Hubble tracks down a 'blue lurker' among stars

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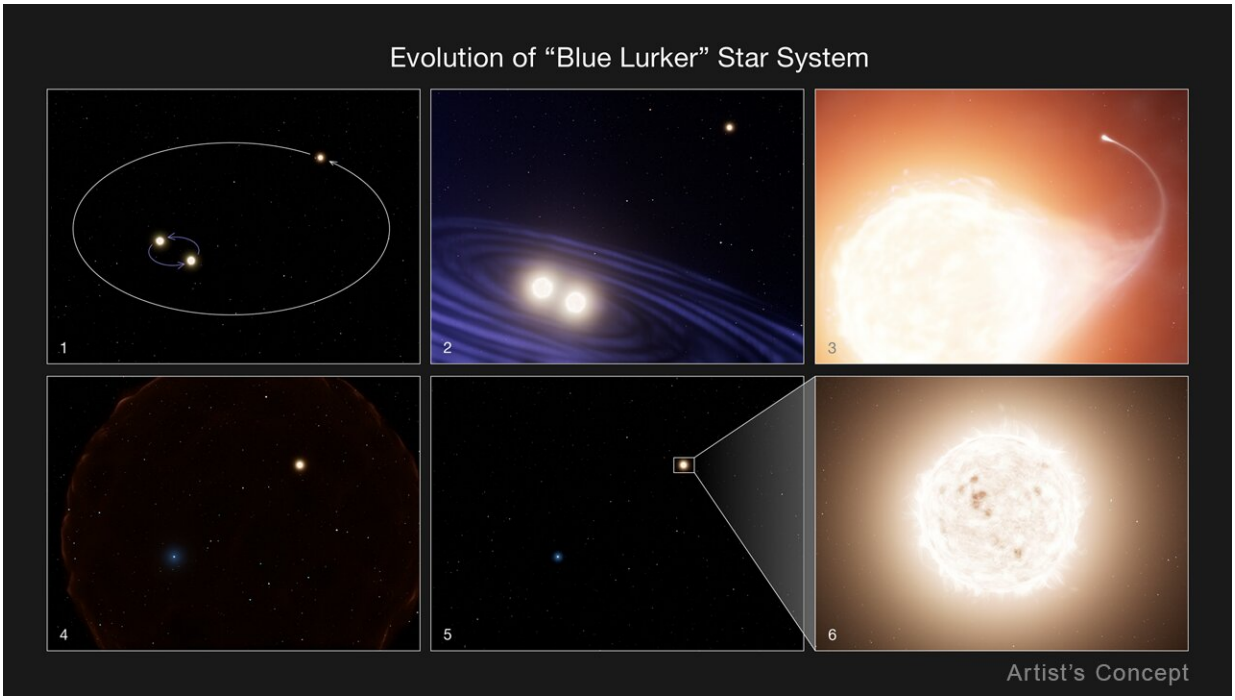

Evolution of a "Blue Lurker" Star in a Triple System. Panel 1: A triple star system containing three sun-like stars. Two are very tightly orbiting. The third star has a much wider orbit. Panel 2: The close stellar pair spiral together and merge to form one more massive star. Panel 3: The merged star evolves into a giant star. As the huge photosphere expands, some of the material falls onto the outer companion, causing the companion to grow larger and its rotation rate to increase. Panels 4–5: The central merged star eventually burns out and forms a massive white dwarf, and the outer companion spirals in towards the white dwarf, leaving a binary star system with a tighter orbit. Panel 6: The surviving outer companion is much like our sun but nicknamed a "blue lurker." Although it is slightly brighter bluer than expected because of the earlier mass-transfer from

the central star and is now rotating very rapidly, these features are subtle. The star could easily be mistaken for a normal sun-like star despite its exotic evolutionary history. Credit: NASA, ESA, Leah Hustak (STScI)

Our sun is a lonely star. At least half the stars in our galaxy have binary companions. This was nicely illustrated in the Star Wars movie trilogy where Luke Skywalker watched two suns set on the horizon as seen from his home planet Tatooine. Now imagine three suns in the sky. This is the story for a system that once contained three co-orbiting stars.

Forensics with Hubble data show that the stars have had a tumultuous life. Two of the stars merged about 500 million years ago to make a more massive star. It eventually burned out and collapsed to an unusually massive white dwarf. The bystander to this mayhem is the once third member of the system. It siphoned material from the merged companion star to gain a new lease on life by becoming more massive and bright.

But, now it is lonely, orbiting a dead star. Hubble discovered that the surviving star has an unusually fast spin rate that can only be explained if it was feeding off of the gas expelled by the stellar merger.

The name "blue lurker" might sound like a villainous character from a superhero movie. But it is a rare class of star that NASA's Hubble Space Telescope explored by looking deeply into the open star cluster M67, roughly 2,800 light-years away.

Forensics with Hubble data show that the star has had a tumultuous life, mixing with two other stars gravitationally bound together in a remarkable triple-star system. The star has a kinship to so-called "blue stragglers," which are hotter, brighter, and bluer than expected because they are likely the result of mergers between stars.

The blue lurker is spinning much faster than expected, an unusual behavior that led to its identification. Otherwise, it looks like a normal sun-like star. The term "blue" is a bit of a misnomer because the star's color blends in with all the other solar-mass stars in the cluster. Hence it is sort of "lurking" among the common stellar population.

The spin rate is evidence that the lurker must have siphoned in material from a companion star, causing its rotation to speed up. The star's high spin rate was discovered with NASA's retired Kepler space telescope. While normal sun-like stars typically take about 30 days to complete one rotation, the lurker takes only four days.

How the blue lurker got that way is a "super complicated evolutionary story," said Emily Leiner of Illinois Institute of Technology in Chicago. "This star is really exciting because it's an example of a star that has interacted in a triple-star system." The blue lurker originally rotated more slowly and orbited a binary system consisting of two sun-like stars.

About 500 million years ago, the two stars in that binary merged, creating a single, much more massive star. This behemoth soon swelled into a giant star, dumping some of its own material onto the blue lurker and spinning it up in the process. Today, we observe that the blue lurker is orbiting a white dwarf star—the burned out remains of the massive merger.

"We know these multiple star systems are fairly common and are going to lead to really interesting outcomes," Leiner explained. "We just don't yet have a model that can reliably connect through all of those stages of evolution. Triple-star systems are about 10% of the sun-like star population. But being able to put together this evolutionary history is challenging."

Hubble observed the white dwarf companion star that the lurker orbits.

Using ultraviolet spectroscopy, Hubble found the white dwarf is very hot (as high as 23,000°F, or roughly three times the sun's surface temperature) and a heavyweight at 0.72 solar masses. According to theory, hot white dwarfs in M67 should be only about 0.5 solar masses. This is evidence that the white dwarf is the byproduct of the merger of two stars that once were part of a triple-star system.

"This is one of the only triple systems where we can tell a story this detailed about how it evolved," said Leiner. "Triples are emerging as potentially very important to creating interesting, explosive end products. It's really unusual to be able to put constraints on such a system as we are exploring."

Leiner's results are being presented at the 245th meeting of the American Astronomical Society in National Harbor, Maryland.

More information: Emily Leiner et al paper: stsci-opo.org/STScI-01JD2Q892BWZFY5V1Q1X81PPHJ.pdf

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