

THE INTERIOR STRUCTURE OF THE SUN AS GLEANED FROM THE VARIOUS EXPLANATIONS OF THE NULL SOLAR NEUTRINO EXPERIMENT RESULTS

(Abstract)

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The experiment of R. Davis, Jr., designed to detect neutrinos from the Sun, was planned as a quantitative test of the conventional ideas of solar evolution, the resulting model of the present Sun deduced therefrom and the corresponding theories of energy generation by nuclear processes. Although a positive counting rate would have been proof of the nuclear processes, the pre-1968 predictions would not have established a unique model for the interior structure of the Sun. Now, however, the null solar neutrino results that have been obtained from the fall of 1967 to the present bring into question all three aspects of the problem. Since several explanations for the null results have been put forth during the past five years, it is of interest to review these explanations and to determine what, if anything, can be gleaned about the interior structure of the Sun. For each published explanation we take this point of view: "if true, what is unambiguously implied about the interior of the Sun?" The various explanations of the null solar neutrino experiment can be divided into five groups, viz., (1) solar neutrinos oscillate or decay; (2) solar neutrinos lose energy through photon or electron scattering before emerging from the Sun; (3) energy generation in the Sun is periodic or is in a transient phase; (4) actual cross sections for the absorption of solar neutrinos by ^{37}Cl are less than the standard cross sections; and (5) measured cross sections for some of the nuclear reactions of the *pp*-chain are in error when extrapolated to the energies of interest for standard solar models. Any ambiguities regarding the solar interior implicit in any explanation will be discussed with comments on the additional information needed to derive a unique model. After considering the above explanations and considering the methods for performing standard solar evolution and solar model calculations, it is argued that the best place to begin in order to resolve the present dilemma of the null solar neutrino experiment is in the astrophysics, starting with solar models that use real-gas physics throughout and models that match observed boundary conditions without the use of *ad hoc* parameters. Even if a positive solar neutrino counting rate is obtained in the future, it is believed that a realistic model of the present sun will require alternative concepts of solar evolution and solar structure. Clearly, the resolution of the null solar neutrino dilemma will be of fundamental importance for the general understanding of the internal structure and evolution of stars in the late stages of evolution.

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