Title of Project : Exploration of Particle Physics and Cosmology with Neutrinos

Tsuyoshi NAKAYA
(Kyoto University, Graduate School of Science, Professor)

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【Purpose of the Research Project】

Today, Particle Physics and Cosmology are in a big turning point. The standard model of Particle Physics is well verified in a wide energy range up to TeV with the development of accelerators. Standard Cosmology describes Nucleosynthesis in the evolution of our universe, and firmly establish the existence of dark matter and dark energy. However, Standard Model and Standard Cosmology can not explain the origins of asymetry between matter and anti-matter in our universe, the origin of inflation, the unified picture between forces and particles consiting of matter. To understand a picture from the beginning of our universe to the present, we must innovate a novel concept of Particle Physics and Cosmology. We challenge to build the new concept of Particle Physics and Cosmology by studying "neutrinos" that are the essential key particle to address these unresolved problems.

【Content of the Research Project】

We proceed with the world's best neutrino experiments: Super-Kamiokande, T2K, and IceCube, and we study neutrino oscillations, explore CP violation, and advance neutrino astronomy. Furthermore, in order to investigate the Grand Unification Theory and the inirial state of our universe, we search for proton decay, measure neutrino mass from observation of Cosmic Mircowave Background (CMB), and search for the signal of inflation (primitive gravity wave). In addition, we also study the Mayorana nature of neutrinos.

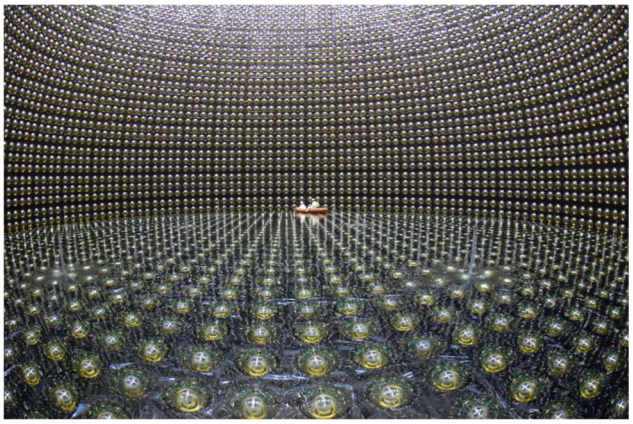

Fig-1 : Super-Kamiokande Detector

In order to realize the next-generation neutrino experiments, we proceed with the development of basic technologies of Hyper-Kamiokande and IceCube Gen 2 experiemnts. With neutrinos, our reseach integrates particle physics, nuclear physics, cosmic rays, and cosmology.

【Expected Research Achievements and Scientific Significance】

[Development of neutrino physics]:
Determination of neutrino oscillations with high precision. Adding absolute neutrino mass and the number of generations, we advance understanding of the origin of neutrino mass and mixing.
[Evolution of neutrino astronomy]: We study Cosmic Neutrino Background, and observe neutrinos from sun, supernovae, galactic extraterrestrial objects, and AGN.
[Great Unified Theory (GUT)]: We search for the proton decay as an evidence of unification. By examining the symmetry between quarks and leptons, the GUT models are constarained.
[Elucidation of the evolution of our universe]: We have a big discovery potential to primitive gravitational waves, the origin of asymmetry between a particle and an anti-particle, dark matters, the B mode polarization of CMB.

【Key Words】

Neutrino: Neutrinos are elementary particles, similar to electrons but with no electric charge. There are three types of neutrinos. Non-zero neutrino mass was discovered by Super-Kamiokande. Neutrinos change their types through a phenomenon called “neutrino oscillation”. Study of neutrino oscillations has advanced understanding nature of neutrinos.

【Term of Project】　FY2018-2022

【Budget Allocation】　1,129,900 Thousand Yen

【Homepage Address and Other Contact Information】

http:// www-he.scphys.kyoto-u.ac.jp/nucosmos/
t.nakaya@scphys.kyoto-u.ac.jp