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Using Phase-resolved Spectral and Energy-dependent Light Curve Modelling of the Vela Pulsar to Scrutinize its GeV Emission Mechanism

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Recent detection of the Vela pulsar in the GeV band up to ∼100 GeV by both H.E.S.S. and the Fermi Large Area Telescope provides evidence for a curved spectral component in this band, distinct from the TeV pulsed emission seen by H.E.S.S. up to ∼7 TeV. We interpret these GeV pulsations to be the result of curvature radiation due to primary particles in the pulsar magnetosphere, primarily the current sheet. We present predictions of energy-dependent light curves and phase-resolved spectra using an extended slot gap and current sheet model in a force-free magnetosphere, invoking a step function for the accelerating electric field as motivated by kinetic simulations. Our refined calculation of the curvature radius of particle trajectories in the lab frame impacts the particle transport and resulting light curves and spectra. Our model reproduces the decrease of flux of the first peak versus the second one (P1/P2 effect), evolution of the bridge emission, near constant phase positions of peaks, and narrowing of pulses with increasing energy. We isolate the distribution of Lorentz factors and curvature radii of trajectories associated with the first and second γ-ray light curve peaks. The median values of these quantities are slightly larger for the second peak, leading to larger spectral cutoffs (i.e., a 'harder' second peak), and thus explaining the P1/P2 effect.

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Collaboration

other Collaboration

Subcategory

Theoretical Results

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