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A New Race to the Moon

Lost Roads of the Roman Empire

The Scariest Problem in Math

The QUANTUM Revolution

Can the next big thing in computing live up to the hype?

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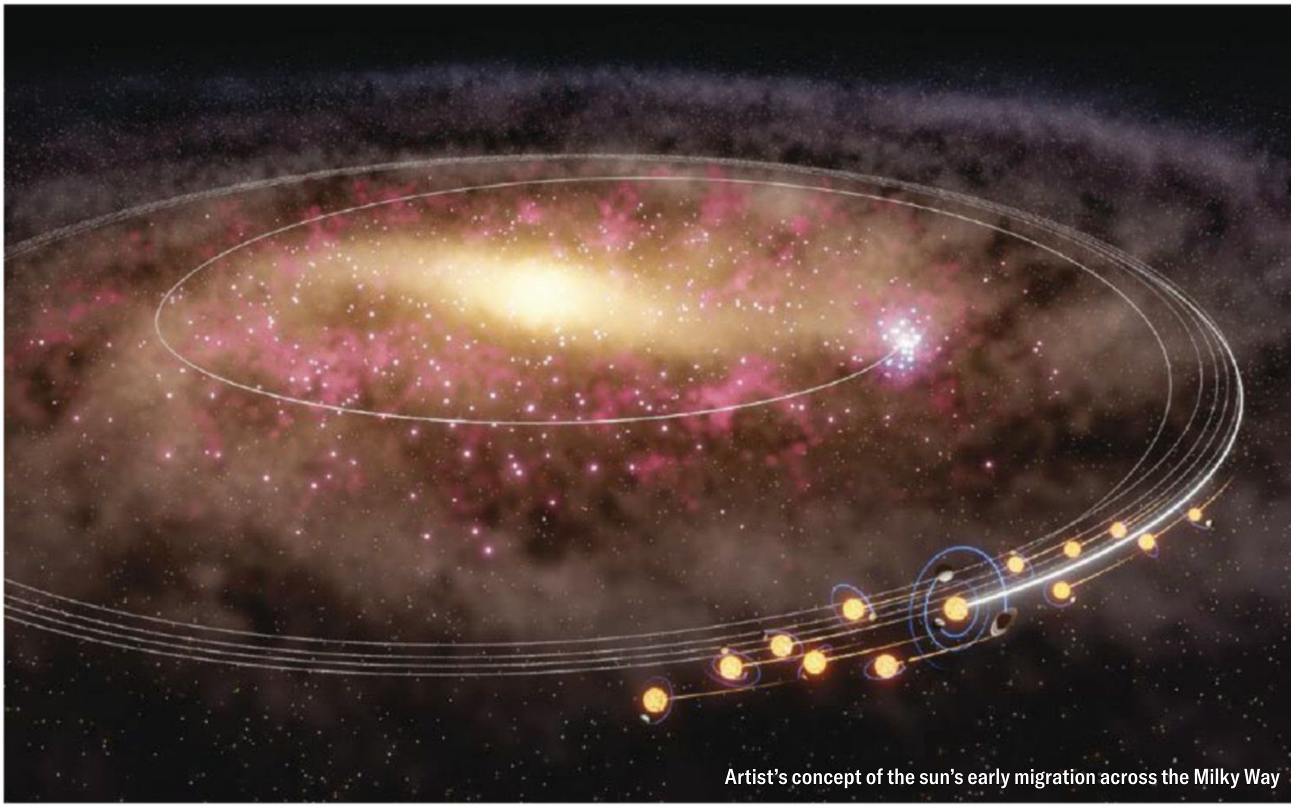

Artist's concept of the sun's early migration across the Milky Way

ASTRONOMY

Stellar Caravan

The sun traveled across the Milky Way alongside thousands of stars

OUR SUN WAS BORN 4.6 BILLION YEARS AGO near the crowded center of the Milky Way and then migrated roughly 10,000 light-years outward to the peaceful galactic suburbs it currently occupies. Now a pair of recent studies in *Astronomy and Astrophysics* argues that the sun did not make this trip alone.

Details of the sun's journey can be found in its chemical composition, says Tokyo Metropolitan University astronomer Daisuke Taniguchi, a co-author on both studies. "Astronomers know that the sun's birthplace lies closer to the galactic core than its current position," Taniguchi explains. The Milky Way's dense inner regions formed stars faster and accumulated heavy metals far more quickly than the outer edges—and a star with the sun's age and chemical components would not have been able to form at its present location. But getting there required crossing a dramatic border.

