

Look up here if you get lost!

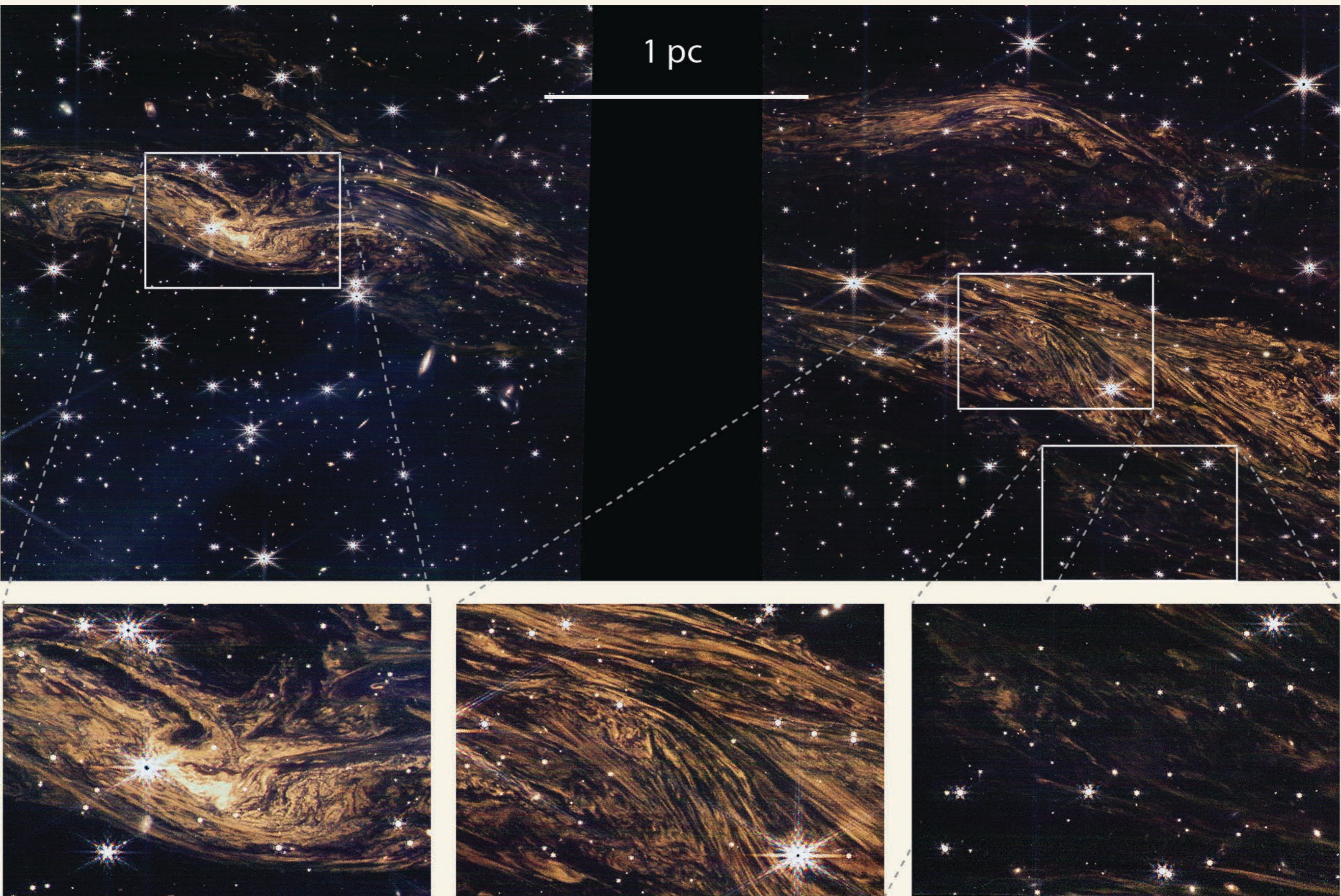
A Path-Breaking Observation of the Cold Neutral Medium of the Milky Way Through Thermal Light Echoes

