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Neutrino oscillations and decoherence in astrophysical environments

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A number of current and future neutrino experiments are devoted to the detection of astrophysical neutrinos. Neutrino interactions with dense matter and strong magnetic fields peculiar to astrophysical environments, such as supernova explosions, are expected to cause considerable effects in the neutrino flavour evolution. One of the interesting effects is damping of the neutrino oscillations due to the neutrino wave packets separation. We develop the wave packet description of neutrino oscillations in astrophysical environments. It is shown that the damping of neutrino helicity transitions caused by their interactions with a magnetic field can occur during supernova explosions. We emphasize the difference between Dirac and Majorana neutrinos. CP-violating effects are also considered.

Based on: [1] A.Popov, A.Studenikin, “High-energy neutrinos flavor composition as a probe of neutrino magnetic moments”, Phys.Rev.D 111 (2025) 12, 123001. [2] A.Popov, A.Studenikin, A.Tcvirov, “Wave packet description of Majorana neutrino oscillations in a magnetic field”, arXiv:2602.02804. [3] A.Popov, A.Studenikin, “Manifestations of nonzero Majorana CP-violating phases in oscillations of supernova neutrinos”, Phys.Rev.D 103 (2021) 11, 115027.

Primary author(s) : POPOV, Artem (Moscow State University)

Co-author(s) : Dr. STUDENIKIN, Alexander (MSU)

Presenter(s) : POPOV, Artem (Moscow State University)

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