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## Ultracool stars take 'wild rides' around, outside the Milky Way

June 9, 2009

Astronomers announced today that stars of a recently discovered type, dubbed ultracool subdwarfs, take some pretty wild rides as they orbit around the Milky Way, following paths that are very different from those of typical stars. One of them may actually be a visitor that originated in another galaxy.

Adam Burgasser and John Bochanski of the Massachusetts Institute of Technology presented the findings on Tuesday, June 9, in a press conference at the American Astronomical Society's semi-annual meeting in Pasadena, Calif. The result clarifies the origins of these peculiar, faint stars, and may provide new details on the types of stars the Milky Way has acquired from other galaxies.

Ultracool subdwarfs were first recognized as a unique class of stars in 2003, and are distinguished by their low temperatures ("ultracool") and low concentrations of elements other than hydrogen and helium ("subdwarf"). They sit at the bottom end of the size range for stars, and some are so small that they are closer to the planet-like objects called brown dwarfs. Only a few dozen ultracool subdwarfs are known today, as they are both very faint - up to 10,000 times fainter than the Sun - and extremely rare.

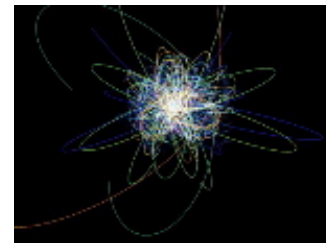
Burgasser, associate professor of physics at MIT and lead author of the study, was intrigued by the fast motions of ultracool subdwarfs, which zip past the Sun at astonishing speeds. "Most nearby stars travel more or less in tandem with the Sun tracing circular orbits around the center of the Milky Way once every 250 million years," he explains. The ultracool subdwarfs, on the other hand, appear to pass us by at very high speeds, up to 500 km/s, or over a million miles per hour.

"If there are interstellar cops out there, these stars would surely lose their driver's licenses," says Burgasser.

Burgasser's team of astronomers assembled measurements of the positions, distances and motions of roughly two dozen of these rare stars. Robyn Sanderson, co-author and MIT graduate student, then used these measurements to calculate the orbits of the subdwarfs using a numerical code developed to study galaxy collisions. Despite doing similar calculations for other types of low-mass stars, "these orbits were like nothing I'd ever seen before," says Sanderson.

Sanderson's calculations showed an unexpected diversity in the ultracool subdwarf orbits. Some plunge deep into the center of the Milky Way on eccentric, comet-like tracks; others make slow, swooping loops far beyond the Sun's orbit. Unlike the majority of nearby stars, most of the ultracool subdwarfs spend a great deal of time thousands of light-years above or below the disk of the Milky Way.

"Someone living on a planet around one of these subdwarfs would have



Courtesy / Adam Burgasser

This image shows the orbits of all recently discovered ultracool subdwarfs in and around the Milky Way, as seen from 150,000 light years away.

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an incredible nighttime view of a beautiful spiral galaxy - our Milky Way - spread across the sky," Burgasser speculates.

Sanderson's orbit calculations confirm that all of the ultracool subdwarfs are part of the Milky Way's halo, a widely dispersed population of stars that likely formed in the Milky Way's distant past. However, one of the subdwarfs, a star named 2MASS 1227-0447 in the constellation Virgo, has an orbit indicating that it might have a very different lineage, possibly extragalactic.

"Our calculations show that this subdwarf travels up to 200,000 light years away from the center of the Galaxy, almost 10 times farther than the Sun," says Bochanski, a postdoctoral researcher in Burgasser's group at MIT. This is farther than many of the Milky Way's nearest galactic neighbors, suggesting that this particular subdwarf may have originated somewhere else.

"Based on the size of its one billion-year orbit and direction of motion, we speculate that 2MASS 1227-0447 might have come from another, smaller galaxy that at some point got too close to the Milky Way and was ripped apart by gravitational forces," explains Bochanski.

Astronomers have previously identified streams of stars in the Milky Way originating from neighboring galaxies, but all have been distant, massive, red giant stars. The ultracool subdwarf identified by Burgasser and his team is the first nearby, low-mass star to be found on such a trajectory. "If we can identify what stream this star is associated with, or which dwarf galaxy it came from, we could learn more about the types of stars that have built up the Milky Way's halo over the past 10 billion years," says Burgasser.

The results presented at the meeting are based in part on two studies recently published in the *Astrophysical Journal* by Burgasser and coauthor Michael Cushing, a postdoctoral researcher at the University of Hawaii's Institute for Astronomy.

Other authors of this paper are Andrew West of MIT; Dagny Looper of the University of Hawaii, Manoa; and Jacqueline Faherty of the American Museum of Natural History, New York, NY.

*A version of this article appeared in MIT Tech Talk on June 10, 2009 (download PDF).*

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