Joshua E. G. Peek w/ Jacob Jencson &
STScI, IPAC

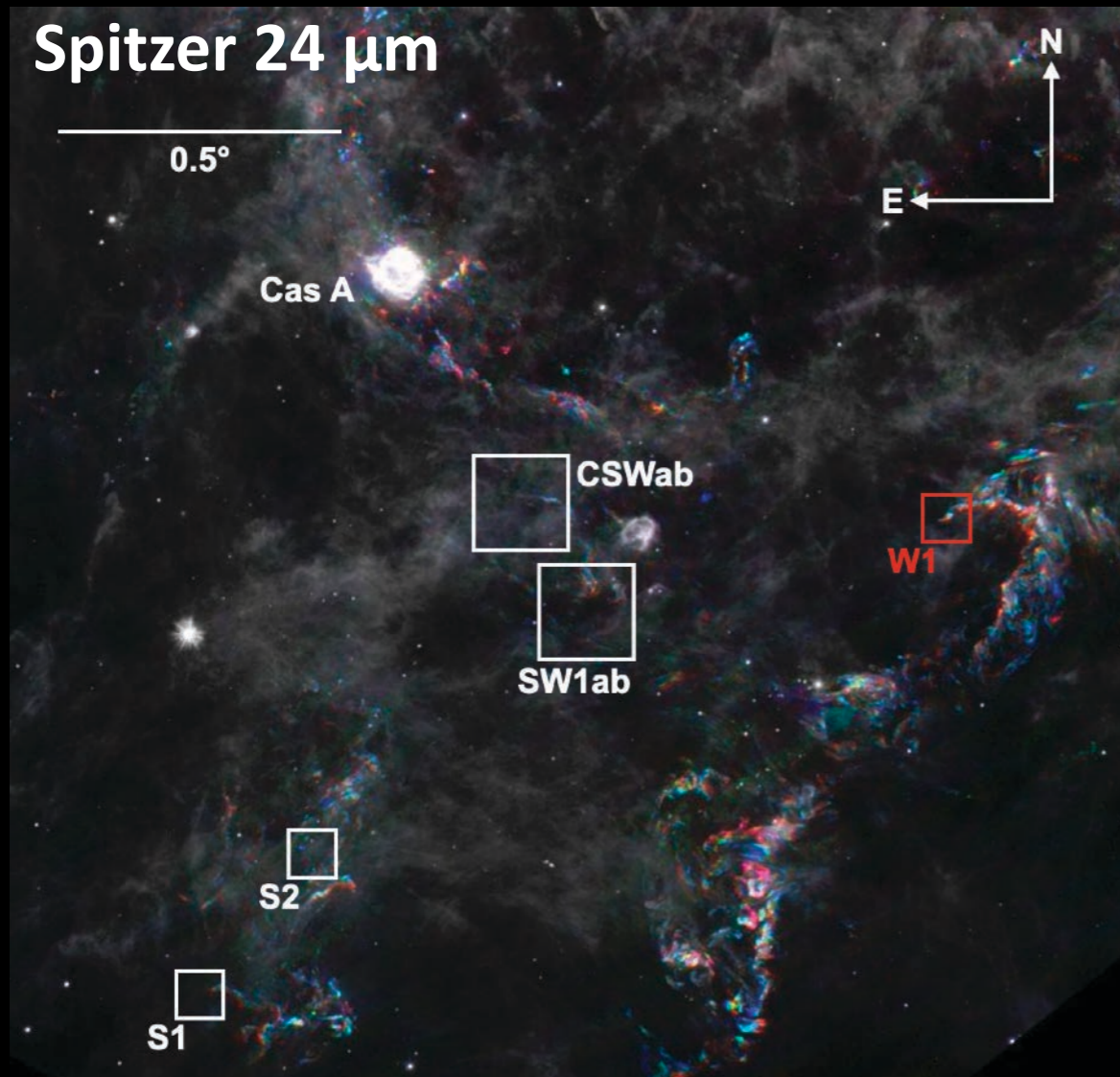
Armin Rest <i>Space Telescope Science Institute</i>	Rodrigo Angulo <i>Johns Hopkins University</i>	Charles Kilpatrick <i>Northwestern University</i>	
Christopher Clark <i>Space Telescope Science Institute</i>	Richard Arendt <i>CRESST/UMBC</i>	Dan Milisavljevic <i>Purdue University, West Lafayette</i>	Qinan Wang <i>Johns Hopkins University</i>
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	Sebastian Gomez <i>STScI/Roman</i>	Tea Temim <i>Princeton University</i>	Andrew Saydjari <i>Princeton</i>

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We found observed something extraordinary in space

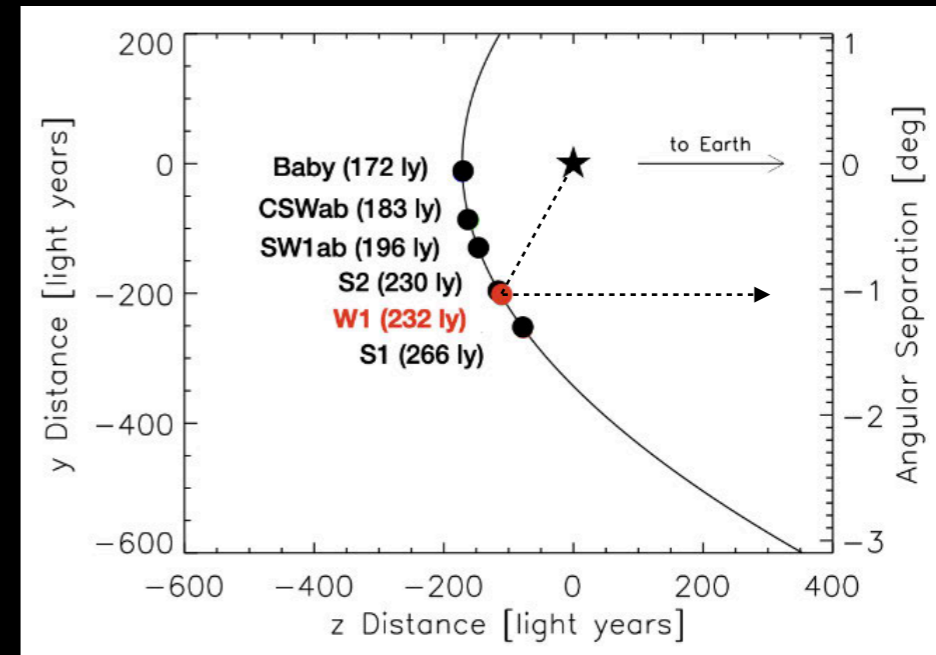


Echoes of a Historic Explosion: A Supernova Flashbulb Illuminates Interstellar Material



NASA/JPL-Caltech/Y. Kim (Univ. of Arizona/Univ. of Chicago)

