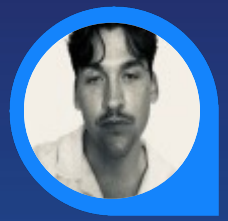
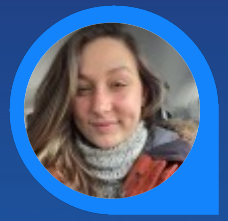
Live from AAS! 2025

Science Briefing



Logan Fries

University of Connecticut



Emma P. Lieb

University of Denver



Josh Peek

Space Telescope Science Institute



Kelly Lepo

Space Telescope Science Institute



NASA/CXC/Penn State Univ./L. Townsley et al.; IR: NASA/ESA/CSA/STScI/JWST ERO Production Team; AAS

Outline of this Science Briefing

Science Briefing

1. **Logan Fries**
   University of Connecticut
   Black Hole Archeology: Mapping the Growth History of Black Holes Across Cosmic Time
2. **Emma P. Lieb**
   University of Denver
   JWST Tracks the Expanding Dusty Fingerprints of a Massive Binary
3. **Josh Peek**
   Space Telescope Science Institute
   A Path-Breaking Observation of the Cold Neutral Medium of the Milky Way Through Thermal Light Echoes
4. **Q&A**
5. **Jim Manning**
   NASA's Universe of Learning
   Science and Education Resources

Black Hole Archaeology: Mapping the Growth History of Black Holes Across Cosmic Time

Logan Fries
Prof. Jonathan Trump (no relation)

University of Connecticut
Department of Physics

Starring:
Kate Grier, Scott Anderson, Yue Shen + BHM-RM.

NASA Universe of Learning Program
National Harbor, MD
January 16th, 2025

Black holes are exotic, yet remarkably simple objects.



Black holes are exotic, yet remarkably simple objects.



Credit: C-Lock Inc.

Black holes are exotic, yet remarkably simple objects.



Credit: C-Lock Inc.

Credit: EHT Collaboration

Black holes are exotic, yet remarkably simple objects.



Credit: C-Lock Inc.

Credit: EHT Collaboration



Credit: Reed Instruments

Black holes are exotic, yet remarkably simple objects.



Credit: C-Lock Inc.

Credit: EHT Collaboration



Credit: Reed Instruments

Black hole spin encodes the growth history of black holes.

Logan Fries

Black hole spin encodes the growth history of black holes.

Growth through eating things will spin BHs up rapidly.



Image Credit: NASA/CXC/M. Weiss

Black hole spin encodes the growth history of black holes.

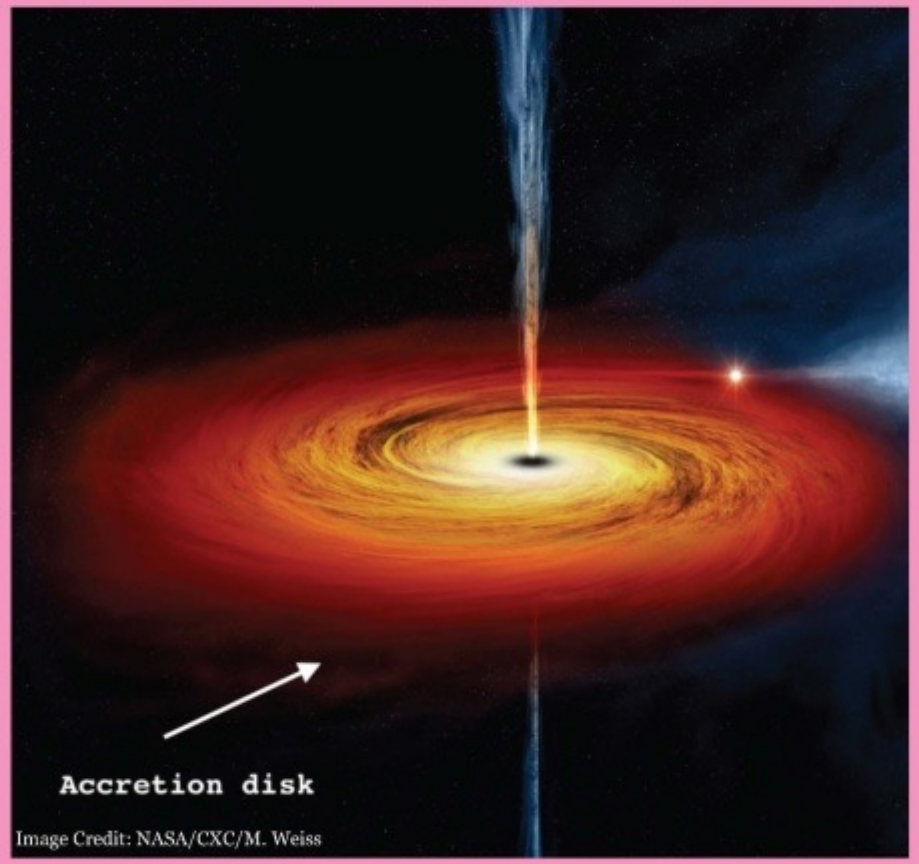
Growth through eating things will spin BHs up rapidly.



Growth through mergers will spin BHs down.



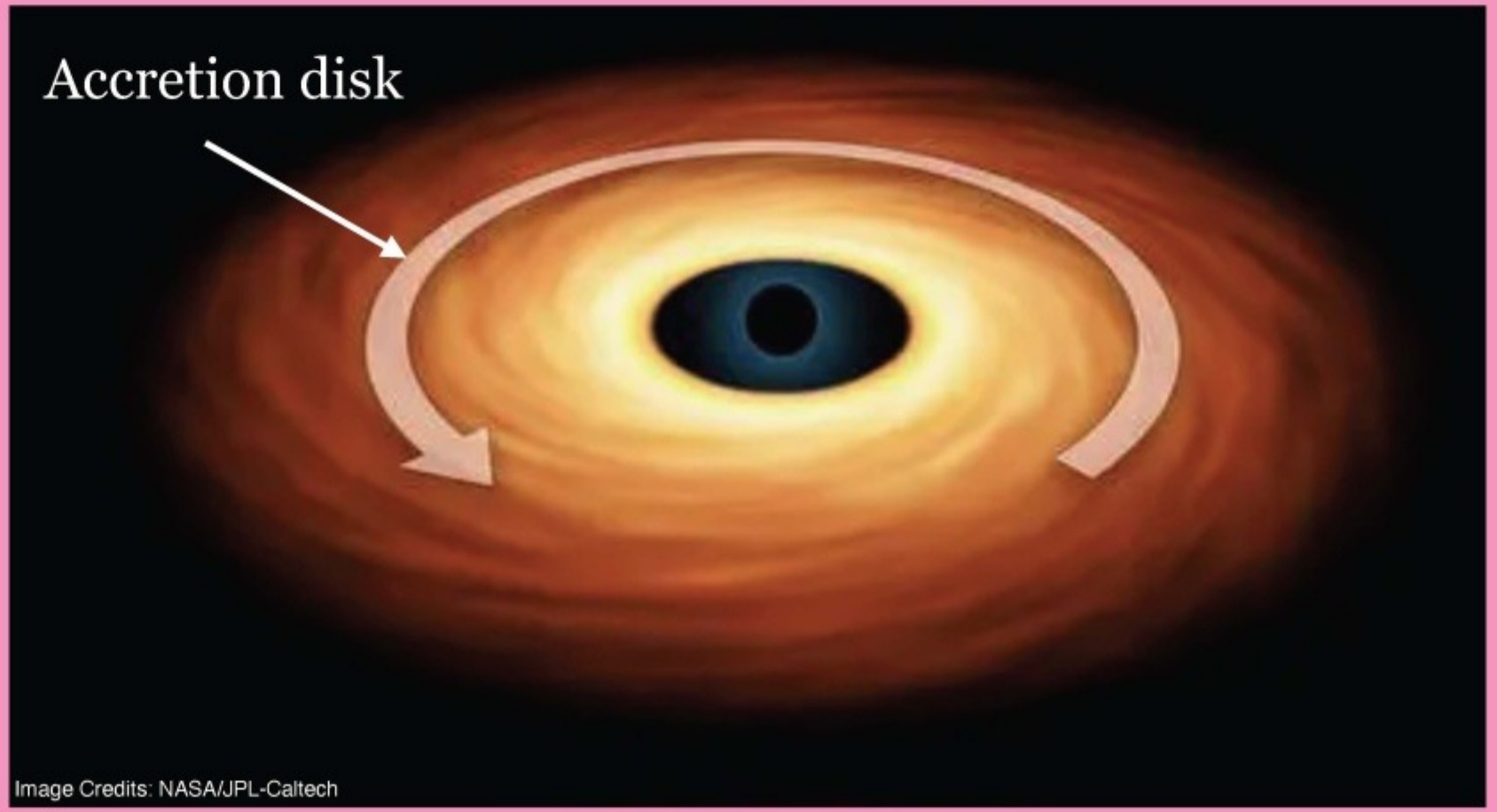
What is the process through which black holes grow their mass over cosmic time?



?



The different ways black holes spin changes the nature of the accretion disk.

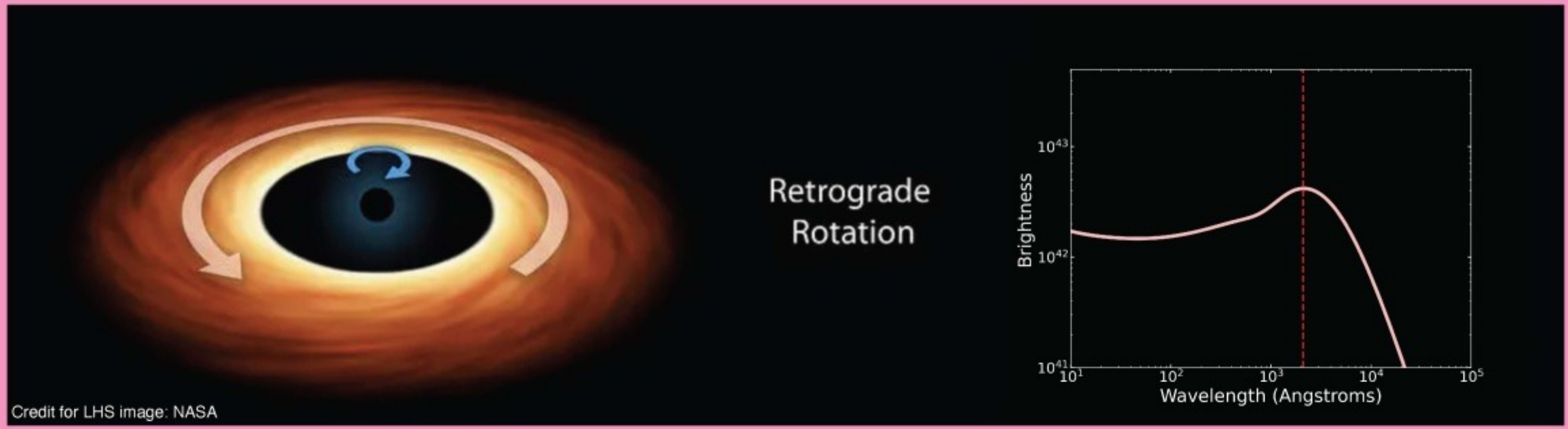


The different ways black holes spin changes the nature of the accretion disk.

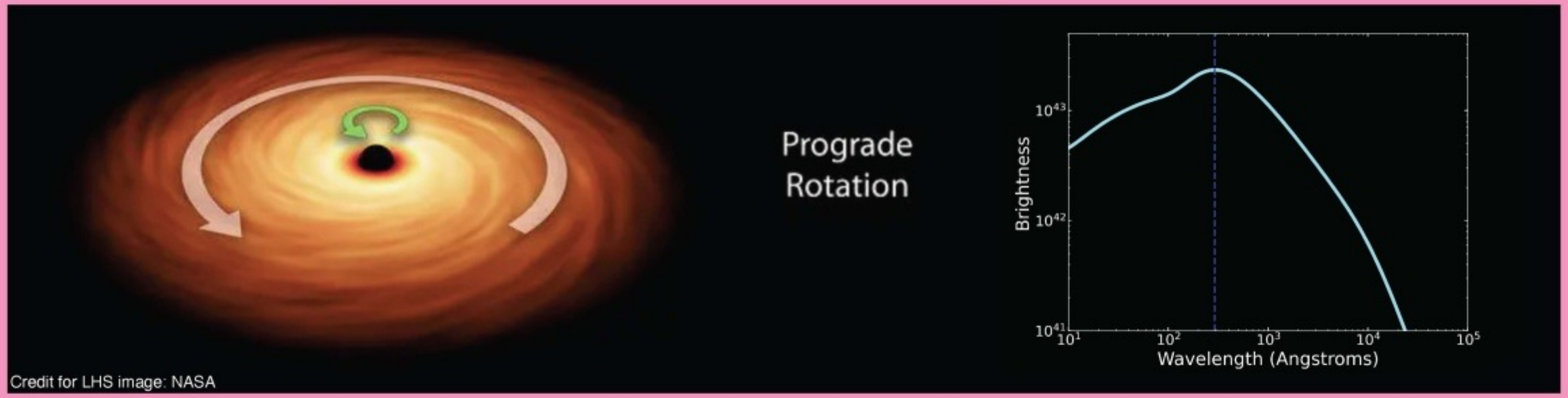
Logan Fries

January 16th, 2025

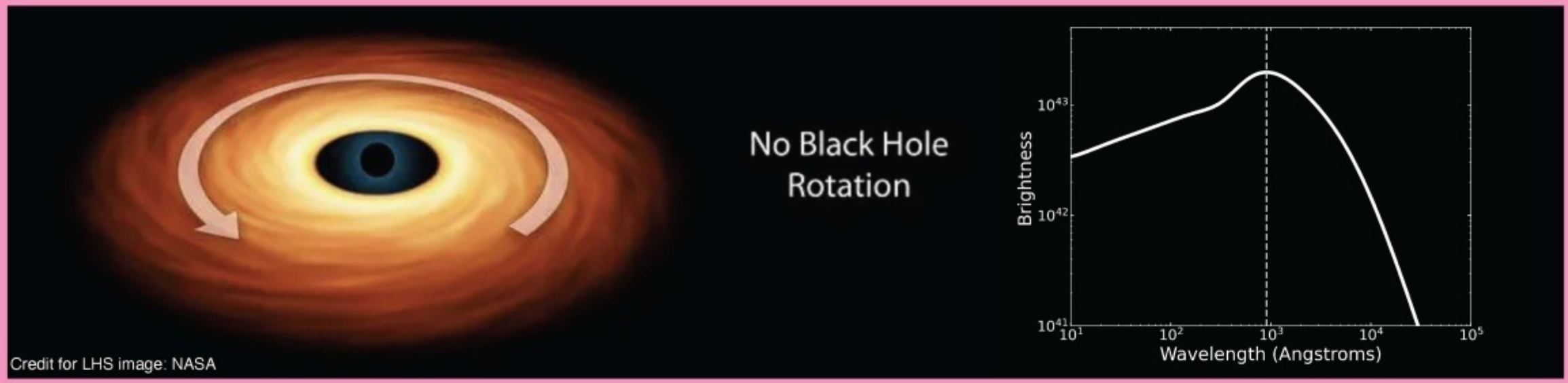
The different ways black holes spin changes the nature of the accretion disk.

