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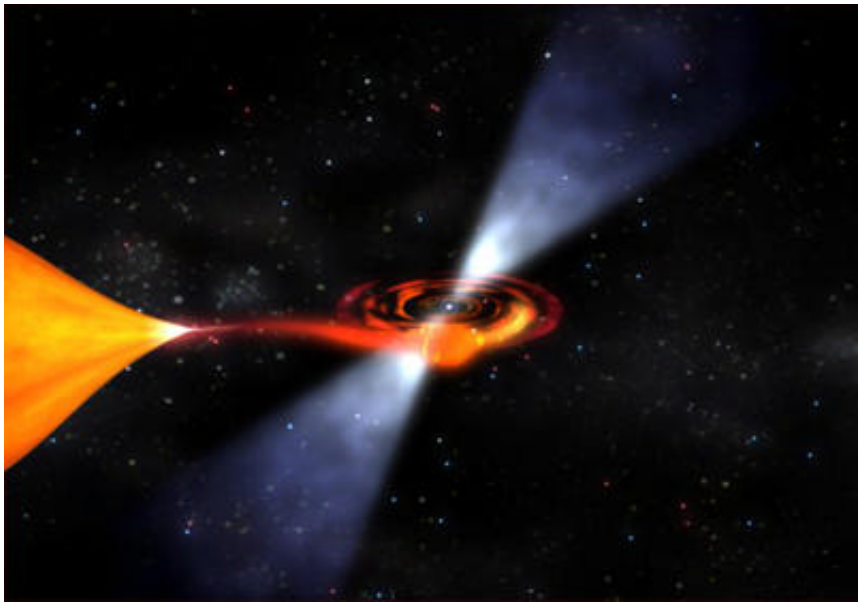
Spinning Neutron Stars Observe Speed Limit

It's more massive than the sun, it's smaller than New York City, and in the time you take to read this sentence, it spins around its axis 2000 times. Now, SAX J1808.4-3658, as the bizarre millisecond pulsar is known, is shedding new light on the behavior of neutron stars, the rapidly spinning remains of exploded massive stars. In particular, a new study suggests that neutron stars can spin only so fast before they begin to emit gravity waves.



In a spin. Millisecond pulsars are spun up by mass transfer from a companion star.
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A millisecond pulsar is a supercompact neutron star, whose spin is highly accelerated by mass transferred from a companion star. That process allows astronomers to probe these objects because when gas slams onto them, they emit a burst of x-rays. Using NASA's Earth-orbiting Rossi X-ray Timing Explorer satellite, an international team of astronomers studied rapid flickerings during a series of bright x-ray outbursts of SAX J1808.4-3658 in October 2002. Confirming expectations, these so-called burst oscillations occurred at the same frequency (401 hertz) as the spin of the millisecond pulsar, which is known to rotate at 24,060 rpm. The oscillations probably result from an X-ray emitting hot spot spinning into view.

"This is the final proof" that burst oscillations betray spin rates, comments Tod Strohmayer of NASA's Goddard Space Flight Center in Greenbelt, Maryland, a pulsar researcher not involved in this work. "The indirect evidence so far has been substantial, but it's great we now have absolute confirmation." If the same relationship holds true for burst oscillations of other accreting millisecond pulsars for which no independent spin rates are known, it appears that neutron stars have a maximum spin frequency of some 760 hertz. That conclusion is based on the fact that faster burst oscillations are never observed, even though continuous mass transfer from the companion star could easily spin a millisecond pulsar to thousands of revolutions per second.

In the 3 July issue of *Nature*, team leader Deepto Chakrabarty of the Massachusetts Institute of Technology in Cambridge and his colleagues suggest the speed limit may be due to a relativistic phenomenon predicted by Albert Einstein. According to this idea, first put forward by Lars Bildsten of the University of California, Santa Barbara, a further increase of rotational energy is offset by energy loss in the form of gravitational waves--propagating spacetime ripples that, according to the theory of relativity, would be produced by any rapidly spinning massive star that isn't perfectly spherical.

--GOVERT SCHILLING

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