Manpower for fundamental physics experiments

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Let me start by mentioning a few major experimental projects in fundamental physics that are seriously being considered in India.

The experimental projects

1. A neutrino oscillation experiment involving a gigantic (50 kton) magnetized iron detector to be mounted inside a huge cavern of the India-based Neutrino Observatory (INO) that has to be dug inside a mountain in Theni District, Tamil Nadu. This detector will be even larger than the huge detectors which are taking data at the Large Hadron Collider (LHC) at CERN, Geneva. So our students will be able to work in the construction of such a detector and use it right here in India.

2. Search for neutrinoless double beta decay (NDBD) which is actually the most fundamental of all neutrino experiments, since it will tell us about the nature of the neutrino itself (whether it is a Dirac or Majorana particle). This also will be installed in the INO cavern.

3. A low-energy neutrino experiment called LENS (Low Energy Neutrino Spectroscopy) which will detect the pp neutrinos from the Sun. These are the most abundant neutrinos from the Sun (amounting to more than 90% of the solar neutrinos) and have not been detected so far. Hence LENS has the capability of revolutionizing solar neutrino physics once again. This experiment which will use an indium-loaded liquid scintillator will be mounted either in the INO cavern (or another existing cavern or tunnel inside a mountain).

4. Astronomers have discovered that most of the matter in the Universe is not the kind we are familiar with. It is called dark matter since it does not emit or absorb light. Although this discovery has already been made, nobody knows what this dark matter is; only physicists can discover that. A dark matter experiment will be mounted in the INO cavern (suitably extended). This has been called DINO (dark matter at INO) and it will be preceded by a smaller experiment at a shallower depth.

5. A neutron–antineutron oscillation experiment in India is being thought of. In fact, a workshop to discuss this was held in Kolkata last year. Such an experiment will put India back on the world scene in the search for baryon number violation which has not yet been observed.

6. A gravitational wave detector is being planned to be set up in India. This is the goal of the Indian Gravitational Wave Observatory (INDIGO) project. Although this is of great importance in astronomy, direct detection of gravitational waves predicted by Einstein's general relativity is also an important area of fundamental physics. So we include it here.

Technology

Although all these projects concern high energy physics, nuclear physics or astronomy, the technology and materials science component involved in all of them must not be lost sight off. The RPC-based magnetized detector to be set up in the INO cavern will require 30,000 sensitive detector elements and 3 million electronic channels. The NDBD, LENS and DINO will need sophisticated cryogenics, chemistry, semiconductor crystal fabrication and other techniques of modern materials science. Construction of gravitational wave detector will require sophistication at an unimaginable level. Hence execution of the above fundamental physics projects will lead to the development of state-of-the-art infrastructure in all these fields. This important offshoot of 'aiming for the Moon' must be kept in mind.

But where is the manpower for all this? None of the above projects can succeed unless the crucial problem of manpower is solved.

Manpower creation

A few suggestions are offered here towards this aim.

1. Much of the manpower for the Department of Atomic Energy came from the innovative Training School started by Homi Bhabha in 1957. Inspired by this, INO started its own training programme 5 years ago. The scope of this programme could be enlarged to cover the other experiments.

However, we need more people at the faculty level to train these young students.

2. We have to contact those bright young Indian scientists who went abroad in search of fertile pastures and lure them back with assurance of such pastures here. There are many good experimental physicists who would be willing to return. A high-level drive has to be undertaken to achieve this. Heads of scientific institutions must go with 'a blank cheque' during their travels abroad and offer jobs straightaway when they meet deserving candidates.

That is what Bhabha did in the 1950s and 1960s and that is how the School of Mathematics, the Cosmic Ray group, the Radio Astronomy group and the Molecular Biology group, all at TIFR, were built by K. Chandrasekaran, Bernard Peters, Govind Swarup and Obaid Siddiqui, all of whom Bhabha brought back from abroad. (Of course, the times were very different then, but still those glorious examples can light our path even now.) Recently, the Chinese have followed this path successfully.

There are many reputed Indian physicists abroad who can identify good candidates and help us in such a recruitment drive (the inverse brain-drain).

3. Where are these new recruits to be placed? All of them need not and should not go to the established institutions such as TIFR, IISc or SINP. We must persuade the IITs, IISERs and the Central Universities to recruit the bulk of the returning experimental physicists. We have already got positive response from the heads of a few of these institutions and we must continue to try and extract similar responses from the other institutions as well. IISERs and NISER have been founded especially to attract bright youngsters into science. What better way to attract than to show them the possibility of joining front-ranking fundamental science experiments in India? The bright students in their fourth year must be put

into project work connected with one of the experiments in the list above.

4. Many privately funded engineering institutions have come up in the country. Unfortunately most of them are money-making institutions rather than the money-spending variety. We need the latter. Academic institutions must earn, not money, but the reputation of excellence in the advancement of knowledge. Nevertheless, one must not write them off. Recently, some of them are showing promise; they are capable of aiming for excellence. We may be able to induct good science and engineering faculty into them.

5. I now come to the most important aspect of the manpower problem. It is a sad fact that because of the continuing neglect of our more than four hundred universities and thousands of colleges, these languish in academic slumber. Since most of our student-power lies in these institutions, it is no wonder that all our plans for major scientific projects suffer from lack of manpower. So it is clear that mobilizing the universities and coupling them to the National Science Projects is the only correct way forward. It will remedy both these ills.

However, this is a gigantic task. I will restrict myself to three brief points. Because of the importance of this problem, I suggest that DST should confer with UGC and come out with innovative solutions. Second, we must try to influence the universities in the physical as well as intellectual neighbourhood of each of us and persuade them to facilitate the participation of their students in a major scientific project. Third, in many of the university departments, a large fraction of the faculty strength has been kept vacant for many years. These must be filled with experimenters who can contribute to one of the experiments in the list above.

There may be many more ideas, but what is needed is action.

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