IAF SYMPOSIUM ON ONGOING AND NEAR FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Science Goals and Drivers for Future Exoplanet, Space Astronomy and Space Physics (2)

Author: Prof.Dr. Vali Huseynov
Azerbaijan National Academy of Sciences, Azerbaijan, vgusseinov@yahoo.com

DETECTION POSSIBILITY OF COSMIC RELIC NEUTRINO SIGNALS AND GATE TO CONSTRUCTION OF RELIC NEUTRINO TELESCOPE

Abstract

Since relic neutrinos are weakly interacting neutral particles and were participants and witnesses to events in the Universe 13.6 billion years ago, they are one of the most important sources of invaluable information on the early Universe.

We investigate the scattering of cosmic relic neutrinos by transversely polarized ultra-relativistic electrons in an external constant homogeneous magnetic field by application of the exact wave function method and the Feynman diagram technique and calculate the cross-section of the considered process. It is determined that when the magnetic field strength is in the range $1000 - 100000\ G$, the spins of the electrons (in the final state) have a certain polarization with respect to the direction of the magnetic field and the electrons (that do not have a momentum component in the direction of the magnetic field at the beginning of the reaction) receive a recoil momentum in the direction of the magnetic field. The possibility of determination of the transverse polarization of the spins of the electrons in the final state and the fact that the third component (that is directed along the magnetic field) of the electron momentum is a conserved and measurable quantity, enable us to evaluate the detection of relic neutrinos quantitatively.

Numerical estimations show that in the presence of the magnetic field of the strength of order 100000 G and ultra-relativistic electrons with energies greater than 158.67 MeV, the cross-section of the process is at least 100000 trillion times greater than the cross-section of the corresponding process in the absence of a magnetic field. This means that the mean free path of relic neutrinos decreases at least 100000 trillion times and it becomes at most 100000 trillion km (100000 ly). Taking into account the size of our Galaxy and the distance from the Earth to the center of our Galaxy, we can conclude that detection of relic neutrino signals from the central parts of our Galaxy, as well as from the depths of outer space beyond the boundaries of our Galaxy, becomes a reality. Numerical estimations show that it is possible to record at least thousands of collisions during one year in the detector having a few cubic meters of the total working volume.

Thus, the results of the presented investigations open the gate for the construction of a relic neutrino telescope that has great advantages and capabilities over optical and other telescopes and becomes a unique instrument for remote space exploration.