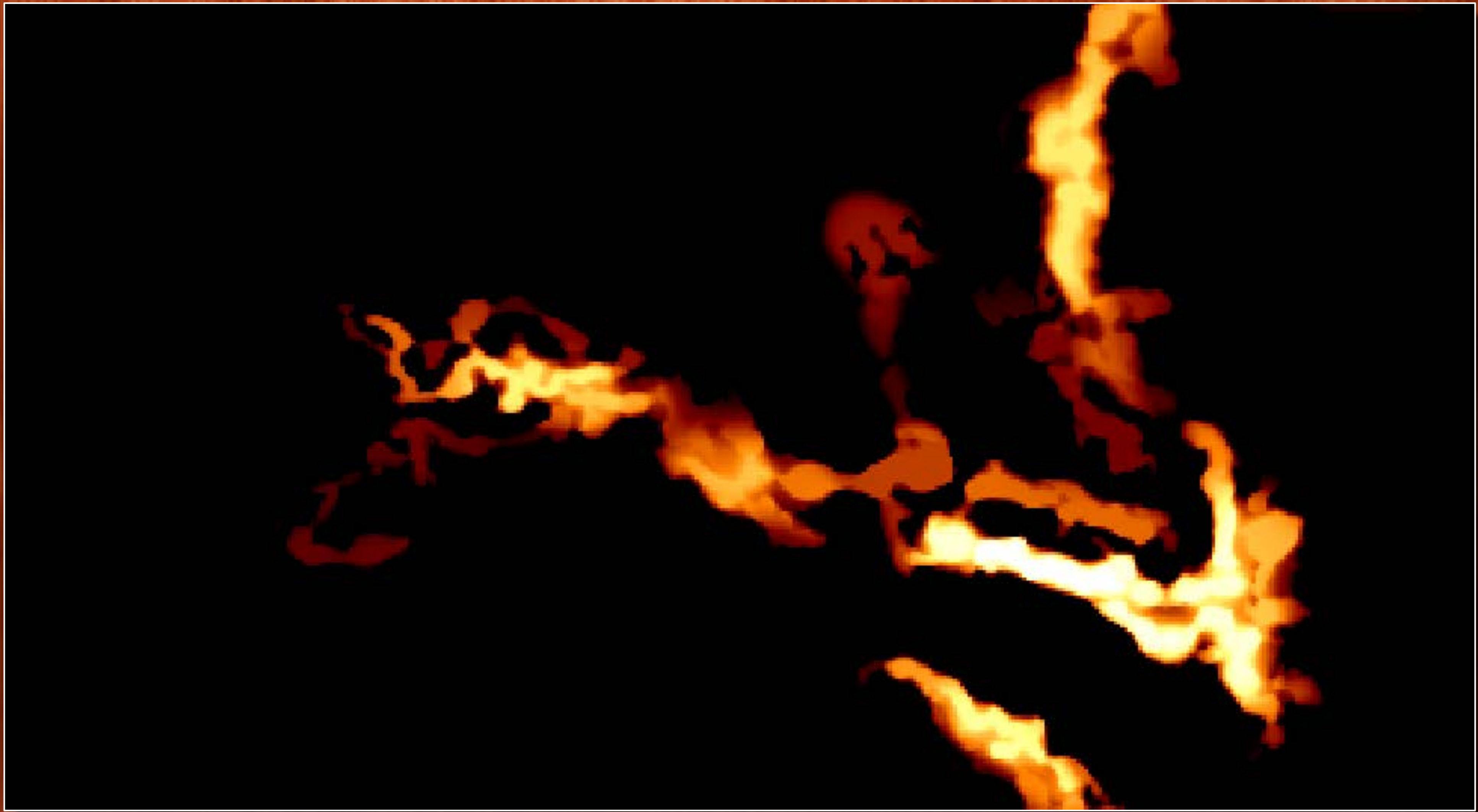
IC 5146 SPIRE 250 µm 0.36×0.20° = 21×12 pc D ↗ 3000 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