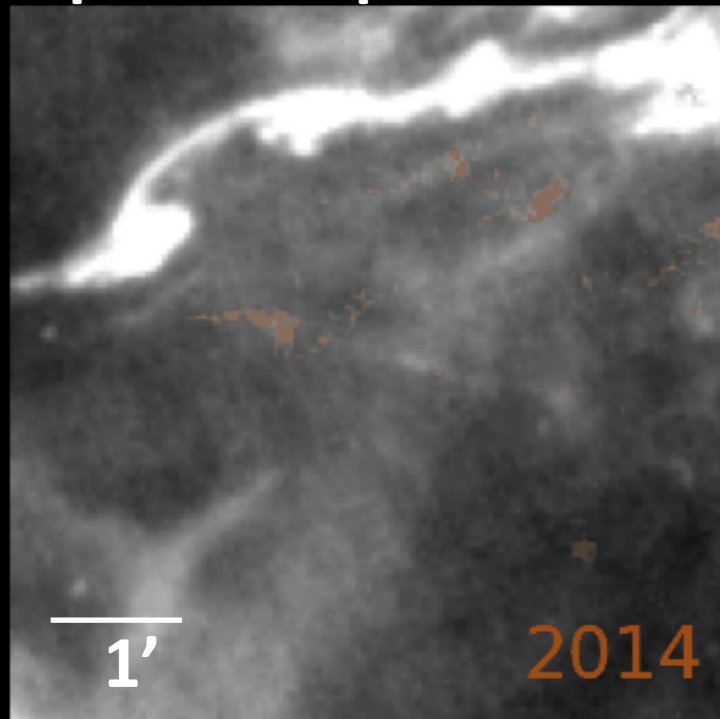
Cas A Echoes / Jacob Jencson



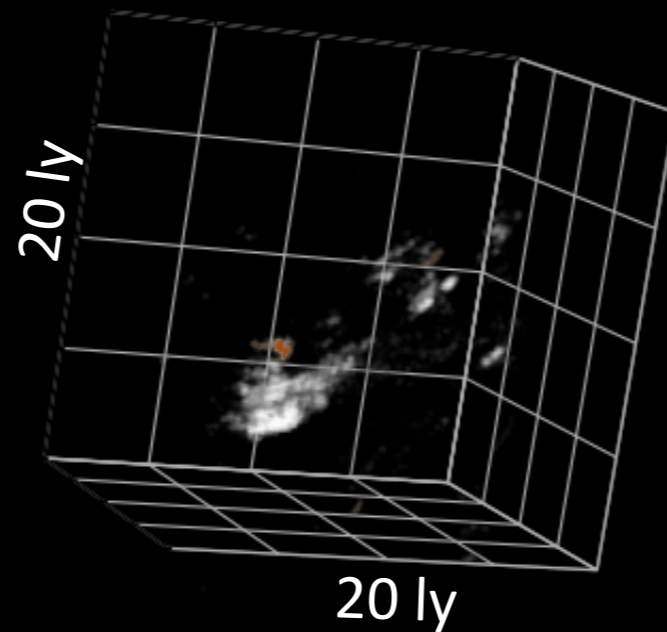
- Cas A is the youngest core-collapse remnant in the Galaxy, light first reached earth ~ 350 ago
- System of thermal infrared echoes discovered by Spitzer, with continued monitoring by NEOWISE

