Title of Project：Unraveling the History of the Universe and Matter Evolution with Underground Physics

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Research Project Number：19H05802　Researcher Number：10242166

【Purpose of the Research Project】

We aim at unraveling the history of the universe and matter evolution to answer “How is matter created?”, “How are galaxies/stars formed?”, “How are elements created?” and “How do they end up with the earth?”, by concentrating all efforts of underground astroparticle experiments covering neutrino-less double beta decay (0ν2β), dark matter (DM), supernova (SN) and geo-neutrino (ν). The vigorous cooperation at “Kamioka” will expands to world-wide, and newly involved subjects (low temp. sensors, nuclear matrix element, DM distribution, SN explosion and matter evolution theory) will further deepen each research field and enhance the synergy among them. It will sustain the competitiveness and superiority in the world and contribute to nurture young talents.

【Content of the Research Project】

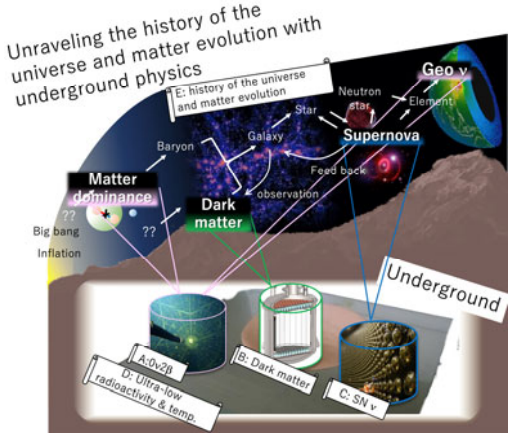

Figure1. Research projects and relevant subjects

KamLAND-Zen is leading the search for 0ν2β in the world. XENON has been leading the direct search of DM and is evolving to XENONnT. Super-Kamiokande has the world best sensitivity on SN-ν detection and is upgrading to SK-Gd. KamLAND is the pioneer of and leading geo-ν observation. We develop the cooperation among these top-runners and challenging projects for future on the common technologies. As challenging projects, a 0ν2β experiment involves isotopic enrichment and scintillating bolometer aiming at an ultimate sensitivity, and directional detection of DM develops under the world cooperation to overcome the limit of neutrino floor. The ultra-low radioactivity technology as the common base will pursue the world-best performance and raise the technological floor of the whole field sharing and internationalizing the low-BG database. We also incorporate low-temp. sensors as novel techniques to improve energy resolution and to achieve lower threshold for new science frontiers, and sustain the competitiveness. Moreover, we aim at a seamless connection of particle cosmology and matter evolution picture as a theoretical flamework that spans the history of the universe from the beginning to the present. It will largely enhance the synergy of research in this area and the connection to diverse fields.

【Expected Research Achievements and Scientific Significance】

We propel researches on the most important subjects in underground astroparticle physics, search for 0ν2β and direct detection of DM, and also SN relic ν and geo-ν detection those provide important information of matter evolution in the universe. These top-runners are closest to world’s first big discoveries. Developing the common novel technologies and theoretical flamework of the whole history of the universe will inspire surrounding fields, therefore, this area continues to be a core of the field of underground astroparticle physics. The international cooperative environment we realize will largely contribute to nurture young active talents in the world.

【Key Words】

Underground astroparticle physics: experimental researches of rare phenomena connected with particle, nuclear, cosmological, astronomical and geo- science run at underground ultra-low radioactivity environment
Neutrino-less double beta decay (0ν2β): unique realistic phenomenon to verify the ν/anti-ν identity as a key to explain the matter dominance in the universe
Dark matter (DM): Yet undiscovered elementary particle indispensable for the structure formation of the universe, with the halo density around the earth at ~0.3GeV/cm^3
Supernova relic ν: ν cumulatively arriving from past SN explosions that provide information on star formation history, SN explosion mechanism and matter evolution

【Term of Project】

FY2019-2023

【Budget Allocation】

1,129,500 Thousand Yen

【Homepage Address and Other Contact Information】

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