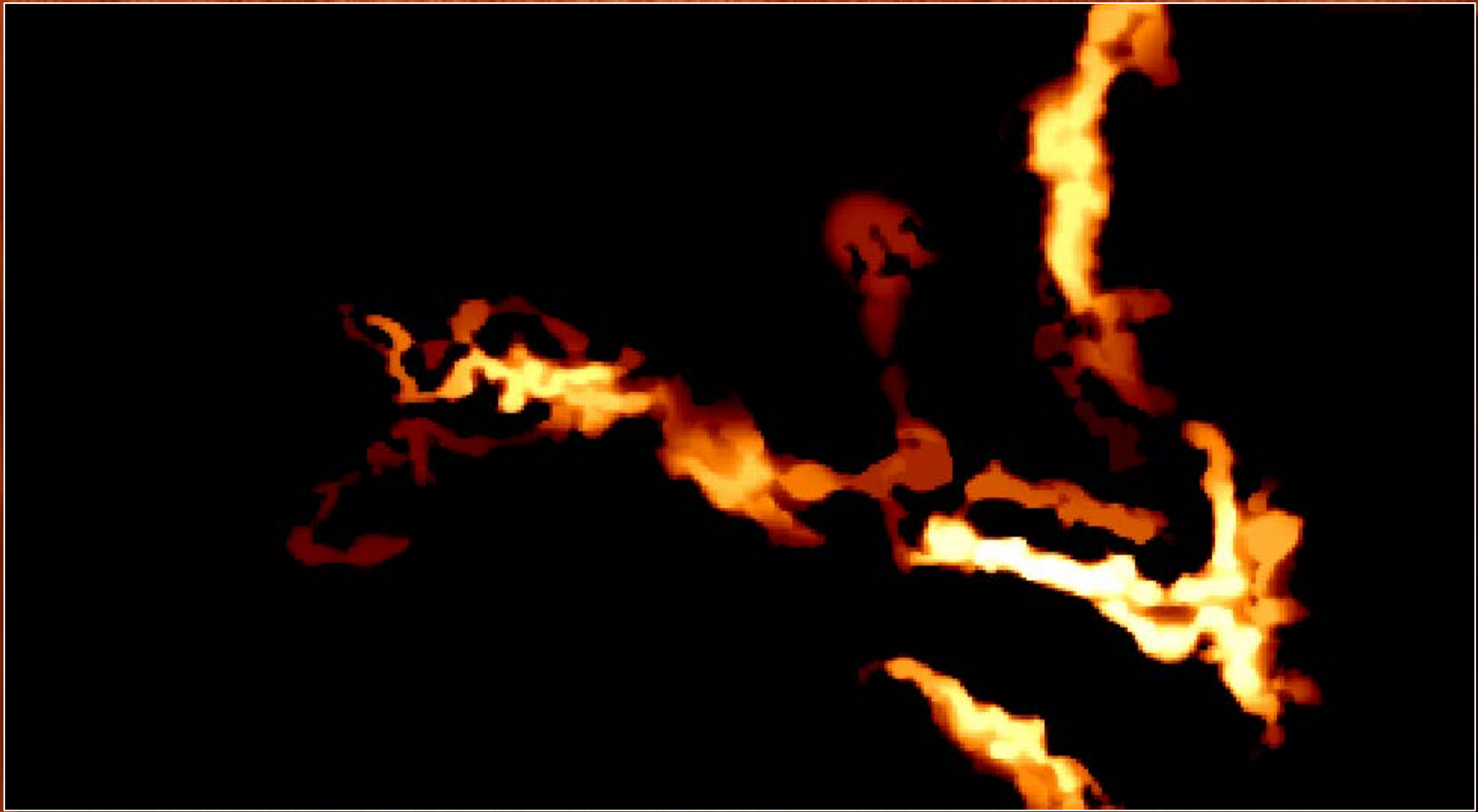
IC 5146 SPIRE 250 μm 0.36×0.20° = 21×12 pc D ↗ 3000 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey SPIRE SAG3

IC 5146 SPIRE 250 µm 0.36×0.20° = 21×12 pc D↗3000 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey

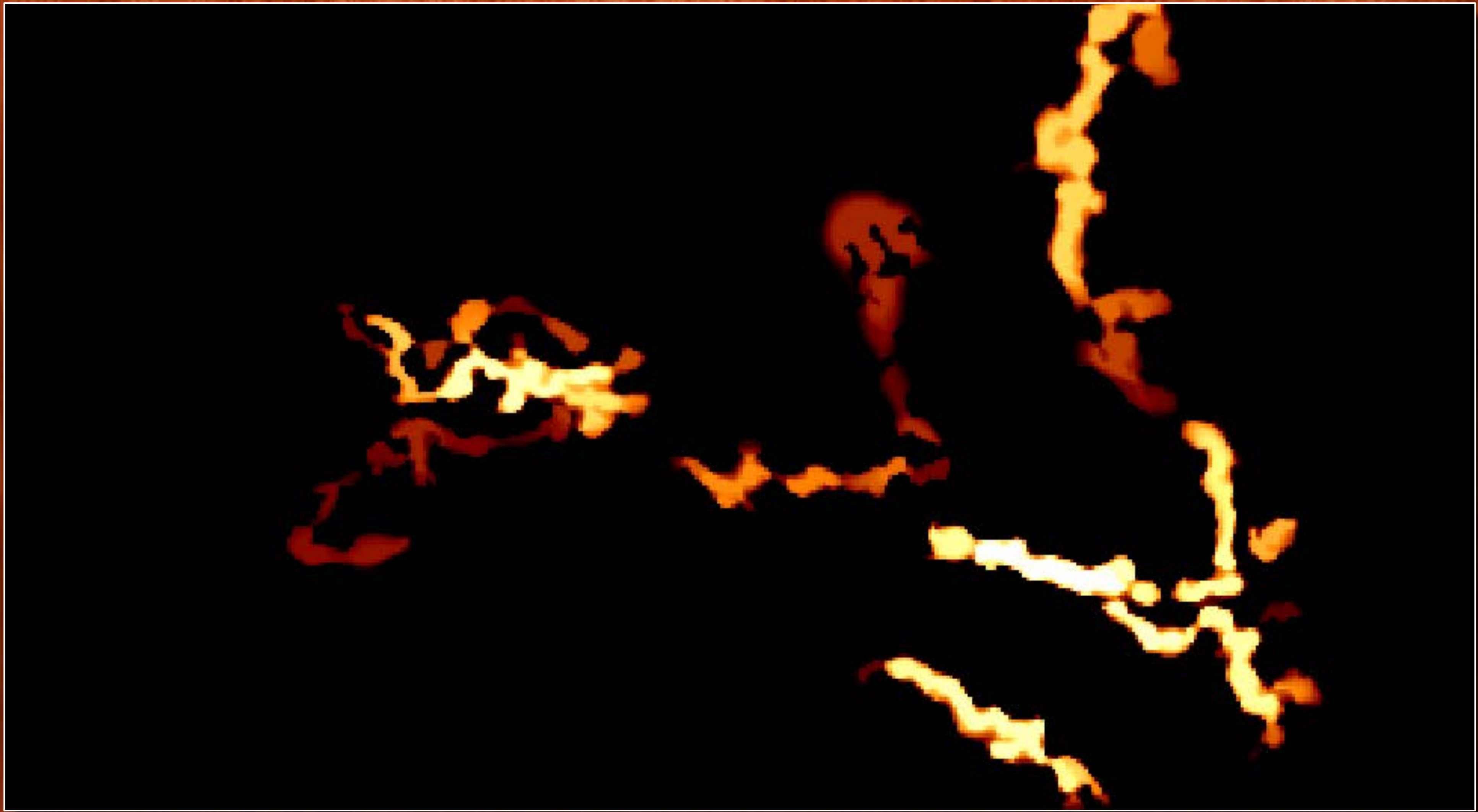
SPIRE SAG3

IC 5146 SPIRE 250 μm 0.36×0.20° = 21×12 pc D↗3000 pc

See also: D. Arzoumanian + (2011)