Times-series imaging creates a true 3D scan of interstellar gas and dust

Spitzer 24 μm

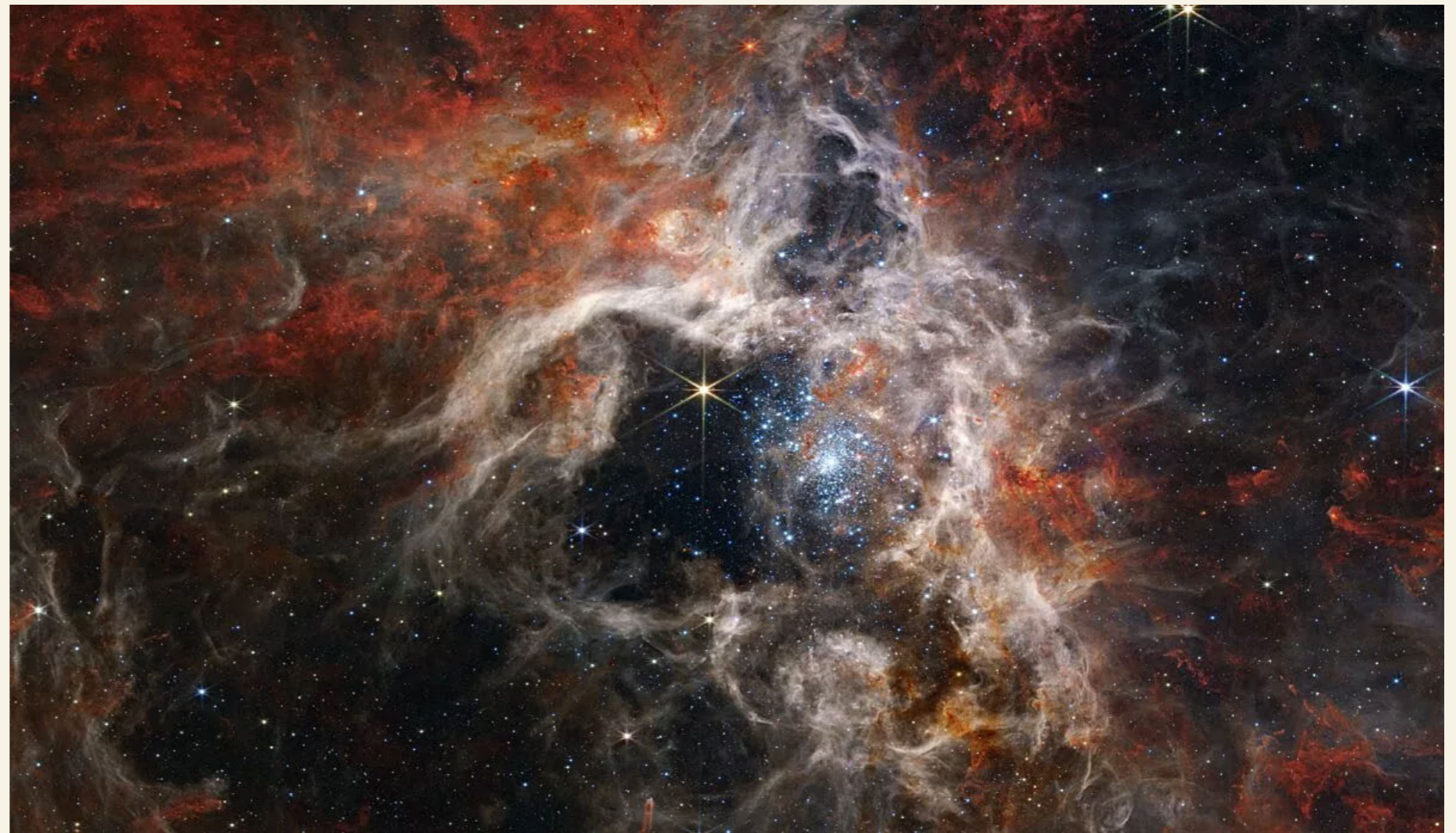
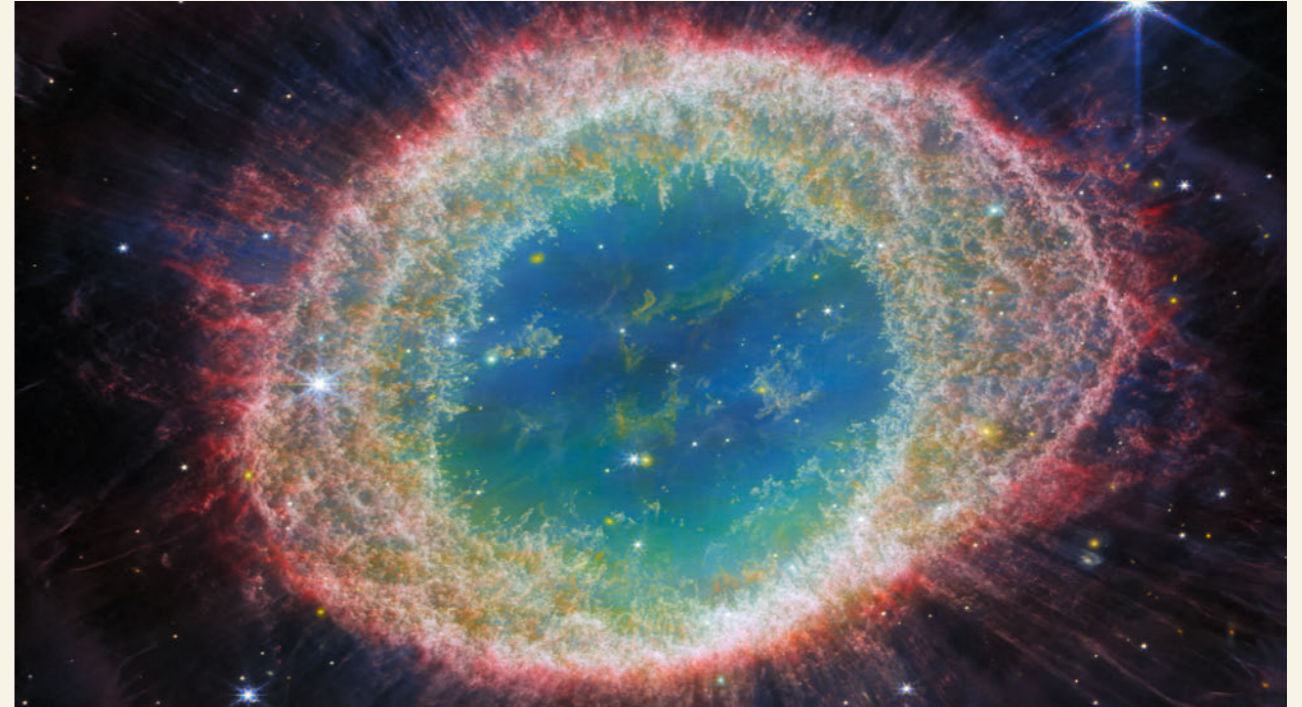


