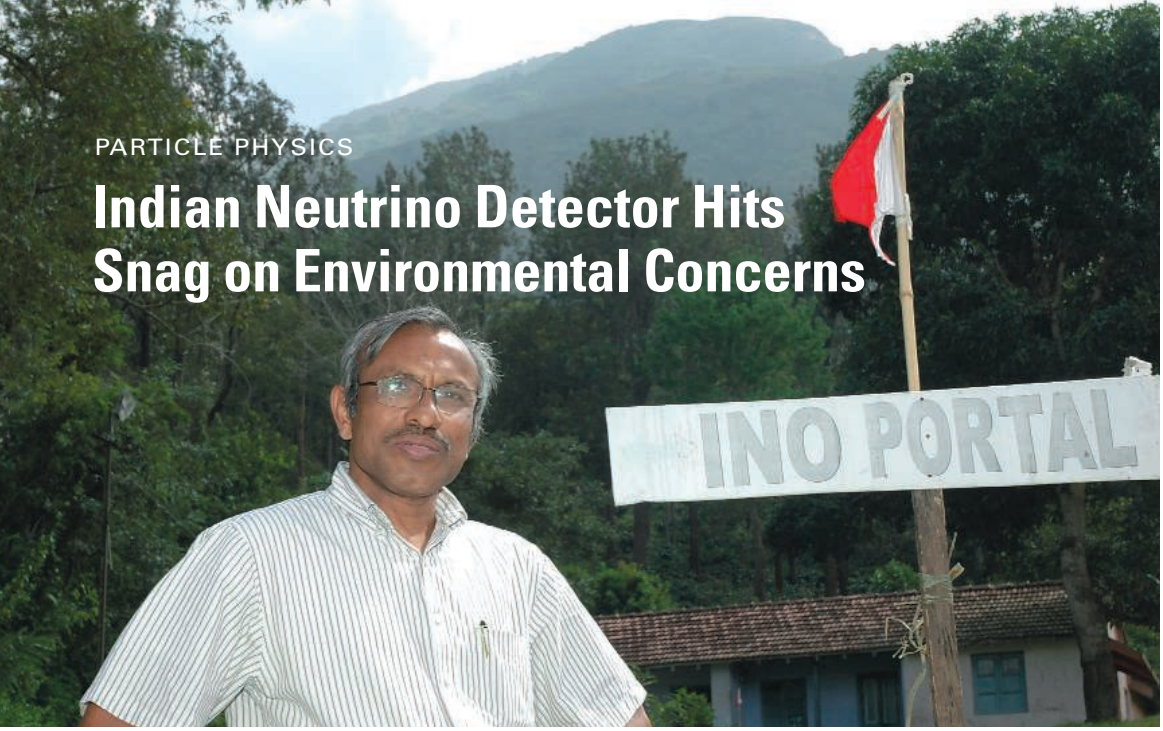
PARTICLE PHYSICS

Indian Neutrino Detector Hits Snag on Environmental Concerns



Waiting game. Naba Mondal at INO's proposed site.

MASINAGUDI, INDIA—The rosewood and teak forest here in southern India's Nilgiri Biosphere Reserve is prime elephant habitat. It's also where Indian particle physicists hope to install a massive detector to stalk a more exotic quarry: neutrinos. But concerns about the well-being of the heaviest land animals have so far blocked plans to tune in to the lightest known fundamental particles.

