RADIO RADIATION CHARACTERISTICS OF PULSARS AND MAGNETIC DIPOLE ANGLE

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The structure of the pulsar magnetosphere, the location of the radio emission region and the radio emission mechanism are important theoretical subjects in the research of pulsars. There may be close relations between these subjects. Nevertheless, it should be possible to set up some empirical relations among them which can be considered as a foundation for studying these important subjects. In this paper some of these relations are studied.

Using subpulse widths published by Ferguson (1977) a correlation is found between the subpulse width and the magnetic dipole angle, i.e.

$$\log \theta_p = -1.69 - 0.23 \log (C \sin^2 \alpha) .$$

The correlation coefficient is -0.54, where θ_p is the angular width of the subpulses and α is the magnetic dipole angle. Taking into account the effect of magnetic decay, we get $\sin \alpha = CP\dot{P}e^{\xi t}$ where $\dot{P} = dP/dt$, ξ is the parameter of magnetic decay (Qu et al. 1976) and C is a constant. The above statistical result seems to be in good agreement with the theoretical work of Henry and Park (1969). The difference in the power of $\sin \alpha$ may be due to scatter in the measured beam widths due to different lines of sight.

Using the integrated pulse widths of 56 pulsars (Backer 1976) we find that $\log \theta_p$ is neither correlated with log P nor with $\log \sin \alpha$. A possible reason is that the summation of pulses for hundreds of periods wipes out the characteristics of basic radiation processes. But it is interesting that $\log (\theta_p/P)$ significantly correlates with $\log \sin \alpha$, i.e.

$$\log (\theta_p/P) = 1.86 - 0.53 \log (C \sin^2 \alpha) .$$

The correlation coefficient is -0.55. In particular, if we take out a few young pulsars from the analysis, the correlation coefficient will be more than 0.70. A possible explanation of this strong correlation is that the number of subpulses tends to increase with the period of pulsars.

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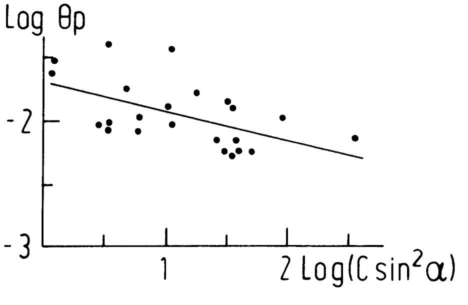

Fig. 1: The statistical relation between log θ_p and log (C $\sin^2 \alpha$)

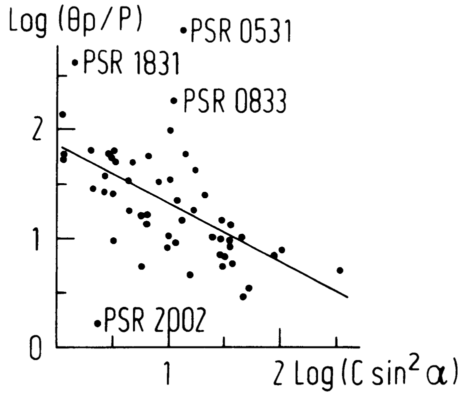

Fig. 2: The statistical relation between log (θ_p/P) and log (C $\sin^2 \alpha$)

A correlation between magnetic dipole angle and the maximum rate of the swing of polarization position angle for 24 pulsars is obtained, i.e.

$$\log\,(\partial\psi/\partial\phi)_{max} = 0.45 + 0.41 \log\,(C \sin^2 \alpha) .$$

The correlation coefficient is 0.60, i.e. similar to the value obtained by Lyne and Smith (1979), where the magnetic decay had been considered.

It can be seen from the above statistical analyses of radio radiation characteristics of pulsars that the magnetic dipole angle plays an important role in the correlations. It seems as if emission comes from the open field line region above the magnetic pole but not from the surface polar region of neutron stars. The emission region may be situated at a distance proportional to that of the light cylinder.

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