Rogue stars ejected from the galaxy are found in intergalactic space

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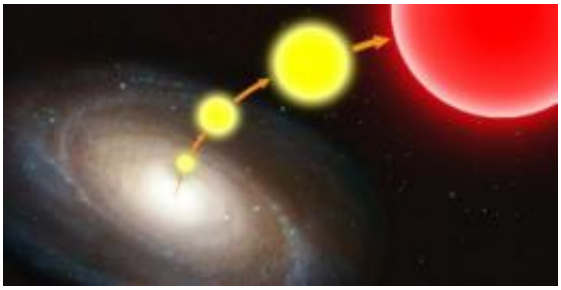

Vanderbilt astronomers have identified nearly 700 rogue stars that appear to have been ejected from the Milky Way galaxy. When these stars received the powerful kick that knocked them out of the galaxy, they were small, yellow stars like the sun. But in the multi-million-year journey they evolved into red giant stars. Credit: Michael Smelzer, Vanderbilt University

It's very difficult to kick a star out of the galaxy.

In fact, the primary mechanism that astronomers have come up with that can give a star the two-million-plus mile-per-hour kick it takes requires a close encounter with the supermassive black hole at the galaxy's core.

So far astronomers have found 16 of these "hypervelocity" stars. Although they are traveling fast enough to eventually escape the galaxy's gravitational grasp, they have been discovered while they are still inside the galaxy.

Now, Vanderbilt astronomers report in the May issue of the Astronomical Journal that they have identified a group of more than 675 stars on the outskirts of the Milky Way that they argue are hypervelocity stars that have been ejected from the galactic core. They selected these stars based on their location in intergalactic space between the Milky Way and the nearby Andromeda galaxy and by their peculiar red coloration.

"These stars really stand out. They are red giant stars with high metallicity which gives them an unusual color," says Assistant Professor Kelly Holley-Bockelmann, who conducted the study with graduate student Lauren Palladino.

In astronomy and cosmology, "metallicity" is a measure of the proportion of chemical elements other than hydrogen and helium that a star contains. In this case, high metallicity is a signature that indicates an inner galactic origin: Older stars and stars from the galactic fringes tend to have lower metallicities.

The researchers identified these candidates by analyzing the millions of stars catalogued in the Sloan Digital Sky Survey.

"We figured that these rogue stars must be there, outside the galaxy, but no one had ever looked for them. So we decided to give it a try," said Holley-Bockelmann, who is studying the behavior of the black hole at the center of the Milky Way galaxy.

Astronomers have now found evidence for giant black holes at the centers of many galaxies. They estimate that the Milky Way's central black hole has a mass of four million solar masses. They calculate that the gravitational field surrounding such a supermassive black hole is strong enough to accelerate stars to hypervelocities.

The typical scenario involves a binary pair of stars that get caught in the black hole's grip. As one of the stars spirals in towards the black hole, its companion is flung outward at a tremendous velocity.

A second scenario takes place during periods when the central black hole is in the process of ingesting a smaller black hole. Any star that ventures too close to the circling pair can also get a hypervelocity kick.

Red giant stars are the end stage in the evolution of small, yellow stars like the Sun. So, the stars in Holley-Bockelmann's rogues' gallery should have been small stars like the Sun when they tangled with the central black hole. As they traveled outward, they continued to age until they reached the red giant stage. Even traveling at hypervelocities, it would take a star about 10 million years to travel from the central hub to the spiral's edge, 50,000 light years away.

"Studying these rogue stars can provide us with new insights into the history and evolution of our home galaxy," said Holley-Bockelmann. The researchers' next step is determine if any of their candidates are unusually red brown dwarfs instead of red giants. Because brown dwarfs produce a lot less light than red giants, they would have to be much closer to appear equally bright.

Provided by Vanderbilt University