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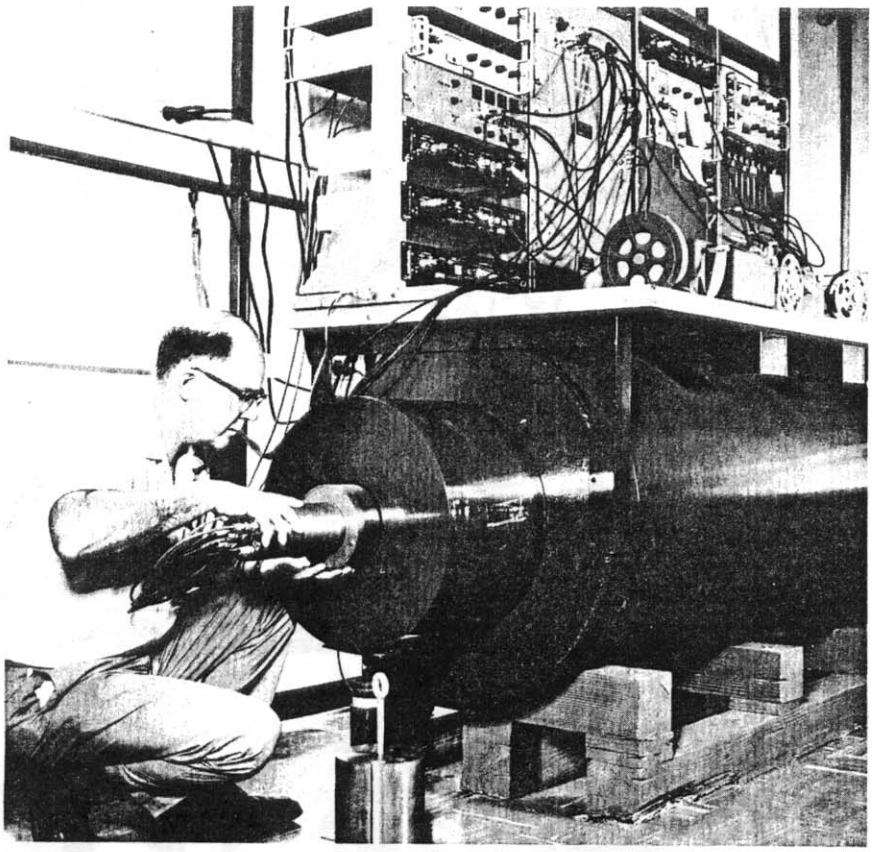
Solar Neutrinos Are Counted At Brookhaven



Dr. Ray Davis of Chemistry is shown placing a low level counter in a cut-down navy gun barrel which acts as a shield from stray cosmic radiation. This equipment is used in the Brookhaven Solar Neutrino Experiment.

A BNL team of scientists, headed by R. Davis, Jr., of Chemistry has gone 4850 feet into the earth to learn more about what is going on deep inside the sun.

Known as the Brookhaven Solar Neutrino Experiment, the effort combines some ather unsophisticated facilities such as a 00,000 gallon tank of cleaning fluid (tet-achloroethylene) in the Homestake Gold Mine in South Dakota and a 16-inch Navy gun barrel at BNL. In combination with some sophisticated instrumentation, the net result is a kind of "telescope" that permits Brookhaven scientists to look into the heart of the sun.

At the center of the sun, where the temperature is 30 million °F, fusion takes place, producing energy in the form of heat, light and neutrinos. Heat and light are familiar to man, but neutrinos are not. We know they are weightless, they have no electrical charge, and they travel at the speed of light. It is because of these properties that Enrico Fermi coined the name "neutrino" or "little neutral one." We also know they have the ability to pass through matter with only a slight chance of being captured or absorbed. Earth is almost as nothing in their path. For example, Davis and his group calculate that ten billion-billion neutrinos pass through their 20-ft. diameter by 48-ft long tank every day, yet hey capture only about two neutrinos per day.

Initial results are reported in a paper, "The Brookhaven Solar Neutrino Experiment" being presented in Chicago at the American Chemical Society meeting on September 14. Authors of the paper are Ray Davis, Jr., Don S. Harmer, Ken C. Hoffman and N. Blair Munhofen, all of BNL.

The paper describes the method of neutrino observation and the initial results. The detection of neutrinos in the tank of tetrachloroethylene depends upon the production of the radioactive isotope Argon-37 (half-life 35 days). This happens when a neutrino passing through the tank reacts with an atom of chlorine-37 to produce an atom of Argon-37 plus an electron. (This is equivalent to a neutrino capture.) The Argon-37 that is produced is then trapped in a special charcoal filter, from which it is removed and returned to Brookhaven where it is detected in a special counter mounted inside the bore of a 16-inch Navy gun barrel.

The gun barrel is one of four that are used in the basement of the Chemistry building as shields against stray radiation in low level counting experiments. Originally the gun barrels were procured from surplus, and brought to BNL for conversion to more peaceful uses. The long guns were cut into 8-foot sections, weighing about 16,000 pounds each. These guns are made from "old" iron (before the use of atom and hydrogen bombs) and contain a very small amount of residual radioactivity.

For accurate results, it is necessary to reduce the background radiation to as low a level as possible. Hence, the tank was placed deep underground to shield it from cosmic radiation and the counter was mounted in the thick gun barrel, which acts as a shield. Additional precautions, however, are taken to eliminate interferences from unrelated nuclear processes that could also produce Argon-37 in the tank and possibly result in a false neutrino reading.

Various elements, when they decay, are capable of producing neutrinos, but there is a definite energy level for each neutrino, and chemists use this method of identifying the neutrino source. In the Brookhaven experiment, the only neutrinos having enough energy to produce Argon-37 plus an electron from chlorine-37 are those produced in the decay of Boron-8, which is part of the thermonuclear process taking place in the sun.

The theoretical forecast had led scientists to believe that the neutrino emission from the sun would allow from 1.5 to 5 neutrino captures per day. In the single experiment performed to date, Dr. Davis reports that the capture rate in the underground tank was less than 2 neutrinos per day. Knowing this plus the efficiency of neutrino capture allowed Dr. Davis and his group to calculate the flux from the Boron-8 decay to be approximately 60 million solar neutrinos per square inch per second at the earth's surface. Previous calculations had predicted the flux could be anywhere from 40 million to 150 million solar neutrinos per square inch per second at the earth's surface.

Dr. Davis stressed that this was only the first experimental run, and that additional measurements must be made extending over a period of several years. Because of the low rate of neutrino capture, their removal from the tank filter and subsequent analysis at Brookhaven Laboratory can be done only three times per year. The results should provide an experimental test of the present theory of the solary energy generation process.