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WHY PARROTS ARE TAKING OVER THE WORLD

Our Sun Was Born Far, Far from Here

New clues suggest our nearest star has a complex origin story

By Phil Plait

Is the sun an only child? Or was it born into a (very, *very*) big family?

The answer would tell us more than just how awkward holiday family reunions can be (if you think yours are bad, imagine how much worse they would be with a few thousand sibling rivals). After all, the sun's origin story is, ultimately, our own. We've seen tremendous leaps in our understanding of how stars form, but, ironically, we still have some pretty fundamental questions about our nearest and dearest one—such as whether the sun was born solo or along with a huge passel of other stars.

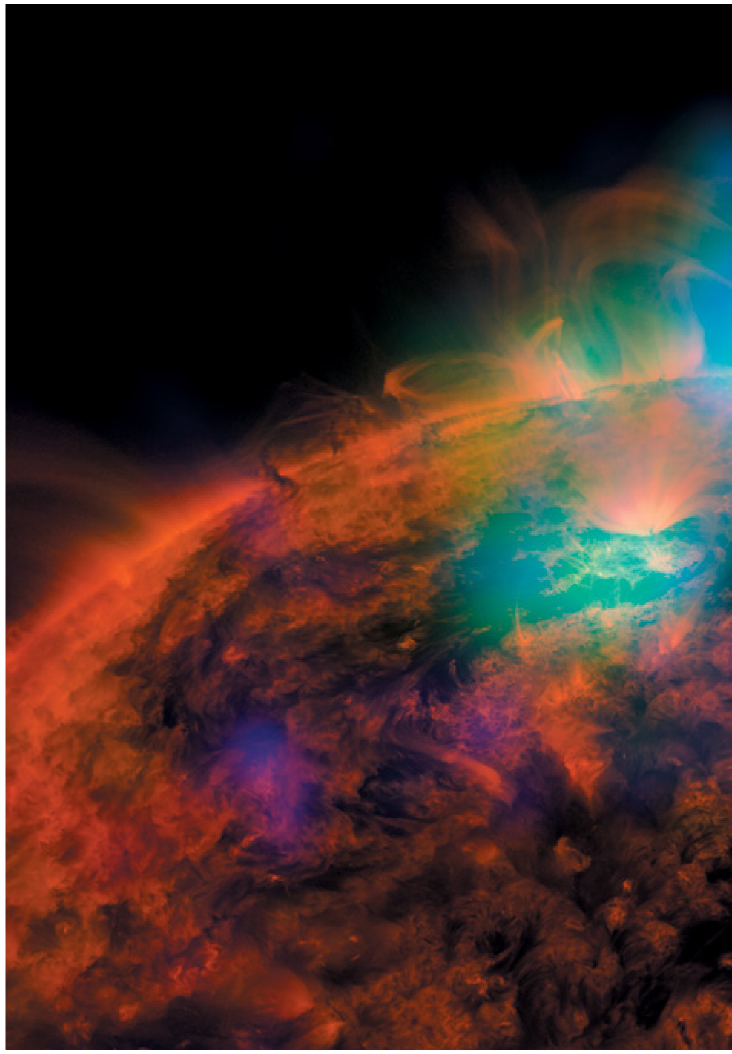
Despite the sun being close enough that we can almost touch it, the details of its inception have remained a mystery. The biggest problem is its age. Born 4.6 billion years ago, our star is well into midlife and has wandered far from its ancestral home—some nameless, now vanished "stellar nursery" of gas that long ago dispersed or consolidated into stars.

We can't find that nursery, but we can still learn about it. We have some evidence of it in the perhaps surprising form of meteorites, some of which still carry clues about their gestational environment during the birth of the solar system. For example, isotopes of elements such as potassium inside meteorites have told us where those objects formed in presolar cosmic clouds called nebulae, and variations between meteorites can be used to help determine a nebula's condition well before the emergence of any planets.

With data from meteorites in hand and aided by state-of-the-art computer simulations, an international team of astronomers investigated the likely natal environment of the sun. Its results were published in March in the *Monthly Notices of the Royal Astronomical Society*. Using a clever line of reasoning, the group suggests the sun not only had many siblings but was spawned in a rather metropolitan neighborhood.

Stars are born in nebulae when a cloud's interior collapses onto a central pilelike point that becomes the nascent star. Nebulae come in many shapes and sizes, from small, dark globules to immense molecular clouds. How a star forms in any given nebula is much more a story of nature than of nurture.

For example, the nebula Barnard 68 is a dark clot of cold gas and dust—tiny grains of silicates (rocky material) and complex carbon molecules similar to soot—relatively close to us in space at only a few hundred light-years away. It's one of my



A photograph shows our sun from data taken by NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) and Solar Dynamics Observatory (SDO).

NASA/JPL-Caltech/GSFC

favorite objects: an eerie, pitch-black ghostly mass that utterly blocks light from stars behind it like an opaque hole in the sky.

Only half a light-year across (just about three trillion miles), it has barely enough material in it to make a single star slightly heftier than the sun. Most likely it's in the middle of that process now and could transmogrify into a star in as little as 200,000 years.

On the other end of the scale we have the Orion molecular cloud complex, a truly enormous site of active star formation that's more than 1,000 light-years away and many hundreds of light-years across. It's beefy enough to make a staggering number of stars—at least 100,000 like the sun. The iconic Orion nebula, visible to the naked eye and the birthplace of hundreds of stars, is only one small part of this gigantic stellar factory.

