SCIENCE NEWS of the week

At Last, Neutrino Results From GALLEX

Although neutrinos are among the most difficult of fundamental particles to detect, they provide a unique window on how the sun uses its nuclear fuel to generate energy. Every step in the fusion of hydrogen and other nuclei at the sun's core produces neutrinos, and vast numbers of these ghostly particles stream unhindered directly to Earth.

Using specially designed detectors in underground laboratories in the United States, Japan and Russia, researchers have tried to capture a few of these elusive particles. So far, the three experiments have revealed a puzzling deficit in the number of solar neutrinos detected compared with the number expected based on theoretical models of how the sun generates energy (SN: 10/28/89, p.280). Last week, after many months of data analysis, scientists in the GALLEX collaboration—a fourth attempt to sample the sun's neutrinos — finally reported their keenly anticipated findings.

In 14 measurements made over nearly a year, the GALLEX researchers also found fewer solar neutrinos than predicted by theory. They did, however, find enough neutrinos to conclude that they had detected low-energy neutrinos produced specifically by the fusion of two protons, the initial step in the chain of fusion reactions that occur at the sun's core.

"This measurement constitutes the first observation of the [proton-proton] neutrinos," says GALLEX team member Richard L. Hahn of Brookhaven National Laboratory in Upton, N.Y.

At the Gran Sasso underground laboratory in Italy, GALLEX researchers measured the rate at which nuclei of gallium-71 capture solar neutrinos to produce radioactive germanium-71. They obtained an average value for the capture rate of 83 solar neutrino units (SNU), where 1 SNU equals 10^{-36} neutrinos captured per atom per second. Theoretical models of neutrino production within the sun predict capture rates ranging from 124 to 132 SNU.

The GALLEX collaboration has submitted two papers for publication in PHYSICS LETTERS B. The papers report preliminary results and suggest potential implications of the findings for neutrino and solar physics.

"This is the fourth solar neutrino experiment which has observed a deficit of neutrinos from the sun," says Thomas J. Bowles of Los Alamos (N.M.) National Laboratory, a member of the SAGE (Soviet-American Gallium Experiment) group. "Once again, it's been confirmed that there is something unusual going on. The question now is what."

Although the GALLEX results show a neutrino shortfall, this deficit is less than that observed in the other neutrino experiments. "Clearly, we see a major fraction of what's predicted," Hahn says.

At the same time, the discrepancy is large enough to leave room for some of the explanations that theorists had proposed to account for the larger deficits observed in previous experiments. For example, theorists had suggested that electron-neutrinos (one of the three types of neutrinos known to exist) produced at the sun's core might actually change into another type of neutrino as they travel out of the sun and through space. None of the neutrino detectors now operating would detect such transformed neutrinos. However, the GALLEX result is somewhat higher than expected by theorists who favor this scenario.

One possible interpretation of the GALLEX findings hinges on the fact that the observed capture rate is close to that predicted just for low-energy neutrinos arising from proton-proton reactions. These low-energy neutrinos may make it to Earth unchanged, whereas high-energy neutrinos, produced in other nuclear reactions involving such isotopes as boron-8 and beryllium-7, somehow transform themselves into a different form that can't be observed.

Such a scenario would be roughly consistent with the larger neutrino deficits observed at the Kamiokande detector in Japan and a long-running experiment at the Homestake Mine near Lead, S.D., which have detected only high-energy neutrinos. "There are slight differences among the experiments, but I don't see any strong inconsistency," says Kenneth Lande of the University of Pennsylvania in Philadelphia, who is involved with the Homestake experiment.

"You're faced with either not believing one of the three experiments or believing that they're consistent," says John N. Bahcall of the Institute for Advanced Study in Princeton, N.J., who favors an explanation of the results in terms of neutrino behavior rather than as an unknown nuclear effect at the sun's core.

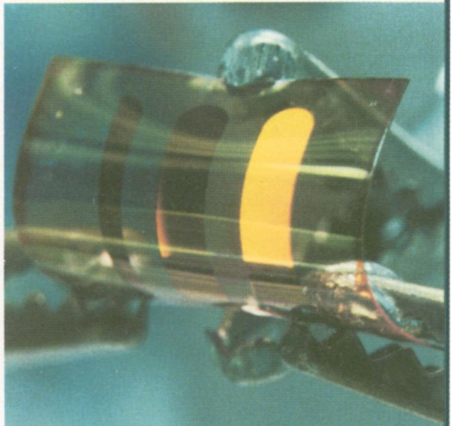
Still a puzzle is why SAGE has seen so few neutrinos compared with the numbers detected by GALLEX (SN: 12/21&28/91, p.406). Both detectors rely on gallium as a medium for capturing neutrinos and should give similar results.

Taking into account uncertainties in the data, the two sets of results actually overlap, Bowles says. "I think both [average] values are bound to change as we get more data, and then we'll see if there's a real discrepancy or not," he says.

The SAGE and GALLEX groups also plan to introduce an intense, neutrino-generating radioactive source into each of their detectors to check how efficiently they capture neutrinos.

—I. Peterson

Bright, bendable light-emitting diodes



UNIAX Corp.

The flex in this light-emitting diode (LED) marks the latest advance in harnessing electroluminescent polymers for billboards, electronic displays and uses not yet imagined.

Earlier this year, British scientists chemically modified polymers so that the materials glowed in a range of colors (SN: 3/14/92, p.164). Now, Goran Gustafsson and his colleagues at UNIAX Corp. in Santa Barbara, Calif., have gotten rid of the stiff metallic electrodes typically used to excite the polymer so that it gives off light. In the June 11 NATURE, they describe a completely plastic LED that they can curl or bend in half without disrupting its properties.

The group used a very thin layer of calcium and a soluble conducting polymer called polyaniline as electrodes. "The true breakthrough is that we can process polyaniline in the conducting form," says UNIAX President Alan J. Heeger. "It's like a liquid metal." This enables the researchers to use a technique called spin-casting to make flexible, more efficient light-emitting devices. They also mounted the electrodes and the luminescing semiconducting polymer on a transparent polymer film.

The new LED's light glows about twice as brightly as a television set, Heeger says. The light turns on with about 3 volts, making this LED compatible with existing digital devices. Next, the researchers hope to improve the device's long-term stability by replacing the calcium electrode with a less reactive material.