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

Science and Engineering (Mathematical and physical sciences)

Title of Project : **The Deep Survey of Ultrahigh Energy Universe by the South Pole Neutrino Telescope Complex**

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Research Area : Physics
Keyword : Particle astrophysics (experiment), Neutrino, Ultrahigh energies, South Pole

【Purpose and Background of the Research】

An observation by an optical telescope pictures our Universe associated with radiation in energy range of visible light. However, the radiation from Universe has known to extend by-far higher energies. The matter flow called "cosmic rays", which consists manly of protons and nuclei, is responsible for the most energetic radiation. Their highest energies are larger than visible light by 10^{20} times. It has been among the biggest scientific mysteries how our cosmic accelerators possibly work out to channel such enormous energies into microscopic particles. At such high energies, the Universe becomes opaque to light – photons cannot travel distances longer than size of our Galaxy due to collisions with the cosmic microwave background, the relics from the Big Bang. The usual technique using light to survey the Universe cannot access to the vast space beyond our Galaxy, which prevents resolving the mystery of the cosmic accelerators. This research proposal measures ultrahigh energy neutrinos that would penetrate over cosmological distances, to understand mechanisms of the cosmic accelerators, and thus the origin of cosmic rays.

【Research Methods】

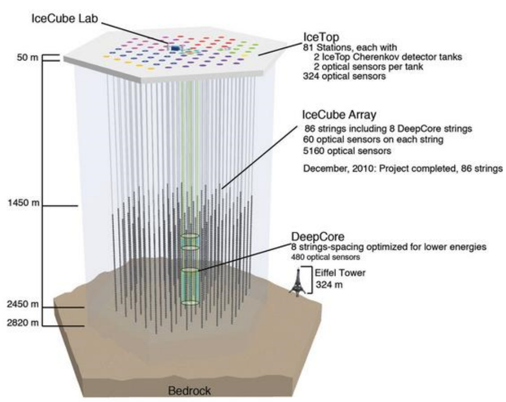

Figure 1: The IceCube Neutrino Telescope

The IceCube Neutrino Telescope consists of an array of the special optical sensors in the thick glacial ice at the South Pole. We search for energetic cosmic neutrinos with this devise to measure of their flux. In addition, the extension of the IceCube detector, called ARA, is built in adjacent to the IceCube site, covering more than 10 times larger area, which will bring high statistics of neutrino data.

The observed rate of neutrinos increases if the cosmic accelerators are more active at deep space (i.e., past) because neutrinos travels long distances without attenuation. The flux estimated by our observation, thus, provides a clue on history of the cosmic acceleration and its power.

【Expected Research Achievements and Scientific Significance】

The present sensitivity to neutrino detection is extended to 100 PeV (10^{17} times higher than visible light), high enough to probe cosmic accelerators. If the neutrino flux is sufficiently high, we can even identify astronomical objects responsible for cosmic ray acceleration.

【Publications Relevant to the Project】

- S.Yoshida and A.Ishihara, "Constraints on the origin of the ultrahigh energy cosmic rays using cosmic diffuse flux limits: An analytical approach", Phys.Rev. D **85**,063002 (2012)
- IceCube Collaboration, "Constraints on the extremely-high energy cosmic neutrino flux with the IceCube 2008-2009 data", Phys. Rev. D **84**, 082001 (2011).

【Term of Project】 FY2013-2017

【Budget Allocation】 160, 900 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.icehap.chiba-u.jp