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The slowest spinning Galactic-field spider PSR J1932+2121: A history of inefficient mass transfer

The Five-hundred-meter Aperture Spherical Telescope (FAST) has recently discovered hundreds of new pulsars, including an unusual millisecond pulsar (PSR J1932+2121) in a close binary system. Unlike most rapidly spinning millisecond pulsars in compact orbits, this one rotates every 14.2 milliseconds, making it at least two times slower than typical pulsars of its kind in the Galactic field. It orbits its companion every 0.08 days (about 2 hours), and its minimum companion mass is estimated to be 0.12 times the mass of the Sun ($M_\odot$). Based on these properties, it is classified as a redback, a type of pulsar that gradually strips material from its companion through intense radiation.

To understand its unusual properties, we modeled its evolution, including phases of mass transfer and pulsar activity. Our results suggest that PSR J1932+2121 underwent an inefficient mass-transfer phase, meaning it accreted only 30–50% of the material from its companion. This lower accretion efficiency likely explains why it spins more slowly than other redbacks. We also find that its initial orbital period was between 2.0 and 2.6 days, shrinking to its current short orbit over time.

However, one major puzzle remains: its strong surface magnetic field (2×10^9 G) is difficult to explain using current models of how pulsar magnetic fields evolve. This makes PSR J1932+2121 a unique system to study the complex relationship between mass transfer, spin-up processes, and magnetic field evolution in pulsars.

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