The cosmos is green: Researchers catch nature in the act of 'recycling' a star (w/Animations)

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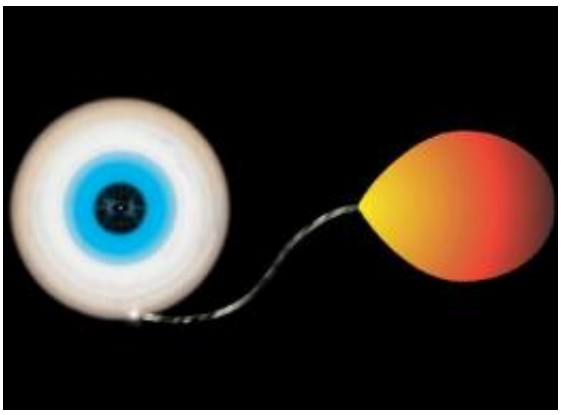

Neutron star with accretion disk (left) drawing material from companion star (right). CREDIT: Bill Saxton, NRAO/AUI/NSF

(PhysOrg.com) -- For the first time, researchers have observed a singular cosmic act of rebirth: the transformation of an ordinary, slow-rotating pulsar into a superfast millisecond pulsar with an almost infinitely extended lifespan.

The discovery was made during a large radio sky survey by an international team of astrophysicists at McGill University, the University of British Columbia (UBC), West Virginia University, the U.S. National Radio Astronomy Observatory (NRAO) and several other institutions in the United States, the Netherlands and Australia.

The sky survey used the Robert C. Byrd radio telescope at Green Bank, West Virginia to observe nearly a third of the celestial sphere. The team's results will be published online by the journal *Science* on May 21.

The discovery was made by astrophysics PhD candidate Anne Archibald and her supervisor, Prof. Victoria Kaspi of the McGill Pulsar Group. "This survey has found many new pulsars, but this one is truly special -- it is a very freshly 'recycled' pulsar that is emerging straight from the recycling plant." said Archibald. The McGill researchers worked with Asst. Prof. Ingrid Stairs of UBC and Scott Ransom of NRAO as well as others from the collaboration to carry out more observations of this unusual pulsar.

Pulsars are rapidly rotating, highly magnetized neutron stars, the remnants left after massive stars have exploded as supernovae. Pulsars emit lighthouse-like beams of radio waves that sweep around as the star rotates. Most rotate relatively slowly, ten times a second or less, and their magnetic fields ordinarily slow them down even further over the course of millennia. Millisecond pulsars, however, rotate hundreds of times a second.

"We know normal pulsars typically pulsate in the radio spectrum for one million to ten million years, but eventually they slow down enough to die out," explained Kaspi. "But a few of these old pulsars get 'recycled' into millisecond pulsars. They end up spinning extremely fast, and then they can pulsate forever. How does nature manage to be so green?"

It has long been theorized that millisecond pulsars are created in double-star systems when matter from the companion star falls into the pulsar's gravity well and increases the rotation speed, but until now the process has never been observed directly.

"Imagine a ping-pong ball in the bathtub, and then you take the plug out

of the drain," explained Archibald. "All the water swirling around the ping-pong ball suddenly makes it spin a lot faster than when it was just bobbing on the surface.

"We've seen systems that are undergoing spin-up, because when the matter is falling in, the stars get really bright in X-rays and they're easy to see," she added. "But we've never seen radio pulsations from these stars during the process of spin-up. At last we've found a true radio pulsar that shows direct evidence for having just been recycled."

The pulsar found by the survey team was fortuitously observed by an independent, optical research group to have had swirling matter surrounding it roughly a decade ago -- the blink of an eye in astronomical time. That group recorded the observation as puzzling, never dreaming that a full-fledged radio pulsar would emerge.

"In other words, for the first time, we have caught a glimpse at an actual cosmic recycling factory in action," said Ingrid Stairs of UBC, who has been visiting the Australia Telescope National Facility and Swinburne University of Technology this year. "This system gives us an unparalleled cosmic laboratory for studying how millisecond pulsars evolve and get reborn."

Source: McGill University (news : web)