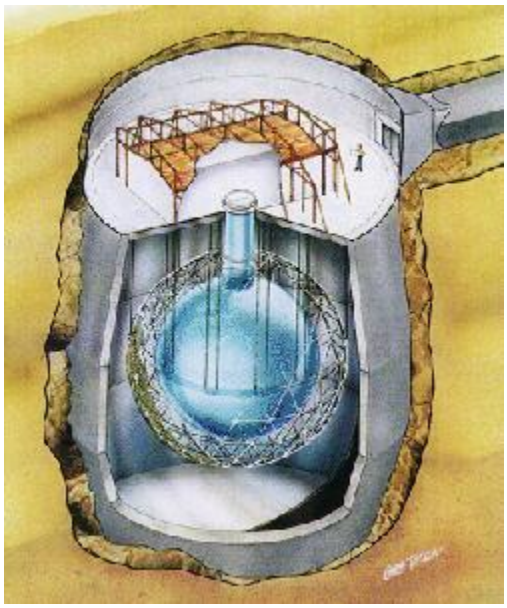
3.8 The Missing Solar Neutrinos



Sudbury Neutrino Observatory in Canada

A neutrino is created, along with an electron, when the nucleus of an atom disintegrates through beta decay. Neutrinos are produced, for example, in the nuclear reactions that fuel the burning of stars, such as the Sun. But for some reason, fewer electron neutrinos reach the Earth than would be expected based on known solar processes. This phenomenon was first suggested by observations at the oldest solar neutrino detector (in South Dakota), for which Raymond Davis of Brookhaven National Laboratory won the 2000 Wolf Prize, and a detector in Japan. The results were confirmed in the 1990s by precise radiochemical experiments called SAGE and GALLEX, supported by the Office of Science. These experiments differ in design from the previous two and detect neutrinos of different energy levels. SAGE and GALLEX also stimulated searches for neutron oscillations (conversion from one type to another), because solar neutrinos may change as they journey from the Sun to the Earth. The search for the missing solar neutrinos continues, led by Sudbury Neutrino Observatory in Canada in an effort that involves several national laboratories, and another group in Japan (also involving Americans).

Scientific Impact: Studies of neutrinos have significant effects on theories in physics, astronomy, and cosmology. Because of these experiments, many physicists and astronomers now believe that the missing neutrinos are due not to a faulty understanding of how the Sun works, but rather to an overly simplistic view of neutrino behavior.

Social Impact: Research on solar neutrinos could be the key to finding the Holy Grail of physics, the so-called unified theory that goes beyond the present Standard Model in explaining matter and the forces of nature. Thus, this research may lead to new understanding of the universe and the place of humans in it.

Reference: "Solar Neutrino Experiments: The Next Generation," Bahcall et al., *Physics Today* July: p. 30 (1996).

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