【Grant-in-Aid for Specially Promoted Research】
Science and Engineering

Title of Project : High Energy Neutrino Universe explored by IceCube-Gen2

Shigeru Yoshida
(Chiba University, Graduate School of Science, Professor)

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Keyword : cosmic-ray, neutrinos, south pole, particle physics, astronomy

【Purpose and Background of the Research】

The IceCube Neutrino Observatory, the three-dimensional detector array deployed in the deep glacier at the South Pole, made the first discovery of high energy cosmic neutrinos in 2013 and pioneered the new frontier of observing our cosmos, High-Energy Neutrino Astronomy. Neutrinos are charge-neutral elementary particles which can travel over cosmological distances without losing their energies. They are unique messengers to reveal dynamically evolving ultra-high energy universe, which could not be explored by the conventional astro-messengers like optical photons. Taking this advantage further, IceCube started operating a realtime neutrino alert system in 2016: Identifying astrophysical neutrinos real-timely to deliver detection information to world-wide astronomical observation facilities for follow-ups. It realized the great achievement last year that the observation of a neutrino in directional and temporal coincidence with high energy γ-rays identified a neutrino emission object. This "multi-messenger astronomy" powers capability of probing energetic phenomena in cosmos and therefore it is critical to improve statistics of high energy neutrino events for multi-messenger campaigns.

【Research Methods】

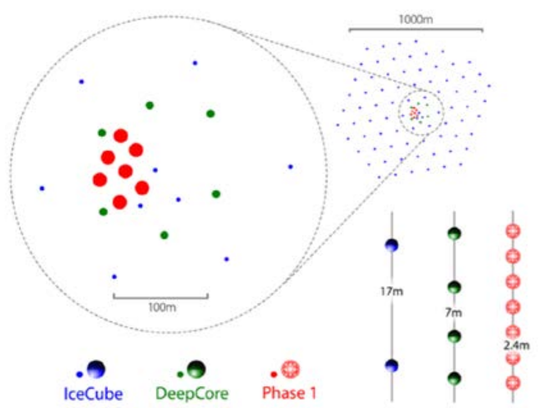

Figure 1. The concept of IceCube Upgrade

In order to greatly enhance the efficiency of high energy astrophysical neutrino detections, IceCube has planned the next generation project, IceCube-Gen2. As the phase 1 of this expansion, we upgrade IceCube facility by densely deploying the new optical detectors in the central area of the IceCube instrumentation volume.
The Japanese group has developed a new type of optical detectors, "D-Egg", which realize twice better photon detection efficiency than the present modules running in IceCube. We will deploy two hundred of D-Eggs down to the glacier ice. This upgrade is expected to improve accuracy in estimation of arrival directions of cosmic neutrinos. We also strengthen the radio detector array for seeking even higher energy neutrinos than ever detected. With this upgrade, we conduct a deeper survey of high energy universe by neutrinos in the wide energy band from TeV to EeV.

【Expected Research Achievements and Scientific Significance】

The upgrade is expected to reveal various objects to emit high energy neutrinos. Follow-up observations by radio, optical, X-rays, and γ-rays will bring us understanding of origin of ultra-high energy cosmic rays, the most energetic radiation in Universe. We also expect to discover neutrino-only luminous objects.

【Publications Relevant to the Project】

・ S.Yoshida et al, IceCube Collaboration, "Constraints on Ultrahigh-Energy Cosmic-Ray Sources from a Search for Neutrinos above 10 PeV with IceCube" Physical Review Letters **117** 141101 1-9 (2016)
・ S,Yoshida et al IceCube Collaboration "The IceCube realtime alert system", Astroparticle Physics **92** 30-41 (2017)

【Term of Project】 FY2018-2022

【Budget Allocation】 411,400 Thousand Yen

【Homepage Address and Other Contact Information】
http://www.icehap.chiba-u.jp