

Research Report
ICRR Inter-University Research Program 2021

Research Subject: Study of supernova neutrinos in Super-Kamiokande

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Participating Researchers:

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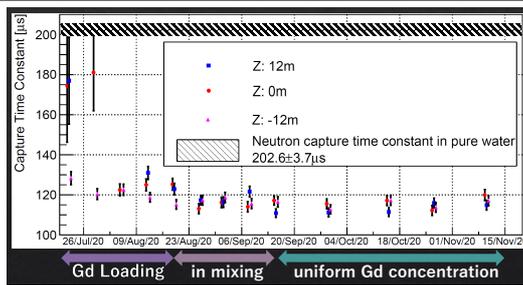
Summary of Research Result :

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.

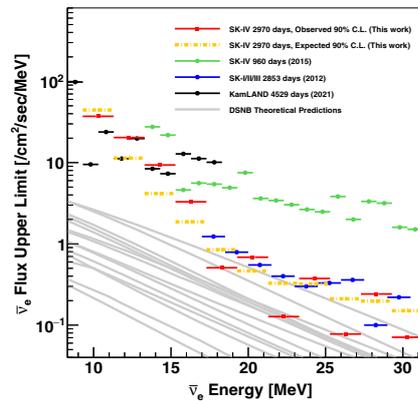
In 2020 summer, we've doped Gadolinium sulfate into Super-Kamiokande. This work went well and finished in one month, and the SK-Gd experiment officially started from August 2020. This result is published [1]. We confirmed the delayed neutron signal using AmBe calibration source, which emits both gamma and neutron and makes mimic signal as supernova relic neutrinos. The left figure shows the capture time as a function of time. It is consistent with the expected value. One of our members, M.Harada, played an important for performing the analysis, and he is now writing a paper. The SK-Gd data taking is now working well.

The paper of the results of SRN search in SK-IV phase (pure water) has published [2]. Unfortunately, we could not see significant signals, however, the world best upper limit above 13MeV has been assigned (right figure).

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Neutron capture time by AmBe source calibration as a function of time. It is stable at $115.6 \pm 0.6 \mu\text{s}$ after September 2020, which is equivalent to the Gadolinium concentration, $110.9 \pm 1.4 \text{ppm}$, and it is consistent with the amount of doping.



Upper limit (90% C.L.) of the anti-electron neutrino fluxes in several experiments overlaid with the expectations. Our works are shown as red.

Published paper

- [1] K.Abe et al, First Gadolinium Loading to Super-Kamiokande, Nucl. Instr. Meth. A, 1027, 166248 (2022).
- [2] K.Abe et al, Diffuse supernova neutrino background search at Super-Kamiokande, Physical Review D 104, 122002 (2021).

Presentations

- (1) Y.Koshio, Supernova neutrino detection in Super-Kamiokande., INT workshop, online, Sep.25, 2021.
- (2) Y.Koshio, 超新星背景ニュートリノ精密測定 (in Japanese), JPS meeting / Symposium, online, Sep. 17, 2021.
- (3) M.Harada, SK-Gd 実験における Am/Be 線源を用いた中性子検出効率評価 (in Japanese), JPS meeting, online, Sep. 14, 2020.
- (4) S. Sakai, SK-Gd 実験における Geant4 ベースのシミュレーション性能評価 (in Japanese), JPS meeting, online, Sep. 14, 2020.

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