



Contribution ID: 65

Type: Oral

The Diffuse Supernova Neutrino Background at Super-Kamiokande: Latest Results and Future Prospects

Thursday, 9 December 2021 12:50 (18 minutes)

The latest results from a search for the Diffuse Supernova Neutrino Background (DSNB) at Super-Kamiokande (SK) is presented, incorporating 22.5×2970 kton.days of data from its fourth data-taking phase, covering an overall antineutrino energy range of 9.3–81.3 MeV, and combining results with previous SK data-taking periods, for a combined analysis of nearly 20 years of data. The analysis achieves a 90% C.L. sensitivity to the DSNB flux comparable to various DSNB predictions. No significant evidence for a DSNB signal has been observed, and upper limits on the DSNB flux are placed, reaching about 2.6 antineutrinos/cm²/s at 90% C.L. for a wide range of models. Identifying the neutron produced by the interaction of DSNB antineutrinos is an important part of our search, as it allows the removal most backgrounds from cosmic muon spallation and atmospheric neutrino interactions, but is particularly challenging in pure water and is a limitation of the current search. Since 2020, Gadolinium has been dissolved in the SK water, dramatically increasing the efficiency of the neutron tagging procedure and, consequently, the sensitivity to the DSNB. The impact of the SK-Gd project on future DSNB searches is discussed.

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Session Classification: Parallel 2: Neutrinos