Solar Neutrinos, the Physics Gold Mine

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Abstract

The study of solar neutrinos has borne remarkable fruit, culminating in the discovery by the SNO experiment that neutrinos born in the sun as electron neutrinos undergo flavor transformation en route to earth [1]. Electron neutrinos participate in the process of neutrino oscillation just as μ and τ neutrinos were found to do in the Super-Kamiokande experiment on atmospheric neutrinos [2]. Solar neutrino data are now the most precise source of information about the mixing angle θ_{12}. With the recent cornucopia of information about θ_{13} from reactor experiments [3], a new and intriguing measurement can be contemplated. We explore the possibility that a measurement of the solar neutrino luminosity could be made to a precision of order 1%. With such precision in hand, two questions of immediate interest could be addressed. The sun may be, at a very modest level, a variable star like so many of its siblings. Precise neutrino luminosity data is essentially a look at the future, or long-term, output of the sun, which can be compared with the immediate output measured in electromagnetic radiation. The role of the sun in climate is obviously an important one, and knowledge of the steady-state solar output is crucial. Another interesting question is prompted by the "reactor anomaly" [4] that supports the idea that sterile neutrinos exist and mix with active ones. The neutrino sun can serve as a standard candle to test this hypothesis. Our research has been supported by the US DOE under grant DE-FG02-97ER41020.

References

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