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EVERYTHING WE KNOW ABOUT

THE SUN

PLUS:

THE STARMUS FESTIVAL ROCKS SLOVAKIA

WEBB UNLOCKS STARBIRTH IN SERPENS

BEHIND THE SCENES AT A ROCKET LAUNCH

WHAT CAUSES RAINBOWS AND MOONBOWS?

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WHERE THE (PROTO)STA

JWST discovers embryonic stars that retain the spin of their natal interstellar cloud. BY RICHARD TALCOTT

SOMETIMES THEORY DOESN'T STAND UP TO observational scrutiny. The steady state model ended up on the ash heap of history when astronomers saw evidence that the cosmos is expanding. And the discovery that a mysterious force dubbed dark energy accelerates that expansion threw a monkey wrench into the idea that gravity alone shapes the universe's large-scale structure.

Yet theorists often hit the nail on the head. The latest example comes from the James Webb Space Telescope (JWST) and its deep image of the Serpens Nebula. Astronomers found 20 protostars there with their spin axes closely aligned, suggesting that they all formed at about the same time with the same spin that they inherited from a single filament of interstellar material.

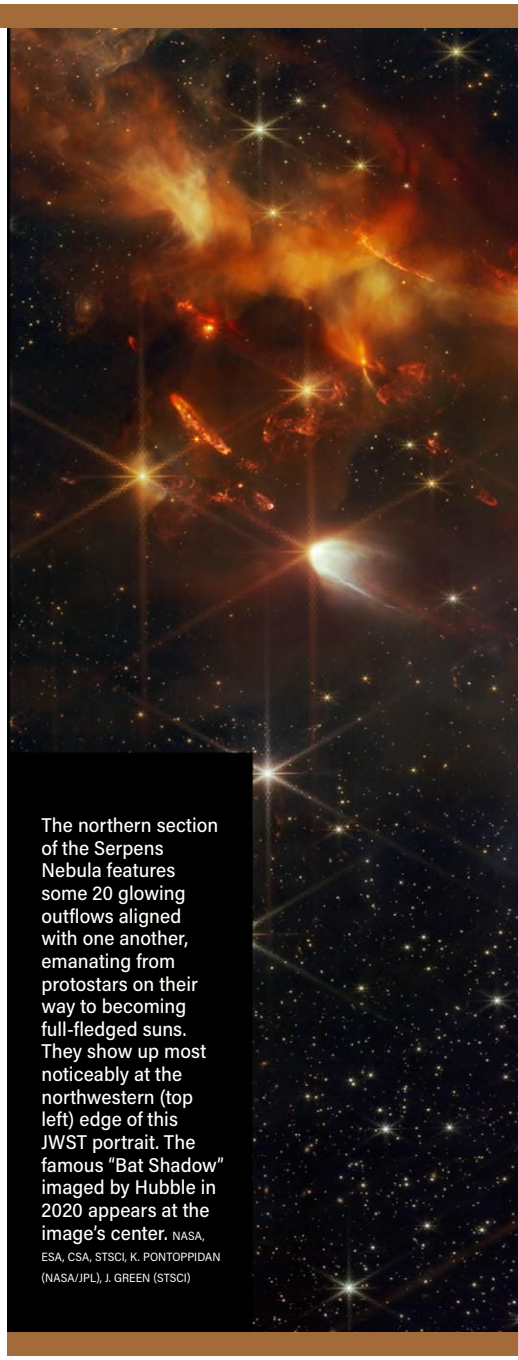
GOING WITH THE FLOW

The Serpens Nebula lies about 1,300 light-years from Earth, making it one of the nearest regions of star formation. It began to coalesce 1 million to 2 million years ago and harbors a 100,000-year-old cluster of still-forming stars. The stellar grouping appears at the center of this JWST image, which encompasses the nebula's richer northern section. Most of the embryonic stars in this region should grow into objects with the mass of the Sun or smaller.

JWST's unique combination of high resolution and sensitivity to near-infrared radiation allows it to penetrate the nebula's thick dust and see these protostars. "Webb is a young-stellar-object-finding machine," said Joel Green of the Space Telescope Science Institute in Baltimore in a press release. The lead author of a paper set to appear in *The Astrophysical Journal*, Green added, "In this field, we pick up signposts of every single young star, down to the lowest-mass [ones]."

These signposts appear as glowing outflows. In the early stages of a star's formation, matter falls toward the stellar embryo, causing it to spin faster. For gas to continue accumulating, the budding star must get rid of angular momentum. An accretion disk forms that lets material flow onto the growing sun like water circling a drain.