NEOWISE 4.6 μm

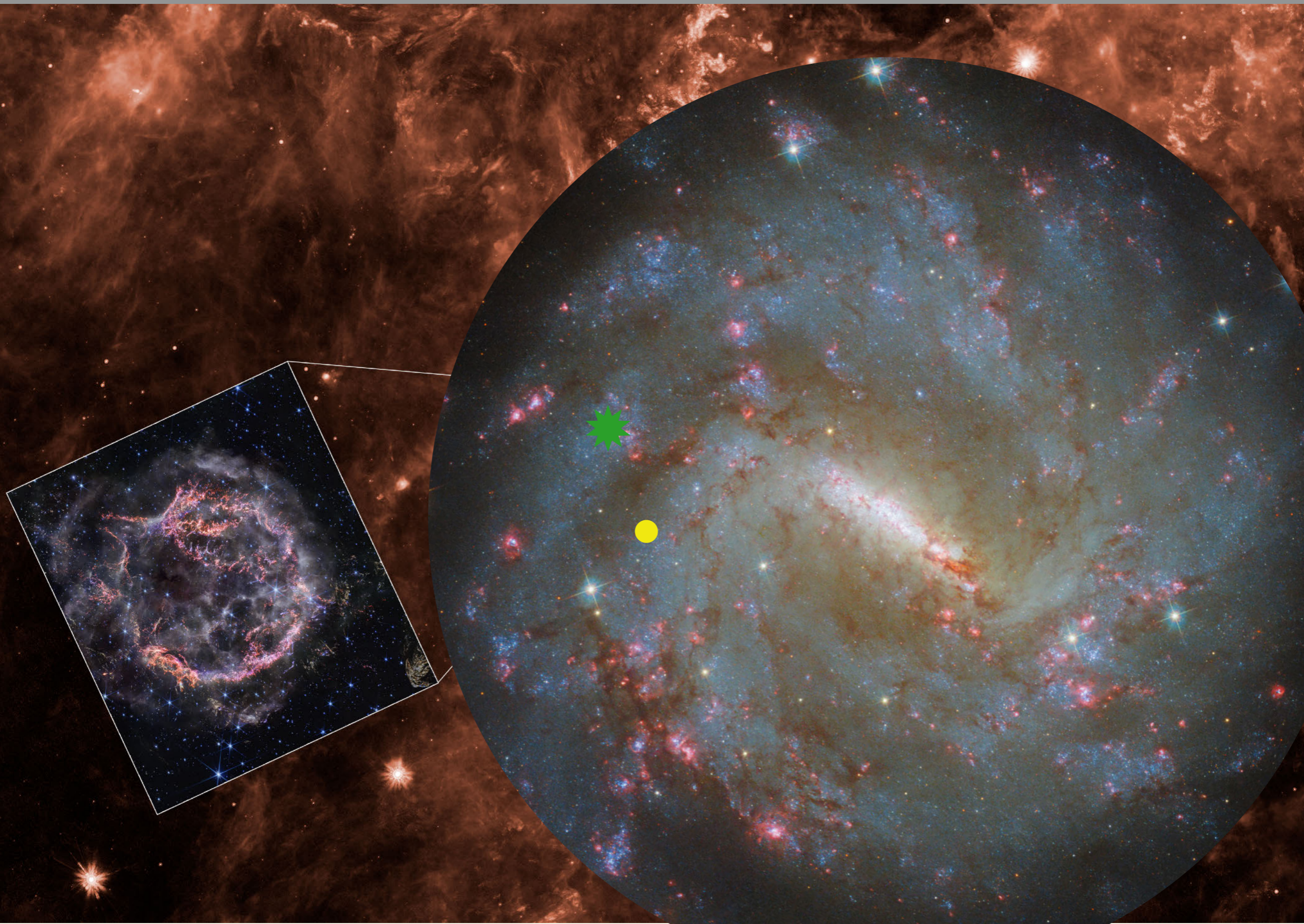


- Short pulse (\sim days) of supernova radiation illuminates a thin layer of dust, allowing us to trace 3D structure
- Spitzer/NEOWISE sensitive to scales of 0.1-0.5 pc in the cold ISM
- Echo analyses suggested highly clumped filamentary structure (Kim+2008)