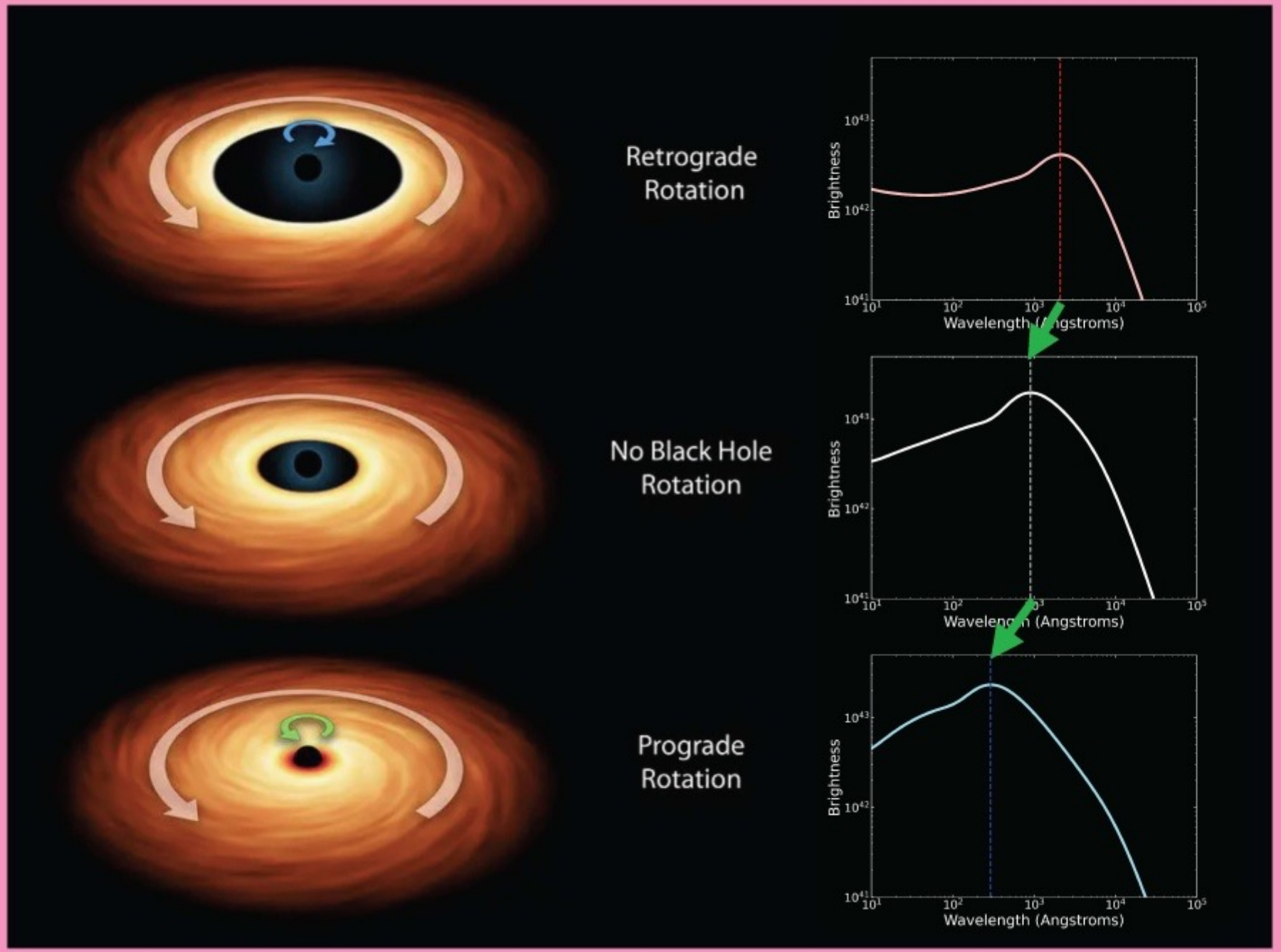


The different ways black holes spin changes the nature of the accretion disk.

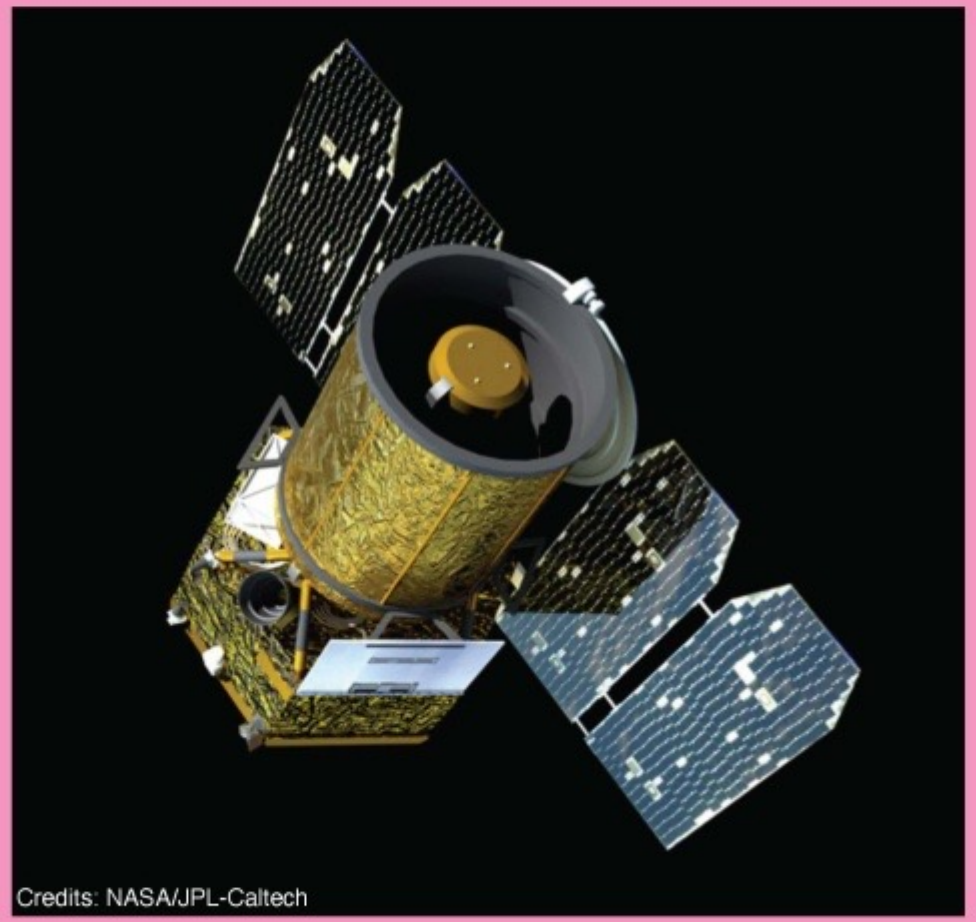


The different ways black holes spin changes the nature of the accretion disk.



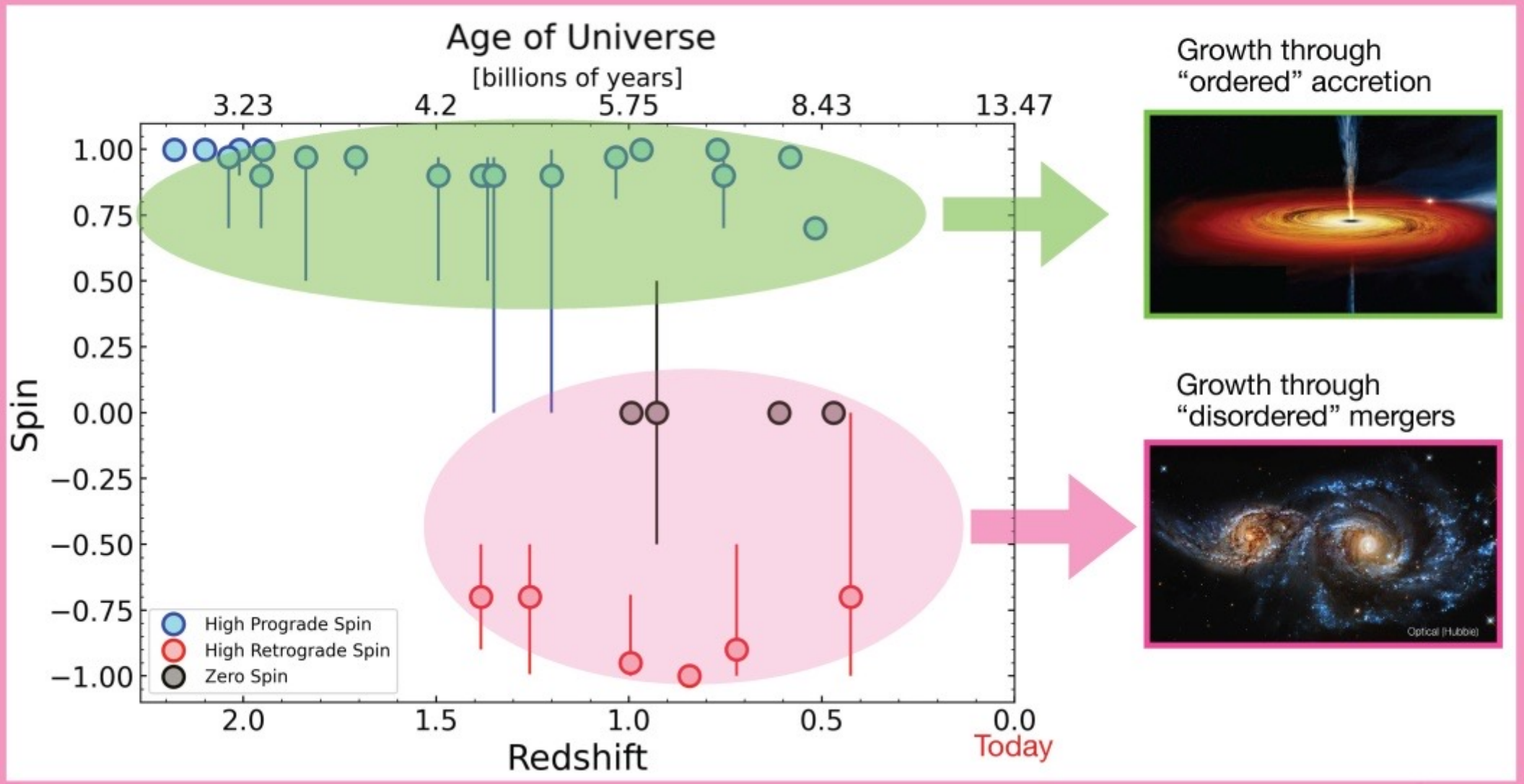

Retrograde Rotation
No Black Hole Rotation
Prograde Rotation
Brightness
Wavelength (Angstroms)

We use the GALEX and Pan-STARRS telescopes.

