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The DCBA experiment searching for neutrinoless double beta decay

Neutrinoless double beta decay (0nuBB) takes place when neutrinos are Majorana neutrinos, which are essential in the so-called seesaw mechanism to describe the reason why existing neutrinos are so light. Heavy parts of Majorana neutrinos in the seesaw mechanism play important roles in the theory of Leptogenesis to explain the asymmetry of matter and anti-matter in the early universe. The observation of 0nuBB would be an evidence of the seesaw mechanism and the Leptogenesis. In the DCBA (Drift Chamber Beta-ray Analyzer) experiment, we measure the momentum and obtain the kinetic energy of individual beta ray of double beta decay from Nd-150 or Mo-100 by drift chamber trackers installed in a uniform magnetic field. The particle identification ability of the magnetic trackers is useful to eliminate backgrounds such as alpha particles, positrons and cosmic rays. A prototype called DCBA-T2 has been constructed and now in the engineering operation with thin plates of natural Mo, which includes 9.6% Mo-100. We have several candidates of two neutrino double beta decay events. The energy resolution has been measured using internal conversion electrons from Bi-207 and about 150 keV (FWHM) has been obtained around 1 MeV. This is corresponding to the sum energy resolution of 6.5% (FWHM) at the Q-value of Nd-150 (3.37 MeV). For improving energy resolution, we are now constructing another prototype DCBA-T3. Its energy resolution is estimated to be less than 5% (FWHM) at 3.37 MeV by simulation studies using Geant4. In order to study the effective neutrino mass down to 0.05 eV, a future plan temporarily called Magnetic Tracking Detector (MTD) is designed on the basis of DCBA-T2 and T3.

Summary

Majorana neutrinos are postulated in both theories of neutrinoless double beta decay (0nuBB) and seesaw mechanism. The observation of 0nuBB would be an evidence of the seesaw mechanism, and support the Leptogenesis scenario of early universe. The DCBA experiment measures kinetic energy of individual beta ray in 0nuBB with powerful background rejection capability. A prototype called DCBA-T2 is in the engineering operation, and another one DCBA-T3 with better energy resolution is under construction. For the future project, MTD is designed on the basis of DCBA-T2 and T3 in order to study the absolute mass scale of Majorana neutrino down to 0.05 eV.

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