We usually see the ISM/star interaction, a key, but rare, mode

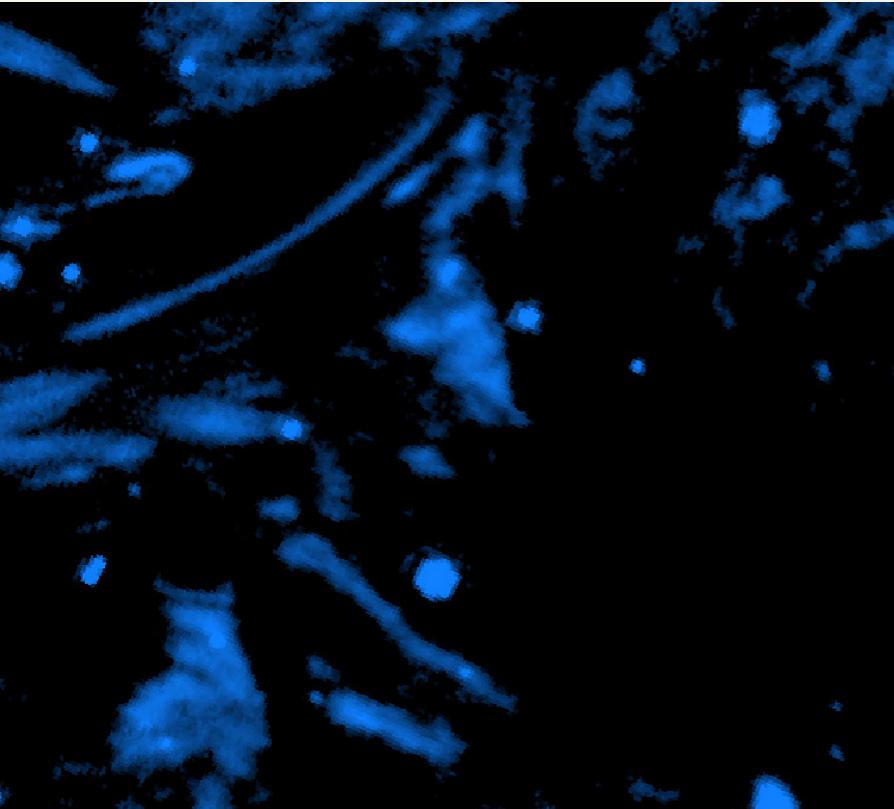


This light echo is probing *typical* ISM

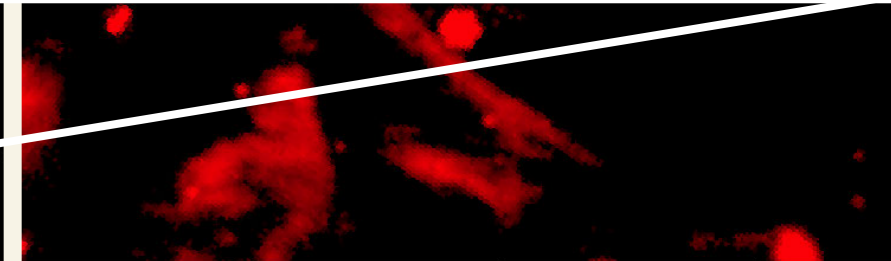
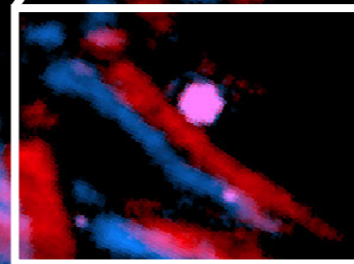
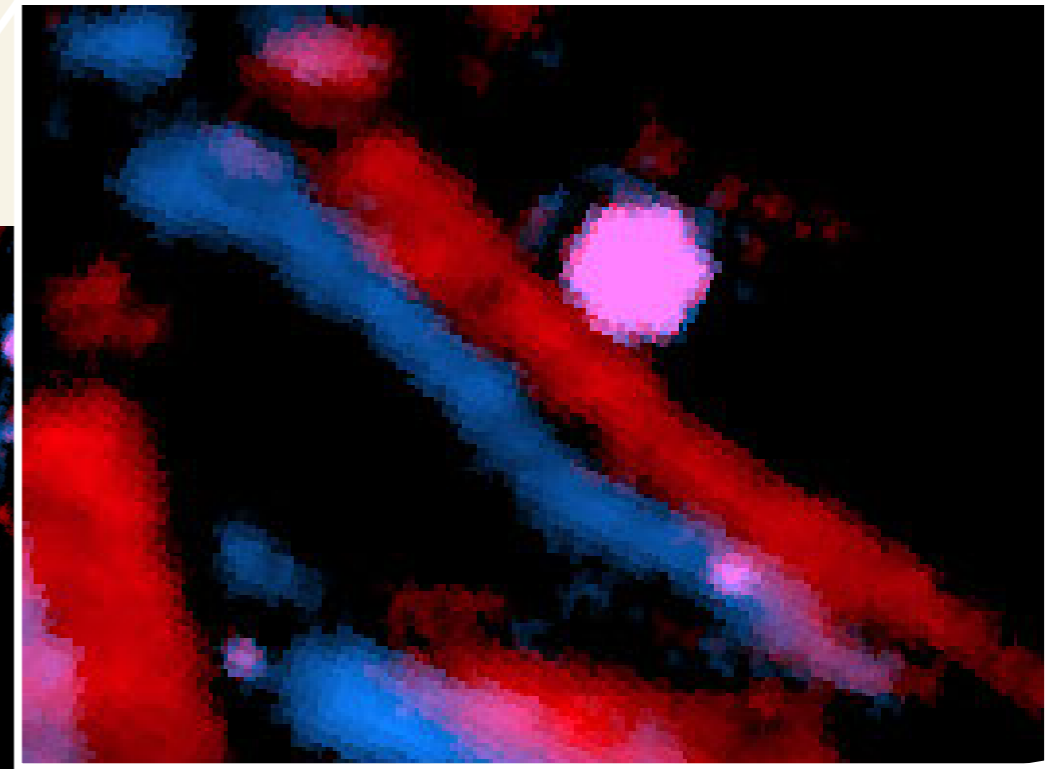
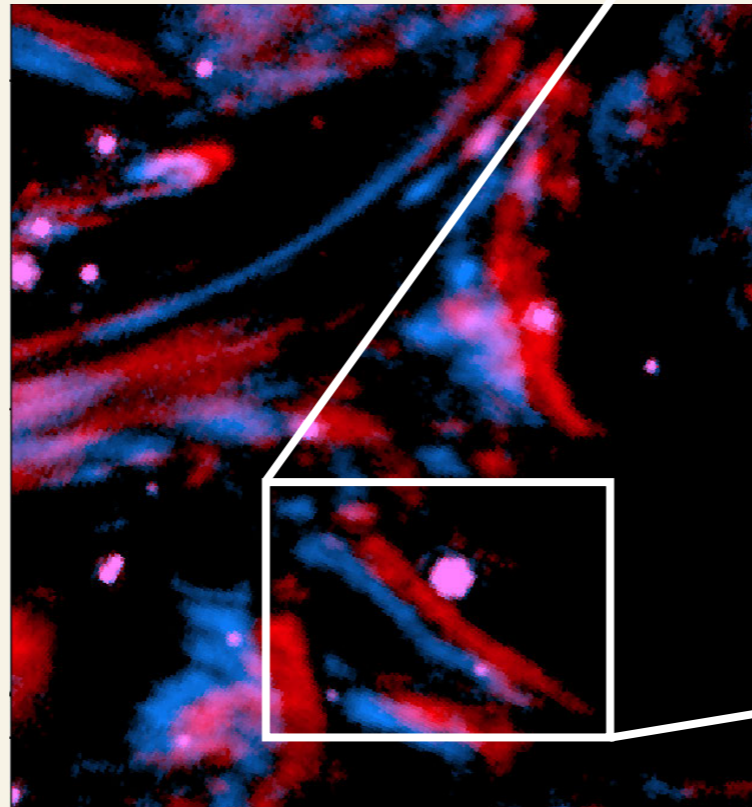


