Research Report
ICRR Inter-University Research Program 2020

Research Subject: Study of supernova neutrinos in Super-Kamiokande

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Summary of Research Result:

The purpose of this research is detection of the supernova neutrino in SK-Gd. There are two targets, one is neutrinos from nearby supernova explosion, the other is diffuse neutrinos from the past supernovae called 'Supernova Relic Neutrinos (SRN)'. The SK-Gd project is gadolinium loading into Super-Kamiokande (SK) to increase inverse beta decay interactions of anti-electron neutrinos.

In 2020 summer, we've doped Gadolinium sulfate into Super-Kamiokande. This work went well and finished in one month, and the SK-Gd experiment officially started from August 2020. Our group members, especially S.Ito, M.Harada, S.Sakai, played an important role for this work. Just after starting SK-Gd, we confirmed the delayed neutron signal using AmBe source, which emits both gamma and neutron and makes mimic signal as supernova relic neutrinos. The left figure in the next page shows the capture time and it is as expected. The data taking is now working well.

As for the supernova relic neutrino analysis in SK-IV phase (pure water), we showed the result of the upper limit of anti-electron neutrino flux as a preliminary (right figure in the next page). The result will be published soon

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Timing difference between the prompt and delayed signal in AmBe source with (red) and without (black) Gadolinium. The capture time with Gadolinium is consistent with the expectation.	(Preliminary) Upper limit of the anti-electron neutrino fluxes in several experiments overlaid with the expectations. Our works are shown as red lines.

Presentations

[1] A. Coffani, Spallation background in Super-Kamiokande, XIX Interntional Workshop on Neutrino Telescopes, online, Feb. 18-26, 2021

[2] H. Kitagawa, Evaluation of energy reconstruction and water transparency before and after Gd sulfate dissolving in the Super-Kamiokande detector, New innovative area 'Exploration of Particle Physics and Cosmology with Neutrinos' workshop, online, Dec. 21, 2020.

[3] Y. Koshio, 中性カレントニュートリノ検出計画 (in Japanese), JPS meeting / Symposium, online, Sep. 17, 2020.

[4] S. Ito, SK-Gdにおける硫酸ガドリニウム中の不純物測定の最新結果, JPS meeting, online, Sep. 16, 2020.

[5] M. Harada, SK-Gd実験における初期データの解析, JPS meeting, online, Sep. 16, 2020.

[6] S. Sakai, 超新星背景ニュートリノ探索における大気ニュートリノ背景事象の研究, JPS meeting, online, Sep. 16, 2020.

[7] S. Sakai, スーパーカミオカンデ SK-5フェーズにおけるPMTの量子効率測定のための検出器較正, JPS meeting, online, Sep. 16, 2020.

[8] L. Bernard, Spallation background in the Super-Kamiokande experiment, ICHEP 2020, online, July 29, 2020.

[9] S. Sakai, Study of the atmospheric neutrino background for Supernova Relic Neutrino search, poster, Neutrino 2020, online, July 2, 2020.

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