

# Researching condensed matter theory in two continents

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Here I would like to share some of my observations about the business of researching condensed matter theory in India, where I did my PhD and much of early work, and in USA where I have been situated for the last five years. My hope in giving this talk is to give those of you who have done your PhD's here in USA and may be contemplating returning to India sometime in the future, an idea of the differences you may expect. For others having a general interest in the problem of doing science in the third world, the following may give a glimpse into the problems facing individuals, and may provide a bird's-eye view of the Indian academic milieu. In focusing the talk on condensed matter theory, I have been guided by my somewhat limited personal experience, and have partially sacrificed generality for the sake of accuracy. Other branches of theoretical sciences presumably have not too dissimilar experiences of the 'two cultures'.

## The distribution of condensed matter theory research

Firstly I enumerate the broad families of research organizations that patronize condensed matter research in India.

1. University Grants Commission (UGC). The 100-odd universities, with the premier 5 central universities, prominently the JNU, University of Hyderabad, Shillong and BHU, and particularly the Indian Institute of Science at Bangalore.
2. Department of Atomic Energy (DAE). Tata Institute of Fundamental Research Bombay, BARC, Institute of Mathematical Sciences (Madras), Institute of Physics (Bhubaneswar).
3. Department of Science and Technology (DST). Bose Institute in Calcutta.
4. Indian Institutes of Technology.

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There are five at Delhi, Bombay, Madras, Kharagpur and Kanpur.

On the same coarse grained scale the three families in the USA are: 1. Universities; 2. Industrial Labs; 3. National Labs.

My purpose in making the above lists, is to point along the way, the 'universalities within families'. In particular, the UGC family members have much in common, as do the DAE members. I should explain that this year I have reached a chronological centre of gravity in my own career after PhD, having spent seven years in India (two in UGC Family and five in DAE), and seven years in USA (three in Universities and four in Industrial Labs), making the preparation of this talk somewhat timely, at least for myself. The format of the remainder is the following. I have listed a few informal subheadings listing some of the broad concerns as they have struck me. These are topics that you may have worried about too. In the paragraphs following the subheadings, I have contrasted the experience in the two countries. The organization of topics is in a direction of decreasing dissatisfaction with one and decreasing satisfaction with the other. I recognize the complexity of the issues involved, and hope that there are not too many simplistic conclusions.

## Interaction with experimentalists

This very important part of normal condensed matter research is in a rather bad shape in India, and the US environment definitely continues to be first rate in this regard. The situation in India is that although there are excellent theorists and also experimentalists, the organization of science usually draws a thick line between the two. There is no active effort to bring theorists and experimentalists to work together on problems of common interest. This common attack on worthwhile problems, is what Bell Labs is all about, and is certainly very much in sight at many US universities as well.

My own feeling is that not enough organization is done to get the two groups together in most places in India. The synergy generated by these discussions is known to be of considerable influence in setting goals and directions in Bell Labs and also other places here in USA.

## Hierarchy

This is one of the most troublesome aspects of doing science of any sort in India. The extent and depth of this depends very much on the various families in India: the extremes being the 'dak-sahib' in certain Universities where the Professors lord over the Readers etc. The DAE families are different, at the other extreme, a place like TIFR is in no way different from any place in USA. I also take this opportunity to contrast the behaviour of non-scientific administrative supporting staff in say TIFR to those in a University: one finds an unwritten rule that the *raison d'être* of TIFR is the scientists, young or old, senior or junior. I remember a very senior administrator coming and courteously asking a group of very noisy graduate students (including yours truly) to vacate a place that they had no right to be in. A few years later I was a humble lecturer in a University, and had the experience of holding out my hand to a top administrator to whom I was being introduced, and having him ignore it! He merely nodded in my general direction and continued his conversation with the introducer, who was as embarrassed by this as I was. In retrospect, the administrator was no Darth Vader: I was just being too uppity from his frame of reference, and he was showing me my place. Luckily as years go by, I note a change in the right direction in most places in India, with some informality creeping into the right places.

However, in most matters of importance like hiring, changes in directions, etc., hierarchy will not simply disappear: the good ideas and leadership are

expected from the top rather than from the bottom. This is the diametrically opposite world view from that in the US. This reversal of expectations runs deep and perhaps has a sociological dimension to it. At a practical level this means that if you have good ideas for improving things, make sure you do not put your trademark too loudly on it: self-effacement is in!

## The tools of theory

**Computers.** The basic tools of theory are undergoing a revolution, bringing 386/486 PCs to every desk-top, making programs like MATHEMATICA, MAPLE, REDUCE, and laser printers commonplace in the US. As far as I know, the same is true of TIFR and IISc Bangalore, but may well be within reach of every 'family' in India. The cost of this equipment is also rather nominal, and no one should really depend on the system and should make an effort to be self-sufficient. Things are really improving in this area, thanks largely to diminishing costs at Silicon Valley. Sun workstations and IBM RISC stations have been sighted in India too. Heavier computer users will no doubt complain in India about the lack of CRAY'S etc., but I have no particular insight into solving this problem beyond the suggestions: *do not compute*. Anything not doable on networked Sun stations is probably not worth doing in India, and probably anywhere else for that matter!

**Libraries** are very variable in India, the UGC system probably has more problems than others in getting journals by air mail. The TIFR library is truly excellent and ranks well above any other that I have seen save the Princeton Library. The DAE family tends to have better funding/organization in these logistics. Old journals are available in one place or the other but the problem usually is of getting things you want in a time span short enough to retain your interest in a problem. This is by no means a purely Indian problem as I have been recently discovering!! Many libraries in the US are also very selective in what they keep in one form or the other, and the problem of getting old journals quickly (within say a week) is very serious here too. The unofficial channels work a lot better as

we all know, friends and colleagues send relevant stuff by fax when the chips are really down. This brings me to the next item: communications.

