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Neutrino eigenstates and flavour, spin and spin-flavour oscillations in a constant magnetic field

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We further develop a recently proposed new approach to the description of the relativistic neutrino flavour $\nu_e^L \leftrightarrow \nu_\mu^L$, spin $\nu_e^L \leftrightarrow \nu_e^R$ and spin-flavour $\nu_e^L \leftrightarrow \nu_\mu^R$ oscillations in a constant magnetic field that is based on the use of the exact neutrino stationary states in the magnetic field. The neutrino flavour, spin and spin-flavour oscillations probabilities are calculated accounting for the whole set of possible conversions between four neutrino states. In general, the obtained expressions for the neutrino oscillations probabilities exhibit new inherent features in the oscillation patterns. It is shown, in particular, that: 1) in the presence of the transversal magnetic field for a given choice of parameters (the energy and magnetic moments of neutrinos and the strength of the magnetic field) the amplitude of the flavour oscillations νLe↔νLμ at the vacuum frequency is modulated by the magnetic field frequency, 2) the neutrino spin oscillation probability (without change of the neutrino flavour) exhibits the dependence on the mass square difference Δm2. It is shown that the discussed interplay of neutrino oscillations in magnetic fields on different frequencies can have important consequences in astrophysical environments, in particular in those peculiar for magnetars.

Author: POPOV, Artem (MSU)

Co-author: STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))

Presenter: POPOV, Artem (MSU)

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