PROCEEDINGS OF SCIENCE

Solar neutrino results from Super-Kamiokande

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The results of the third phase of the Super-Kamiokande (SK-III) solar neutrino measurement are presented and combined with the first (SK-I) and the second (SK-II) phase results.
In SK-III, due to a water purification system upgrade and water flow tuning in the SK tank, the background level was lowered. Furthermore, with improved detector calibrations, a full detector simulation, and new analysis methods, the systematic uncertainty on the total neutrino flux is estimated to be 2.1%, which is about two thirds of the systematic uncertainty during SK-I.
The observed ^{8}B solar flux in the 5.0 to 20 MeV total electron energy region is 2.32 ± 0.04 (stat.) $\pm$ 0.05 (sys.) $\times 10^6$ cm^{-2}sec^{-1}, in agreement with previous measurements.
By adding SK-III data to SK-I and SK-II, it was found that the energy spectrum and the time variation of solar neutrinos obtained from our measurements favor only the large mixing angle solution (LMA) by constraining the ^{8}B and hep neutrino flux to SNO NC flux and SSM prediction respectively.
The oscillation analysis results are also combined with the results of other solar neutrino experiments. The best-fit oscillation parameters are obtained to be $\sin^2\theta_{12} = 0.30^{+0.02}_{-0.01}(\tan^2\theta_{12} = 0.42^{+0.04}_{-0.02})$ and $\Delta m^2_{21} = 6.2^{+1.1}_{-1.9}\times 10^{-5}\mathrm{eV}^2$. Combined with KamLAND results, the best-fit oscillation parameters are found to be $\sin^2\theta_{12} = 0.31\pm 0.01(\tan^2\theta_{12} = 0.44\pm 0.03)$ and $\Delta m^2_{21} = 7.6\pm 0.2\times 10^{-5}\mathrm{eV}^2$. The ^{8}B neutrino flux obtained from global solar neutrino experiments is 5.3 ± 0.2(stat.+sys.)$\times 10^6$cm^{-2}s^{-1}, while the ^{8}B flux becomes 5.1 ± 0.1(stat.+sys.)$\times 10^6$cm^{-2}s^{-1} by adding KamLAND result.
In a three-flavor analysis combining all solar neutrino experiments, the upper limit of $\sin^2\theta_{13}$ is 0.060 at 95% C.L.. After combination with KamLAND results, the upper limit of $\sin^2\theta_{13}$ is found to be 0.059 at 95% C.L..

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New Results

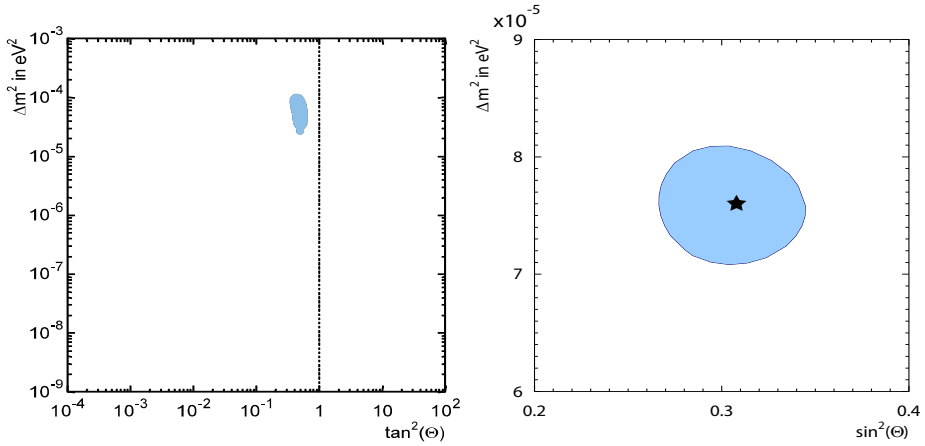

Figure 1: Left: 95% C.L. allowed region from SK-I,II,III combined analysis. The ^{8}B flux is constrained by SNO NC rate (LETA and phase-III). Right: 95% C.L. allowed region for all solar experiments and KamLAND for two-flavor analysis.

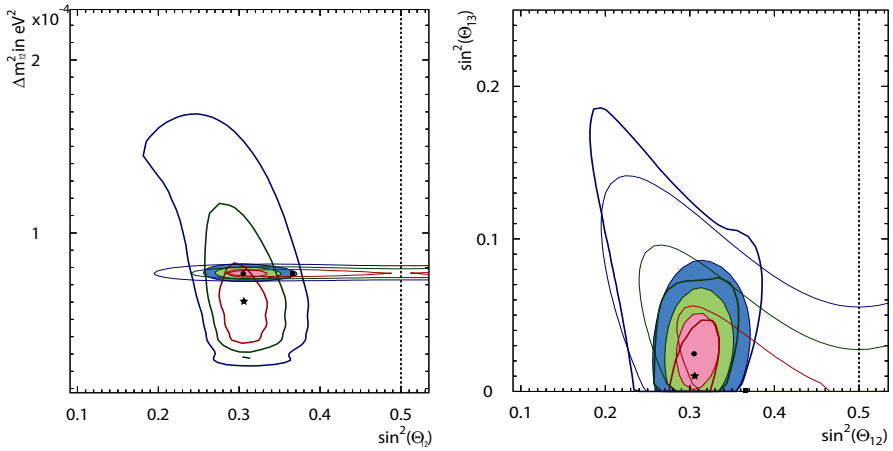

Figure 2: Allowed region in solar parameter spaces $(\theta_{12}, \Delta m^2)$ and $(\theta_{12}, \theta_{13})$ obtained by the three-flavor analysis. The thick lines and the star mark show the allowed regions and the best fit point of the global solar analysis. The thin lines and the square mark show the allowed regions and the best fit point of our KamLAND analysis. The filled areas and the filled circle mark show the allowed regions and the best fit point of the combined analysis. For all regions, the innermost area (red), the middle area (green) and the outermost area (blue) show 68.3, 95, 99.7 % C.L. respectively.

References

[1] K. Abe *et al.*, *Solar neutrino results in Super-Kamiokande-III*, arXiv:1010.0118v1