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Development of Scintillating Bolometers for Neutrinoless Double Beta Decay of Ca-48

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The observation of neutrino-less double beta decay (0νββ) would be the most practical way to prove the Majorana nature of the neutrino and lepton number violation. CANDLES studies Ca-48 double beta decay using CaF₂ scintillator. The detector is currently operating with CaF₂ crystals in the Kamioka underground observatory, Japan.

As a next generation detector of the CANDLES experiment, we develop a simultaneous detection method for heat and light signals from CaF₂ crystals at mK temperatures. The simultaneous detection using a scintillating bolometer is advantageous for 0νββ search experiments because of its good energy resolutions and strong particle identification capability.

As an R & D of the project, we carried out low temperature experiments with both CaF₂(pure) and CaF₂(Eu) scintillation crystals using metallic magnetic calorimeter (MMC) technology.

We achieved simultaneous measurement of heat and light signals from a CaF₂ crystal for the first time. The signals associated with electron/gamma events were also distinguishable from internal alpha events in the crystal.

We also found ultraviolet scintillation of CaF₂(pure) was absorbed in the gold film on the crystal surface resulting in a part of heat signal. The gold film was designed as a phonon collector for the heat channel. This heat signal contribution from light absorption in the phonon-collector film affects the measured energy resolution of about 2% but with some improvement possibility from pulse shape analysis. On the other hand, another set of measurement was made using a CaF₂(Eu) which has scintillation in visible region. Improved resolutions and discrimination power were obtained. In the presentation, we discuss the measurement results using both CaF₂(pure) and CaF₂(Eu) crystals together with future plans for 0νββ applications.

Less than 5 years of experience since completion of Ph.D

N

Student (Ph.D., M.Sc. or B.Sc.)

N

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