Seeking neutrinos under the ocean

Astrophysicists have long believed that a variety of highly energetic objects in the sky emit neutrinos. The actual detection of such neutrinos from supernova 1987A proved the point and got the science of neutrino astronomy off to an observational start. Now interested scientists hope to deploy the largest detector for astronomical neutrinos yet contemplated. DUMAND, or the Deep Underwater Muon and Neutrino Detector, will use a volume of the ocean off the island of Hawaii as its detection medium. The group that wants to build it has just completed the first stage: verification that a string of instruments deployed underwater can detect astronomical neutrinos and determine the direction from which they come.

The second stage of DUMAND, the actual instrument, will consist of 208 photomultiplier detectors, distributed among nine strings each 330 meters long. Eight strings will be at the corners of an octagon and the ninth in the center. They will be attached to the ocean bottom in water 4.8 kilometers deep, 30 km off Keahole Point, Hawaii. With buoys on their upper ends, the strings will float vertically, "like sea grass," says John Learned of the University of Hawaii at Manoa, who is technical director of the Hawaii DUMAND Center, which manages the project. DUMAND is an international cooperation involving institutions in the United States, Switzerland and Japan.

A proposal for funding the second stage is just about ready to be sent to the Department of Energy, says Learned. The latest cost estimate is $9 million. If Congress appropriates money in the next fiscal year, he says, the second stage could be deployed in three years.

Astrophysicists have planned DUMAND for more than a decade. Learned says the two smaller detectors that recorded neutrinos from supernova 1987A, the Kamiokande detector at Kamioka, Japan, and the IMB detector at Fairport Harbor, Ohio, were planned at a DUMAND workshop in 1976. These two detectors are large tanks of water with photomultiplier tubes lining their sides.

To detect neutrinos, physicists need a large volume of water. Neutrinos interact with other matter only very weakly. A neutrino can pass through the entire thickness of the earth without hitting anything. However, once in a while a neutrino hits an atomic nucleus and produces a muon particle. The muon is electrically charged (the neutrino is not) and emits the kind of light called Cherenkov radiation as it moves through the water. The photomultipliers record the Cherenkov light, and by whatever tubes are triggered in a given event the computer program can calculate the direction from which the neutrino came.

To observe neutrinos from more distant and possibly fainter objects than supernova 1987A, larger detectors are needed. DUMAND's planners want an effective detecting area of 20,000 square meters, compared with IMB's 400. For that a tank is impractical, so they chose the ocean itself.

The stage one exercise was a way of proving it could be done. In it, the scientists dangled a single string of detectors from the U.S. Navy stable research platform Kaimalino. They made measurements during the week between Nov. 3 and Nov. 10, 1987, at depths from 2 to 4.8 km. Analysis of the data, just recently completed, indicates that the string detected muons and had an effective collecting area of 900 square meters.

A serious problem researchers had to face was competing sources of light in the ocean. The ocean contains a certain amount of radioactive potassium, which emits beta rays that produce Cherenkov light of their own. Bioluminescence also contributes a background glow. In the test, neither of these seriously compromised the detection of muons.

However, these background measurements revealed a new kind of deep-ocean bioluminescence of unknown origin. Most previously known bioluminescence is confined to the upper 1 km of depth where sunlight penetrates and most of the biota lives. This new form goes deeper, however, and diminishes in brightness by a factor of two every 600 meters. Soviet groups working in various places have confirmed its existence.

DUMAND's managers are confident that they can build a detector that will record neutrinos from such things as the centers of active galaxies, quasars and possibly other supernovas. A particularly likely class of candidates is the binary star X-ray sources in our galaxy, such as Cygnus X-3, Hercules X-1 and Vela X-1. For an astronomical object to produce neutrinos, Learned says, something in it must produce a flow of energetic protons. These protons hit other matter and produce the particles called neutral pions. The neutral pions decay into gamma rays and neutrinos. Astronomers have already detected extremely high-energy gamma rays (energies in the tens of trillions of electron-volts) coming from these binary X-ray sources. To them that is *prima facie* evidence that the neutrinos are also there. *– D.E. Thomsen*

Wild-bean protein wipes out weevils

A protein found in some wild beans but absent from common cultivated varieties can protect against an important bean pest, new research indicates. In a collaborative effort involving plant breeders, entomologists and molecular biologists, the protein has been analyzed and cloned, and the trait is being experimentally bred into the common kidney bean, *Phaseolus vulgaris*, according to a report in the April 8 SCIENCE.

Moreover, one of the researchers suggests, the discovery of the rare protein underlines the importance of current efforts to preserve the genetic diversity of earth's plants. Ecologists are increasingly concerned about the permanent loss of genetic variation that is resulting from modern agricultural practices and global development.

The protein, called arcelin, is closely related to a more common seed protein, phytohemagglutinin, or PHA. While PHA may have some insecticidal qualities, tests show that at normal concentrations it is ineffective against two common varieties of bean-destroying beetles called bean weevils. In contrast, the researchers report, arcelin is highly toxic to bean weevil larvae.

The tiny weevils, members of the family Bruchidae, usually lay their eggs in beans before harvest. While the beans are in storage the eggs hatch into larvae, which feed on the stored beans until they emerge as adults.

"The adults can mate again and go through several life cycles while the beans are in storage," says Thomas C. Osborn, a researcher at the University of Wisconsin at Madison who coauthored the report. "Eventually, if you have a bad infestation, the seeds will turn to dust."

The researchers, affiliated with the University of Wisconsin, the ARCO Plant Cell Research Institute in Dublin, Calif., and Centro Internacional de Agricultura Tropical in Cali, Colombia, bred the arcelin trait into a "garden variety" bean that normally lacks the protein. They observed 97 percent mortality among bean weevil larvae in those beans, compared with an average 7 percent mortality in susceptible beans. In experiments with "artificial seeds" (compressed bean seed flour, laced with varying concentrations of arcelin) larval death was dose related.

Arcelin's mechanism of action is unknown, but evidence indicates its insecticidal activity may result from an ability to disrupt the linings of larval digestive tracts.

According to the researchers, arcelin has been found in only 10 percent of wild bean lines and is not found in cultivated beans. "This is a good example of the need to preserve wild germ plasm," Osborn told SCIENCE NEWS.

– R. Weiss