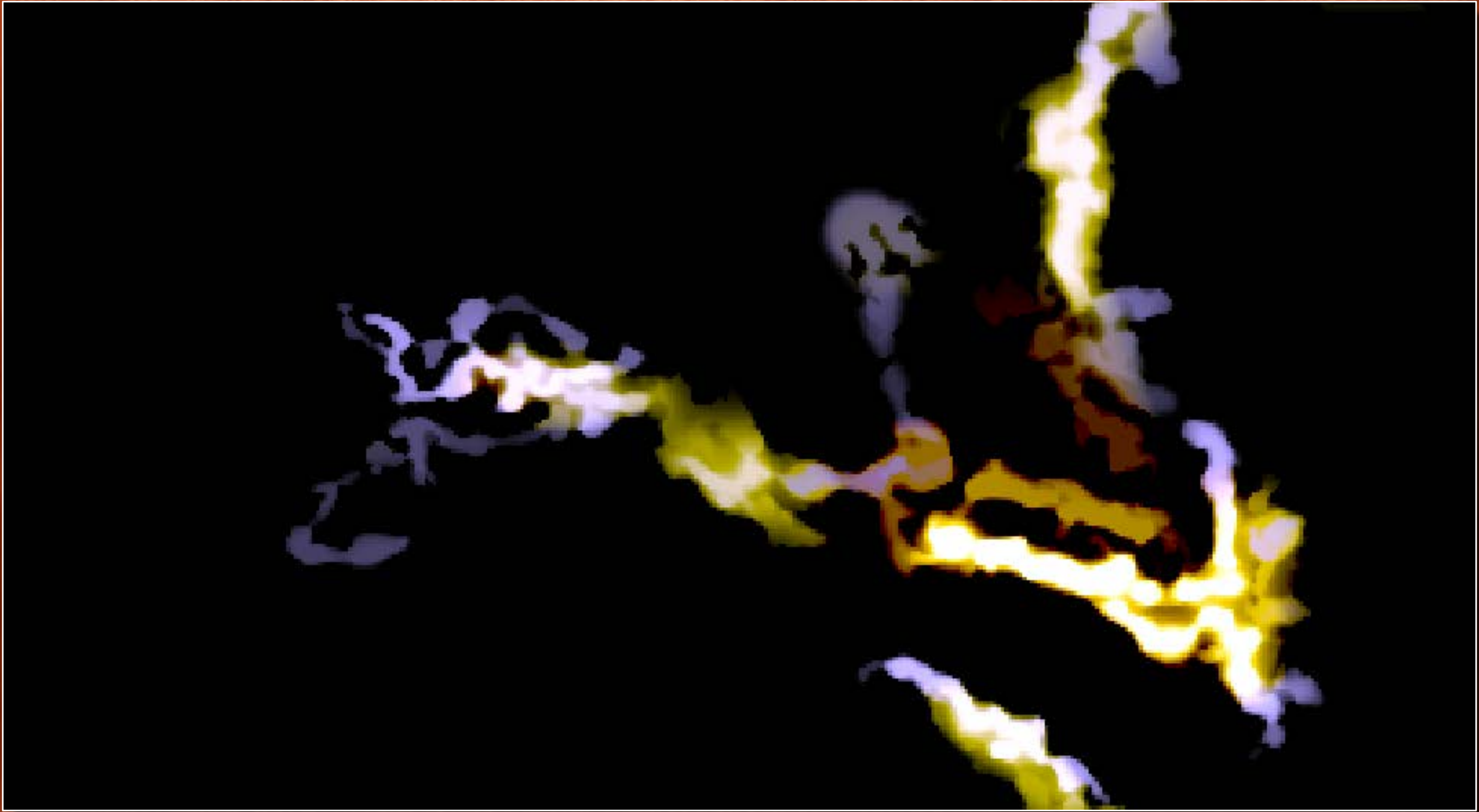
SAG3

IC 5146 SPIRE 250 μm 0.36×0.20° = 21×12 pc *D*↗3000 pc



See also: D. Arzoumanian + (2011)

IC 5146 SPIRE 250 µm 0.36×0.20° = 21×12 pc $D \nearrow$ 3000 pc



See also: D. Arzoumanian + (2011)

HERSCHEL Gould Belt Survey

SPIRE

SAG3

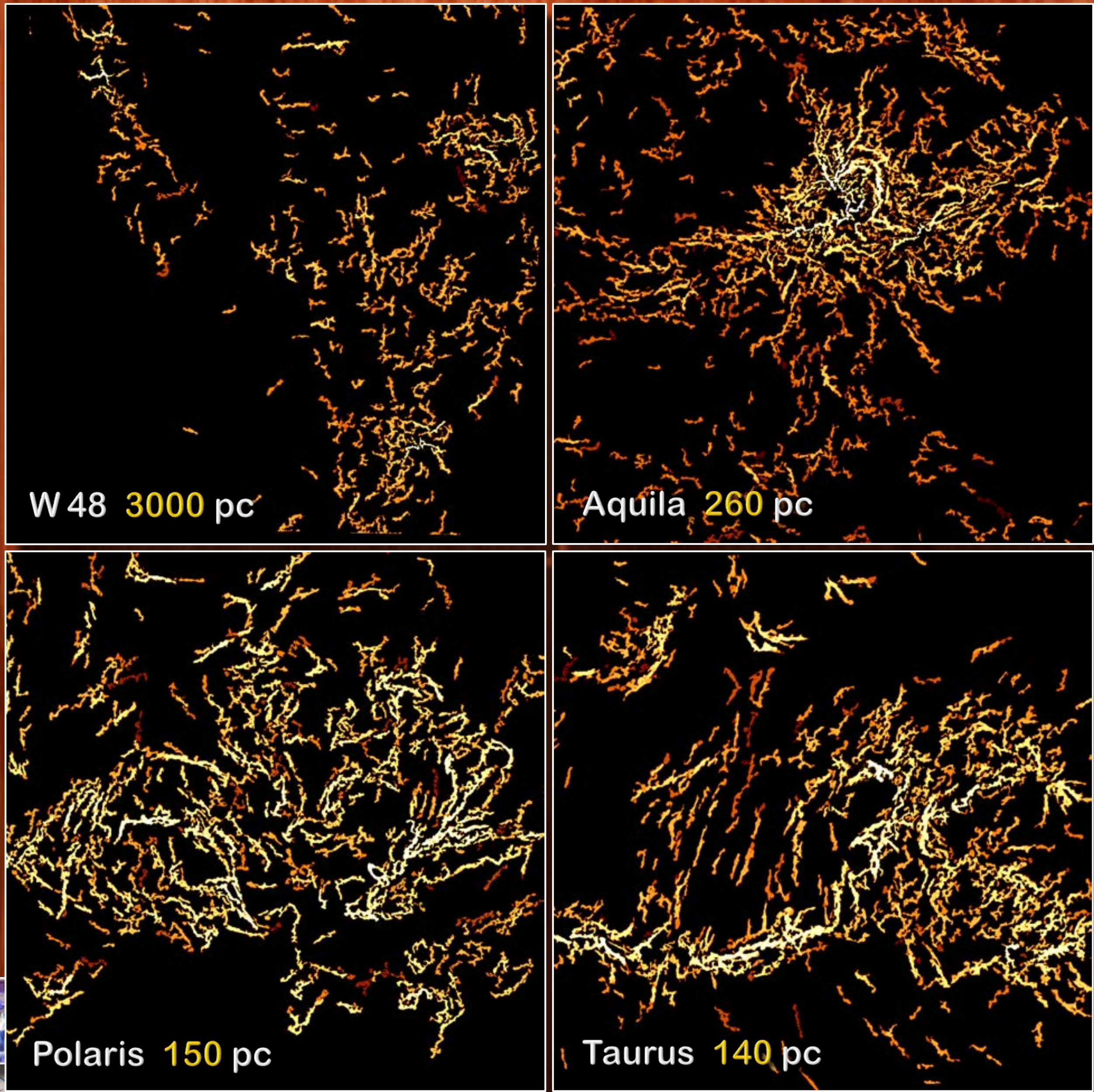
W 48 SPIRE 250 µm 2.3×2.3° = 124×124 pc *D* = 3000 pc

