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Final Technical Report

NASA CGRO Award NAG5-2307
"Gamma Ray Emission From Radio Pulsars"
Term: 8/01/92 - 11/30/94

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While the proposed research recieved partial funding under this grant, during the term of support substantial progress was made on the development of a new model for the emission of γ-rays from isolated rotation-powered pulsars. In phase 1) of the work (Chiang and Romani 1994, following Chiang and Romani 1992), we showed how a modified version of the 'outer gap' model of pulsar emissison could reproduced the double peaked profiles seen in *CGRO* pulsar observations. This work also demonstrated the the spectrum of gap radiation varies significantly with position in the magnetosphere, and produced approximate computations of the emission from outer magnetosphere gap zones, including primary curvature radiation, $\gamma - \gamma$ pair production and synchrotron radiation and inverse Compton scattering by the resulting secondary particles.

This work was followed in phase 2) by a more complete treatment of the geometry of the radiation zone, and improved connections with observations at other wavelengths. In Romani and Yadigaroglu (1995) we computed pulse profiles for individual pulsars, showing that our model produces detailed profiles and radio-gamma ray pulse lags in very good agreement with the data. These sums also produced polarization sweep models for the high energy emission which provide a new and successful interpretation of optical data on the Crab pulsar. This model thus constitutes a substantial advance in our understanding of high energy pulsar emission. In Yadigaroglu and Romani (1995a) we extended this work with a computation of the evolution of gamma ray luminosity with pulsar age, a prediction for the gamma ray flux from individual known radio pulsars and from the entire population and a comparison with the EGRET galactic plane sources. This work showed that EGRET observations are fully in accord with the predictions of our outer gap models and indicated that several new gamma ray pulsars may be detectable in present data. We also (Yadigaroglu and Romani 1995b) examined the possibility that the highly polarized emission predicted by the model might be detectable in careful analysis of data from pair production telescopes, such as the EGRET instrument and future instruments, such as the proposed GLAST system. The Monte Carlo models of the detector tracker response produced in this project allowed us to develop data analysis procedures that markedly

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improve the sensitivity to polarization. While the expected signals are shown to be only marginally detectable in present data, the results guide the design of future missions and show that polarization observations can become a powerful discriminant of pulsar models.

We have reported on this work in the four papers referenced below (re- and pre-prints attached) and in several conference proceedings reports. Talks presenting this work were also given at the AAS HEAD Meeting, the 7th Marcell Grossman meeting, at Goddard Space Flight Center, Max Planck Garching and several university colloquia. We have also produced computer animations of the pulsar model, available at the WWW address (http://geminga.stanford.edu/users/ion/home.html) and adapted for other presentations of EGRET results.

The initial phase of this research formed a large part of the PhD thesis of James Chiang, who is now a post-Doc at CITA. The later phases of work form the core of the thesis of Ion Yadigaroglu. He is continuing with improved modeling of the pulsar high energy gamma-ray spectrum, as well as with computations of lower energy emission and extraction and analysis of related ROSAT and ACSA data. Improved light curves, computer visualizations and pulsar population syntheses are also being provided to the high energy community.

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