THE MAGNETIC FIELDS OF PULSARS

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Abstract. Two generation mechanisms of magnetic fields in pulsars are considered.

If the temperature of a star is more than 10^8 K, the star consists of a normal fluid of neutrons, protons and electrons. Because the angular velocity of pulsars is not constant $d\Omega/dt \neq 0$, inertia effects can occur, and generate magnetic fields through the relative motion of charged particles with different masses. The kinematic viscosity of electrons is 30 times larger than that of protons; hence electrons move with the crust, but the proton-neutron fluid will move relative to the electrons. The magnetic momentum can be calculated by the following formula

$$\mathbf{M} = \frac{4\pi M_{\text{eff}} \cdot R^5 \sigma}{15ce} \frac{d\boldsymbol{\Omega}}{dt}, \tag{1}$$

where $M_{\text{eff}} = M_p + M_n(N_n/N_p)$, R = radius of the star, σ = conductivity. For typical neutron stars we have $d\Omega/dt \sim 10^{-8}$ s^{-2}, $R \sim 10^6$ cm, $\sigma \sim 10^{29}$ s^{-1} and we get a magnetic field of the order of 10^{10} G.

The second mechanism appears when the neutrons and protons are a rotating superfluid, while the electrons are still normal. This produces an additional motion of the protons relative to the electrons. The magnet moment can be calculated by the formula

$$M = \frac{3\mu_B}{4} N_p \ln b/a, \tag{2}$$

where μ_B is Bohr's magneton for protons, N_p is the total number of protons in a neutron star and $\ln b/a \sim 10$, where a is the radius of the core of the vortex, b is a radius of vortex. For neutron Stars $N_p \simeq 10^{54}$ and we get the magnetic field of the order of 10^{14} G.

Reference

Landau, L. D. and Lifshitz, E. M.: 1957, *Electrodynamics of Continuous Media* Addison-Wesley, Reading, Mass., U.S.A.

C. DeWitt-Morette (ed.), Gravitational Radiation and Gravitational Collapse, 187.