Recently discovered periodic radio transient may be a rare white dwarf pulsar, study finds

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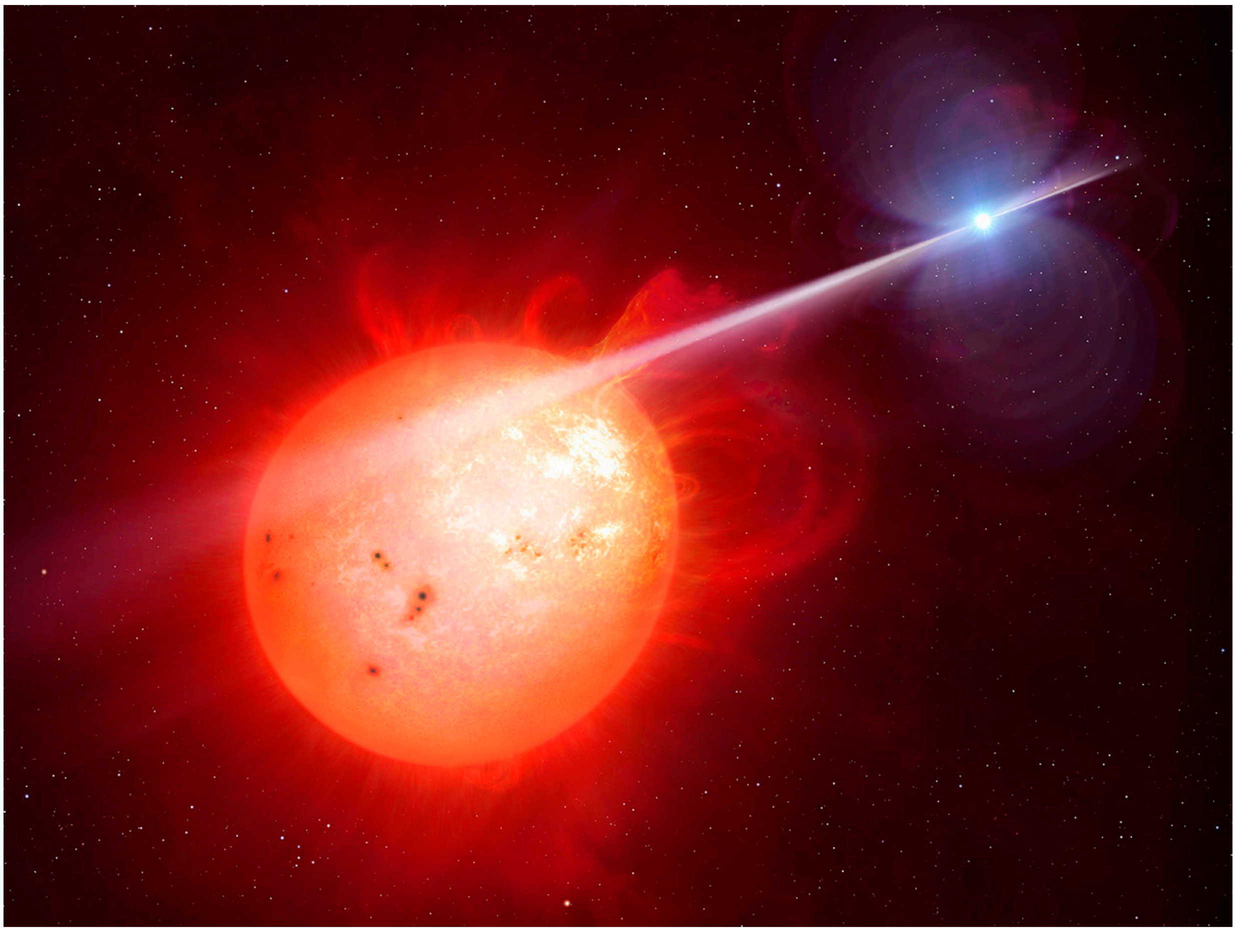

This artist's impression shows the strange object AR Scorpii. In this unique double star a rapidly spinning white dwarf star (right) powers electrons up to almost the speed of light. These high energy particles release blasts of radiation that lash the companion red dwarf star (left) and cause the entire system to pulse dramatically every 1.97 minutes with radiation ranging from the ultraviolet to radio. Credit: M. Garlick/University of Warwick, ESA/Hubble

A new study by Jonathan Katz of Washington University in St. Louis suggests that a recently discovered periodic radio transient source, designated GLEAM-X J162759.5−523504.3, may be a rare white dwarf pulsar. The finding was detailed in a paper published March 16 on the arXiv pre-print server.

Pulsars are highly magnetized, rotating neutron stars emitting a beam of electromagnetic radiation. They are usually detected in the form of short bursts of radio emission; however, some of them are also observed via optical, X-ray and gamma-ray telescopes.

Some astronomers speculate that a rotating magnetic white dwarf (WD) might show pulsar-like activity. To date, only one such "white dwarf pulsar" candidate has been found—named AR Scorpii (AR Sco)—as it contains a rapidly spinning WD bombarding its red dwarf companion with powerful beams of electrical particles and radiation. This causes the system to brighten and fade dramatically twice every two minutes.

GLEAM-XJ162759.5–523504.3 is a recently discovered pulsar with a spin period of approximately 1,091 seconds. It showcases transient radio bursts with durations of about one month, while the pulse widths vary within the range of 30 to 60 seconds. The rotational power of this pulsar was calculated to be less than 12 octillion erg/s, which turns out to be much smaller than the luminosity of the pulsed radio emission that is estimated to be about 40,000 octillion erg/s.

The long period of GLEAM-XJ162759.5–523504.3 remains a puzzle as usually, the rotational periods of radio pulsars and single neutron stars from other populations do not exceed 20 seconds. A previous study suggested that such a long period may be a product of long-term evolution in the fallback disk model—when a neutron star evolves with a fallback disk and with a magnetic dipole field strength of a few trillion G at the equator.

Katz, in his latest study, argues that the peculiar properties of GLEAM-XJ162759.5–523504.3 may be explained by the fact that it is a white dwarf pulsar. By analyzing the available data, he focused on the mean radiated power of this source as it exceeds the upper limit on its spin-down power by more than an order of magnitude.

According to Katz, this is physically impossible for a rotation-powered object as no classical pulsar emits more than about 1 percent of its spindown power as coherent radio emission. He assumes that the WD pulsar scenario could well explain this peculiarity, together with the anomalously long rotation period.

"White dwarf have moments of inertia ~ 10^{50} g cm^2, about five orders of magnitude greater than that of a neutron star, increasing the estimated spindown power to ~ 10^{33} ergs/s, sufficient to power the radio emission with plausible (

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