Milky Way observations have revealed an enormous rotating barlike structure made of gas, dust and millions of stars that slices through our galaxy's center. This bar creates a distinct gravitational phenomenon known as the corotation barrier, which prevents inner stars from traveling to the galactic outskirts. Computer simulations suggest that only about 1 percent of stars born at the sun's presumed original location could successfully breach this barrier to reach our present neighborhood within a 4.6-billion-year time frame. Yet Taniguchi and his colleagues discovered that thousands of "solar twin" stars, each with a mass and a metal makeup similar to those of the sun, managed to do so.

To catalog these stellar migrants, the researchers turned to the European Space Agency's Gaia satellite, an observatory tracking the positions, movements and light wavelengths of more than two billion stars. They identified 6,594 solar twins within about 1,000 light-years of Earth.

When the scientists looked at the age distribution in their catalog, they saw two distinct peaks: one narrow spike of stars around two billion years old that probably formed locally and a broad, massive grouping of stars between six billion and four billion years old that included our sun—"a large population of stars that migrated from their birthplace to their current position," Taniguchi proposes.

Alice C. Quillen, a physicist and astronomer at the University of Rochester, who was not involved in Taniguchi's studies, warns that there's a chance that the broad peak of solar twins might be an artifact resulting from the sample-selection method—a mere statistical illusion. "The sample is distance-limited, and most of it would be stars that make it into the solar neighborhood," Quillen says. This factor could favor stars with more oblong orbits, which tend to be older, because younger stars with circular orbits wouldn't have made it to

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our vicinity yet. But Taniguchi says his team addressed this bias and found no strong effect of age on the distribution of orbital shape among the solar twins.

His team proposes that the corotation barrier did not stop the migration of the sun and its cohort, because the barrier was not fully formed when it happened. In fact, Taniguchi suggests, the growing galactic bar could have pushed the migration forward instead of restricting it. The sun and its thousands of solar twins could have been propelled by the combined gravitational forces of the forming bar, the Milky Way's spiral arm structure and, most likely, close passages of the nearby Sagittarius dwarf galaxy.

Rosemary Wyse, an astrophysicist at Johns Hopkins University, who was not involved in the studies, says that the researchers' argument is persuasive but adds that (as the study authors note) the exact timescales remain uncertain. "The field of galaxy dynamics is itself dynamic," she says.

—Jacek Krywko

ANIMAL SENSING

Nocturnal Navigation

These ants use a sophisticated lunar compass

WHEN THE SUN SETS, millions of nocturnal ants awaken ready to eat. Some species forage all night, traveling from nest to food source and back again, often following trails they mark with scent. Scientists assumed bull ants, which don't rely primarily on scent navigation, had to wake up before dark and use the day's last light to find their way to sustenance. But a new study of one bull ant species shows the insects continue to navigate when the sun goes down—using an innate lunar compass.

Just as diurnal ants follow the relatively steady movement of the sun, the bull ant species has adapted to the orbiting moon's constant changes, according to research published in *Current Biology.* The ants use what the researchers call time compensation: they keep track of how much time has passed since they left the nest to gauge where the moon should be in the night sky, much like early human navigators used the North Star.

"It was an area where we didn't really know what was going on" until now, says lead study author Cody Freas, an entomologist at University of Toulouse in France. "These ants use a lot of different cues at the same time, and that helps them in case one cue becomes unreliable."

The researchers captured the insects en route to their usual feeding areas and put a subset into darkened boxes that lacked any environmental cues about time passing. (They put others in transparent boxes.) After several hours the scientists released the ants in a new location and watched them try to find their way to food. When held in darkness for long enough that the moon moved significantly, the ants veered off course, suggesting its position was their main cue.

"This is just a little bonkers," says Rodolfo da Silva Probst, an entomologist at the University of California, Davis, who was not involved in the study. "They need to compensate for the trajectory of the moon. I mean, I don't know how to do that."

Other nocturnal creatures, including sand hoppers and moths, are thought to use the moon's position to find their way, but these bull ants are the first found to have such an intricate, time-linked approach to lunar navigation. Additionally, researchers learned that the ants combine their impressive lunar compass with terrestrial and solar cues, at dawn and dusk, to navigate consistently even as moon visibility varies during the lunar month.

There are more than 12,000 ant species in the world, and they all do things a little differently, but figuring out how one species has adapted to its unique ecological niche might help researchers understand others, da Silva Probst says. "Maybe by studying other nocturnal ants, you might discover other mechanisms." *—K. R. Callaway*

Ants show newfound lunar navigation skills.

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