【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Mathematical and physical sciences)

Title of Project： Study of double beta decay of 48Ca

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Research Area：Particle/Nuclear/Cosmic-ray/Astro physics
Keyword：Nuclear physics (experiment)

【Purpose and Background of the Research】

Almost all substance of the universe is made of "matter". On the other hand, we know the existence of a partner called its "antimatter". At the beginning of the universe, the amount of "antimatter" is the same as that of the "matter". At present, no "antimatter" exists. Why does the universe mostly consist of "matter"? There are two key points to solve the mystery. The one is the CP violation that means "antimatter" world is slightly different from "matter" world. The other one is the lepton number violation that means "antimatter" and "matter" can convert to each other.

The study of double beta decay will give a solution to the problem of "matter" and "antimatter". There are two types of double beta decay (see figure 1). The one is two-neutrino double beta decay. The other one is neutrino-less double beta decay. Neutrino-less double beta decay can only occur if a neutrino converts to an anti-neutrino, which demonstrates the lepton number violation. The purpose of this project is to study of "neutrino-less double beta decay".

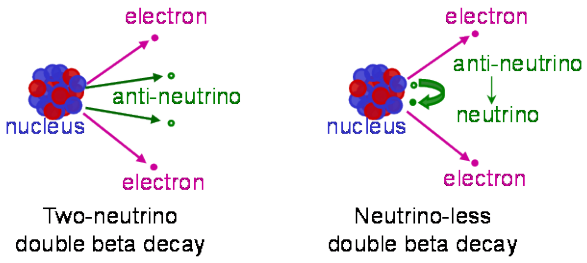

Figure 1 "Two-neutrino double beta decay (left)" and "neutrino-less double beta decay (right)".

【Research Methods】

Neutrino-less double beta decay has a very long half-life, which is longer than 10^{24} years. In order to measure the decay, a detector system needs a large amount of double beta decay nuclei and low background condition.

To realize the low background condition, we selected ^{48}Ca among double beta decay nuclei. ^{48}Ca has an advantage of the highest $Q_{\beta\beta}$-value. The $Q_{\beta\beta}$-value corresponds to the sum energy of two electrons in the neutrino-less double beta decay. This large $Q_{\beta\beta}$-value, which is larger than the energies of natural radiations, ensures the least backgrounds from them. In this project, we study double beta decay of ^{48}Ca with CANDLES system, which consists of CaF_2 including ^{48}Ca. We also construct a production system to enrich ^{48}Ca. The enrichment of ^{48}Ca is an only firm way to increase double beta decay nuclei without increasing backgrounds.

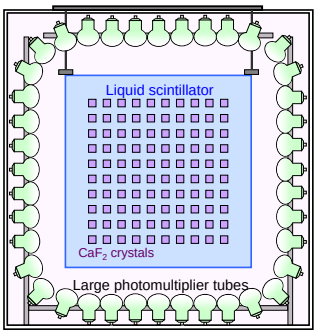

Figure 2 Conceptual design of CANDLES.

【Expected Research Achievements and Scientific Significance】

When we realize the ^{48}Ca enrichment and the low background measurement for double beta decay, sensitivity of the measurement will be improved. Then, we will make a substantial contribution to the progress of astroparticle physics.

【Publications Relevant to the Project】

・"Neutrino-less Double Beta Decay of 48Ca -CANDLES-", T. Kishimoto *et al.*, AIP Conf. Proc., 1388 (2011) 142.
・"Search for neutrino-less double beta decay with CANDLES", CANDLES collaboration, AIP Conf. Proc., 1441 (2012) 448.

【Term of Project】 FY2012-2016
【Budget Allocation】 167,000 Thousand Yen
【Homepage Address and Other Contact Information】

http://www.rcnp.osaka-u.ac.jp/~candles/KibanS2012/index.html
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