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Phase resolved spectral analysis of 25 millisecond gamma-ray pulsars

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Millisecond pulsars (MSPs) are a growing class of gamma-ray emitters. Spectral analyses of their pulsed emission bring important constraints to the theoretical models which describe the electromagnetic processes responsible for high-energy radiations in pulsar magnetospheres. The gamma-ray data collected during five years of Fermi Large Area Telescope (LAT) observations have allowed in-depth phase resolved spectral analyses of 25 of the brightest objects in the 50 MeV to 170 GeV energy band. The sample exhibits a significant evolutionary sequence in spectral energy distribution of the total pulsed emission. The sequence relates three spectral parameters, namely the spectral index at low energy, the apex energy at which the maximum energy flux is emitted, and the cut-off energy, with the spin-down power of the neutron star. As the latter increases, the spectral energy distribution broadens, softens, and shifts in energy. This evolution is primarily driven by the emission in the caustic peaks. Spectral parameters change with phase present systematic patterns. Pulsars with aligned gamma-ray and radio peaks tend to be particularly luminous and soft. The sequence highlights an important transition in MSP evolution near a spin-down power of 10^{27} W and the possible onset of a soft emission component in addition to curvature radiation. The phase dependence of the radiative efficiency also suggests that multiple emitting regions, with different levels of electric field screening, contribute to the total pulsed gamma-ray emission.

Collaboration

FERMI

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Primary author: RENAULT-TINACCI, Nicolas (Institut d’Astrophysique de Paris)

Co-authors: Dr HARDING, Alice (NASA Goddard Space Flight Center); Prof. GRENIER, Isabelle (Laboratoire AIM Paris-Saclay, CEA/Irfu, CNRS, Université Paris Diderot)

Presenter: RENAULT-TINACCI, Nicolas (Institut d’Astrophysique de Paris)

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