

Multifrequency Radio Properties of the Crab Pulsar

David A. Moffett and Timothy H. Hankins

New Mexico Institute of Mining and Technology

1. Introduction

During a single Arecibo observation in 1981 of the Crab pulsar, a profile at 4.7 GHz was recorded which appeared to contain additional components and an interpulse (IP) shifted to earlier phase. The experiment was continued at the VLA, taking advantage of its phased array mode to form a synthesized beam, which resolves out the bright Crab Nebula background. Observations were conducted between February 9 and May 27, 1994, at 0.33, 1.4, 4.9, and 8.4 GHz. Additional radio profiles presented here were recorded at Arecibo (0.43, 0.6, and 4.7 GHz) and Effelsberg (2.7 GHz) by Hankins & Fowler (unpublished).

2. Results

In Figure 1 we have plotted a summary of normalized profiles from several radio frequencies and infrared. The VLA profiles are time aligned, while the rest are aligned to the main pulse (MP). A new component (labeled LFC) appears 36° ahead of the MP between 0.6 and 4.9 GHz, not coincident with the position of the precursor, and with a spectral index similar to that of the MP. The MP disappears at 8.4 GHz, probably due to spectral effects. The IP appears to undergo a transition in phase and flux, disappearing at 2.7 GHz and reappearing 10° earlier at 4.7 GHz with a radically different spectral index. Two high radio frequency components (labeled HFC1 and HFC2) appear at 4.9 and 8.4 GHz, and possibly at the noise level at 1.4 GHz. They have flatter spectral indices than the MP and IP and their centroid phase changes with respect to the MP – moving to later phase with increasing frequency. The infrared profile exhibits a “bump”, or third component near the same phase as HFC1 and HFC2.

3. Conclusions

New components of the Crab pulsar have been discovered in a multifrequency study of profiles between 0.33 and 8.4 GHz. The average profiles show a strange, frequency-dependent behavior, not easily explained by emission from a dipolar field geometry. The phase asymmetry and surprising number of components may correspond to emission from regions in the magnetosphere not associated with the normal component's emission zones: perhaps from quadrupole fields near the surface or from near the outer gap.

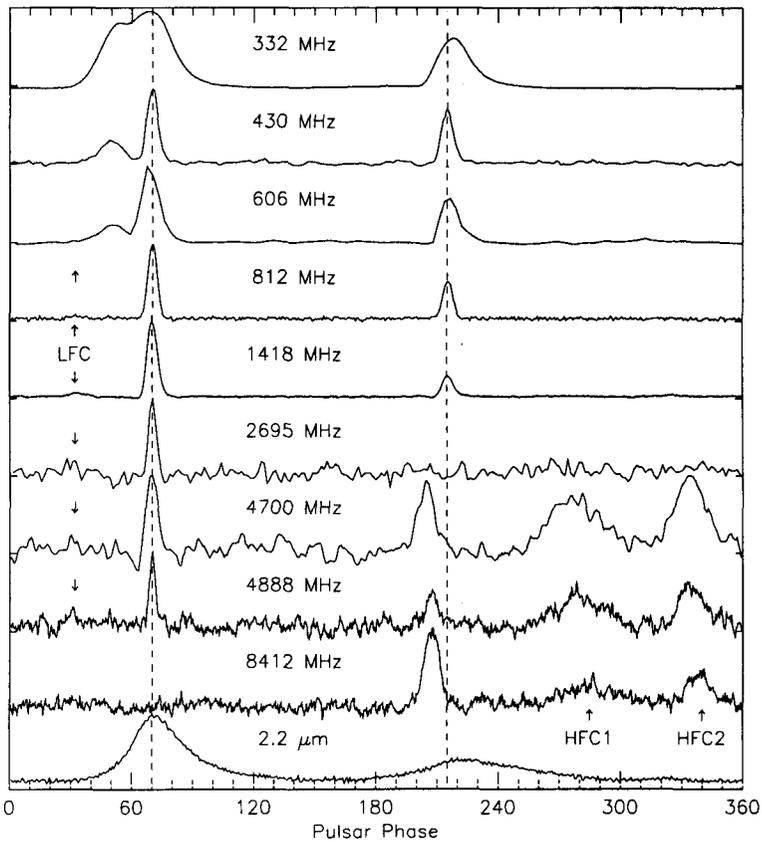


Figure 1. A summary of Crab Pulsar profiles. 332, 430, 606, 1418, 2695, 4700, 4888 and 8412 MHz: this work; 812 MHz, 2.2 μm : Lundgren, Cordes, & Beckwith (1995)

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References

Lundgren, S. C., Cordes, J. M., Beckwith, S. V. W. 1995, private communication.