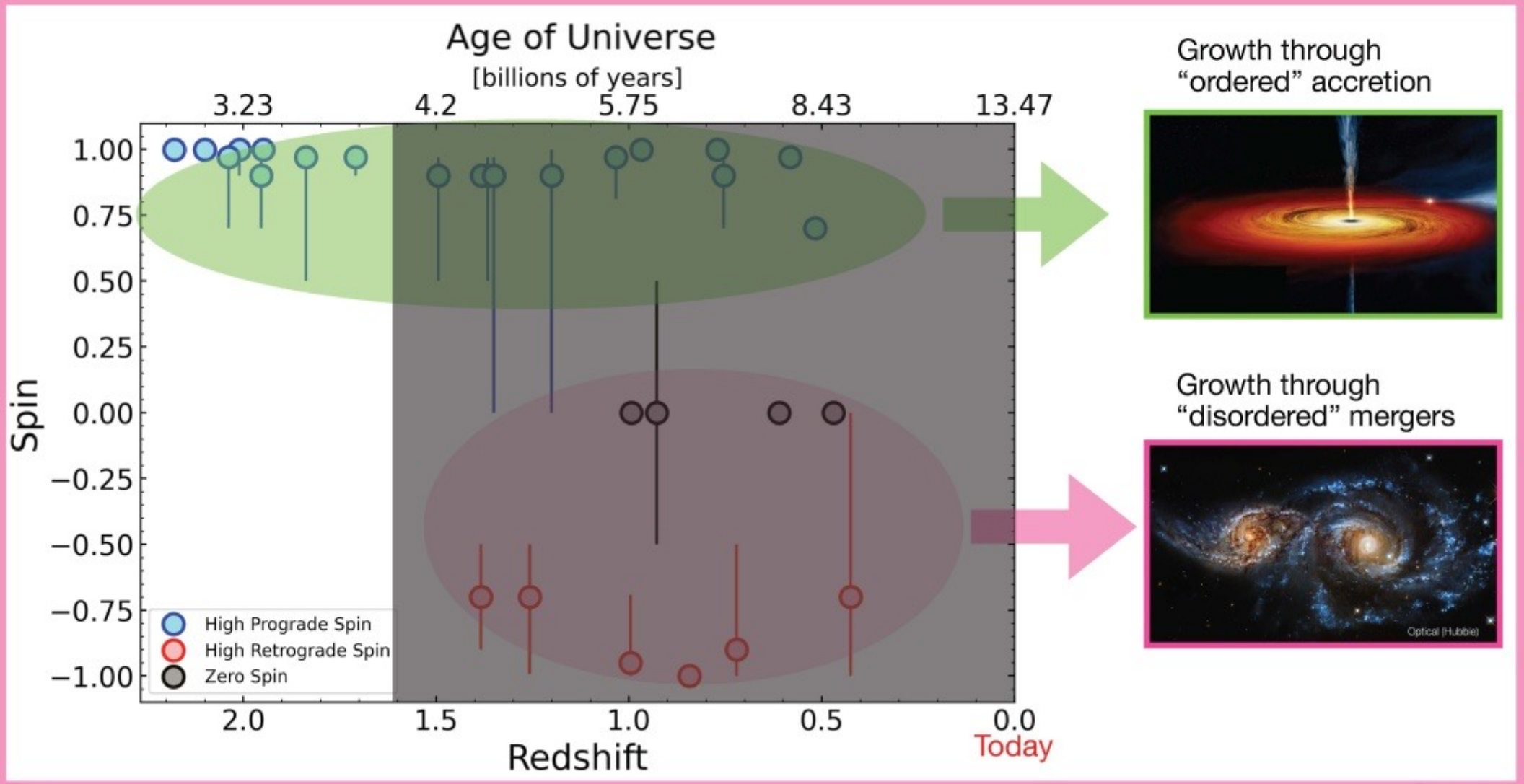

Credits: NASA/JPL-Caltech


Credits: Rob Ratkowski Photography and the Haleakala Amateur Astronomers

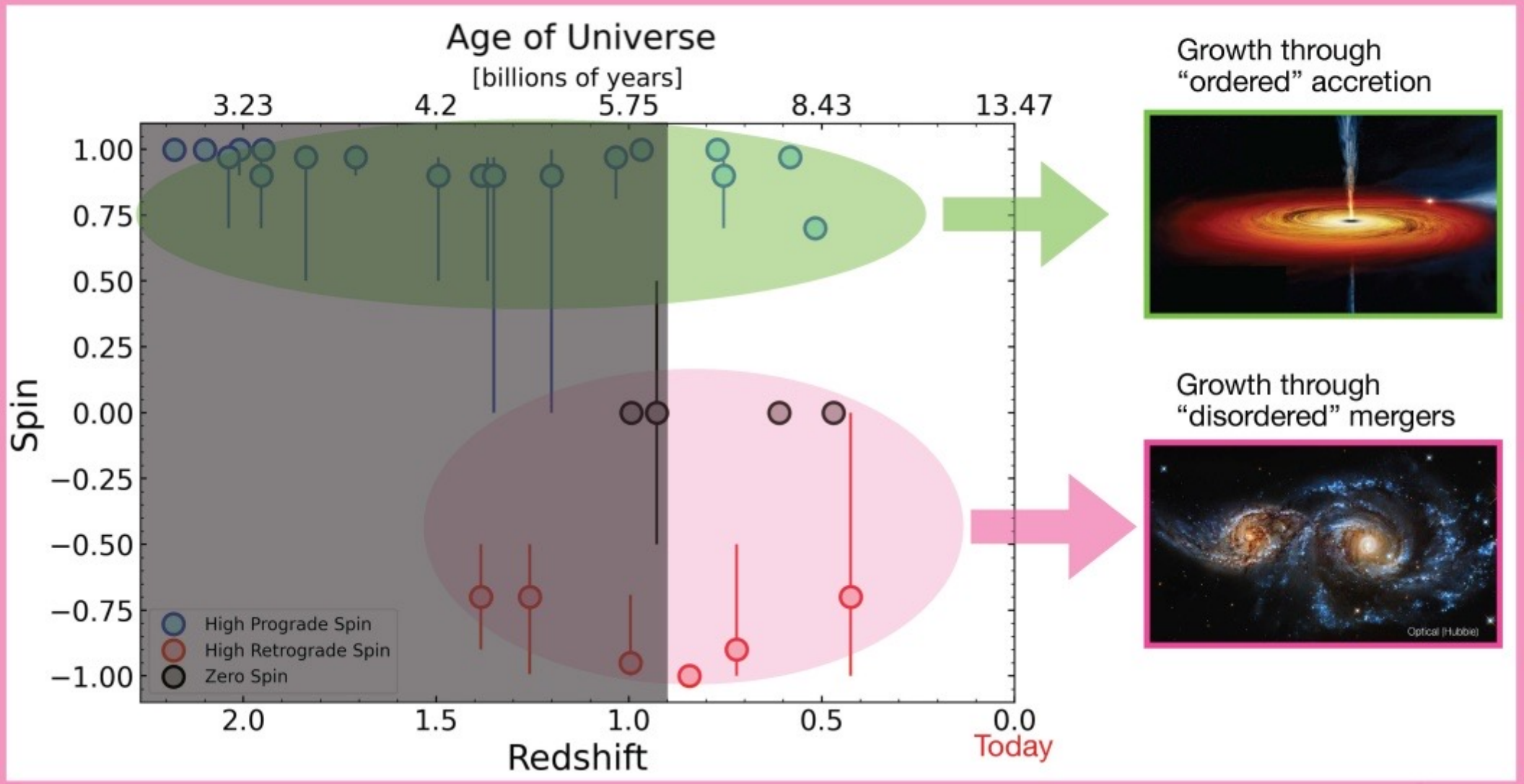
We are finding that ~10 billion years ago, black holes were rapidly spinning.



We are finding that ~10 billion years ago, black holes were rapidly spinning.



We also find a mix of spins in the nearby Universe.



Summary:

1. Black hole spin is a way of archaeologically studying black holes.
2. The black holes from ~10 billion years ago formed through eating things.

