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What NICER tells us about pulsar emission and magnetic fields

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We review the results of the recent modeling of soft thermal X-ray pulsations from the surface of the isolated millisecond pulsar PSR J0030+0451, observed by Neutron Star Interior Composition Explorer. Obtained independently by two research groups (Riley et al. 2019, Miller et al. 2019), the locations and shapes of emitting hot regions can not, to our best knowledge, be reconciled with heating by the magnetospheric currents at the footpoints of open field lines in canonical dipolar models of pulsar magnetic fields. Developing models of physically motivated, non-dipolar magnetic field configurations and the currents that they can support poses a challenging task. However, such models may have profound implications for the interpretation of observational data for many aspects of pulsar research, including pulsar braking, estimates of birth velocities, and multi-wavelength magnetospheric emission.