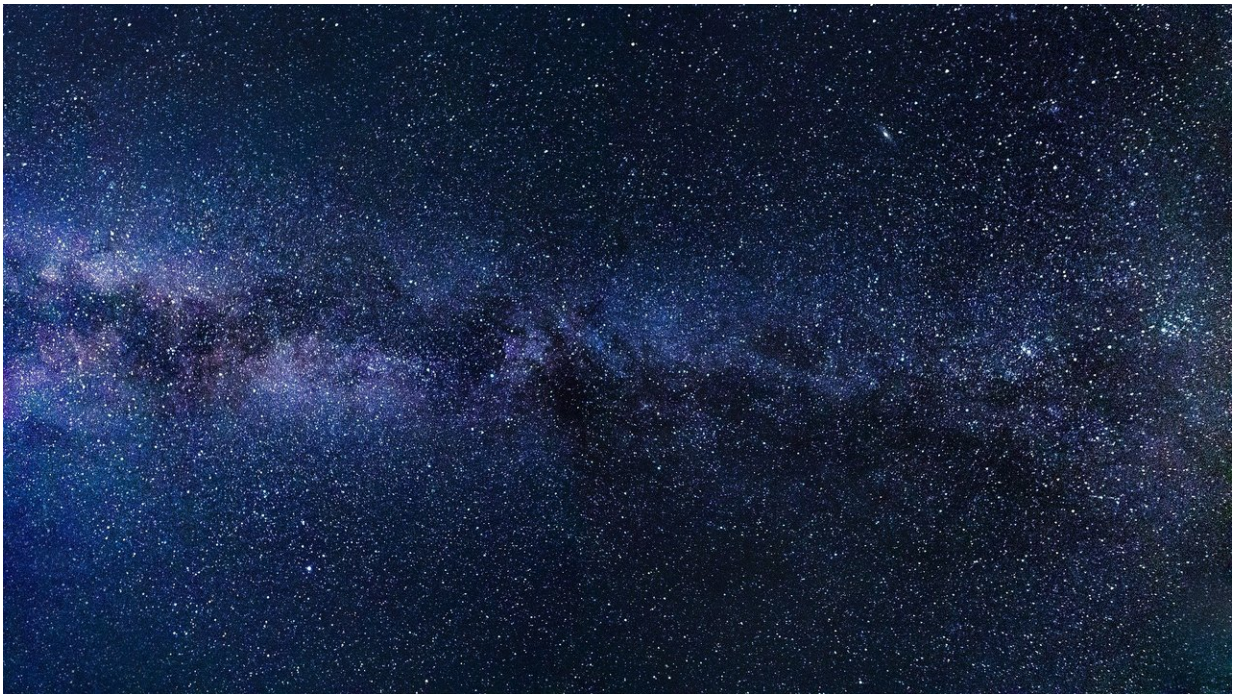


New type of star gives clues to mysterious origin of magnetars

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Magnetars are the strongest magnets in the universe. These super-dense dead stars with ultra-strong magnetic fields can be found all over our galaxy but astronomers don't know exactly how they form.

Now, using multiple telescopes around the world, including European Southern Observatory (ESO) facilities, researchers have uncovered a

living star that is likely to become a magnetar. This finding marks the discovery of a new type of astronomical object—massive magnetic helium stars—and sheds light on the origin of magnetars.

Despite having been observed for over 100 years, the enigmatic nature of the star HD 45166 could not be easily explained by conventional models, and little was known about it beyond the fact that it is one of a pair of stars, is rich in helium and is a few times more massive than our sun.

"This star became a bit of an obsession of mine," says Tomer Shenar, the lead author of a study on this object published in *Science* and an astronomer at the University of Amsterdam, the Netherlands. "Tomer and I refer to HD 45166 as the 'zombie star,'" says co-author and ESO astronomer Julia Bodensteiner, based in Germany. "This is not only because this star is so unique, but also because I jokingly said that it turns Tomer into a zombie."

Having studied similar helium-rich stars before, Shenar thought magnetic fields could crack the case. Indeed, magnetic fields are known to influence the behavior of stars and could explain why traditional models failed to describe HD 45166, which is located about 3,000 light-years away in the constellation Monoceros. "I remember having a Eureka moment while reading the literature: 'What if the star is magnetic?'," says Shenar, who is currently based at the Center for Astrobiology in Madrid, Spain.

Shenar and his team set out to study the star using multiple facilities around the globe. The main observations were conducted in February 2022 using an instrument on the Canada-France-Hawaii Telescope that can detect and measure magnetic fields. The team also relied on key archive data taken with the Fiber-fed Extended Range Optical Spectrograph ([FEROS](#)) at ESO's La Silla Observatory in Chile.

Once the observations were in, Shenar asked co-author Gregg Wade, an expert on magnetic fields in stars at the Royal Military College of Canada, to examine the data. Wade's response confirmed Shenar's hunch: "Well my friend, whatever this thing is—it is definitely magnetic."

Shenar's team had found that the star has an incredibly strong magnetic field, of 43,000 gauss, making HD 45166 the most magnetic massive star found to date. "The entire surface of the helium star is as magnetic as the [strongest human-made magnets](#)," explains co-author Pablo Marchant, an astronomer at KU Leuven's Institute of Astronomy in Belgium.

This observation marks the discovery of the very first massive magnetic helium star. "It is exciting to uncover a new type of astronomical object," says Shenar, "especially when it's been hiding in plain sight all along."

Moreover, it provides clues to the origin of magnetars, compact dead stars laced with magnetic fields at least a billion times stronger than the one in HD 45166. The team's calculations suggest that this star will end its life as a magnetar. As it collapses under its own gravity, its magnetic field will strengthen, and the star will eventually become a very compact core with a [magnetic field](#) of around 100 trillion gauss—the most powerful type of magnet in the universe.

Shenar and his team also found that HD 45166 has a mass smaller than previously reported, around twice the mass of the sun, and that its stellar pair orbits at a far larger distance than believed before. Furthermore, their research indicates that HD 45166 formed through the merger of two smaller helium-rich stars. "Our findings completely reshape our understanding of HD 45166," concludes Bodensteiner.

More information: Tomer Shenar, A massive helium star with a sufficiently strong magnetic field to form a magnetar, *Science* (2023).

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