

APR12-2012-001030

Abstract for an Invited Paper
for the APR12 Meeting of
the American Physical Society

Pulsar Radio Emission Mechanisms: The Crab Enigmas¹

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The Crab pulsar, which resulted from a supernova explosion in year 1054 A. D., has been studied intensely over a wide range of wavelengths, yet it continues to reveal new phenomena that challenge explanation. The emission structures in the radio regime are complex and some may be unique among pulsars. The standard models for pulsar geometry and radio emission physics are reviewed briefly. Their predictions are then compared with observations of the Crab pulsar radio emission and the observations are used to critique the theoretical models from an observer's point of view. The models must explain the extremely short and bright nanopulses (0.4 ns duration implying an equivalent brightness temperature of 10^{42} K), the wide bandwidths of radio emission (at least 0.02 to 46 GHz), the regular banded nature of the high frequency interpulse emission, the complex polarization structure, and the phases of pulsar rotation where emission occurs. So far no comprehensive model satisfies all of the observational discriminants.

¹The author thanks the staffs at the Arecibo and Green Bank Observatories for assistance. Partial support from NSF grant AST-0607492 is gratefully acknowledged.