Giant clouds like Orion are relatively rare but crank out

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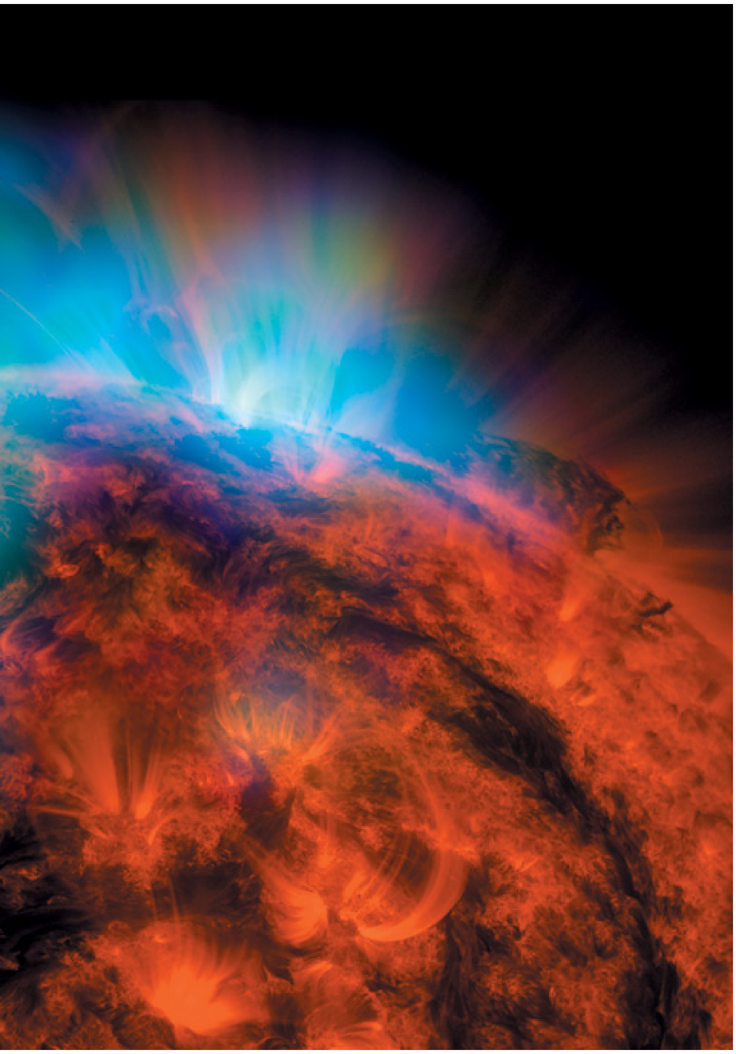

stars on an industrial scale, whereas the smaller clouds are less fecund but litter the galaxy. It's not possible to discern the origin of the sun just by looking at these statistics, though; it could have come from either kind of stellar nursery.

These nebular environments are vastly different, which affects the stars they create. Massive stars found in a nebula have a big influence on their gestating siblings. They can blast out fierce winds of subatomic particles—like the solar wind but ramped up way past 11. These winds can seed forming stars with heavy elements such as aluminum and magnesium. Later, when they explode as supernovae, they fling a different mix of elements such as iron and cobalt a very long way.

Massive stars, however, are rare. Maybe one out of 100 stars is big enough to hold this kind of sway, and small nebulae simply don't make them. That means that in principle, looking at the chemical composition of the early solar system could tell us in what kind of nursery the sun was born.

This idea was the focus of the international team's recent research. The astronomers looked at two elements in particular: aluminum 26 and iron 60. Aluminum 26 is created inside massive stars and blown out in their winds, whereas iron 60 is forged in the thermonuclear hell of an exploding star. Both elements are radioactive, decaying into magnesium and cobalt, respectively. By carefully measuring the amounts of their daughter elements in pristine samples from the earliest days of the solar system—from meteorites, that is—we can learn about the environment in which the sun formed.

For their analysis, the scientists used the physics of nebulae and star formation to simulate a sunlike star's birth in a variety of environments, from nebulae containing very few stars (representing smaller clouds) to large ones with many thousands. Next they calculated the elemental composition of the proxy proto-presolar disk that emerged in each one and compared

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these virtual yields with what's actually measured in meteorites.

Their results indicate that as it formed in its natal disk, the early sun was probably pummeled by powerful winds and supernovae explosions—both arising from massive stars. That means the solar nursery was more like the Orion complex than Barnard 68.

By coincidence, in late 2022 a different team of scientists published a paper in the journal *Astronomy & Astrophysics* investigating a similar question. The researchers reason that at least one supernova must have exploded near the still-forming solar system to create the radioactive elements seen in ancient meteorites, so—because of the relative rarity of such events—they conclude the sun's birth cluster must have been very large to ensure, statistically, that this could occur.

In other words, it's probable that the sun was more of a downtown city kid than a rural small-town star. Of course, with its nebular nursery gone, we can't confirm this hypothesis easily. After all, you can't go home again.

And what of the sun's siblings—the thousands of other stars in its extended family? They once nestled together like a litter of puppies but wandered out on their own eons ago and are now orphans scattered across the galaxy. Still, astronomers do look for stars with the same age and composition as ours so we can discover more about our sun.

A reunion is pretty unlikely. So if we want to see a family album, we'll just have to put it together ourselves. SA

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