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Status of ⁴⁸Ca double beta decay search with CANDLES

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Neutrino-less double beta decay ($0\nu\beta\beta$) is acquiring great interest after the confirmation of neutrino oscillation which demonstrated nonzero neutrino mass. Measurement of $0\nu\beta\beta$ can provide a test for the Majorana nature of neutrinos and gives an absolute scale of the effective neutrino mass.

The CANDLE project is the challenge to discovery of ⁴⁸Ca $0\nu\beta\beta$. Among double beta decay nuclei, ⁴⁸Ca has an advantage of the highest $Q_{\beta\beta}$ -value (4.27 MeV). This large $Q_{\beta\beta}$ -value gives a large phase-space factor to enhance the $0\nu\beta\beta$ rate and the least contribution from natural background radiations in the energy region of the $Q_{\beta\beta}$ -value. Therefore, good signal to background ratio is expected in a $0\nu\beta\beta$ measurement.

In order to search for $0\nu\beta\beta$ of 48 Ca, we have constructed the CANDLES-III system by using CaF₂ scintillators at the Kamioka underground laboratory, ICRR, the University of Tokyo. The CANDLES-III system aims at a high sensitive measurement by a characteristic detector system. The system realizes a complete 4π active shield by immersion of the CaF₂ scintillators in liquid scintillator. The active shield leads to a low background condition for the measurement. And we have also installed a shielding system in the CANDLES-III system to reduce background events by the high energy γ -rays, which were emitted from neutron capture reaction on surround materials. By the system, we reduced the background events from neutron capture by two orders of magnitude. After this upgrade, the system has achieved low background measurement with background level of 10^{-3} events/keV/yr/(kg of $^{nat.}$ Ca) at the Q_{ββ}-value. This is comparable or less than those of other sensitive experiments for double beta decay. Based on the result, we also started development for a next generation detector system for 48 Ca double beta decay measurement. In this system, we will use a CaF₂ scintillating bolometer and enriched 48 Ca.

In this paper, we will report result of 48 Ca double beta decay measurement by the CANDLES-III system and current status of the CaF₂ scintillating bolometer and enrichment of 48 Ca.

Primary authors: UMEHARA, Saori; CANDLES COLLABORATION; LIS COLLABORATION

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