Logan Fries

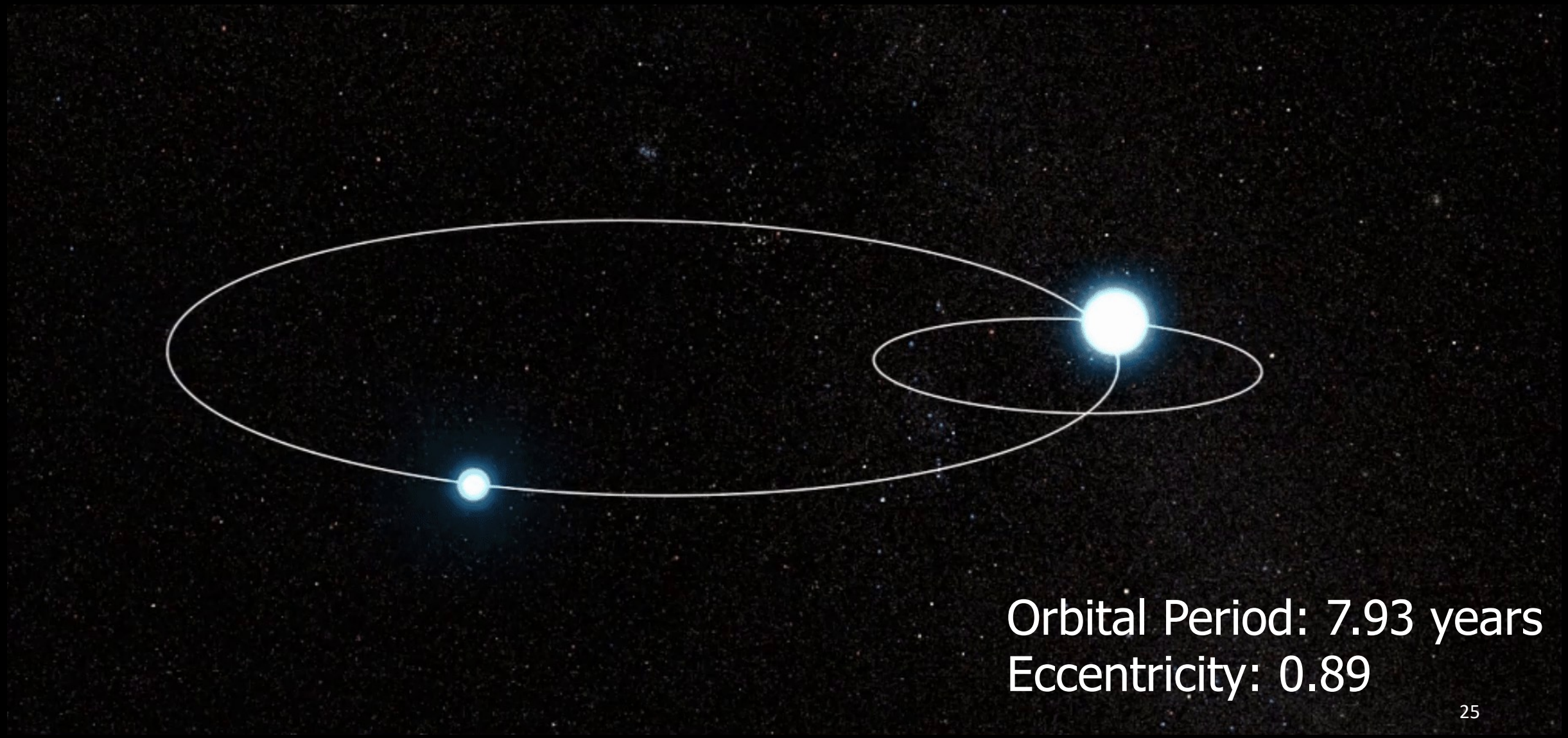
Email: logan.fries@uconn.edu

JWST Tracks the Expanding Dusty Fingerprints of a Massive Binary

Emma P. Lieb[1], Ryan M. Lau[2], Jennifer L. Hoffman[1], WRDustERS Team

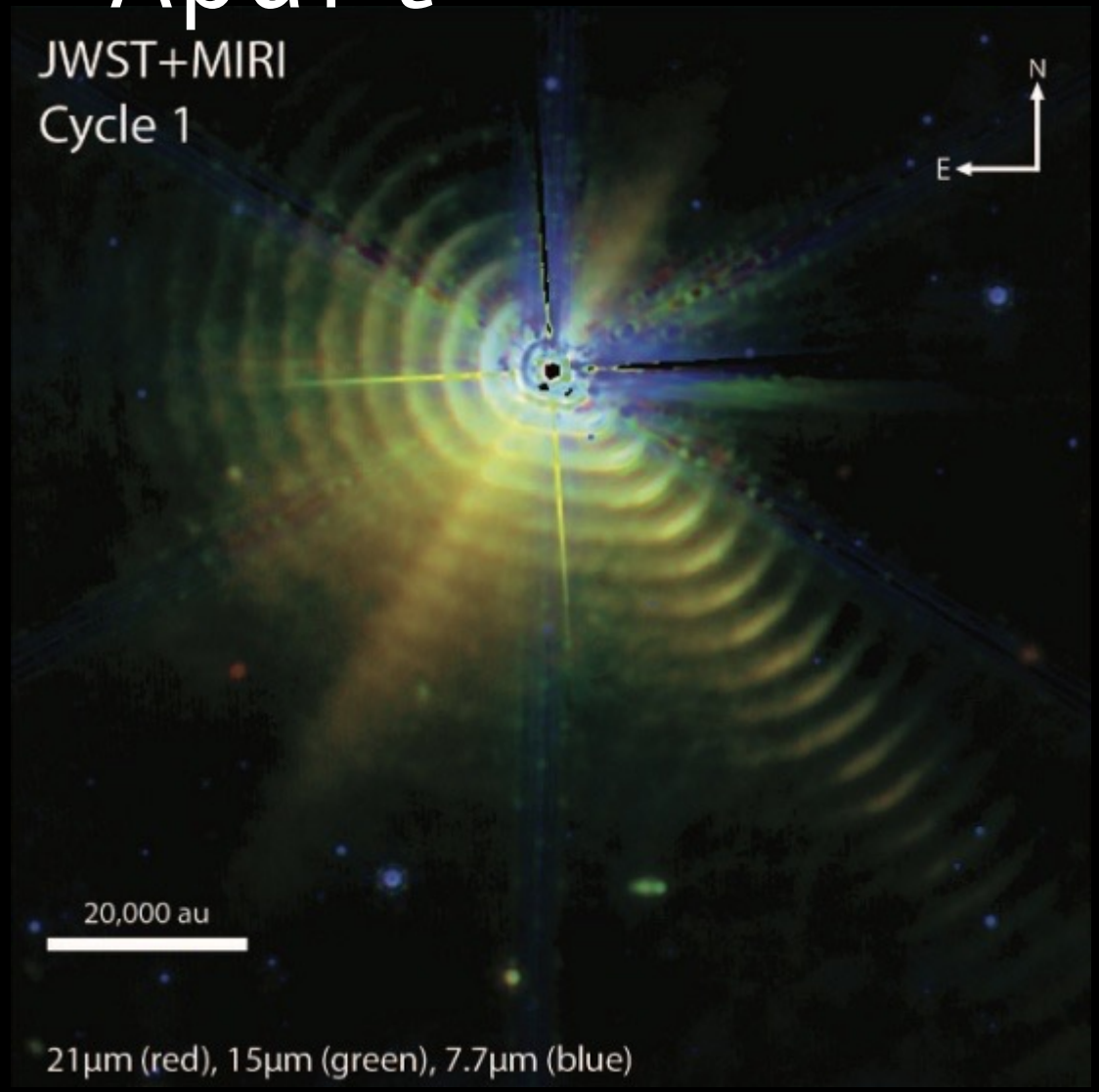
1. University of Denver, 2. NOIRLab

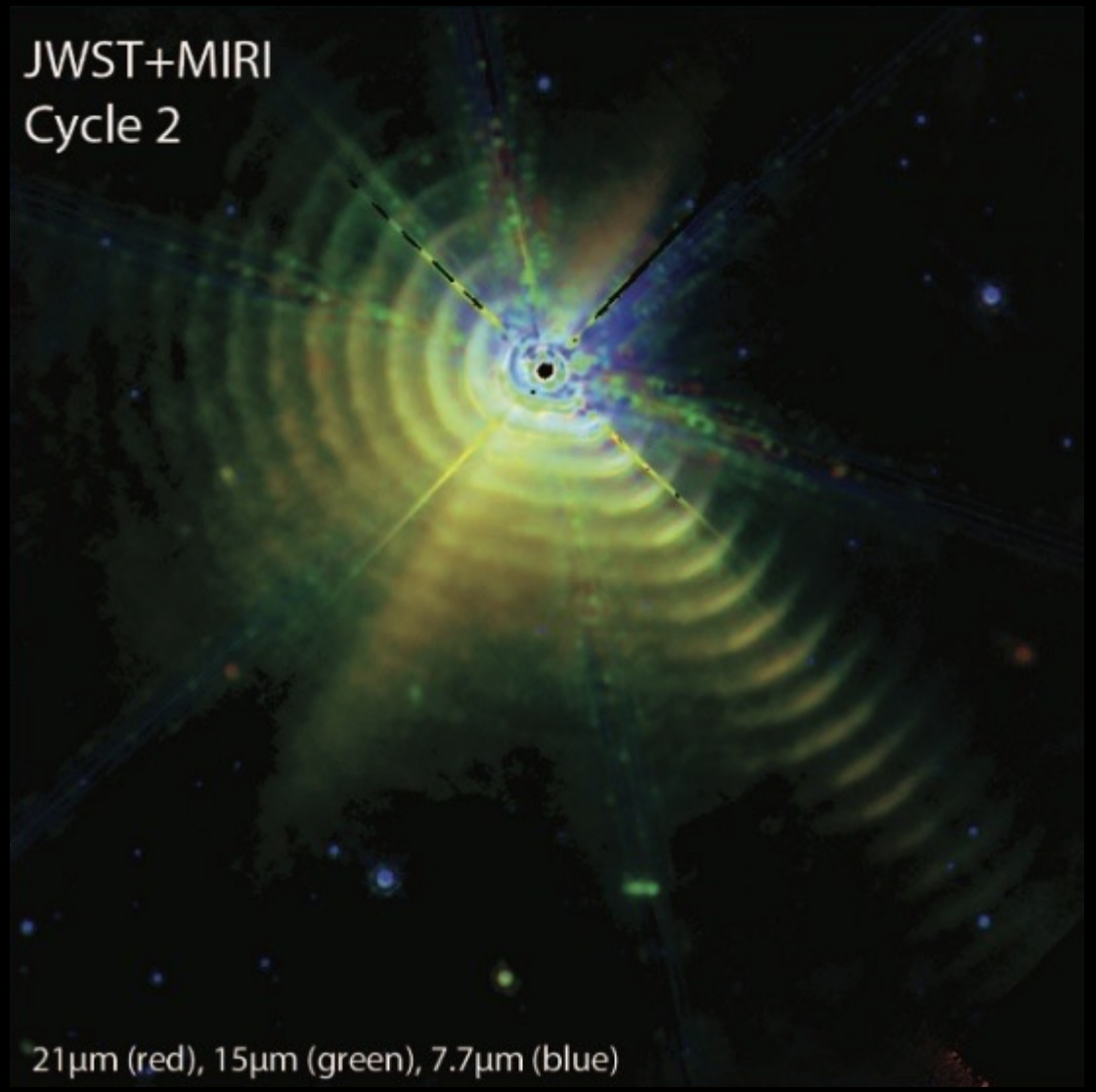
WR140



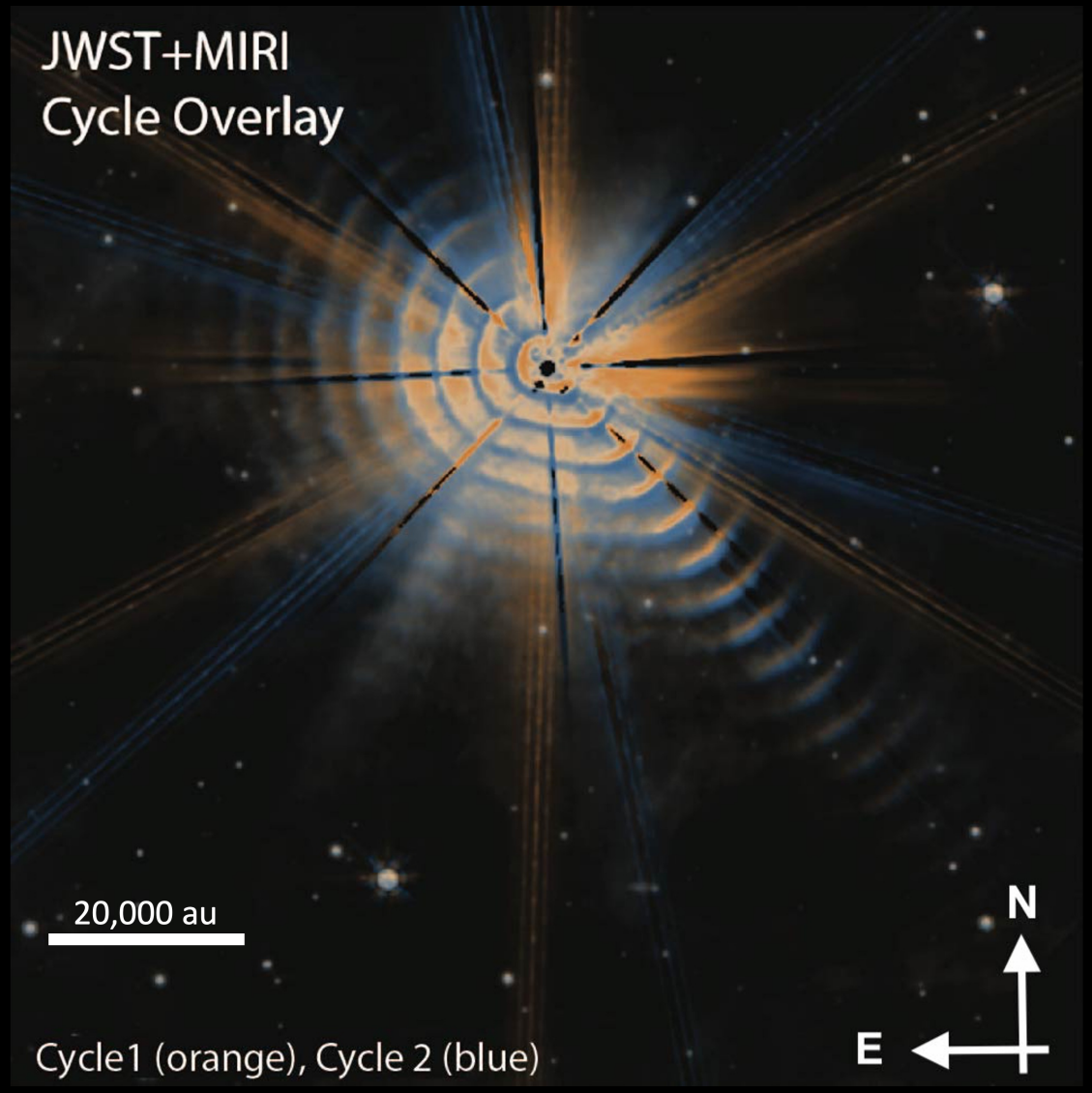
Orbital Period: 7.93 years
Eccentricity: 0.89