We can limit the length of the light pulse to < 10 days

Day 0

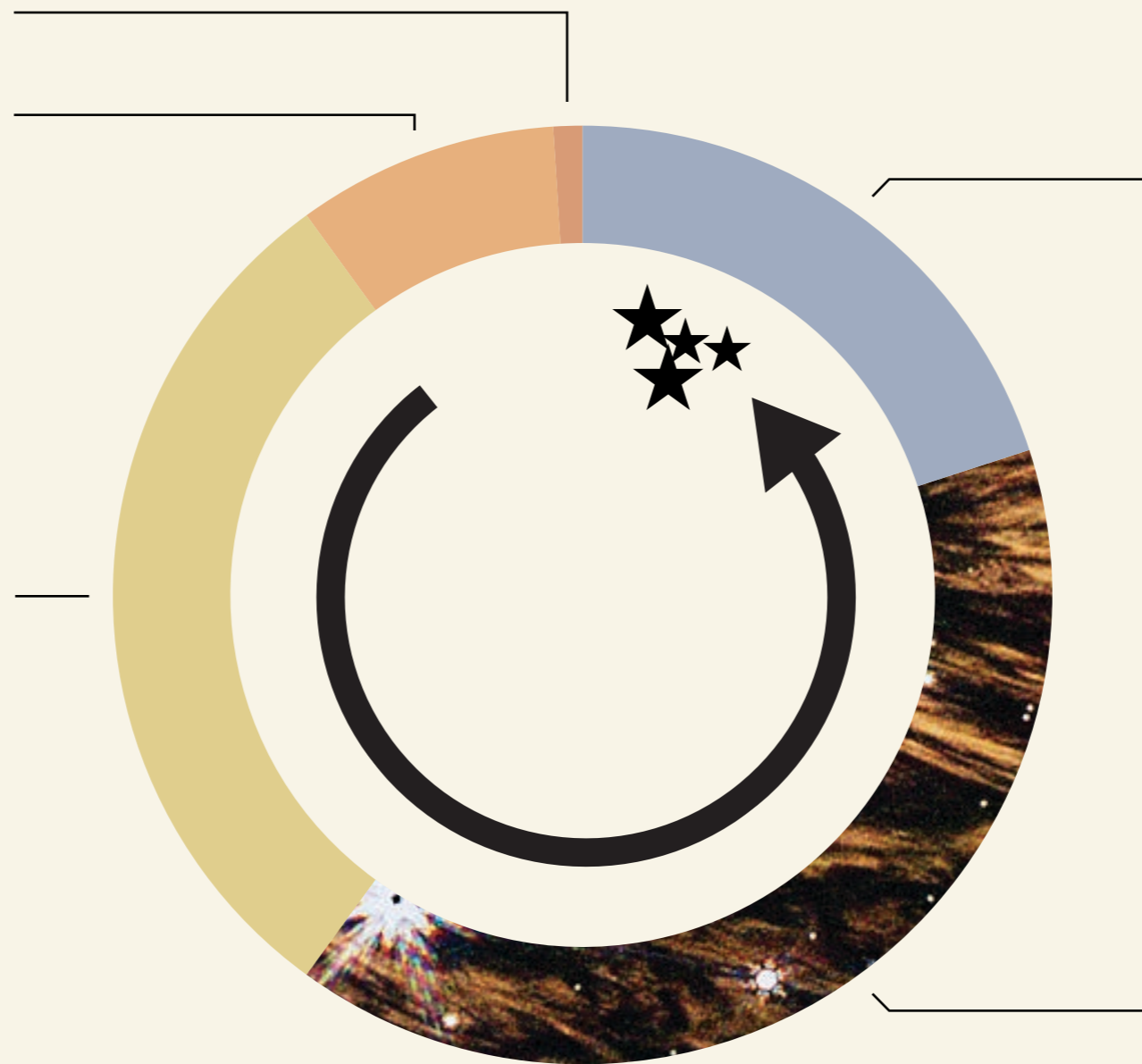


14 Day Interval



Which also allows us to constrain **the density of the gas**, consistent with the **cold neutral gas** that is the precursor to star forming molecular gas

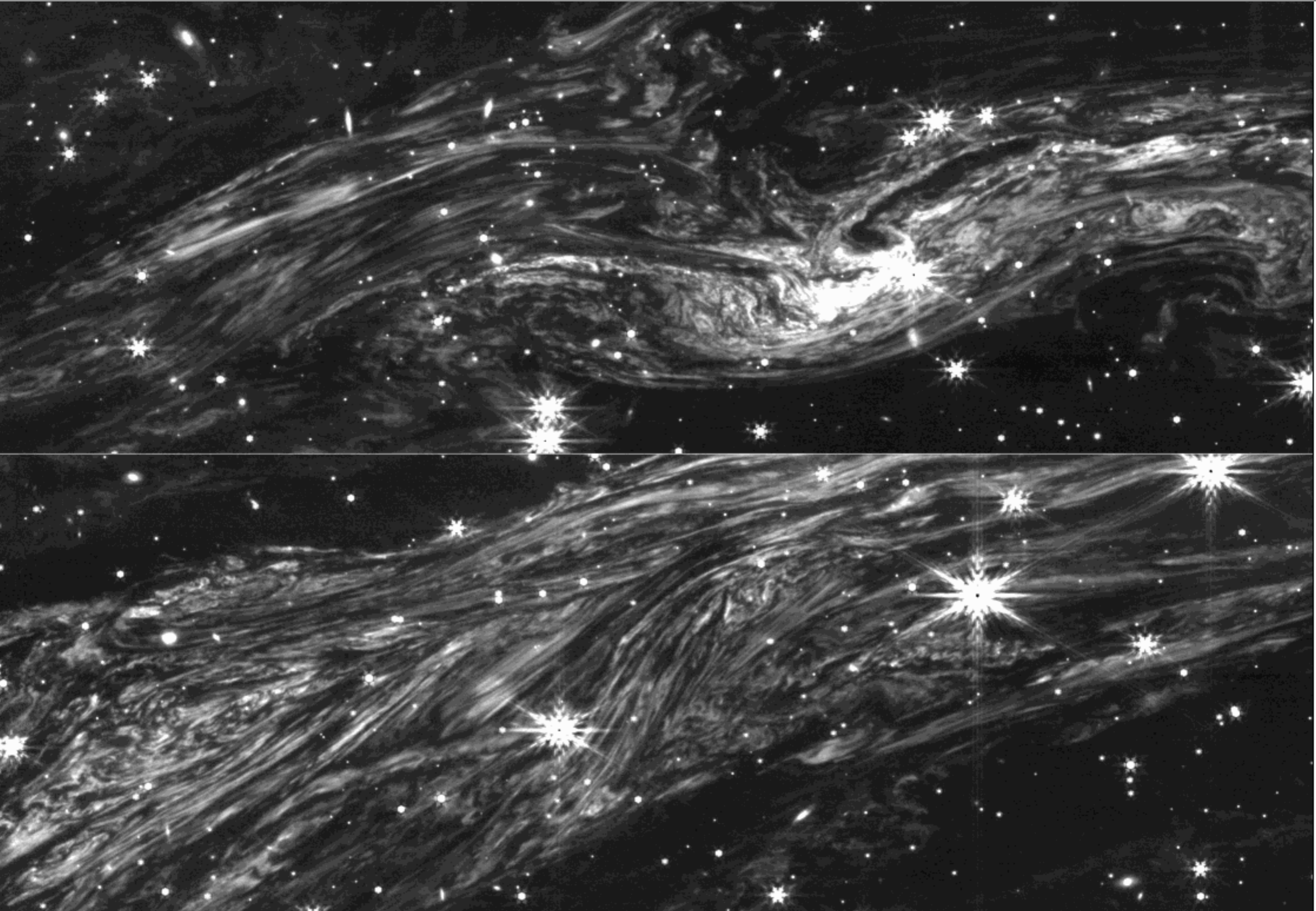
~40% of the gas in the Milky Way looks like this inside!



