

Nuclear spin polarization and strong magnetic fields in astrophysics

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The research is done according to the suggestion of V.G. Baryshevsky and V.V. Tikhomirov. Since existence of nuclear pseudomagnetic field [1, p. 55] is confirmed experimentally, there is a possibility of spontaneous spin polarization of nucleons at high densities, and it can affect magnetic fields B in astrophysics. We consider Stoner criterion [2, p. 187, 198], beta-equilibrium equation and Fermi-liquid approach [3] for degenerate neutron-proton-electron system. $\alpha = (n_n - n_p)/(n_n + n_p)$ is isospin asymmetry parameter (n_n, n_p are nucleon densities).

Table 1 - Nucleon or nucleon-electron system at different conditions.

Examples	Where	α	chemical equilibrium	$T = 0$ K approximation
White dwarfs	under H-envelopes	≈ -1	is necessary	is good
Type II SNae	in ejected mass	≈ 0	is not necessary	is bad
Neutron stars	in liquid cores	≈ 1	is necessary	is good

Table 2 - Numerical values of B (examples of calculations and observations).

Objects	$n_n + n_p, \text{fm}^{-3}$	$B, \text{Gs (calc.)}$	$B, \text{Gs (observ.)}$
White dwarfs	$\sim 10^8$	the results are not reliable	$\sim 10^4 - 10^8$
Type II SNae	~ 0.002	$\sim 10^{11}$?
Neutron stars	$\sim 0.1 - 0.2$	$\sim 10^{14}$	$\sim 10^{10} - 10^{14}$

It is possible that the age of white dwarfs with $B \sim 10^8$ Gs is $\ll 10^5$ years (the time of hydrogen burning) when the probability of nuclear spin polarization is higher. Magnetic fields of Type II Supernovae can affect further nucleosynthesis.

[1] V.G. Baryshevskii. *Nuclear Optics of Polarized Media* [in Russian]: Moscow, Energoatomizdat (1995).

[2] L.S. Levitov, A.V. Shitov. *Green Functions* [in Russian]: Moscow, Fizmatlit (2003).

[3] A.A. Isayev, J. Yang. *Spin polarized states in nuclear matter with Skyrme effective interaction*: arXiv: nucl-th/0403059 v1 20 Mar 2004.