Two Observations, One Year Apart

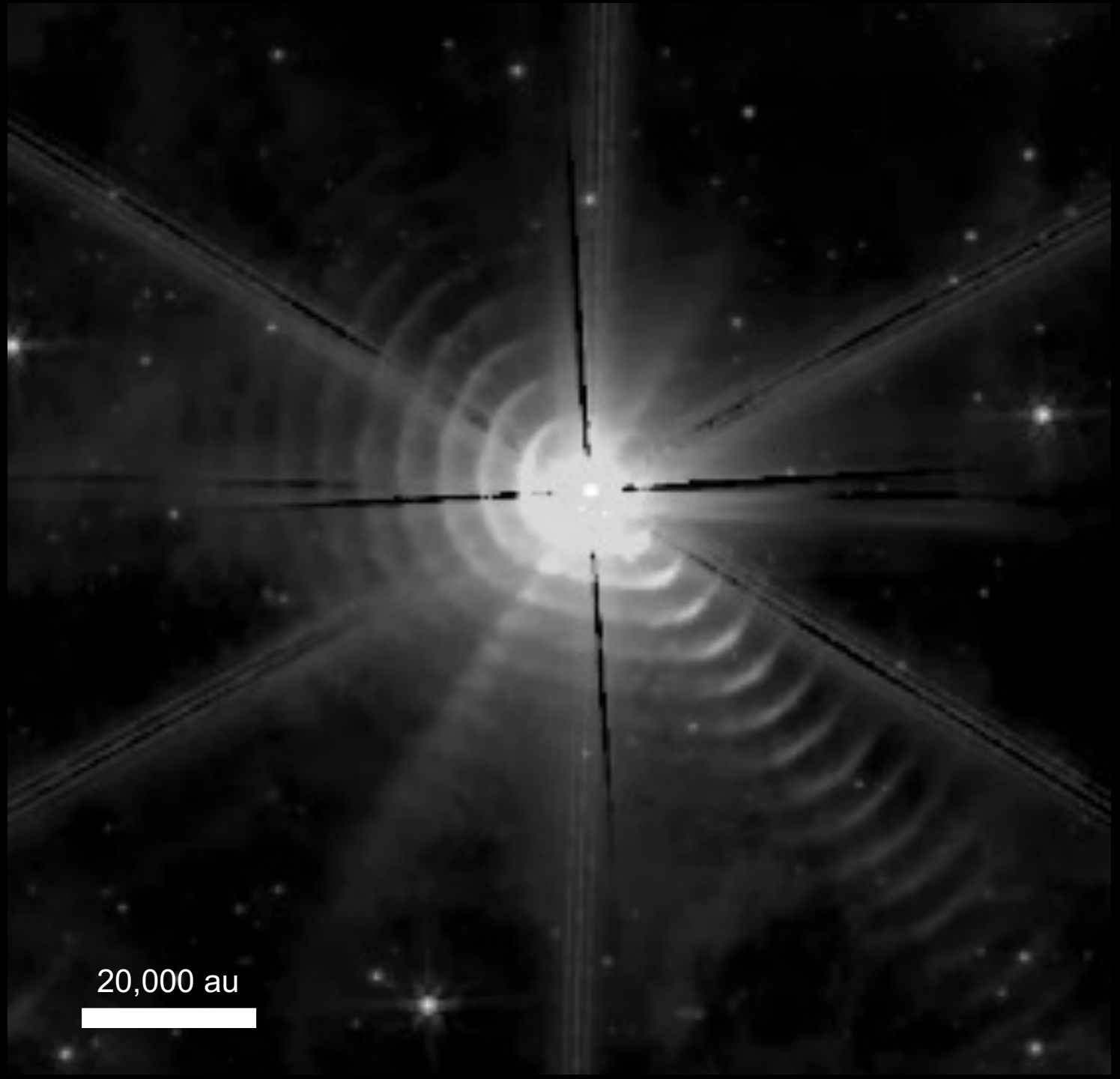


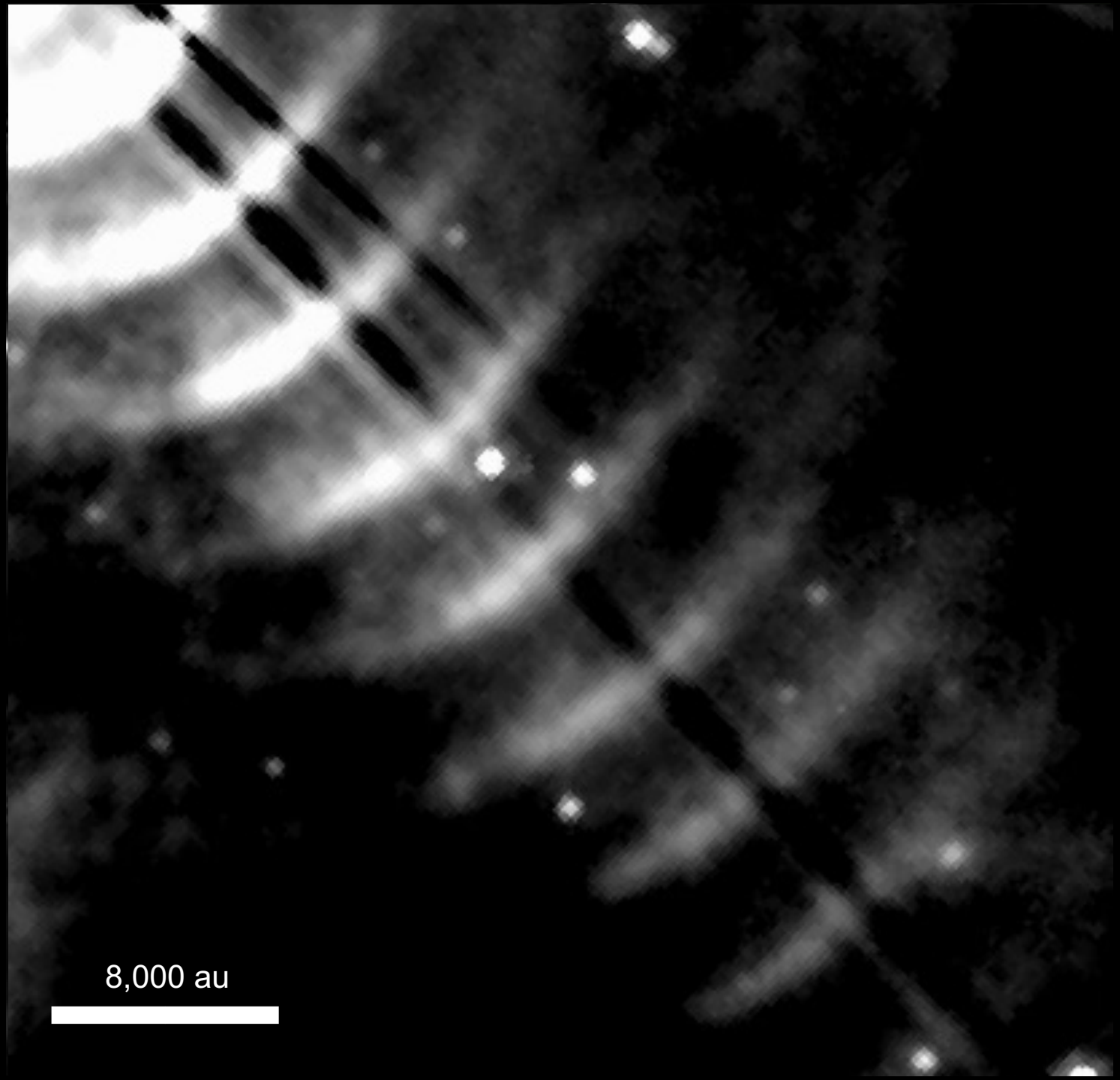


Two Observations, One Year Apart



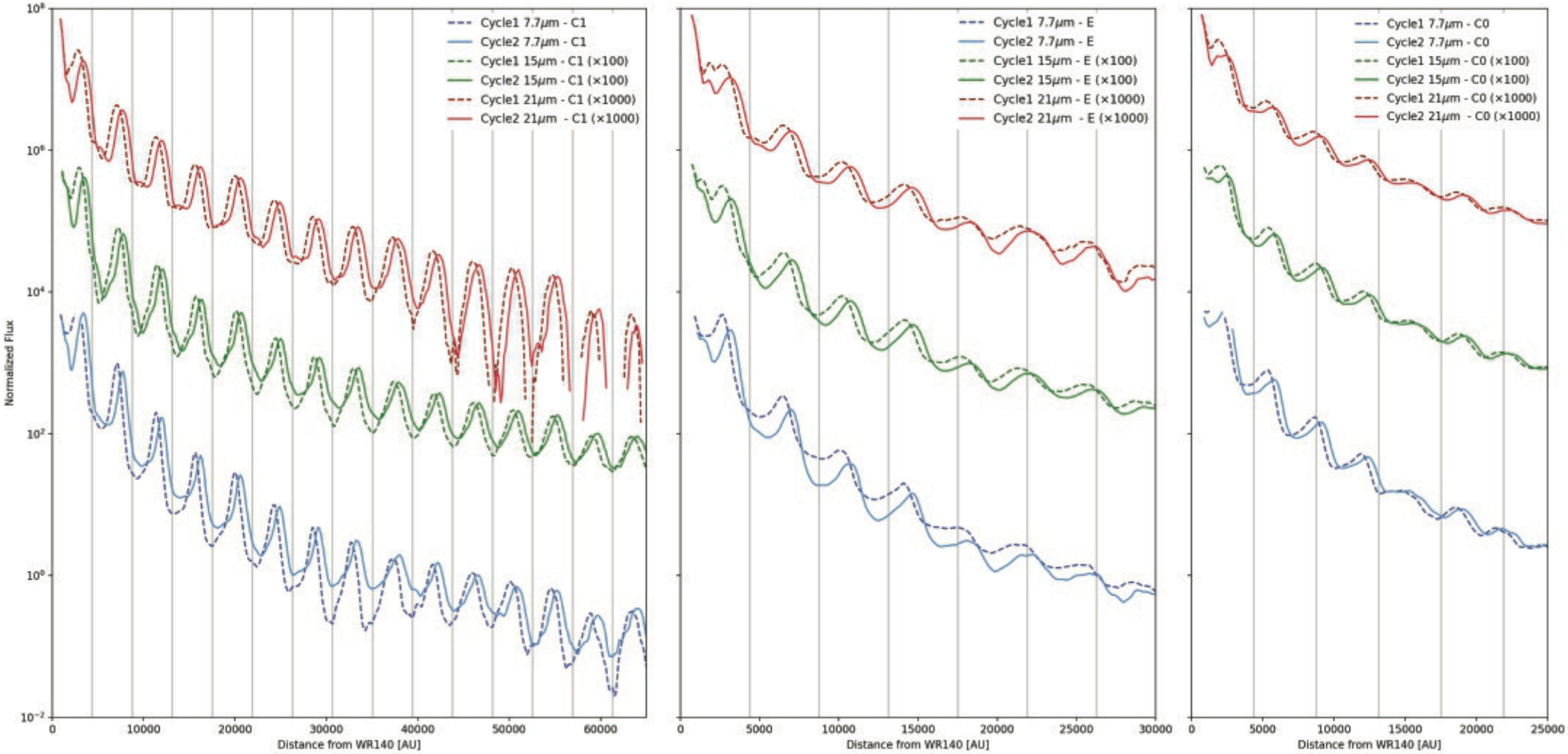
JWST Time Lapse



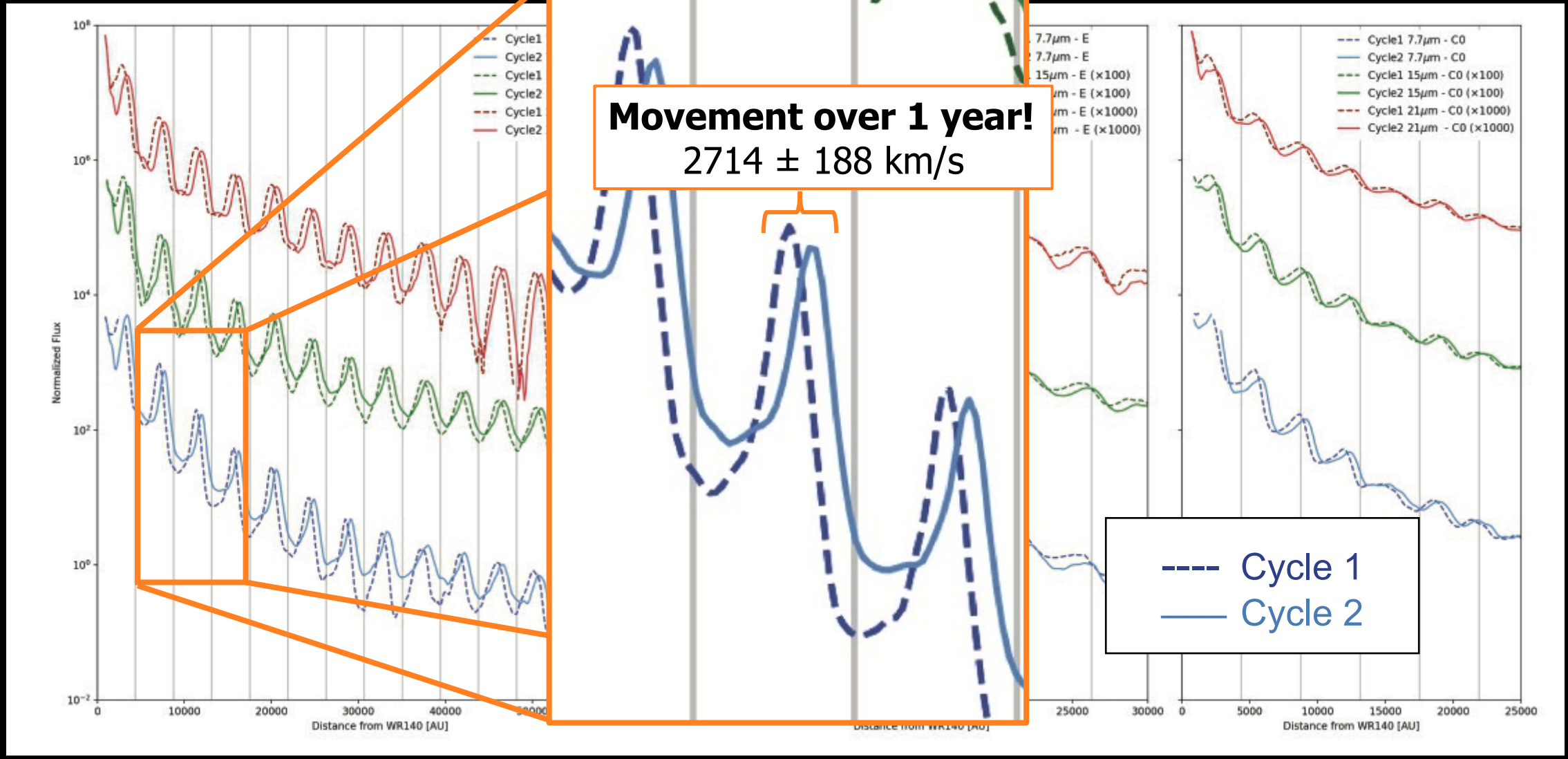


JWST Time Lapse

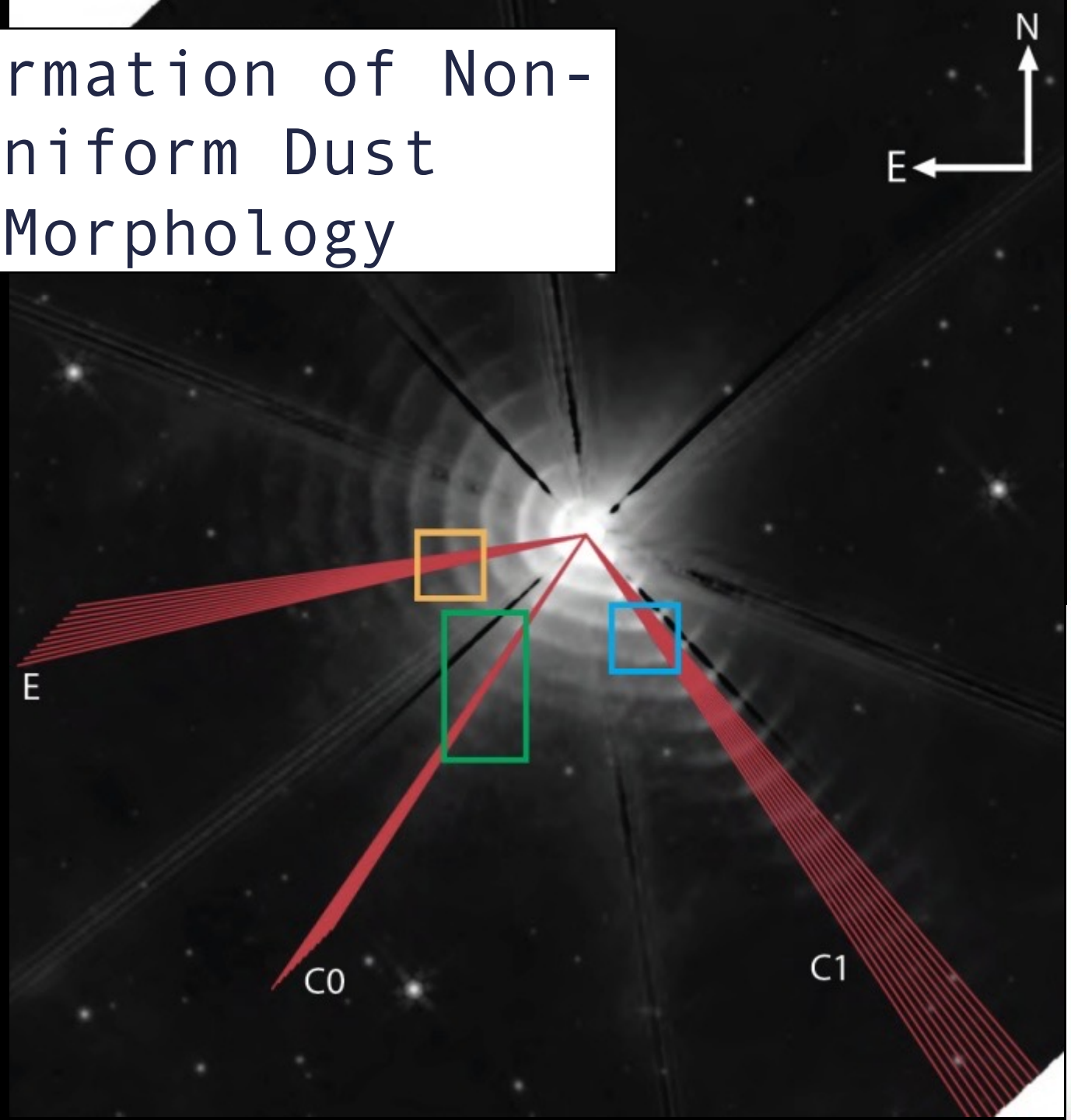
Measuring Proper Motions

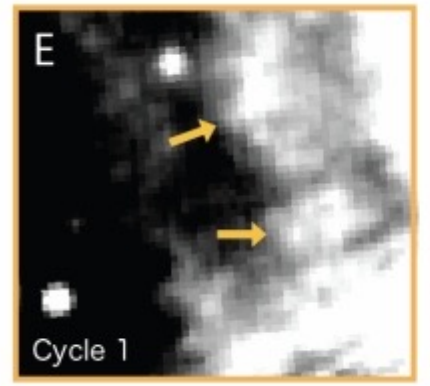


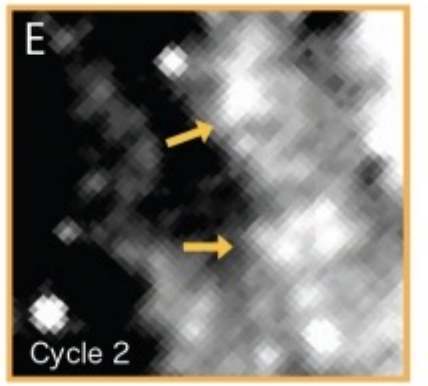
Measuring Proper Motions

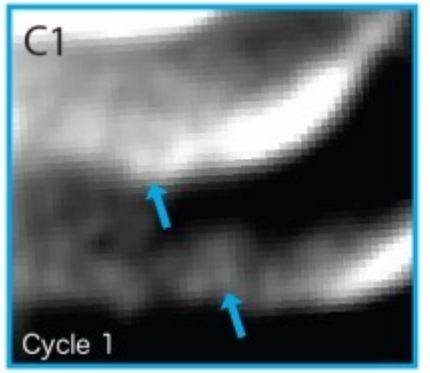


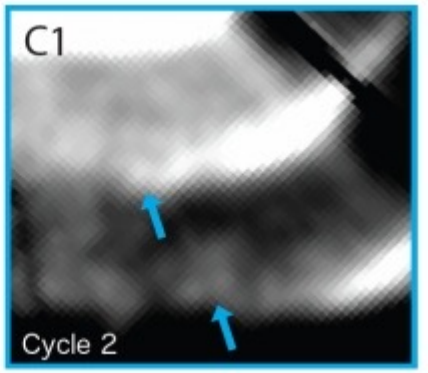
Confirmation of Non-Uniform Dust Morphology

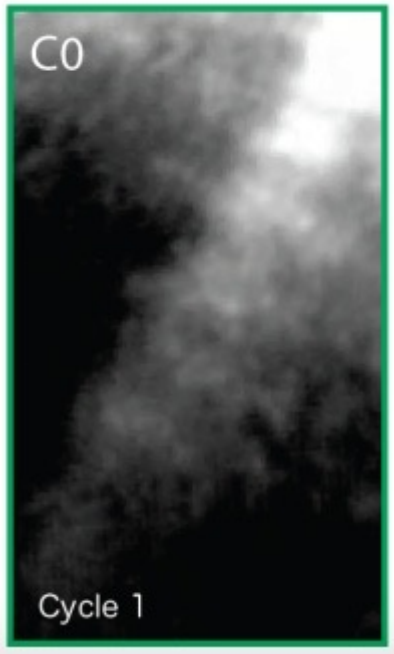






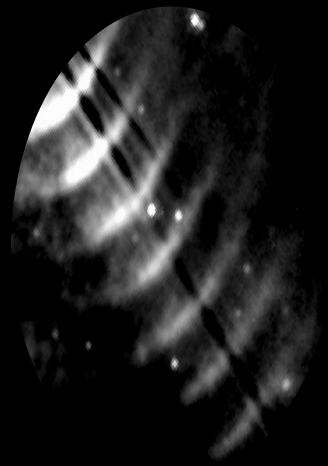








Major Takeaways



WR140's dust is expanding away at almost 1% the speed of light



Irregularities in the dust shells' morphology hints at underlying physical mechanisms for dust formation



WR140 should enrich its local environment with the necessary dust for star and planet formation

Look up here if you get lost!

