the curve to the right. For values of roughly $\Delta m^2 = 5 \times 10^{-6}$ eV^2 and $\sin^2 2\theta = 0.007$, we find that *pp* neutrinos survive as electron neutrinos most of the time, while ^{7}Be neutrinos are almost completely converted to muon neutrinos (Figure 3). This appears to be a good description of data measured by the current generation of solar-neutrino experiments. (See the article "Exorcising Ghosts" on page 136.) Next-generation experiments, such as the one planned at the Sudbury Neutrino Observatory, are designed to determine whether oscillations to other neutrino states do indeed occur and whether the MSW effect or *in vacuo* oscillations solve the solar-neutrino problem.

There is one final, but very interesting, comment. Our planet Earth may play a unique role in the study of the MSW effect. There turns out to be a well-defined range of mixing angles and mass differences for which the enhancement density is less than 15 g/cm^3. This density occurs in both the Sun and Earth, and thus neutrinos that are converted from electron neutrinos to muon neutrinos in the Sun may be reconverted to electron neutrinos when they pass through Earth.

This effect would be seen as a significant increase in the solar-neutrino signal at night, when Earth is between the Sun and the detector. Observation of such a "day-night" effect would be an unambiguous and definitive proof of the MSW effect and of neutrino mass. It would also be nature's tip-of-the-hat to the insightful Lincoln Wolfenstein, who once observed that "...for neutrinos, the Sun shines at night!" ■

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Further Reading

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