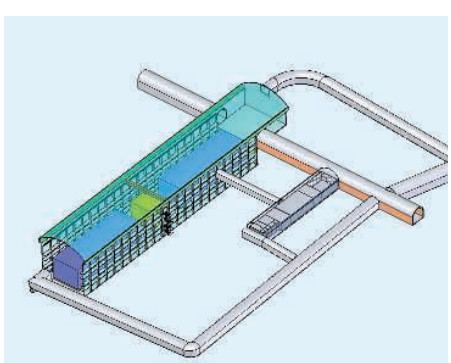
The $167 million India-based Neutrino Observatory (INO), slated for completion in 2012, is the country's most expensive science facility ever. The magnetized iron detector would be nestled in a cavern 2 kilometers deep inside a granite mountain in Tamil Nadu state, some 250 kilometers southeast of Bangalore. Neutrinos are produced in stars as well as on Earth, in nuclear reactors and when cosmic rays smash into the upper atmosphere. They have the slightest mass and are elusive because they interact with other particles only by means of the weak nuclear force. The granite in Nilgiri would absorb most cosmic rays that at the surface would swamp any neutrino signal, but neutrinos will readily pass through to the detector.

A 100-strong team of physicists has conducted site surveys and has begun fabricating detector components at Tata Institute of Fundamental Research (TIFR) in Mumbai and at collaborating institutions. The initiative is "unique and important," says Maury Goodman, a neutrino specialist at Argonne National Laboratory in Illinois. INO, adds Anil Kakodkar, chair of the Atomic Energy Commission, is a "perfect launching pad" for attracting fresh blood into basic sciences in India.

Before work at Nilgiri can begin, INO must obtain a permit from Tamil Nadu's forestry department. State officials say the physicists have not yet made a convincing case. "INO would be detrimental to the ecological balance of the area," says a senior forestry official, who cites two chief concerns: damage to fragile habitat as equipment and materials are hauled through the forest, and debris from tunneling choking the watershed. The World Wide Fund for Nature–India also opposes the facility, arguing that Nilgiri "is already under pressure, and INO will lead to permanent detrimental impacts on wildlife."

Last month, forestry officials and INO scientists met in Chennai, capital of Tamil Nadu, to seek common ground. Kakodkar and project staff outlined their strategy for minimizing INO's environmental impact. The discussions were "positive," says INO spokesperson Naba K. Mondal, a particle physicist at TIFR. But as *Science* went to press, it was unclear whether the state government would issue a permit.

A few decades ago, India was at the forefront of neutrino research. In 1964, a TIFR team led by B. V. Sreekantan and M. G. K. Menon, using an iron calorimeter in a gold mine shaft, were the first in the world to detect neutrinos created in the atmosphere. The facility was shuttered in 1992 when Kolar Gold Fields closed and the experiment became too costly to maintain. "Many of us in the international community grieved over the termination of that line of work," says John Learned, a physicist at the University of Hawaii, Manoa.



Taking the measure. INO aims to make precise calculations of neutrino mass.

India hopes INO will help it secure a leading position in the next generation of neutrino research. For instance, more robust estimates of neutrino mass could shed light on an enduring mystery: why there is more matter than antimatter in the universe. The project entails delving an underground laboratory and installing a 50,000-ton detector for studying atmospheric neutrinos and antineutrinos. Down the road, the detector could be doubled in size to study neutrinos beamed through the planet from particle accelerators in Europe or Japan. Both experiments aim to yield more precise calculations of neutrino masses. "No large dedicated experiment to study atmospheric neutrinos has ever been built," Goodman says. "The INO design is certainly a better way to study atmospheric neutrinos than has been done before."

According to Mondal, the Nilgiri site is ideal in part because the geology was well-characterized during preparation for a hydroelectric project at the mountain. (The waterworks were built a decade ago, when India's environmental movement was weaker than it is today.) Mondal acknowledges that excavating the tunnel will require hauling huge amounts of materials and rubble through elephant habitat. "No doubt there will be some pain," says Raman Sukumar, an elephant biologist at the Indian Institute of Science in Bangalore who has worked in the area for 3 decades. But he argues that "INO can also be converted into an opportunity" if the project funds conservation efforts in Nilgiri. INO plans to create just such a fund, Mondal says.

In that case, Sukumar says, "both neutrinos and elephants can be winners." Mondal and his colleagues are anxiously waiting to see if Tamil Nadu officials agree.

–PALLAVA BAGLA

CREDITS (TOP TO BOTTOM): PALLAVA BAGLA; INO

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