Contribution ID: **318** Type: **Oral**

Neutrino magnetic moments and high-energy neutrinos flavour composition

Wednesday 3 July 2024 15:50 (15 minutes)

Neutrino propagation in the Galactic magnetic field is considered. To describe neutrino flavour and spin oscillations on the galactic scale baselines an approach using wave packets is developed. Evolution equations for the neutrino wave packets in a uniform and non-uniform magnetic field are derived. Analytical expressions for neutrino flavour and spin oscillations probabilities accounting for damping due to wave packet separation are obtained for the case of uniform magnetic field. It is shown that for oscillations on magnetic frequencies $\omega_i^B = \mu_i B_\perp$ the coherence lengths that characterizes the damping scale is proportional to the cube of neutrino average momentum p_0^3. Probabilities of flavour and spin oscillations are calculated numerically for neutrino interacting with the non-uniform Galactic magnetic field. Flavour compositions of high-energy neutrino flux coming from the Galactic centre are calculated accounting for neutrino interaction with the magnetic field. It is shown that for neutrino magnetic moments $\sim 10^{-13}\mu_B$ and larger these flavour compositions significantly differ from ones predicted by the vacuum neutrino oscillations scenario.

Based on:
1) A.Popov, A.Studenikin, "High-energy neutrinos flavour composition as a probe of neutrino magnetic moments", arXiv: https://arxiv.org/abs/2404.02027.
2) A.Popov, A.Studenikin, Manifestations of nonzero Majorana CP-violating phases in oscillations of supernova neutrinos, Phys.Rev.D 103 (2021) 11, 115027.
3) A.Popov, A.Studenikin, Neutrino eigenstates and flavour, spin and spin-flavour oscillations in a constant magnetic field, Eur.Phys.J.C 79 (2019) 2, 144.

Section

Neutrino physics and nuclear astrophysics

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Session Classification: Neutrino physics and nuclear astrophysics