Q. Nguen Luong + (2011)
K. Rygl + (2014)

Filling factor 0.068

Ph. André + (2010)
A. Men'shchikov + (2010)
S. Bontemps + (2010)
V. Könyves + (2010)

Filling factor 0.16



Ph. André + (2010)
A. Men'shchikov + (2010)
M.-A. Miville-Dechênes + (2010)
Ward-Thompson + (2010)

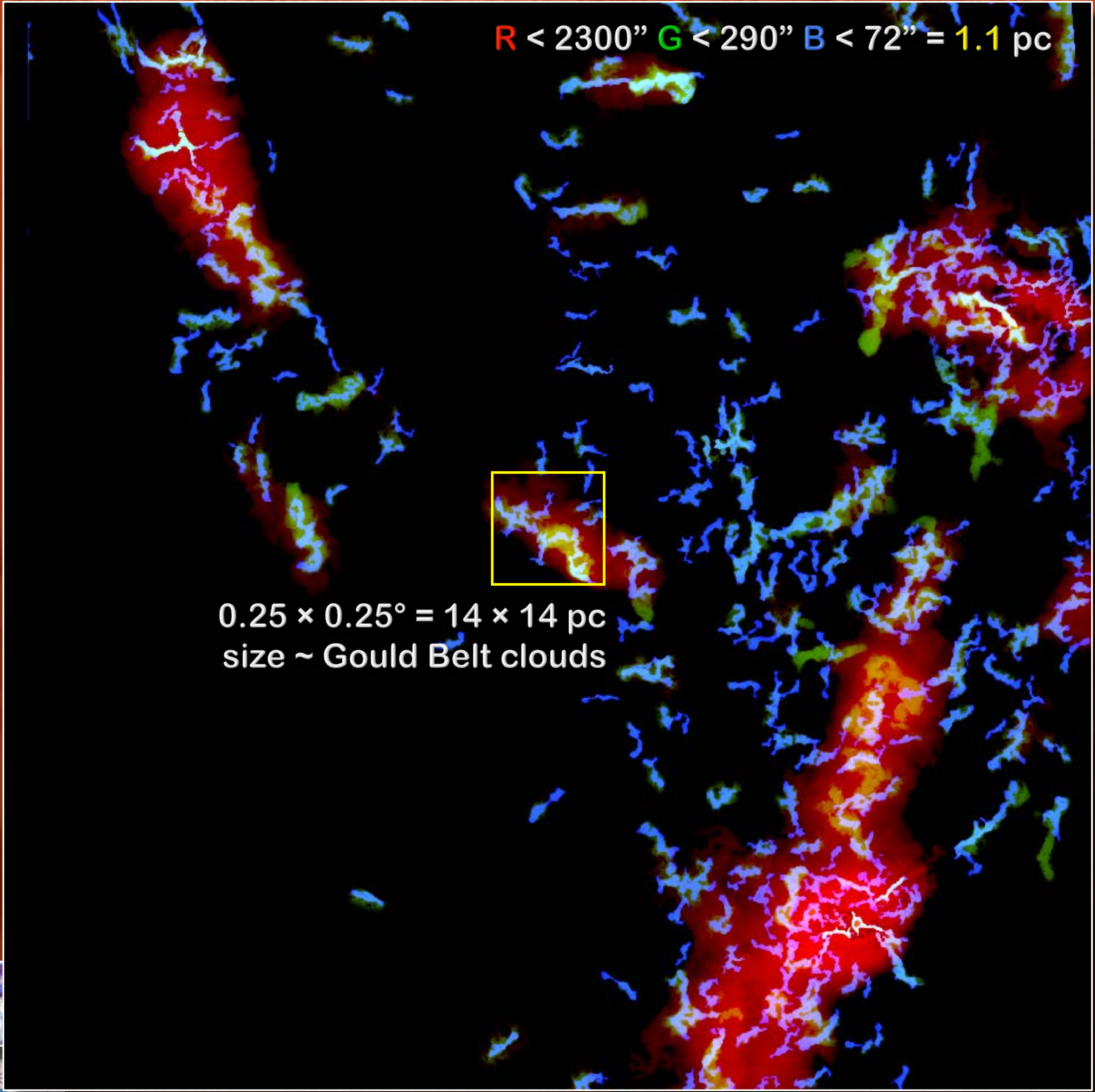
Filling factor 0.15

P. Palmeirim + (2013)
J. Kirk + (2103)
K. Marsh + (2014)

Filling factor 0.16

SAG3

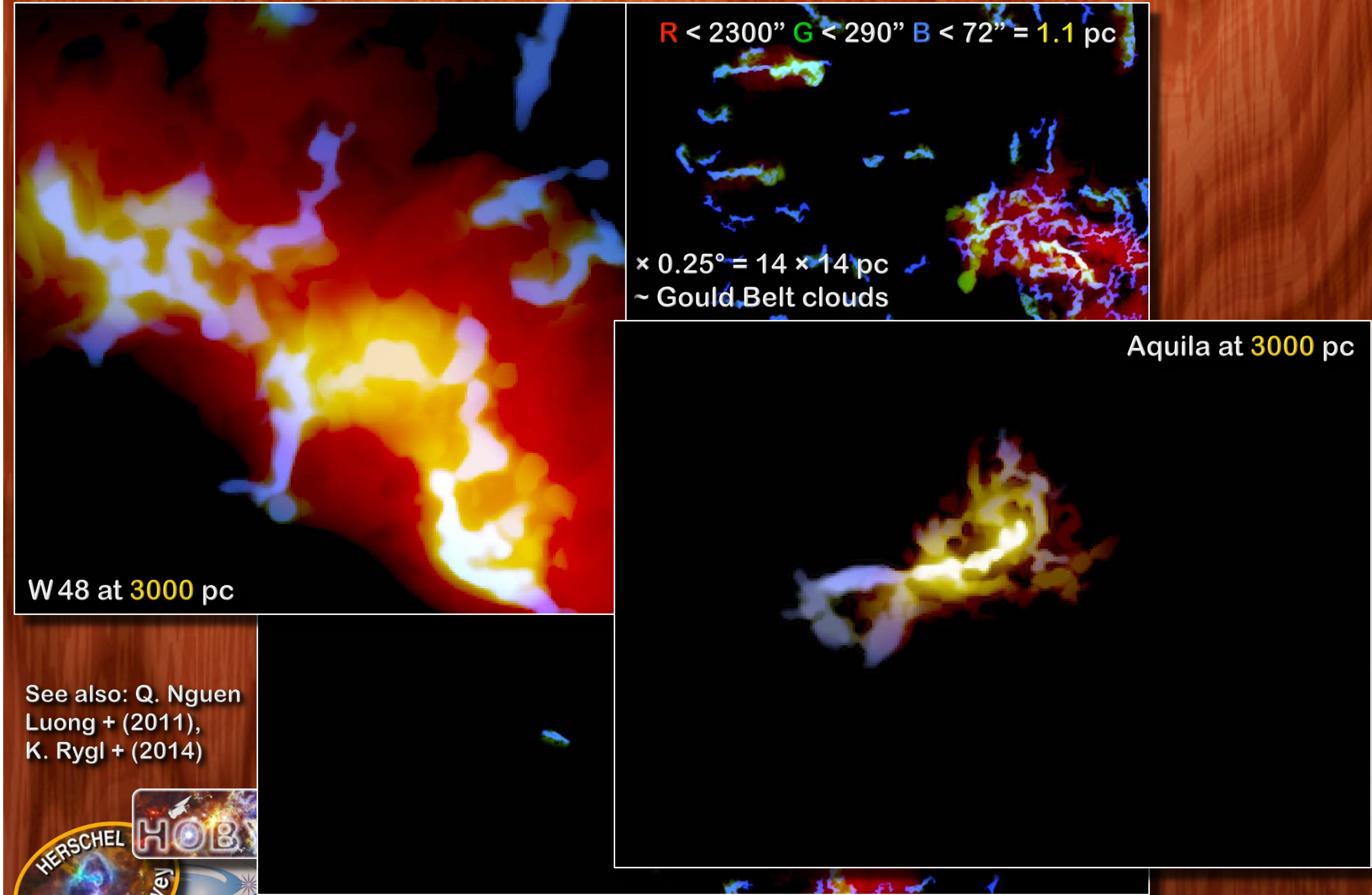
W 48 SPIRE 250 μm 2.3 × 2.3° = 124 × 124 pc *D* = 3000 pc



