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Investigating cannibalistic millisecond pulsar binaries using: New constraints from pulsar spin and mass evolution

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Millisecond pulsars (MSPs) are rapidly spinning neutron stars often found in close binary systems with a companion star. Some of these systems, known as spiders, experience a process where the pulsar's intense radiation gradually strips away material from its companion. These systems are classified into two types: redbacks (RBs), where the companion has a mass between 0.1 and 0.5 times the mass of the Sun ($M_\odot$), and black widows (BWs), where the companion is much lighter, typically less than 0.1 $M_\odot$. We modeled how these binaries evolve, focusing on how mass is transferred from the companion to the neutron star and how the pulsar's radiation affects the system. Our results show that for efficient mass transfer, at least 70% of the material stripped from the companion is accreted by the neutron star. This process can significantly increase the neutron star's mass, with some MSPs in spider systems reaching more than 2.0 $M_\odot$, making them among the most massive neutron stars ever observed. But if a neutron star gains too much mass, it may collapse into a black hole before reaching sub-millisecond spin periods. We also explain why some BWs appear to lack hydrogen in their spectra and show that RBs naturally evolve into BWs over time. Overall, our findings help clarify how MSP binaries evolve and highlight the delicate balance between mass accretion and pulsar radiation in shaping their final states.

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