

Understanding the Pulsar Multipolar Field Structure through NICER and Fermi data

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Modeling of the NICER X-ray waveform of the pulsar PSR J0030+0451 aimed to constrain the neutron star mass and radius has inferred surface hot spots (i.e., the magnetic polar caps) that imply significantly non-dipolar magnetic fields. We investigate magnetic field configurations that comprise offset dipole plus quadrupole components using static vacuum field and force-free global magnetosphere models and their inferred hot spots (polar caps). To this end, we compute geodesics from the observer plane to the polar caps to compute the resulting X-ray light curve. Through Markov chain Monte Carlo techniques, we explore the detailed magnetic field configurations that can reproduce the observed X-ray light curve and have discovered degeneracies. Having obtained the force-free field structures, we then compute the corresponding synchronous gamma-ray light curves based on dissipative pulsar magnetosphere models, and we compare these to those obtained by Fermi-LAT to lift the degeneracies and provide models consistent with both the X-ray and the gamma-ray data, thereby restricting further the multipole field parameters. An essential aspect of this approach is the proper computation of the relative phase between the synchronous X- and gamma-ray light curves. The next steps and the broader implications of this study will be discussed.

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