MULTIFREQUENCY POLARIZATION OBSERVATIONS OF INTEGRATED PULSE PROFILES

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ABSTRACT

Polarization observations of integrated pulse profiles have been made in seven frequency ranges between 170 MHz and 2700 MHz. Forty-nine pulsars have been observed at three or more of these frequencies. The frequency variation of the degree of linear and circular polarization is discussed for these pulsars.

INTRODUCTION

The 64m radiotelescope at Parkes has been used to make a series of observations of the polarization characteristics of integrated pulse profiles. Observations have been made in seven frequency ranges near 170 MHz, 270 MHz, 400 MHz, 630 MHz, 950 MHz, 1612 MHz and 2700 MHz. A total of 76 different pulsars have been observed, 49 of these at three or more frequencies. The observations at 400 MHz, 630 MHz and 1612 MHz have been reported previously (Hamilton et al. 1977; McCulloch et al. 1978; Manchester et al. 1980). Similar observing techniques and equipment which have been discussed in detail in the above papers were used at each frequency. We recorded the four Stokes parameters simultaneously taking particular care to eliminate spurious instrumental polarization.

OBSERVATIONS

We have examined the frequency dependence of both the average degree of linear polarization and circular polarization for the 49 pulsars. The majority of the sample, 33, conform to the pattern reported by Vitkevich and Shitov (1970) and Manchester et al. (1973) in that the fractional linear polarization is constant or decreases with increasing frequency. The remaining 16 pulsars do not appear to conform to the simple behaviour described by Manchester et al. (1973). For ten of these the fractional polarization has a maximum. In four pulsars the

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fractional linear polarization is seen to increase monotonically with increasing frequency. For two of these, PSR 0833-45 and PSR 1641-45, the reduction in polarization at lower frequencies may be attributed to the depolarizing effects of interstellar scattering, as both are very strongly scattered at low frequencies. However, there remain two pulsars in this group including PSR 1818-04, and many in the group of ten which have a maximum in the polarization for which scattering does not provide an adequate explanation. The apparent low-frequency depolarization could be produced by the change in relative contribution of polarized and unpolarized components to the overall profile which accompany changes in pulse shape; but no pulse shape changes are seen in many of these pulsars. Depolarization can also result from the overlapping of orthogonal emission modes. However, this effect appears to be more common at higher frequencies (Manchester et al. 1980).

About 80% of the pulsars show some circular polarization at most frequencies. In about half these pulsars the sense of this circular polarization remains the same at all frequencies; in a third the degree of circular polarization is small but the sense changes with frequency. For PSR 0835-41 the circular polarization averages about 25% and is considerably stronger than the linear polarization at frequencies below 1 GHz. In a number of pulsars the sense of circular polarization reverses abruptly part way through the profile. For PSR 2020+28 Cordes et al. (1978) find that a change in the sense of circular polarization accompanies a sharp 90° change in position angle and a null in the degree of linear polarization, and can be explained in terms of a switch between dominant orthogonal polarization modes. The question arises as to whether the changes in the sense of circular polarization with frequency are similar mode changes. This would imply a complete shift of 90° in their position angle curves. We have analysed our data to determine rotation measures and find no evidence for 90° discontinuities in position angle for these pulsars, nor do we see any nulls in the degree of linear polarization which might be expected to accompany such mode changes.

REFERENCES

Cordes, J.M., Rankin, J.M., and Backer, D.C.: 1978, Astrophys. J. 223, p. 961.

Hamilton, P.A., McCulloch, P.M., Ables, J.G., and Komesaroff, M.M.: 1977, Mon. Not. R. Astr. Soc. 180, p. 1.

McCulloch, P.M., Hamilton, P.A., Manchester, R.N., and Ables, J.G.: 1978, Mon. Not. R. Astr. Soc. 183, p. 645.

Manchester, R.N., Taylor, J.H., and Huguenin, G.R.: 1973, Astrophys. J. Letters 179, p. L7.

Manchester, R.N., Hamilton, P.A., and McCulloch, P.M.: 1980, Mon. Not. R. Astr. Soc. 192, p. 153.

Vitkevich, V.V. and Shitov, Yu.P.: 1970, Nature 226, p. 1235.

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