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

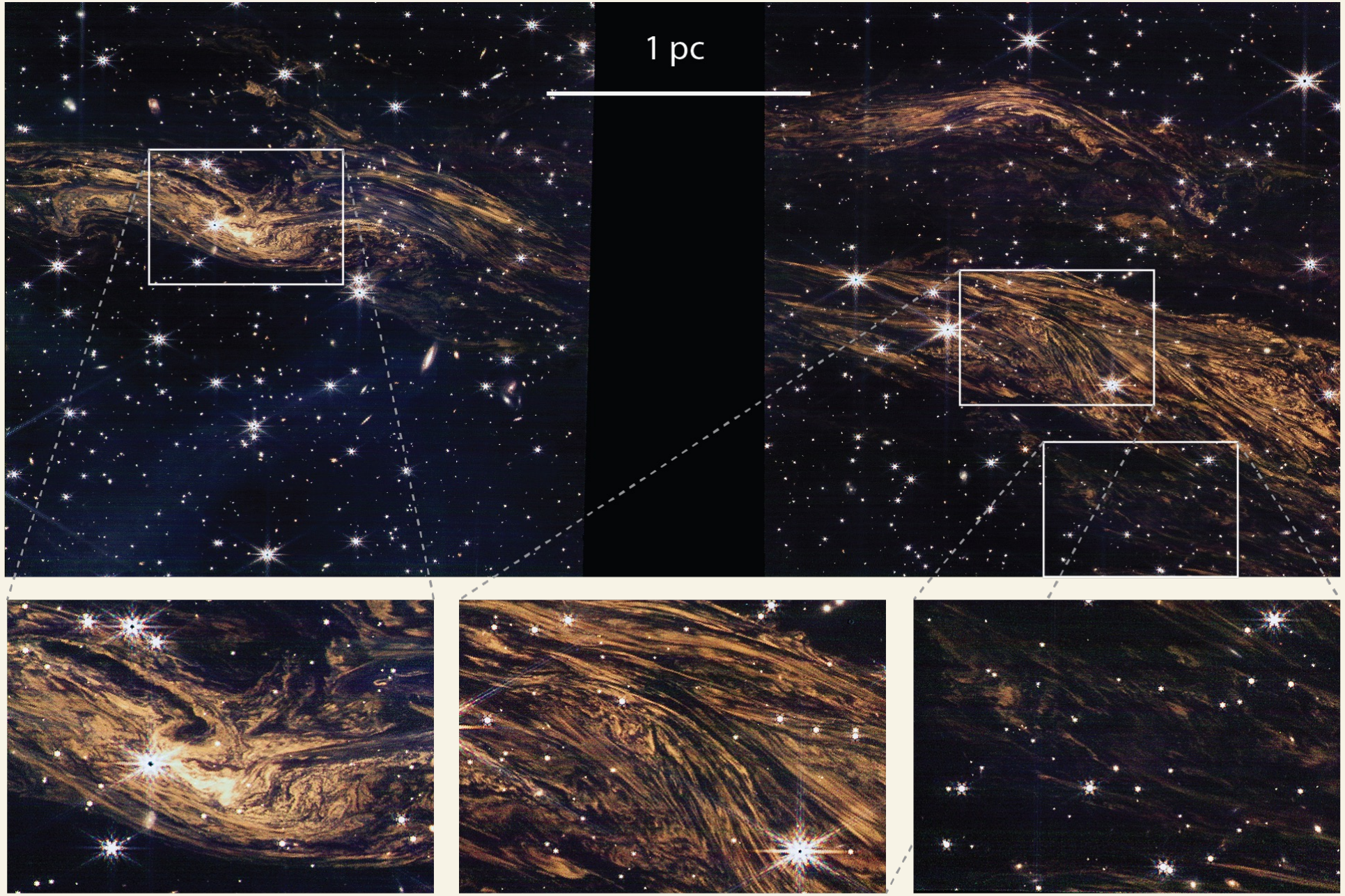
Joshua E. G. Peek w/ Jacob Jencson &

STScI, IPAC

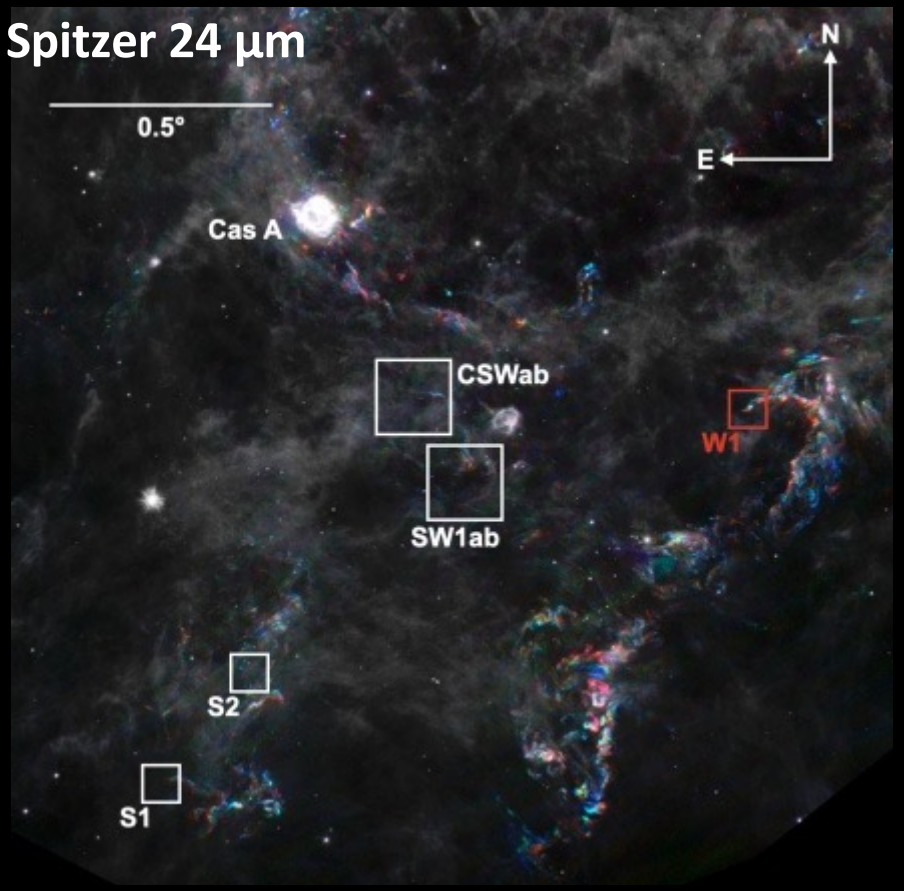
Armin Rest
Space Telescope Science Institute
Christopher Clark
Space Telescope Science Institute
Susan Clark
Stanford University
Drummond Fielding
Cornell University
Karl Gordon
Space Telescope Science Institute
Claire Murray
Space Telescope Science Institute
Pablo Richard
LPENS
Rodrigo Angulo
Johns Hopkins University
Richard Arendt
CRESST/UMBC
Martha Boyer
Space Telescope Science Institute
Kishalay De
MIT
Eli Dwek
NASA Goddard Space Flight Center
Michael Engesser
STScI
Ori Fox
STSci
Sebastian Gomez
STScI/Roman
Charles Kilpatrick
Northwestern University
Dan Milisavljevic
Purdue University, West Lafayette
Karl Misselt
Steward Observatory
Muryel Guolo Pereira
U Federal de Santa Catarina
Justin Pierel
Space Telescope Science Institute
Melissa Shahbandeh
STScI/Roman
Matthew Siebert
Space Telescope Science Institute
Tea Temim
Princeton University
Qinan Wang
Johns Hopkins University
Roger Wesson
Nebulous Research
Yossef Zenati
Johns Hopkins University
Catherine Zucker
CfA / Smithsonian

2025–01–16 *American Astronomical Society*

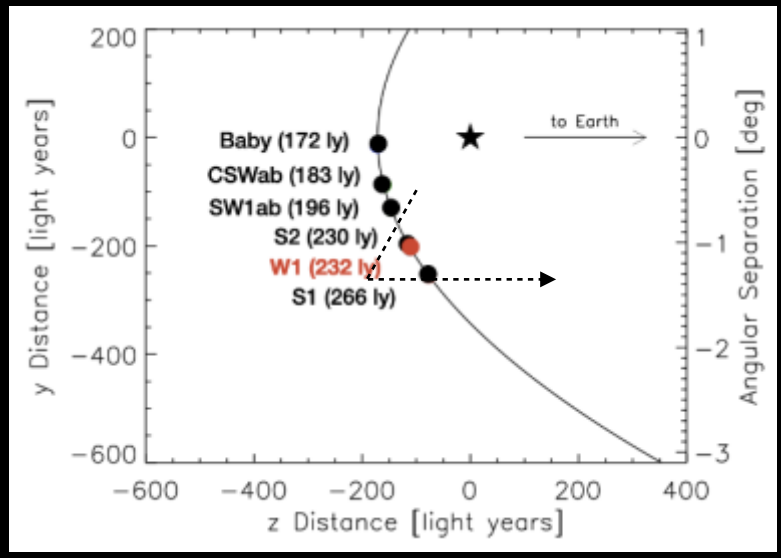
We found something extraordinary in space



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

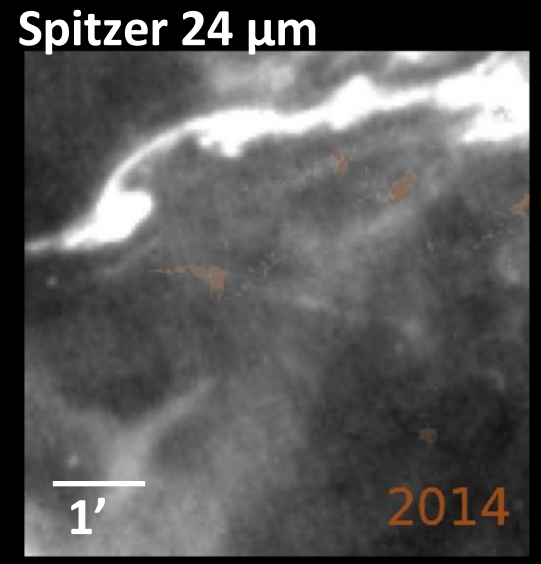


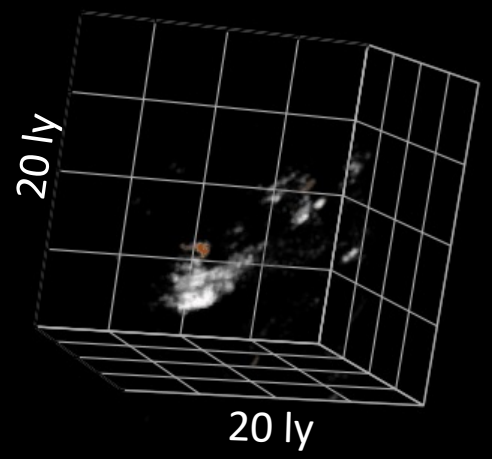
NASA/JPL-Caltech/Y. Kim (Univ. of Arizona/Univ. of Chicago)



