NEUTRINO 2016
SOUTH KENSINGTON, LONDON
XXVII INTERNATIONAL CONFERENCE ON NEUTRINO PHYSICS AND ASTROPHYSICS
4–9 JULY 2016

Saturday 9 July, 10:05 – 10:25

Session 17: Neutrinos as probes of the universe

Supernova neutrinos in SK-Gd and other experiments

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Now many detectors are waiting for core-collapse supernovae (ccSN) in or near our galaxies, so if ccSN occurs in our galaxy we will be able to reveal the mechanism of supernova explosions and also be able to access the properties of neutrino, such as mass hierarchy. Even dark mater detectors can reach them via coherent elastic neutrino nucleus scattering, however no supernova neutrinos have been observed since February 1987.

Supernova explosions in our galaxy may be fairly rare, but supernovae themselves are not. On average, there is one ccSN somewhere in the universe each second. The neutrinos emitted from all of these ccSN since the onset of stellar formation have suffused the universe. We refer to this thus-far unobserved flux as the “relic” supernova neutrinos.

The flux of the supernova relic neutrinos is expected to be several tens per square centimetre per second. Theoretical models vary, but as many as five supernova relic neutrinos per year above 10 MeV are expected to interact in Super-Kamiokande. However, in order to separate these signals from the much more common solar and atmospheric neutrinos and other backgrounds, we need a new detection method.

On June 27 2015, the Super-Kamiokande Collaboration approved the SK-Gd project. It is the upgrade of the SK detector via the addition of water-soluble gadolinium (Gd) salt. This modification will enable it to efficiently identify low energy anti-neutrinos for the world's first observation of the relic supernova neutrinos via inverse beta decay.