Abrupt Changes in Pulsar Pulse Profile Through Multiple Magnetospheric State Switching

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A purely magnetospheric model is introduced for observed abrupt changes in pulsar radio profile. The motion of the magnetospheric plasma is described in terms of a drift frequency, $\omega_{\rm dr}$, that depends on a parameter $0 \leq y \leq 1$, and a change in the magnetospheric state is described by a change in y. Emission is assumed to arise from m spots distributed uniformly around the magnetic axis, so that spots drift by at the rate $m\omega_{\rm dr}$. Observable features, such as subpulses, appear to rotate as $\omega_{\rm R} = m\omega_{\rm dr} - \omega_{\rm V}$. The motion of the visible point, described by the angular frequency $\omega_{\rm V}$ is ignored in a "standard" version of the viewing geometry that assumes a fixed line of sight (rather than a fixed line-of-sight direction), implying $\omega_{\rm V} = 0$. Neglect of $\omega_{\rm V}$ is strictly valid only for $\alpha = 0$; for $\alpha \neq 0$ it is a valid approximation only in a narrow range of pulsar phase ψ about $\psi = 0$, and this range decreases as α increases. With $\omega_{\rm V} \neq 0$, the apparent distribution of emission spots around the trajectory of the visible point is uneven, and the apparent motion of an individual spot is not constant. The apparent density of spots is highest around $\psi = 0$ (the center of the pulse window), where their apparent motion is slowest, allowing more spots to be present simultaneously in the pulse window than in the "standard" version. An abrupt (or more gradual) change in y implies a change in $\omega_{\rm R}$, which affects the pulse structure and profile. For example, a change from smaller y to larger y causes a peak in the profile (at a fixed ψ) to appear to shift to an earlier ψ. We apply the model for profile shifts observed with PSR B0919+06.

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