

**Title of Project : Revealing the history of the universe with  
underground particle and nuclear research**

**Kunio Inoue**  
(Tohoku University, Research Center for Neutrino Science,  
Professor)

Research Project Number : 26104001 Researcher Number : 10242166

**【Purpose of the Research Project】**

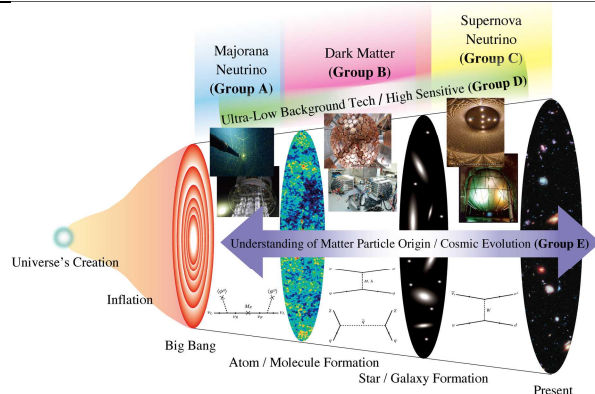
There are yet unsolved problems in the history of the universe. Initially created elementary particles formed light elements in the first three minutes. Gravity gathered them and produced large and small structures in the universe. Supernova synthesized and spread variety of elements and the Earth with rich resources was formed from them. Habitable environment was finally realized with the aid of the sun. This history contains so-called Big mysteries of particle physics and cosmology beyond the present standard theory.

Why weren't the same amount of particles and anti-particles created? What is dark matter essential for the structure formation but not in the standard theory? What is the supernova history and their explosion mechanism? What energy drives the sun and the Earth? Why are neutrinos so light?

This project challenges these questions in the ultra-low radioactivity environment, and aims at forming the unified particle theory and cosmological understanding.

**【Content of the Research Project】**

- The only feasible way to investigate the Majorana nature of neutrinos is a search for neutrino-less double- $\beta$  decay and continuous improvement of its sensitivity and development of innovative technologies are both planned.
- Direct search and detector development for dark matter including its directionality are planned.
- The first detection of relic supernova and pre-burst neutrinos from nearby supernova are aimed at. In parallel, solar and geological neutrinos are observed.
- Commonly important ultra-low background techniques are gathered and improved to be fed back to each observation.
- New paradigm of the unified theory seamlessly involving the Majorana nature and dark matter and describing the history of the universe is studied.



History of the universe and our challenges

**【Expected Research Achievements and Scientific Significance】**

The world leading searches for neutrino-less double- $\beta$  decay and dark matter, and also development of innovative techniques are done simultaneously to sustain the cutting edge sensitivities longer term thus to expect the first discoveries. Astro-neutrino observation with the largest detectors will influence related fields like gravitational wave observations. This project connects important epochs and subjects in the history of the universe and is effective to establish its systematic understanding. The project gathers various knowhow and develops them, avoiding duplications. These technologies will be applied to various rare phenomena and high precision experiments in diverse fields.

**【Key Words】**

Majorana nature : Charge 0 neutrinos may not distinguish particles and anti-particles. It is a unique feature of neutrinos.

Dark matter : Unknown particle that played important role in the gravitational structure formation of the universe.

**【Term of Project】** FY2014-2018

**【Budget Allocation】** 1,122,800 Thousand Yen

**【Homepage Address and Other Contact Information】**

<http://www.lowbg.org/ugnd/>