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A comparative study of Dirac and Majoarana ultrahigh-energy neutrino oscillations in an interstellar magnetic field

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One of the important developments in the field of neutrino astrophysics is a search for ultrahigh-energy (UHE) cosmic neutrinos (even above PeV–EeV energies), which are believed to be produced by reactions of UHE cosmic rays composed of protons and nuclei. These neutrinos can be detected with neutrino telescopes, such as IceCube, ANTARES, Baikal-GVD, and KM3NeT, and are expected to provide information about cosmic accelerators and the high-energy, distant universe. One of the major advantages of exploring the UHE neutrinos as astrophysical messengers is supposed to be their ability, as opposed to the case of charged particles, of traveling in straight lines in magnetic fields in space. This feature allows one to point back their intensively energetic sources in the sky, including active galactic nuclei, supernovae and associated phenomena like γ-ray bursts, and compact objects such as black holes and neutron stars. At the same time, even though neutrinos are generally believed to be electrically neutral particles they can still have nonzero magnetic moments [1]. This means that the propagation of the UHE cosmic neutrinos can be influenced by interstellar magnetic fields due to the effect of spin oscillations [2]. In this contribution we examine the UHE neutrino propagations in interstellar space in the Dirac and Majorana cases. Employing the two-neutrino mixing approximation and using the most stringent astrophysical constraints on neutrino magnetic moments, we show that both the flavor and the spin oscillations of the Dirac and Majorana neutrinos exhibit qualitatively different behaviors in an interstellar magnetic field for neutrino-energy values characteristic of, respectively, the cosmogenic neutrinos, the Greisen-Zatsepin-Kuz'min (GZK) cutoff, and well above the cutoff.

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