Millisecond Pulsars:
Decoding Magnetospheres

by

Shauna Michele Sallmen

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Committee in charge:

Professor Donald C. Backer, Chair
Professor Jonathan A. Arons
Professor Robert Lin

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Abstract

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A hollow-cone model explains the pulse profile morphology and polarization properties of long-period (1 second) pulsars. The radio emission originates in the open-field line region above the polar cap, which is larger in millisecond pulsars. The emission in these rapidly rotating objects may occur at altitudes which rotate at a speed closer to that of light. Relativistic effects and magnetic field distortions may therefore be more important. Pulse profile studies of millisecond pulsars indicate that the long-period pulsar classification system fails to account for the properties of these objects.

Multi-frequency polarization observations with high temporal resolution are presented for several millisecond pulsars. Secure classification of the pulse profile morphology remains elusive for many objects. Pulse components are narrower than expected, and the spectral behaviour makes core and cone component identification uncertain. The fractional polarization of these objects remains relatively constant with frequency, in contrast to the behaviour of slow pulsars. The polarization position angle curves are similar at all frequencies, suggesting that they are geometric in origin. Their small slopes can be reconciled with the results for long-period pulsars by a simple period-scaling of the pulsar magnetosphere. Long-term variations in the intensity and polarization profiles are observed; polarization variations are seen more frequently in millisecond pulsars than in slow pulsars.

Single pulses studies of normal pulsars revealed the phenomenon of microstructure - radio emission on very short time scales. This modulation may be due to either an angular or a temporal effect. In the former case, it would be expected to scale with pulse period. Giant pulses in the Crab pulsar dominate the emission at some radio frequencies. Simultaneous dual-frequency observations of these pulses reveal that the emission mechanism must be broadband. Both temporal and angular models can account for the modulation. Giant pulses are also seen in PSR B1937+21. These are unexpectedly delayed relative to the average pulse peaks, and are difficult to explain in an angular model. Single-pulse observations of PSR B1534+12 also reveal no evidence for microstructure which scales with pulse period, although an angular beaming origin for the intensity modulation cannot be ruled out.

This dissertation is dedicated to

John Sallmen	Lawrence Bostwick
Gertrude Sallmen	Irene Bostwick

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'Cause you know that -
People like you help people like me go on, go on
People like you help people like me go on, go on
People like you help people like me go on, go on, go on

"People Like You" by Bob Bossin

There are many people to thank, and it is hard to know where to begin. Except that this thesis could not have been completed without the cooperation, encouragement, and candy-making of my husband Steve, who takes me as I am.

Who I am today results from my family and my past. So I would like to thank my parents for encouraging me to always do my best, and Mrs. Buchwitz, for her patience with capricious five-year-olds. My brother Mark showed me that a thesis can take a long time, but still be done! All my aunts, uncles, and cousins bring warm memories to mind, while the courage of my grandparents gives me strength. Meanwhile Sarah keeps me tied to my roots, and encourages freedom in life.

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It's teamwork
I couldn't make it on my own
It takes teamwork...
"Teamwork" by Tamarack

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