What determines the inclination angle of radio pulsars

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If one can describe a pulsar spin-down as a sum of magnetic dipole braking and current momentum losses (in the regime of free electron emission) then the angle χ between the magnetic dipole axis and the spin axis comes to an equilibrium state at $\chi \approx 45°$. This equilibrium is stable. It is important that the shape of a pulsar tube cross section depends on χ.

Taking into account a nondipolar magnetic field at the neutron star surface (near the polar cap) we can decrease the current in a pulsar tube which decreases χ. We will characterize deviations from the dipole magnetic field by the ratio ν of the nondipolar to dipolar magnetic fields components at the polar cap. By changing this parameter from $\nu = 0$ to $\nu = 0.8$, we can change the equilibrium angle from $\chi \approx 45°$ to $\chi = 0°$. The majority of pulsars have angles $\chi \sim 10° - 30°$. In our model, they correspond to $\nu \sim 0.7 - 0.8$. We can assume that the pulsars with $\chi \sim 45° - 80°$ were born close to orthogonal state; their angles have already reached equilibrium values.

It is interesting that pulsars with a nondipolar magnetic field and certain values of χ may have the negative Goldreich-Julian density near polar cap surface. In this case, the pulsar diode must be placed close to the zero charge density point (at the altitude of $0.01 - 0.2$ of the neutron star radius). The tube below the diode is filled by unmoving positively charged particles, like the area of close magnetic field lines. They create a potential barrier for electrons, that prohibits the normal free charge emission current in the pulsar diode and allows only a weak thermo-emission electron current. As a result, the diode begins to mimic the Ruderman-Sutherland regime diode, with possible generation of sparks.

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