- 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





- Short pulse (~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

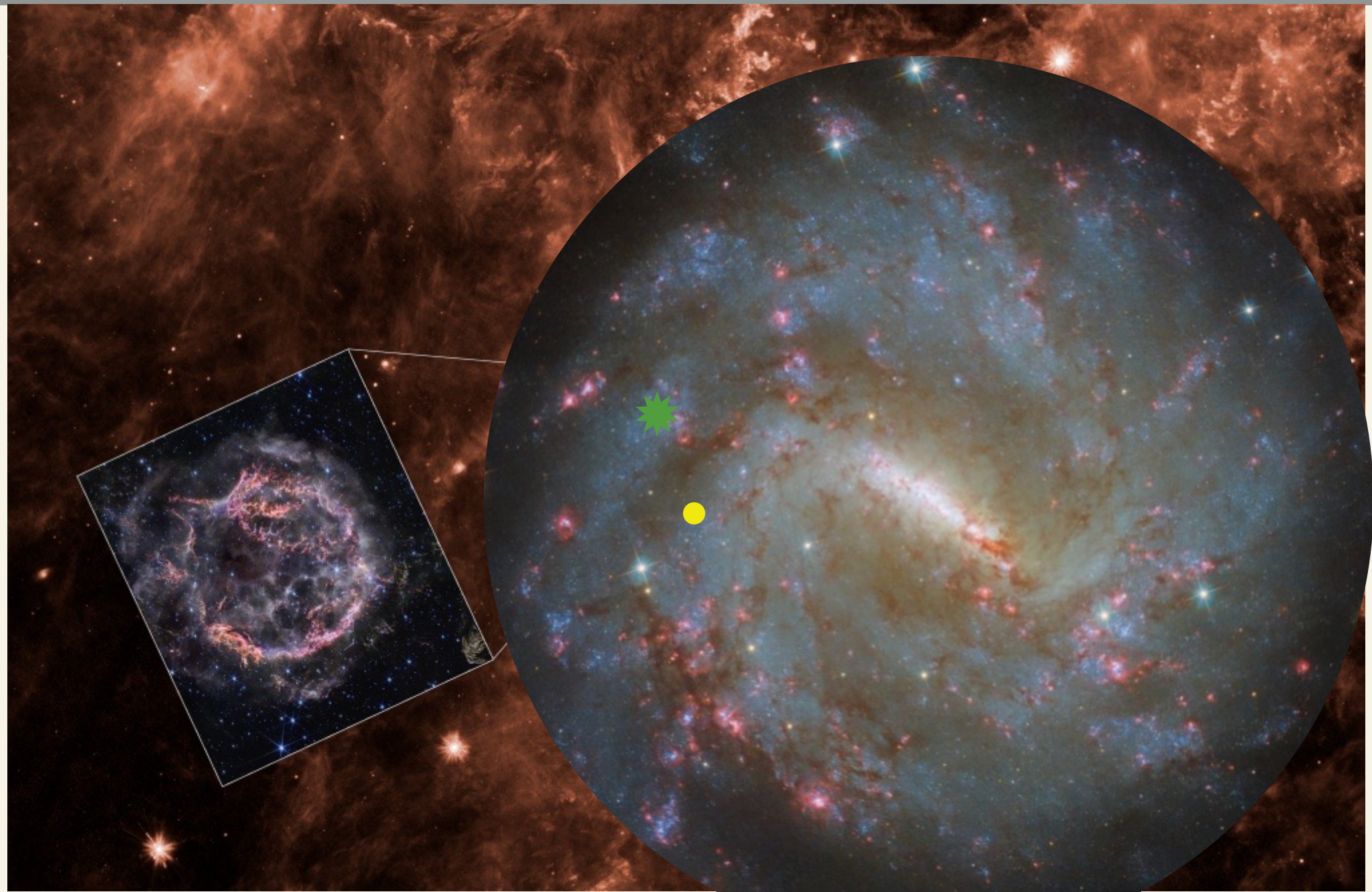




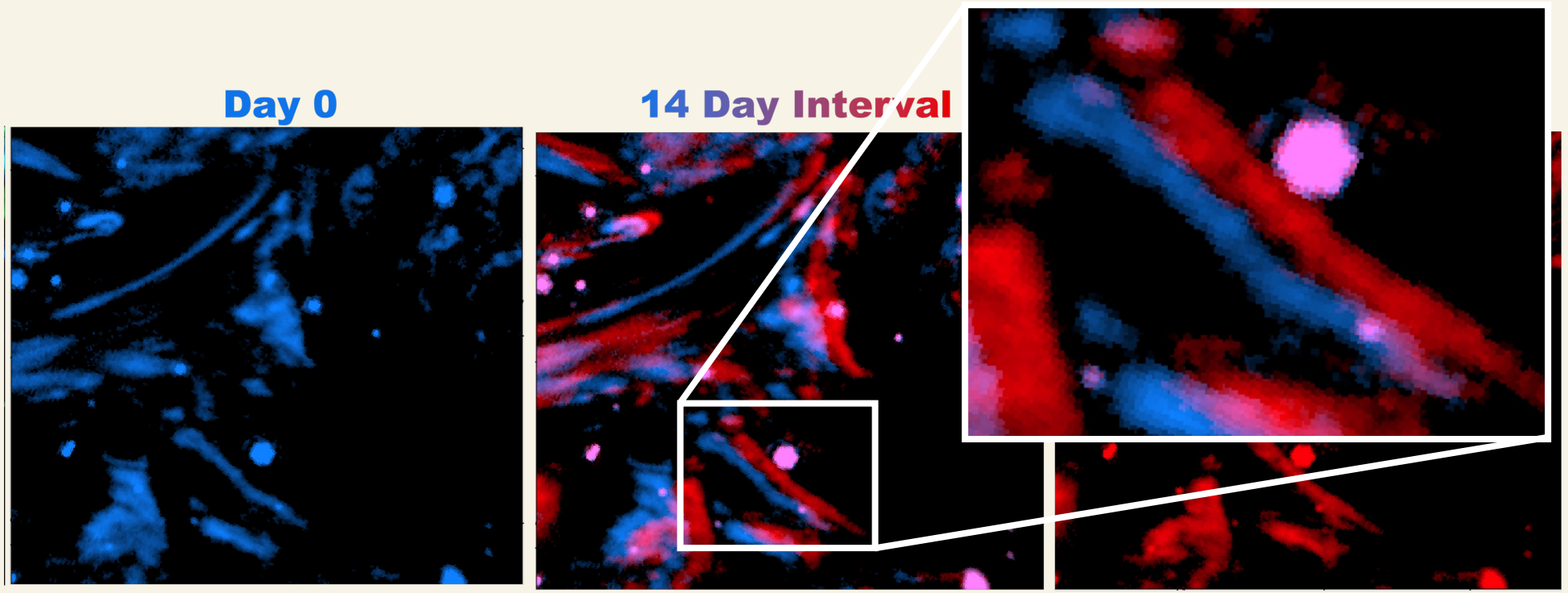




This light echo is probing typical ISM

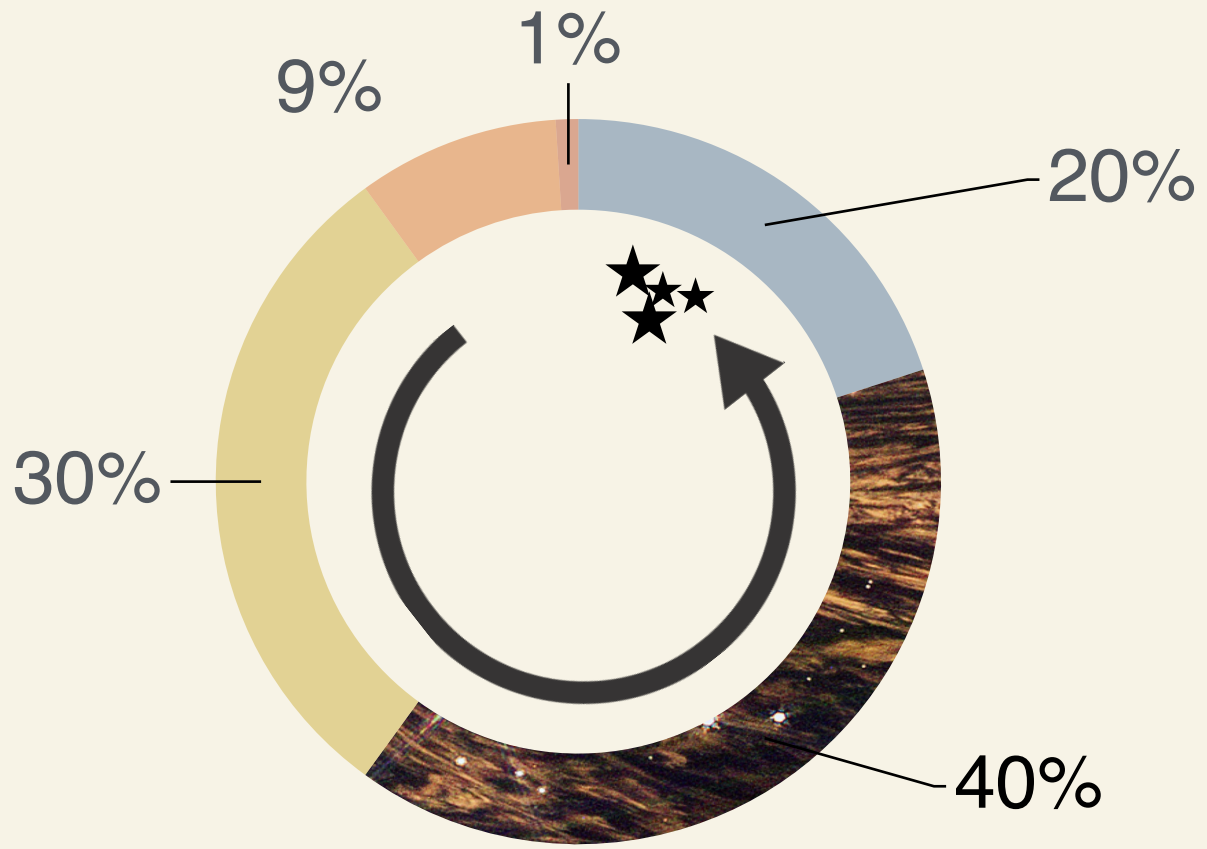


We can limit the length of the light pulse to < 10 days



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

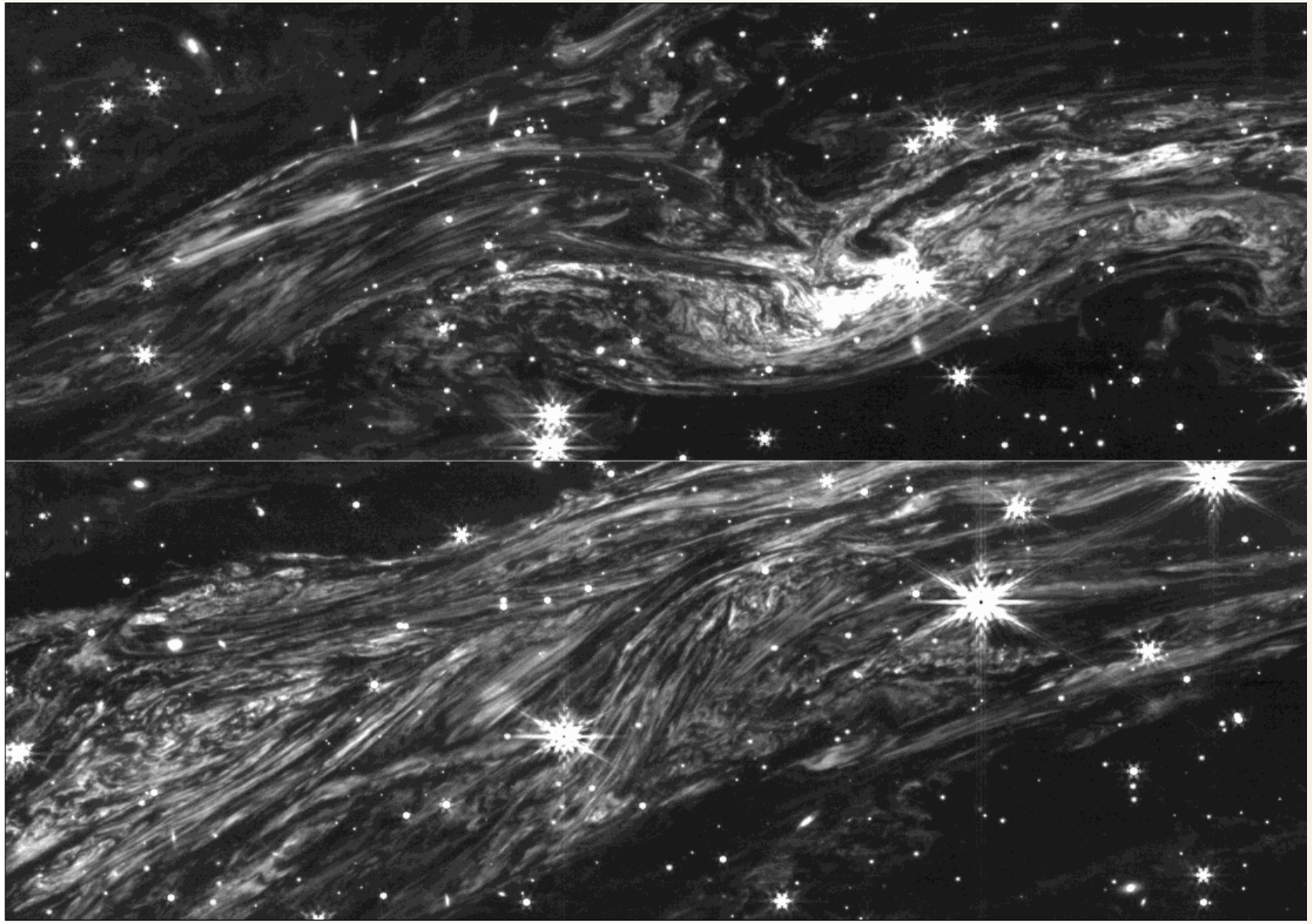
~40% of the gas in the Milky Way looks like this inside!



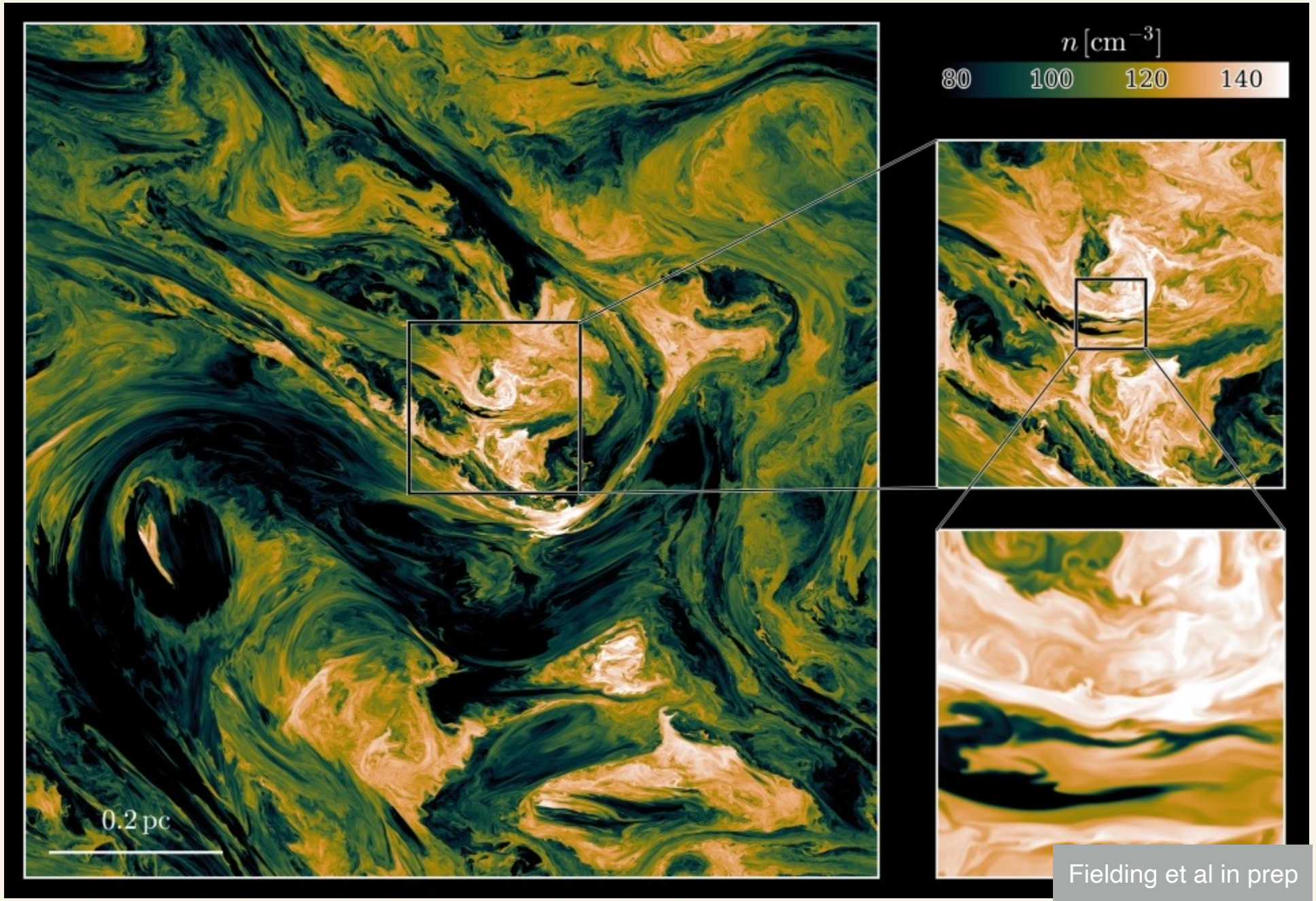
Molecular | Cold Neutral | Warm Neutral | Warm Ionized | Hot Ionized

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



Fielding et al in prep

- A super-bright, super-short burst of UV light created thermal light echoes, illuminating the ISM

- 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.**

Additional Science News from AAS



Meercat - P. Schmidt/Pixabay

Reported by Jim Manning

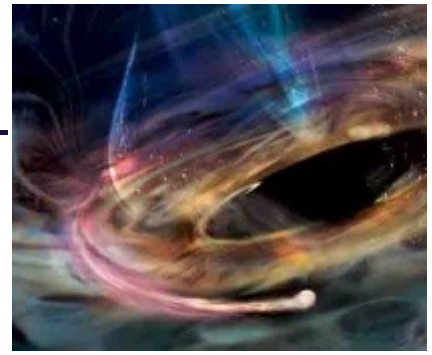


Westerlund 1 – ESA/Webb/NASA/CSA/M. Zamani(ESA/Webb)/M.G. Guarcello(INAF-OAPA)/EWOCS Team

A Feast of Feasting Black Holes

Science Briefing

Meyer – Witnessing the Birth of a New Plasma Jet from a Supermassive Black Hole: a nearby galaxy with a supermassive black hole has launched a radio-emitting double plasma jet at one-third the speed of light; it may be a short-lived jet triggered by a tidal disruption event (like a star being pulled apart by the black hole's tidal force).



NASA/A. Simonnet (Sonoma State University)

Masterson – Rapidly Evolving X-ray Oscillations in the Active Galaxy 1ES 1927+654: rapid X-ray oscillations very near to the galaxy's supermassive black hole might be caused by oscillations in its plasma jets or by a white dwarf orbiting very close to the black hole's event horizon.

Boorman – Uncovering the Dining Habits of Supermassive Black Holes in Our Cosmic Backyard with NuLANDS: a new archival study suggests that 35% of supermassive black holes in the centers of galaxies may be obscured from view by gas and dust, with implications for the true abundance of growing black holes in the universe.

Achenbach – The Discovery of a Newborn Quasar Jet Triggered by a Cosmic Dance: a plasma jet launched from a Quasar (where a feeding supermassive black hole creates a bright, active core) hosted in a spiral galaxy (which is unusual) may have been triggered by an interaction with another galaxy.

