Counting neutrinos from an 'artificial sun'

The nuclear fusion reactions that power the sun produce huge quantities of neutrinos. Experiments designed to detect these elusive, weakly interacting particles provide a glimpse deep into the sun's core, where these reactions take place.

Over the last few years, however, several Earth-based neutrino detectors have found fewer solar neutrinos than scientists had expected, based on theoretical models of how the sun generates energy (SN: 6/13/92, p.388). That deficit has proved an enduring puzzle.

Now, researchers participating in the GALLEX solar neutrino project have completed an important check on the efficiency of their neutrino detector and have raised some intriguing questions.

"This is the first time that neutrinos, produced in known amounts by an immensely radioactive source, or 'artificial sun,' have been used to test the overall operation of a solar neutrino experiment," says Richard L. Hahn of the Brookhaven National Laboratory in Upton, N.Y. Hahn is a member of the GALLEX team.

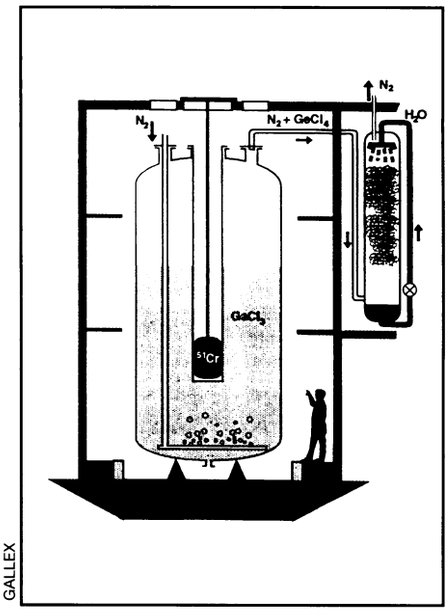
Preliminary results indicate that the GALLEX detector picks up essentially all of the available neutrinos. Submitted for publication to PHYSICS LETTERS B, this finding helps rule out the possibility that detector inefficiency accounts for the solar neutrino deficit. It confirms that about 40 percent of the expected neutrinos are missing and focuses renewed attention on possible explanations for the conflict between theory and experiment.

At the Gran Sasso underground laboratory in Italy, GALLEX researchers looked for low-energy neutrinos produced by the decay of chromium-51, a specially prepared, highly radioactive isotope of chromium. This source generated neutrinos at a rate 16 times greater than that of the sun.

In the experiment, neutrinos from the decay of chromium-51 interacted with gallium atoms to convert them into germanium-71 atoms. Detection of these germanium atoms provided a count of neutrino interactions.

The researchers found that the measured rate of germanium production matched the rate expected from the known activity of the source to within 10 percent. Incorporating additional data, they expect to have a more precise result in the spring.

The GALLEX solar neutrino measurements, along with those from the Soviet-American Gallium Experiment (SAGE) in Russia and the Kamiokande detector in Japan, spotlight one particular step in the chain of nuclear fusion reactions occurring in the sun's core.



GALLEX

In the GALLEX test, neutrinos emitted by a chromium-51 source enter a tank containing a gallium chloride solution. They interact with gallium atoms to produce germanium chloride, which is extracted from the solution.

The sun's energy comes primarily from the fusion of two protons to form a deuteron, accompanied by the emission of a positron and a neutrino. A secondary reaction involves the production of boron-8 from the fusion of a proton with beryllium-7, a process that also creates a neutrino.

"It turns out that the energies of the neutrinos from the chromium-51 source are very close to those from beryllium-7," Hahn says. "Since we have just shown that we can detect essentially all the neutrinos from chromium-51 in the GALLEX detector, we should also be able to detect the solar beryllium-7 neutrinos. But, apparently, we don't see them."

In other words, although researchers detect neutrinos from boron-8 at the end of the nuclear fusion chain, they see very few of the neutrinos from beryllium-7, without which the boron-8 cannot be made.

"Solar neutrino science is entering a new phase," comments R.S. Raghavan of AT&T Bell Laboratories in Murray Hill. N.J., in the Jan. 6 SCIENCE. "The solar neutrino puzzle is deepening into a paradox that refutes the basic logic of the reaction chain that powers the sun by the fusion of protons into heavy elements."

Raghavan suggests that one way to avoid this "missing link" problem is to postulate that the neutrino, generally thought to be without mass, actually has a small mass. — *I. Peterson*

Study sizes up fetal cells for transplant

Human fetal tissue from miscarriages and ectopic pregnancies appears unsuitable, in most cases, for transplantation to treat human diseases, according to a new study.

The history of human fetal tissue transplantation in the United States has been touch and go. In 1992, President Bush continued the Reagan-era ban on federal funding of research using human fetal tissue obtained from induced abortions. To mollify the research community, however, Bush did allow federal funding of research on fetal tissue obtained after a female donor had had a spontaneous abortion or an ectopic pregnancy (SN: 7/4/92, p.15).

The new study demonstrates for the first time that the amount of usable human fetal tissue obtained from such donors is quite small.

D. Ware Branch of the University of Utah in Salt Lake City, Thomas J. Gill III of the University of Pittsburgh, and their colleagues examined fetal tissue obtained from women who had gone to the emergency room or been hospitalized during a miscarriage or an ectopic pregnancy — a life-threatening condition in which the fertilized egg starts to grow in the fallopian tube of a woman's reproductive tract.

The researchers studied 1,250 embryos expelled during miscarriages and 247 specimens of tissue obtained during the surgical treatment of an ectopic pregnancy. Their analysis revealed that only seven embryos seemed suitable for transplantation therapy.

Most of the unsuitable embryos appeared to have suffered bacterial contamination. In addition, a large number showed a variety of chromosomal abnormalities. Such genetically abnormal fetal cells might go on to become a malignant tumor if transplanted to a recipient's body, Gill says.

In 1993, President Clinton lifted the ban on federal funding for research on fetal tissue obtained during an induced abortion. "The availability of human fetal tissue from induced abortions should increase the amount of useful tissues," say the researchers in the Jan. 4 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

Fetal tissue transplants have reversed the ravages of Parkinson's disease, a condition in which brain cells manufacturing dopamine die off (SN: 11/28/92, p.372). Yet researchers may never get enough of this precious tissue to meet the demand for such therapy.

"We believe that the limited availability of fetal tissue will curtail transplantation procedures that require large amounts of fetal tissues," the authors say.

— *K.A. Fackelmann*