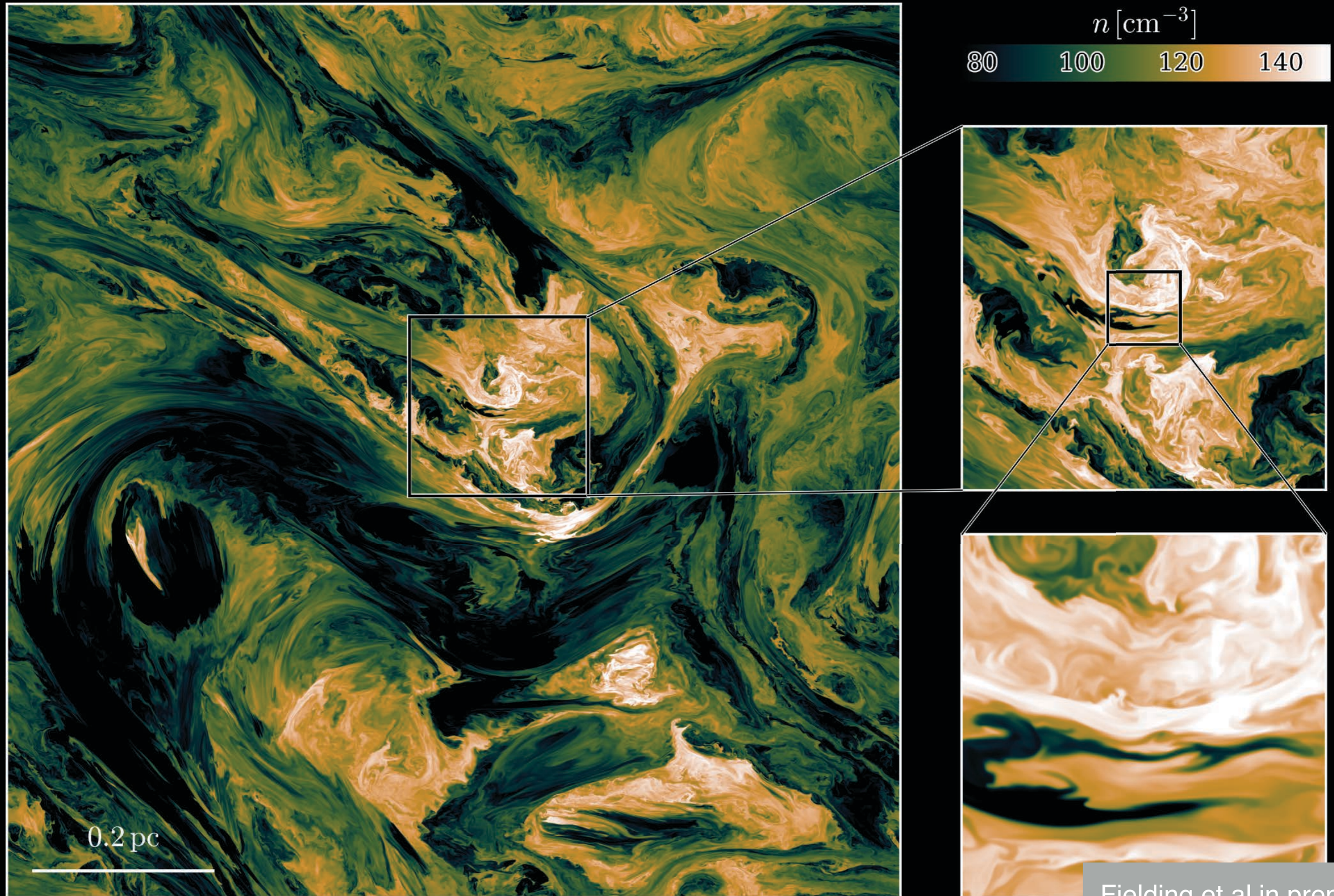
● Molecular ● Cold Neutral ● Warm Neutral ● Warm Ionized ● Hot Ionized

This gas is the pathway to forming stars, but we don't understand how it compresses, given how magnetized it is

Knots and *Bundles* may both represent crumpled ribbons



Simulations find similar morphology, tracing magnetism



- This project exemplifies a rarity in astrophysics: **a short path from beauty to truth**
- Unlike most images, we are seeing the beautiful ISM **as it usually is**, not as it interacts with stars. ***40% of the gas in our Galaxy looks like this!***
- The structure is composed of *bundles* and *knots* which may indicate an overall ***crumpled ribbon morphology***
- **Simulations see similar structures** in magnetized gas. Magnetic fields resist the compression of gas to stars. **Comparisons will allow us to resolve a mystery of how stellar nurseries form.**