See also: Q. Nguen Luong + (2011), K. Rygl + (2014)

HERSCHEL Gould Belt Survey
HOBYS
SPIRE
SAG3

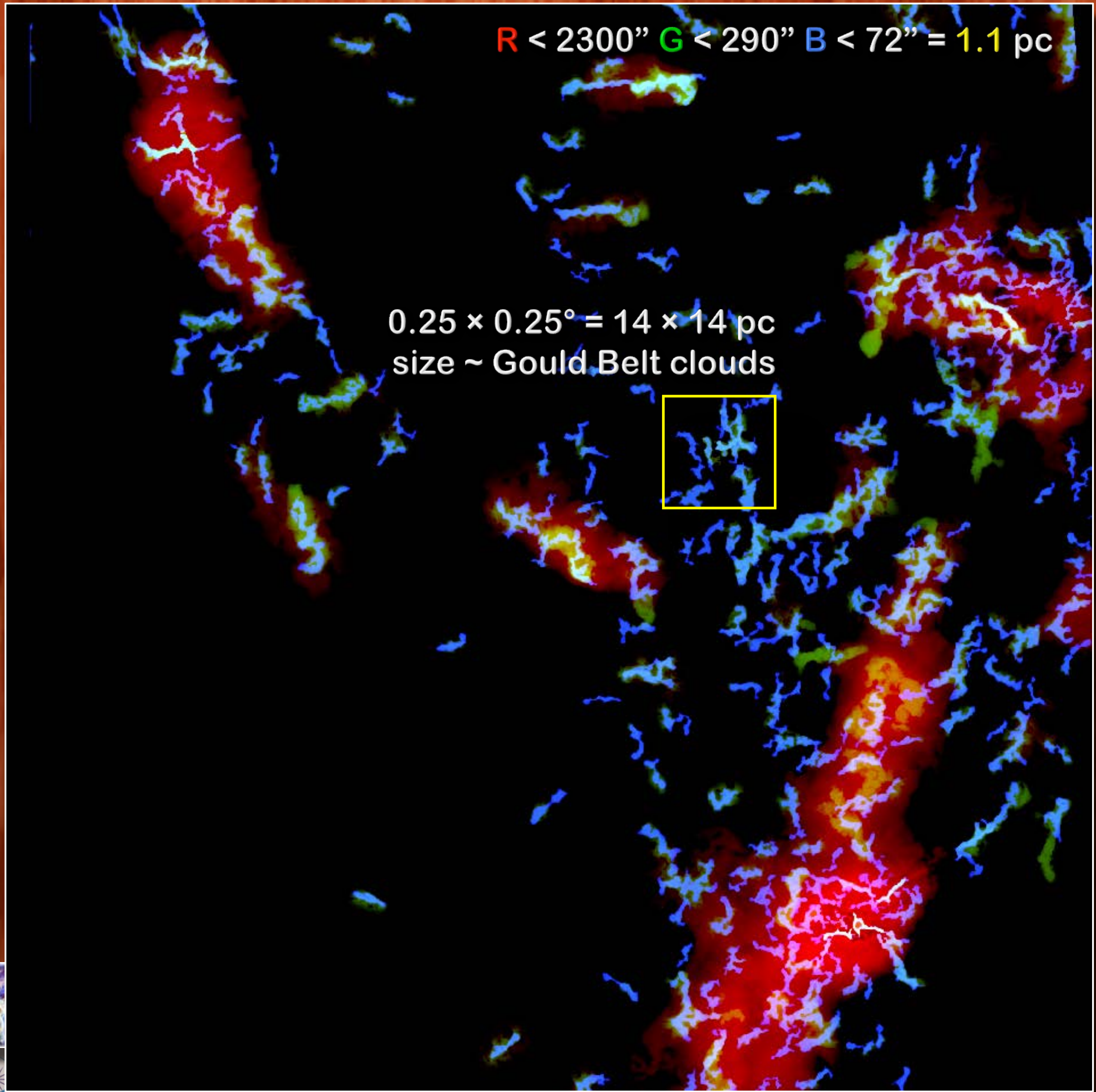
W 48 SPIRE 250 μm 2.3 × 2.3° = 124 × 124 pc D = 3000 pc



See also: Q. Nguen Luong + (2011), K. Rygl + (2014)

