last few years a renaissance is taking place in the Department. There is a new spirit amongst the younger group. What is striking to an outsider (I am almost an insider) is the way collaborations have naturally evolved in recent years on specific problems; the way bright young students have interacted freely with many faculty members and learnt different kinds of physics, different styles of working ranging (in theoretical work) all the way from exact analytical solutions to large scale supercomputing. One notes with some happiness that new and innovative experimental techniques are coming in as a matter of course and young scientists are not afraid to do new things. A high level of international competitiveness (the buzz word these days) has been built up as measured by the now fashionable unit of *Physical Review Letters*!!

I am not certain whether this Department will produce the *National Administrators* of the type I have mentioned in a previous paragraph but I have no doubt at all that this Department will produce good scientists and excellent science.

May I express the hope that this Department will not only consolidate what they have gained but also establish a new style and identity which is uniquely theirs for which they will be known in the years to come.

Solid state physics through the years: Need for new initiatives

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Solid state physics developed in India later than elsewhere in the world. What is particularly disconcerting is the poor state of experimental solid state physics today. A new thrust and better funding are essential if this field has to thrive in the country.

The best starting point for discussing the status of solid state physics today would be to examine the status of physics in India as it has emerged in the last few decades in relation to that in the world at large. In the early 1950s, most physics departments in the country specialized in areas such as electronics (what was then called wireless), spectroscopy, crystallography and nuclear physics (in a few places). Proper courses in quantum mechanics and statistical mechanics were not offered at the M Sc level in most physics departments. There would be a course in mathematical physics in some places, although what exactly the subject implied varied from place to place. In some universities, there would be a course in chemical physics. At this time, elsewhere in the world, lasers and masers were being discussed in classrooms. There were well-founded courses in solid state physics, especially the physics of semiconductors. The transistor had already made its great impact on the practice and teaching of physics.

When we come to the 1960s and 70s, one notices that solid state physics was formally part of physics instruction in the country. Some people preferred to call it crystal physics. Lattice dynamics had more than its share in terms of research effort, but there were no worthwhile laboratory facilities, at least in the educational sector, for carrying out the kind of experiments in solid state physics that one would have desired. Low-temperatures could not be reached readily, a situation that prevails even today in most places. Some of the national laboratories were supposed to specialize in experimental solid state physics, but for reasons unknown to me, very few centres in India have gained international recognition for accomplishments in this area. During this period, semiconductor physics had already reached its peak elsewhere. Laser physics and optoelectronics had also become important. Almost every department I knew abroad had particle physics (generally, theory) as a teaching and research activity. Towards the end of the 70s, the direction of physics appears to have changed in a significant manner. Even efforts in theoretical solid state physics seemed to be different in quality and coverage, compared to what most of us did here.

Let us examine the present-day scenario. Today, solid state physics is commonly taught everywhere in India, but the experimental facilities available in the educational sector (in most universities) remain poor. Elsewhere, on the other hand, within solid state physics, traditional semiconductor physics is no longer the main subject of interest. Many laboratories in the advanced countries work on heterostructures or superlattices (quantum dots, wells etc.) High technology and high science are nicely married in the efforts of several educational institutions. We have no such activities in India, not having gone through the experimental semiconductor physics boom. In theoretical solid state physics, however, Indian physicists work in areas comparable to those elsewhere. What is of utmost concern is that experimental solid state research in India has been slowly dying. The number of publications in experimental solid state physics from India in main-stream journals is negligible and our visibility in the international scenario is therefore marginal.

In research, we have generally worked on known materials, on known (nearly understood) phenomena and carried out some standard measurements. It is common in many physics departments to have one or two well-established techniques in search of problems. A number of people work on thin films, but very few use MOCVD or MBE. I would say that experimental physical science, in particular solid state physics, has suffered badly from inadequate support, poor thrust and indifferent interest. In the meantime, other areas with a major overlap with solid state physics have emerged. I am referring to materials science and solid state chemistry which are closely connected with solid state physics.

It is my view that we in India have to work on the following types of problems in solid state physics, if we have to keep a measurable pace with the advances in the subject:

1. We have to upgrade the general quality of the on-going experiments.
2. We have to investigate new and known phenomena based on good (precise) measurements on good samples (e.g. single crystals) or on new materials. The recent thrust on superconductivity gave such an opportunity, but for some reason, Indian experimental physics efforts were by and large not at the cutting edge (I am ignoring a few possible exceptions whenever I make such statements).
3. We must work on complex materials and phenomena. While there has been some work on liquid crystals and soft solids, we have not made a real beginning with molecular materials.
4. We have to initiate work on artificial superlattices.
5. New techniques and good instrumentation have to be developed if we have to create a place for ourselves.
6. In the absence of standard facilities and other requirements, it may be best that one creates one's own area in solid state or materials physics, working on problems related to complex solids, nanomaterials, cluster physics, fullerenes, interfaces, etc. This kind of attitude does not seem to be present amongst many in the physics community. Although I do not formally belong to the physics community, I notice that either many of the physicists are afraid or tend to be condescending in their attitude when it comes to working on problems where they may have to work closely with chemists and materials scientists. Working in such areas may indeed yield respectable results.
7. It is important that we make our presence felt in the world at large. I feel that at least 150–200 good experimental research papers (per year) should come out from India in main-stream journals (I give this figure as a target).
8. Wherever possible, we should carry out investigations of possible use to industry so that a physics-based industry comes up based on national expertise. Opto-electronics and sensors would be typical of such areas. Such knowledge-based industries would have a major physics component.

Clearly, we have to incorporate all the above aspects in order to develop a proper experimental solid state physics base having a good overlap with materials science and chemistry. Once we have such an experimental base, physics teaching will also undergo a significant transformation. For this to happen, there is need for considerable funding. Compared to nearly Rs 80 crores p.a. of funding for biological sciences, all of physical sciences and engineering get not more than 20 crores per year. Of this, probably solid state science gets Rs 5 to 8 crores p.a. What we require however is something on a completely different scale. We would require an annual budget of about 15–20 crores of rupees for solid state science alone, after having established the basic infrastructure for experimentation in this area. To establish proper infrastructure and facilities for good experimental solid state research, I believe that there should be an initial investment of about 50 crores of rupees. This investment should be treated as a COSIST programme for solid state science. I do hope that the powers in Delhi and elsewhere would look at this issue not as another demand of a bunch of scientists, but as a national requirement for a future technology base.