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Spindown of Pulsars Interacting with Companion Winds

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The spindown of isolated pulsars, both aligned and oblique, has been extensively studied over the past few decades. However, in some binary systems, the interaction of pulsar magnetosphere and the wind from the companion can alter the rate of pulsar spindown. In this study, we use the particle-in-cell method to measure the spindown of pulsars surrounded by relativistic winds from companion stars, where the stand-off distance between the magnetosphere and the shocked wind is well inside the light cylinder of the pulsar. Our results show that the spindown of the aligned component is enhanced due to the confinement of the magnetosphere by the wind, while the oblique component is suppressed due to the mismatch between the pulsar wind stripe wavelength and the waveguide formed by the cavity in the companion wind. This difference from the well-known spindown formula affects the estimate of the surface magnetic field strength in observed pulsar systems. We apply our findings to the double pulsar system PSR J0737−3039, where a normal 2-second pulsar PSR J0737−3039B is thought to be surrounded by a wind produced by its millisecond companion PSR J0737−3039A, with a shock stand-off distance estimated to be 1/3 of its light cylinder. We provide updated estimates of magnetic field strength of PSR J0737−3039B, and discuss the implications for its high energy emission and radio eclipse mapping.

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