Immigrant Sun: Our star could be far from where it started in Milky Way

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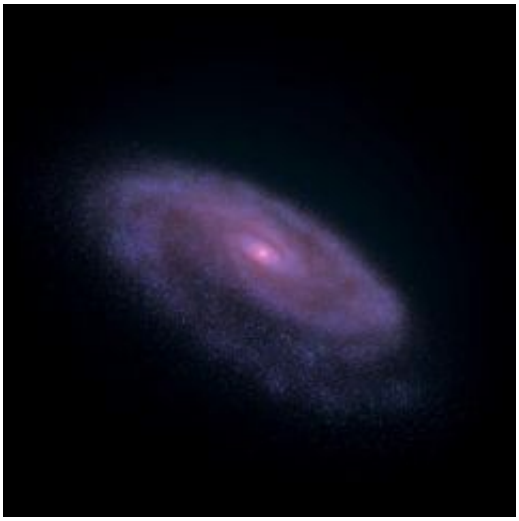

This image is from a computer simulation showing the development and evolution of the disk of a galaxy such as the Milky Way. Credit: Rok Roškar

A long-standing scientific belief holds that stars tend to hang out in the same general part of a galaxy where they originally formed. Some astrophysicists have recently questioned whether that is true, and now new simulations show that, at least in galaxies similar to our own Milky Way, stars such as the sun can migrate great distances.

What's more, if our sun has moved far from where it was formed more than 4 billion years ago, that could change the entire notion that there are parts of galaxies – so-called habitable zones – that are more conducive to

supporting life than other areas are.

"Our view of the extent of the habitable zone is based in part on the idea that certain chemical elements necessary for life are available in some parts of a galaxy's disk but not others," said Rok Roškar, a doctoral student in astronomy at the University of Washington.

"If stars migrate, then that zone can't be a stationary place."

If the idea of habitable zone doesn't hold up, it would change scientists' understanding of just where, and how, life could evolve in a galaxy, he said.

Roškar is lead author of a paper describing the findings from the simulations, published in the Sept. 10 edition of the *Astrophysical Journal Letters*. Co-authors are Thomas R. Quinn of the UW, Victor Debattista at the University of Central Lancashire in England, and Gregory Stinson and James Wadsley of McMaster University in Canada. The work was funded in part by the National Science Foundation.

Using more than 100,000 hours of computer time on a UW computer cluster and a supercomputer at the University of Texas, the scientists ran simulations of the formation and evolution of a galaxy disk from material that had swirled together 4 billion years after the big bang. (See a simulation video at http://www.astro.washington.edu/roskar/astronomy/12M_hr_rerun_angle.mpghttp://www.astro.washington.edu/roskar/astronomy/12M_hr_rerun_angle.mpg.)

The simulations begin with conditions about 9 billion years ago, after material for the disk of our galaxy had largely come together but the actual disk formation had not yet started. The scientists set basic parameters to mimic the development of the Milky Way to that point,

but then let the simulated galaxy evolve on its own.

If a star, during its orbit around the center of the galaxy, is intercepted by a spiral arm of the galaxy, scientists previously assumed the star's orbit would become more erratic in the same way that a car's wheel might become wobbly after it hits a pothole.

However, in the new simulations the orbits of some stars might get larger or smaller but still remain very circular after hitting the massive spiral wave. Our sun has a nearly circular orbit, so the findings mean that when it formed 4.59 billion years ago (about 50 million years before the Earth), it could have been either nearer to or farther from the center of the galaxy, rather than halfway toward the outer edge where it is now.

Migrating stars also help explain a long-standing problem in the chemical mix of stars in the neighborhood of our solar system, which has long been known to be more mixed and diluted than would be expected if stars spent their entire lives where they were born. By bringing in stars from very different starting locations, the sun's neighborhood has become a more diverse and interesting place, the researcher said.

Such stellar migration appears to depend on the galaxy having spiral arms that twist their way through the galaxy, as are present in the Milky Way, Roškar said.

"Our simulated galaxy is very idealized in the formation of the disk, but we believe it is indicative of the formation of a Milky Way-type of galaxy," he said. "In a way, studying the Milky Way is the hardest thing to do because we're inside it and we can't see it all. We can't say for sure that the sun had this type of migration."

However, there is recent observational evidence that such migration might be occurring in other galaxies as well, he said.

Roškar noted that the researchers are not the first to suggest that stars might be able to migrate great distances across galaxies, but they are the first to demonstrate the effects of such migrations in a simulation of a growing galactic disk.

The findings are based on a few runs of the simulations, but it is expected additional runs using the same parameters and physical properties would produce largely the same results.

"When you swirl cream into a cup of coffee, it will rarely look exactly the same twice, but the general process, and the resulting taste, is always the same," said Wadsley, the team member from McMaster University.

The scientists plan to run a range of simulations with varying physical properties to generate different kinds of galactic disks, and then determine whether stars show similar ability to migrate large distances within different types of disk galaxies.

Source: University of Washington