Chapter 6

Conclusions

In this thesis we have addressed problems concerning the shape of radio pulsar emission beams, evolution of multipolar magnetic fields in isolated neutron stars as well as the effect of magnetic multipoles on the polarization characteristics of pulsar radio emission. We have also studied the scattering of pulsed radio signals due to the inhomogeneties in the interstellar medium. The main conclusions of our study are as follows:

(a) From our analysis of the shape of radio pulsar beams, we find that the beams follow a nested cone structure with at least three distinct cones of emission, although not all cones may be active in a given pulsar.

The emission cone is found to be illuminated in the form of an annular ring of width typically about 20% of the cone radius.

The shape of the beam is found to he independent of the pulse period (P). The overall size of the beam scales as $P^{-0.5}$ as expected from the notion of dipolar field lines.

(b) Our investigation of the evolution of multipolar magnetic fields in isolated neutron stars suggest that except for multipoles of very high order ($l \gtrsim 25$) the evolution would be similar to that of a dipole. If the illumination pattern of tho pulse emission cone is determined by magnetic multipole structures, then no significant evolution is expected in the pulse shape of isolated radio pulsars due to the evolution of the multipole structure of the magnetic field.

(c) Existence of strong multipolar components of the magnetic field in the region

where pulsar radio emission originates can give rise to kinks in the sweep of the position angle of the linearly polarized radiation through the pulse. This effect is expected to result in a frequency dependence of the shape of the position angle sweep curve. Using high-resolution polarization observations at several frequencies, we investigate this effect for PSR B0329+54. We do find evidence of a frequency dependence of the position angle sweep curve, and of kinky features at high frequencies ($\geq$ 2.7 GHz) which could be attributed to the presence of at least a quadrupolar component of the magnetic field at the emission region.

(d) We report measurements of scatter broadening (τ_{sc}) of 48 pulsars at 327 MHz using the Ooty Radio Telescope. We significantly improve on the available set of τ_{sc} measurements for pulsars with dispersion measure (DM) in the range 100 to 250 pc cm^{-3}. The observed correlation between τ_{sc} and DM is found to follow that expected from a Kolmogorov spectrum of irregularities, but only at DM $<$ 100 pc cm^{-3}. At higher DMs significant departures from this are observed. Our measurements of τ_{sc} for pulsars in the direction Gum Nebula suggest that a portion of the nebula, known as the IRAS Vela shell, is characterized by a different fluctuation parameter compared to the rest of the nebula.

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