Supernovae and Massive Stars

Coulter – JWST Discovery of a Distant Supernova Linked to a Massive Progenitor in the Early Universe: a JWST study has identified one of the most distant supernovas yet noted, exploding when the universe was less than two billion years old—and important step toward finding explosions of the first stars.

Shahbandeh – Core-Collapse Supernovae as Key Dust Producers-–New Insights from JWST: study of a dust-producing supernova suggests this type of stellar explosion may be responsible for much of the dust created in the early universe.

Monsch – Stellar Pyrotechnics on Display in Super Star Cluster: JWST imagery of massive star cluster Westerlund 1 reveals how fierce stellar winds and radiation interact with surrounding material.



D. Capela (U of Lisbon)/M.G. Guarcello (INAF-OAPA)/EWOCS Team

Leiner – A Blue Lurker Emerges from a Triple-System Merger: a star spinning faster than it should at its age may have been sped up mass accretion when its binary companions merged into a single star.

Black Holes & New Outcomes from SDSS

Science Briefing

Marcotulli – A Variable X-Ray Monster at the Epoch of Reionization: the X-ray variability of the most luminous black hole observed at the "Epoch of Reionization," when the energy of the first stars and galaxies reionized the universe's neutral hydrogen less than a billion years after the Big Bang, suggests it is launching plasma jets aimed in our direction. It may provide insights into the contribution of black holes and jets to reionization.

Kocevski – JWST's Little Red Dots and the Rise of Obscured Active Galactic Nuclei in the Early Universe: study of an assembled sample of small, compact red objects that existed in large numbers during the first 1.5 billion years after the Big Bang are likely young galaxies with obscured black holes growing in their centers.

NASA/ESA/CSA/STScI/D. Kocevski (Colby College)



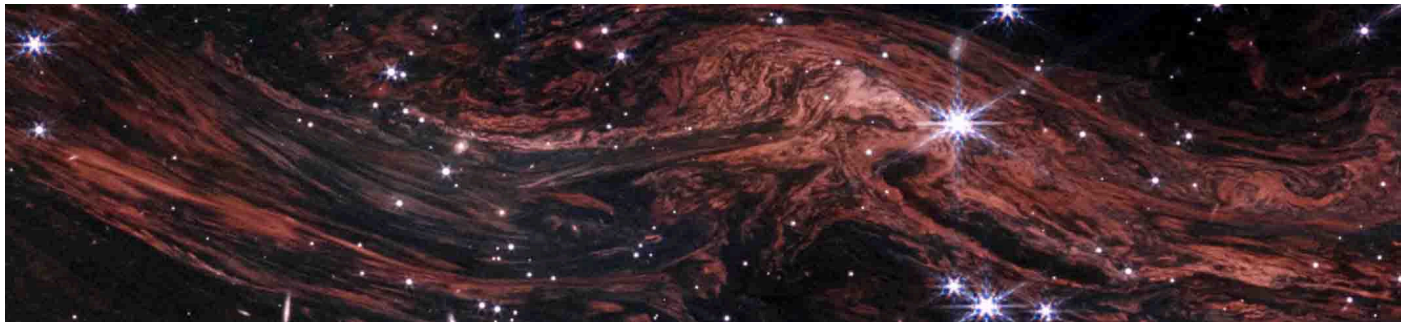
Michail – Revealing the Mid-Infrared Properties of the Milky Way's Supermassive Black Hole: the first detection of a flare in mid-infrared wavelengths from Sgr A*, the supermassive black hole at the center of the Milky Way Galaxy, is consistent with models suggesting they're triggered by energy releases from tangled magnetic field lines in the black hole's surrounding accretion disk.

Krishnarao – The SDSS-V Local Volume Mapper: Early Data and Science: a new robotic telescope array has begun to make a comprehensive map of the interstellar material in our galaxy.

New Info from Milky Way Highlights

Science Briefing

Jencson – Infrared Echoes of Cassiopeia A Reveal the Dynamic Interstellar Medium: the explosive flash of the supernova creating the remnant Cassiopeia A has created "light echoes" in the surrounding interstellar medium as the energy of the explosion propagates through space, warming gas and dust to glow in the infrared and reveal knots, sheets, and clouds likely sculpted by magnetic fields.



NASA/ESA/CAS/STScI/J.Jencsen (Caltech/IPAC)

Kastner – Imaging an Astronomical Icon in 3D—A new View of the Ring Nebula: scientists mapping molecular carbon monoxide gas in three dimensions in the ejected envelope of this famous planetary nebula have determined that the nebula is a barrel-shaped ellipsoid ejected about 6,000 years ago.

Alboslani – X-Ray Echoes from Sgr A* Provide Insight on the 3D Structure of Molecular Clouds in the Galactic Center: scientists have created 3D maps of two molecular clouds in the Milky Way's center by assembling light echoes as X-rays from the central supermassive black hole Sgr A* propagate through the clouds.

Discovering the Universe Beyond Our Galaxy

Science Briefing

Rich – 100 Years Since Hubble Discovered the Universe Beyond our Galaxy: It was 100 years ago this year that Edwin Hubble announced his ground-breaking measurement of the distance to the Andromeda Nebula using Cepheid variable stars, proving that it was very far away and that we lived in a vast universe of galaxies.

Scolnic – The Hubble Tension in Our Own Backyard: scientists have precisely remeasured the distance to the Coma Cluster of galaxies to refine the "distance ladder" used to measure the current expansion rate of the universe locally. The new refinements still show the universe expanding faster than it should be based on initial conditions and our standard model of cosmic evolution.

Habel – JWST Reveals the Early Universe in Our Backyard: scientists studying protostars in a stellar nursery in the relatively metal-poor Small Magellanic Cloud find them enshrouded in the dusty molecules important in planet formation. Used as an analog for protostars in the early metal-poor universe, the implication is that planets could still form early on.

Rupke – Growing in the Wind—Watching a Galaxy Seed Its Environment: scientists studied a galaxy's hot wind pushing out and shredding cool oxygen clouds into surrounding space, and found that the clouds are growing.

Sand – Three Quenched, Faint Dwarf Galaxies—New Probes of Reionization and Stellar Feedback: three isolated white dwarf galaxies containing only ancient stars and no gas are being studied to determine if star formation was abruptly halted when gas was stripped away by high energy photons during the Epoch of Reionization or more gradually by supernovas sweeping away remaining gas.

New findings About Stars Near & Far

Science Briefing

Beck – A Predicted Great Dimming of T Tauri—Has It Begun?: The star T Tauri—the prototype of a young sun-like star--has dimmed in recent years. Study shows that a disk of material surrounding its companion—a binary pair of stars--is beginning to pass in front of T Tauri for an extended period of time.

Nayak - A Super Star Cluster is Born—JWST Reveals Dust and Ice in a Stellar Nursery: a young "super star cluster," a very massive open cluster containing many young massive stars, has been identified and is being studied in the Large Magellanic Cloud. Its central protostars are displaying outflows of dust and gas.

Whitaker - The Discovery of Ancient Relics in a Distant Evolved Galaxy: a galaxy dating from about 2.5 billion years after the Big Bang`` has been found to host a population of globular star clusters in a variety of sizes and ages, possibly assembled by different means. By studying globulars early in the universe's history, we may better understand when and how they form.

Mason – Exploring the Sun's Active Regions in the Moments Before Flares: scientists have studied data from a sample of past solar flares, searching for changes in coronal loops of flaring active regions during the six hours beforehand to look for indicators that might allow prediction of future flares. They found that loops underwent small, rapid changes of brightness most actively one to two hours before the flares, which may relate to small scale changes in these regions.

To Investigate Further . . .

- Check Press Page for press releases and slide sets on completed sessions:

Press Information 245th Meeting

- View livestreams of press conferences archived at the AAS Press Office You Tube Channel:

AAS Press Office

- Access the AAS Astronomy-in-the-News page for press releases:

Astronomy in the News



NASA/ESA/CSA/Z.Levay

Additional Background Resources

Science Briefing

BLACK HOLES

Science Briefing: Black Holes, Out of the Shadows

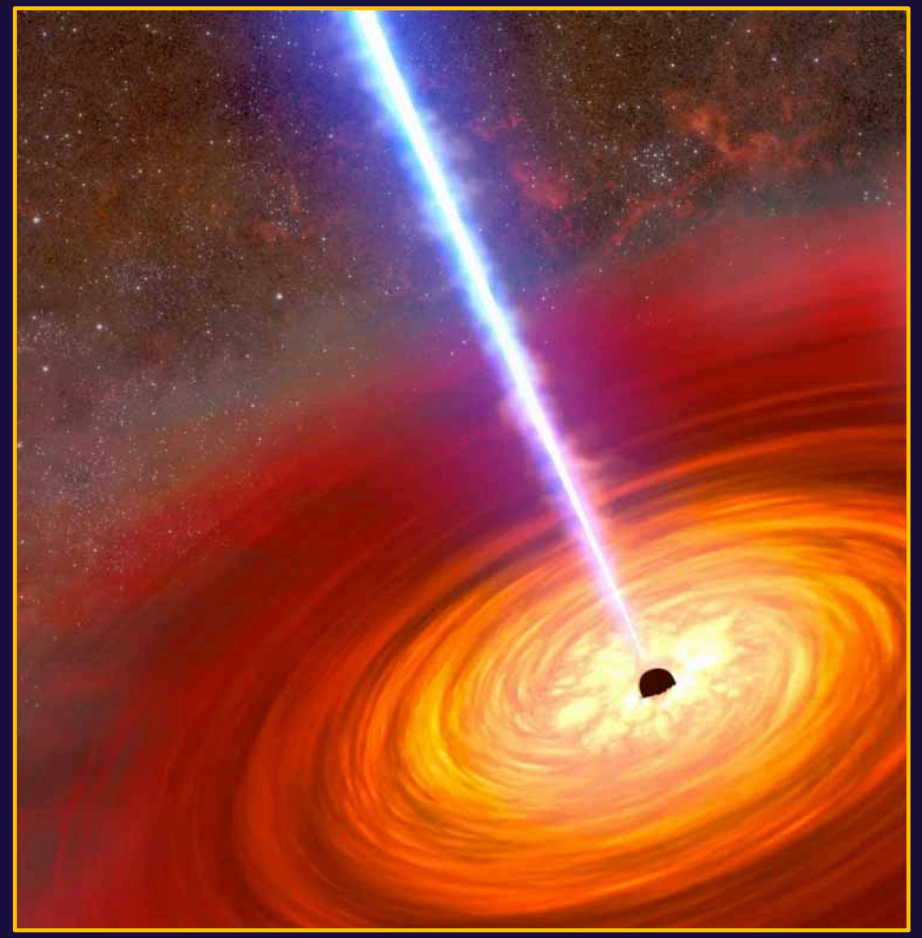
(Includes an extensive list of varied resources.)

Black Hole Basics

(Introductory information.)

Black Holes

(Introductory information and news links.)



NASA,ESA, J Olmstead (STScI)

Additional Background Resources

CASSIOPEIA A/INTERSTELLAR MEDIUM

Cassiopeia A Resources

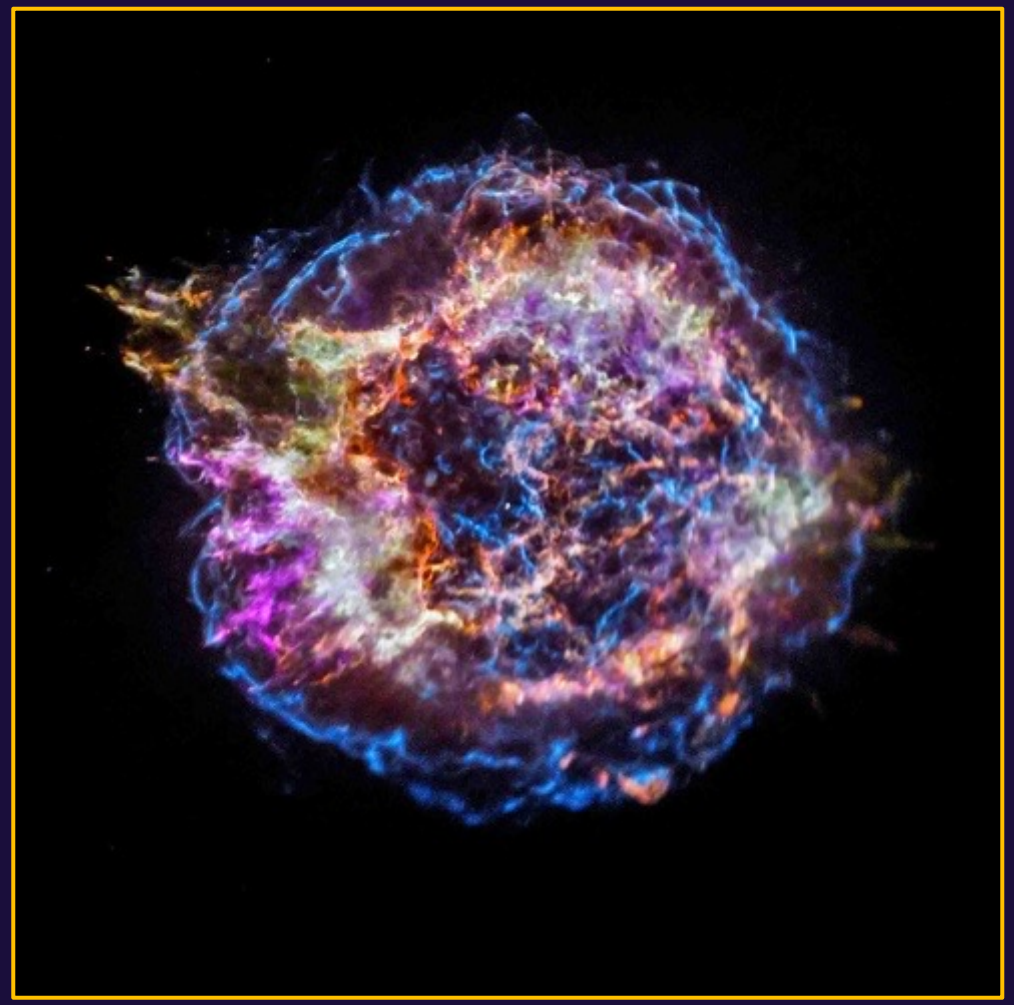
(Includes a variety)

Interstellar Medium and Molecular Clouds

(Introductory information, related news)

Interstellar Medium

(Introduction)



NASA/CXC/SAO

Additional Background Resources

BINARIES/COSMIC DUST

Dancing Stars: Binary Star Systems in the Classroom

(Information plus educational resource links)

Wolf-Rayet Stars

(Description)

Dust in the Stellar Wind: A Cosmological Primer

(Introductory information)



ESA/Hubble/NASA/J. Schmidt

NASA/JPL-Caltech

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