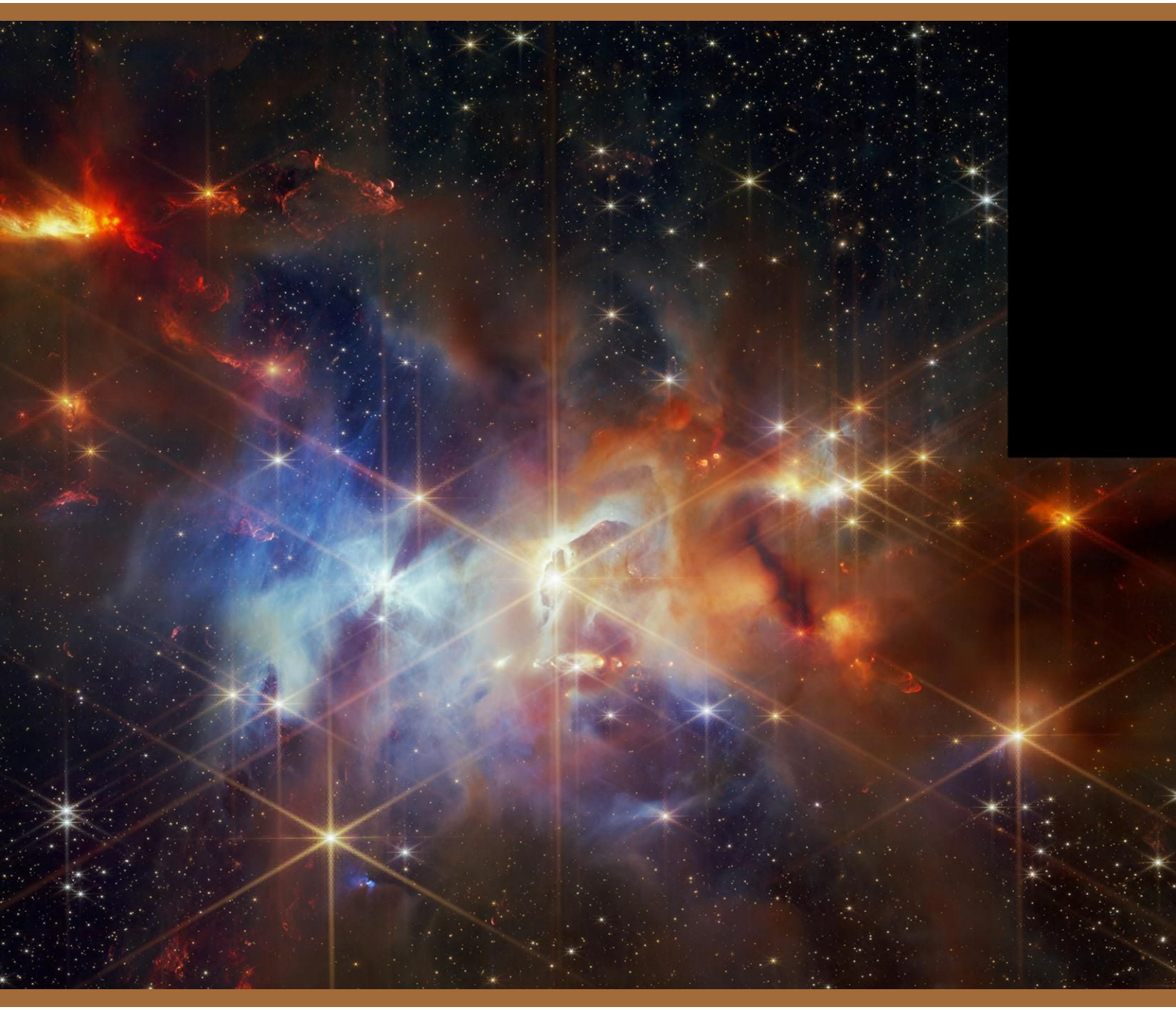
Magnetic fields in the inner part of the disk hurl some of the infalling matter into jets aligned with the protostar's spin axis and thus perpendicular to the disk. Moving at hundreds of thousands of miles per hour, the jets smash into clumps of surrounding gas, causing the molecular hydrogen and carbon monoxide there to glow.



The northern section of the Serpens Nebula features some 20 glowing outflows aligned with one another, emanating from protostars on their way to becoming full-fledged suns. They show up most noticeably at the northwestern (top left) edge of this JWST portrait. The famous "Bat Shadow" imaged by Hubble in 2020 appears at the image's center. NASA, ESA, CSA, STSCI, K. PONTOPPIDAN (NASA/JPL), J. GREEN (STSCI)

A STELLAR ALIGNMENT

If you look closely at the northwestern edge (top left) of the image, you'll see these glowing streaks have similar orientations, angling from upper left to lower right. They all fall within 24° of the long axis of the Serpens filament from which they



formed. The researchers estimate the chances of such a close alignment arising from a random sample of such jets to be 1 in 10,000.

"Astronomers have long assumed that as clouds collapse to form stars, the stars will tend to spin in the same direction," said principal investigator Klaus Pontoppidan of NASA's Jet Propulsion Laboratory in Pasadena, California. "However, this has not been seen so directly before. These aligned, elongated structures are a historical record of the fundamental way that stars are born."

The researchers note that the jets align more closely in the northwestern sector compared with the southeastern. They suspect that the northwestern region is younger so that their spin axes have not had as much time for interactions with their surroundings to tweak them. The team next plans to investigate the nebula's composition with JWST spectra.

RS ALIGN

Contributing Editor **Richard Talcott** *wrote about JWST's observations of black hole and galaxy mergers in the infant universe in the October issue.*