PULSAR POLARIZATION LIMITING RADII AND THE EVOLUTION OF PULSAR BEAMS

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ABSTRACT. We estimate the polarization limiting radius, r_{pl}, as a function of rotation period P, magnetic field strength B, and radio frequency ν, in radio pulsars assuming plasma parameters that are typical of polar-cap pair-creation models of pulsars. We find that $r_{pl} \simeq 9 \times 10^8 (P/1s)^{0.4}$ cm, for a surface magnetic field strength of 10^{12} G, and radio frequency of 10^9 Hz. For short rotation periods, r_{pl} approaches the light cylinder radius, r_{lc}. Here the magnetic field becomes more azimuthal, and the excursion in position angle over a pulse is less, on average, than when $r_{pl} << r_{lc}$. With the assumption of a vacuum magnetic field we calculate the polarization position angle as a function of pulse longitude, and the angles i (the angle between the magnetic moment and the rotation axis) and α (the angle between the line of sight and the rotation axis). We calculate the average change in polarization angle as a function of pulsar period, assuming a circular beam, and find consistency with the polarization data summarized by Narayan and Vivekand (1983). We conclude that the evidence is consistent with beams that are roughly constant in shape, providing an alternative to the evolving elliptical beam model of Narayan and Vivekand (1983). This interpretation is further supported by the frequency dependence of the polarization angle in the Crab Pulsar, the frequency of pulsars with double and multiple pulse components, the frequency of pulsars with interpulses, and the absence of pulsars in plerions. See Barnard (1986) for further details.

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REFERENCES

Barnard, J.J.: 1986, Astrophys. J., 303, p. 280.
Narayan, R. and Vivekanand, M.: 1983, Astron. Astrophys., 122, p. 45.

D. J. Helfand and J.-H. Huang (eds.), The Origin and Evolution of Neutron Stars, 56.