HERSCHEL Gould Belt Survey HOBYS SPIRE SAG3

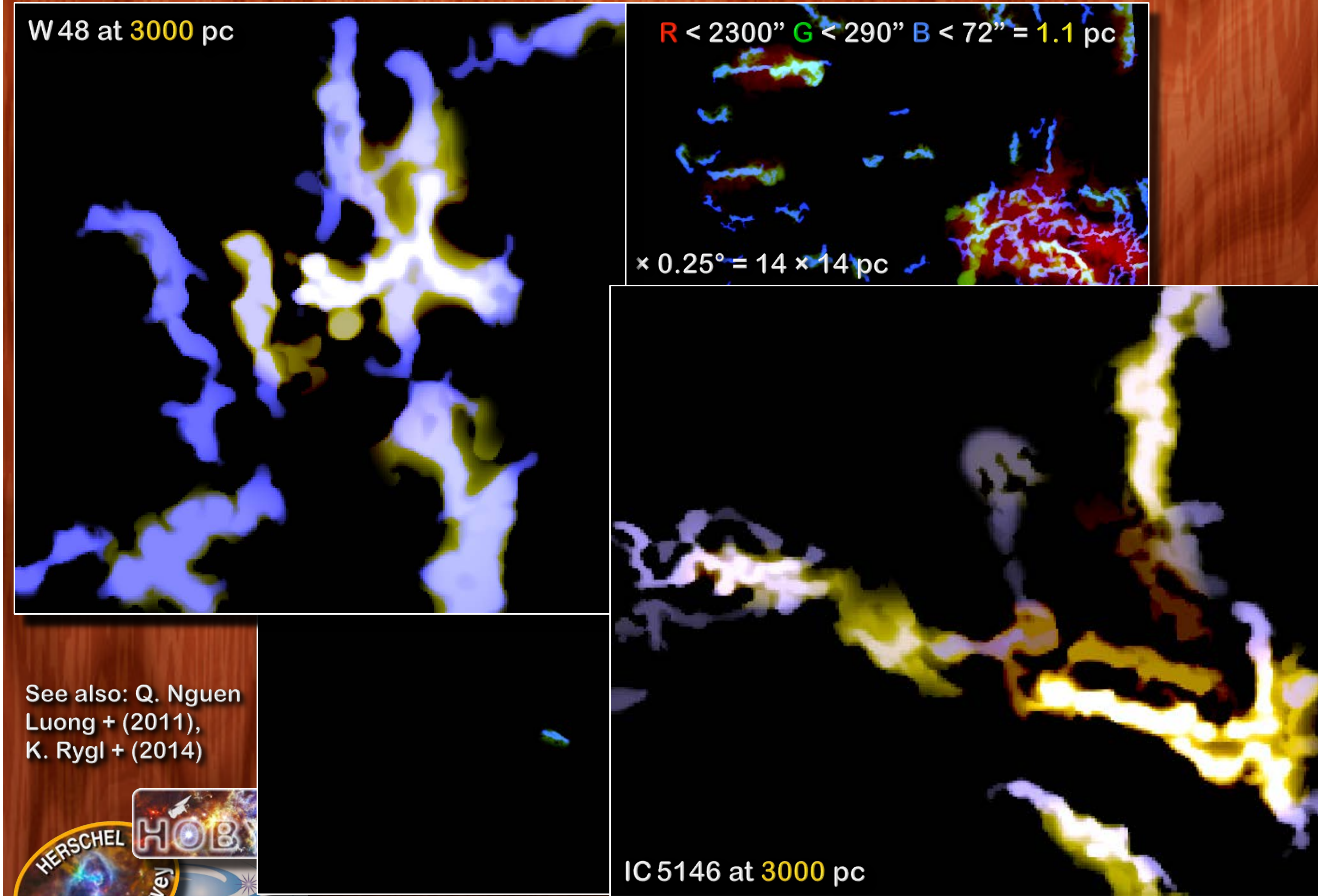
W48 SPIRE 250 μm 2.3×2.3° = 124×124 pc D = 3000 pc



See also: Q. Nguen Luong + (2011), K. Rygl + (2014)

HERSCHEL Gould Belt Survey HOBYS SPIRE SAG3

W 48 SPIRE 250 μm 2.3×2.3° = 124×124 pc D = 3000 pc



See also: Q. Nguen Luong + (2011), K. Rygl + (2014)

HERSCHEL Gould Belt Survey HOBYS SPIRE SAG3

Conclusions

- Gould Belt: fascinating web of omnipresent filamentary structures
- Filaments on *all spatial scales*; resolved fine structures *abundant*
- Sources, filaments, and backgrounds are *blended* components
- Methods to extract (*separate*) components: *getsources*, *getfilaments*
- Fine filaments are very complicated in shapes, heavily overlapping
- Large varieties of ordered patterns: plenty of *valuable information*
- *Dense* small-scale sub-structures: relationship with forming stars
- Distant clouds: fine structures (fibers, striations) become diluted
- Distant clouds: only few densest power-law filaments observable
- Distant clouds: *all* likely to have fine filaments, currently unresolved
- We need kinematical information, magnetic field measurements

HERSCHEL Gould Belt Survey HOBYS SPIRE SAG3 cea


The End
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