A Pair of Dead Stars Locked in a Six-Minute Orbit, Rapidly Spiraling Inward

eRASSU J0608 emerges as a promising verification source for future space-based gravitational-wave observatories

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An international team led by Indian astronomers has found that a pair of dead stars spiralling towards each other at record speed. Using observations from the Chinese-led Einstein Probe mission and NASA's NICER telescope, the team found that a pair of white dwarfs, the dense dead cores left behind when stars like the Sun run out of fuel, are locked in an extraordinarily tight orbit. That orbit is shrinking fast, a telltale sign that the system is radiating away energy as gravitational waves.

The system, originally discovered with the SRG eROSITA all-sky survey, is known as eRASSU J060839.5–704014 (or "eRASSU J0608" for short). The two stars circle each other once every six minutes. Their orbit is decaying faster than almost any other known system of its kind.

The study has been led by Dr. Rahul Sharma and Prof. Chandreyee Maitra of the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, and has been published in The Astrophysical Journal Letters (ApJL).

White dwarfs are what remain after a Sun-like star exhausts its nuclear fuel and sheds its outer layers. What's left is an extremely dense core roughly the size of Earth but packing the mass of a star. When two white dwarfs end up orbiting each other at very close range, they form what astronomers call an "ultracompact" binary system. The orbit is so tight that a complete orbit can take just minutes rather than years. These double white-dwarf systems with such extraordinarily short periods are among the most compact binaries known.

eRASSU J0608 is one of the most extreme examples known. Astronomers call this "direct-impact accretion". The impact heats the surface to temperatures of over a million degrees, producing a bright, pulsing glow of X-rays that repeats every 374 seconds, the orbital period of the binary.

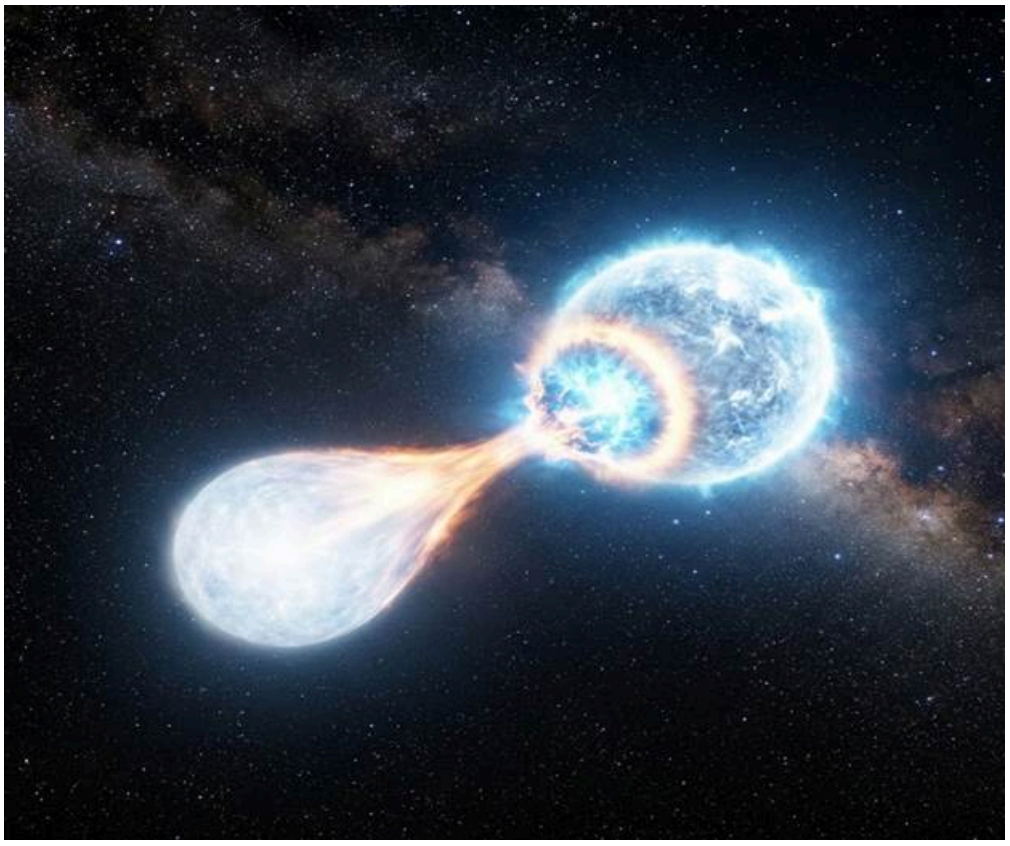
By combining new observations from the NICER and Einstein Probe missions with earlier data from the XMM-Newton observatory, the team precisely tracked the system's orbit over a baseline of three and a half years. They found that it is shrinking exceptionally rapidly, at a rate even greater than that measured in the two other well-known systems of this class, HM Cnc and V407 Vul.

From the measured rate of orbital decay, the team estimates the combined "chirp mass" of the two white dwarfs (a quantity that determines how strong their gravitational-wave signal will be) at about 0.43 times the mass of the Sun, among the highest values known for this class of object.

The strength and predictability of the gravitational-wave signal expected from eRASSU J0608 make it a particularly promising target for future space-based gravitational-wave observatories.

The European Space Agency's planned LISA (Laser Interferometer Space Antenna) mission is designed to detect gravitational waves from compact systems such as rapidly orbiting stellar remnants.

The IUCAA team plans to continue monitoring the system with X-ray telescopes and to search for a visible-light counterpart. That could help pin down its distance and mass more precisely, and sharpen predictions for what LISA and other future missions will eventually detect.



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