**Fax and e-mail.** The fax services inside India are rather primitive and in no case can we get the 'old-paper urgently wanted before sunrise tomorrow' serviced by this channel. Bureaucrats have to authorize these things. Overnight mail exists but is somewhat costly. This brings me to the e-mail issue. There has been a surprising dragging of feet on this in India and even now only a few places have reliable e-mail. Hopefully things will change soon, particularly since this is a universal problem affecting all disciplines.

## Academic environment and support system

This is a truly inhomogeneous problem, and it is very difficult to generalize. My own experience has been extremely happy in India, and reasonably satisfactory in USA. At the very outset, let me say that I have been very fortunate in my collaborators here in USA as well as in India, and regard myself as lucky to have had the honour of working with them. The comments below refer to general interactions, let us say during the March meeting conferences or with visitors, or during visits outside one's organization, and represent integrated views over several years.

I was fortunate in going to graduate school in TIFR where the teaching was, and remains, very personalized and broad in its base. Fellow students tended to be very generous in sharing ideas and teaching me various tricks. I am forever in the debt of these teachers who made things 'easy' and 'fun'. Later the situation remained very healthy and one got extremely useful input from friends working in various areas of theoretical physics. People have tended to be generous in giving their time in listening to one's latest hobby horse, gently pointing out the grave errors and encouraging the right things. A relaxed, intelligent, and interested environment exists in the good places, with no rush to make the next PRL, and somewhat un-competitive attitude. You will find many a Vijay Amritraj of Physics back home. Lovers you say! I am not too

sure. The 'winners and losers' of today may not be judged as so even 20 years on: I have seen this even in my relatively short career.

On the same topic one finds more 'broadcasters' than 'receivers' in the US Physics scene. It is difficult to get intelligent and knowledgeable colleagues to act as sounding boards unless one is very lucky, without their having a personal interest in the outcome (say a self-reference or worse a co-authorship). Unstructured interactions are out. I would be surprised if in the course of a discussion here, I was directed to a paper that does not involve the other person in at least some indirect way. I would be totally shocked if I were directed to a paper written by that brave and faceless Soviet hero 'V. Berezinski', who seems to have done just about everything in low dimensions well before anyone else! The Mathematical Physicists in USA tend to be much more in the mould of 'Classic Old School Scholarship', and one wishes their culture to spread more vigorously.

On the flip side of all this, if one's genuine interest coincides with that of a particular US subcommunity, then bingo! Action results. Much more fruitful collaborations emerge and exciting work can and does result. Tremendous depth and expertise are available in USA in just about any area one can think of, and most experts are a phone call away (AT&T of course). Experts in most areas are few and far between in India in most disciplines, and at the moment most of the groups working there are subcritical in numbers, with little communication between each other thanks to the general lack of good telecommunications networks.

## Intellectual freedom, bandwagons and glass ceilings

This bunch of topics has to do with higher order worries assuming that the basics have been taken care of. So we imagine that a job has been found and the question is what next? Here I find that the differences are rather striking. In the US, there is a severe bunching of interests that change coherently; this is the Bandwagon effect. To be out of Bandwagons may not be your cup of tea, in which case look no further, you are in the right place. If otherwise

minded, the US system is frighteningly conformist, in contrast to the Indian (non)system. Invitations to conferences, and research grants are definitely more likely to come your way, if you have been doing epsilon physics in popular areas. I know of absolutely world class physicists here, who have routinely been getting the cold shoulder for doing excellent things but not using the right buzz words. Secure research funding, and lack of tight structure give the physicist in India a much greater freedom to choose the topics of research. Increasingly, people have been using this option in India, and I know of several excellent Condensed Matter people doing somewhat non-standard things. The absence of bunching does give a somewhat non-professional look to the outside observer, not many PRL's come out, etc. However, this *laissez-faire* way of doing Science, akin in some sense to the individualism of a Bhimsen Joshi rendering, or a Subhash Gupte googly, is quite uniquely Indian, and I submit, a positive and healthy alternative to 'over-organized physics'.

*Glass ceilings* are ubiquitous: if one prejudice does not get you then another will, and the only question is of degree. Luckily this does not seem to be too much of a problem in condensed matter physics in either country at least at this time.

### Roundup

In summary I have presented some of

my thoughts on a few questions that often arise in conversations. Of the various families of organizations that I listed above, I have spoken mostly about the DAE family and TIFR in particular where I grew up. Of late the Institute of Physics in Bhubaneswar and Institute of Mathematical Studies (Madras), both belonging to this family, have shown a very positive and mature policy in hiring very good young theorists, and seem all set to take off in a big way. In the UGC family, IISc Bangalore has clearly been the leader all along, and has played a pivotal role in organizing many meetings in condensed matter physics, but seems to be at a somewhat saturated state as far as hirings go. The Jawaharlal Nehru University in Delhi has been hiring vigorously and has a strong group in nonlinear systems. The IITs seem to be floundering somewhat in their research, despite very good work done there in the past, their charter clearly defines physics as a service faculty with teaching as the main goal. There are very good people in the IITs, but somehow their role, at least at the present, seems to be to produce the best graduate students for Princeton and Harvard!

Excellent individuals dot the landscape in India, working at several places around the country. It is not too difficult to locate a good condensed matter theorist within a 500 mile diameter circle in most parts of India. This was absolutely not the case some 15 years ago when I started out, and is

very encouraging to my eye. Perhaps the next decade will see a further growth in India in this area, there is after all no shortage of people (!), or even of good physicists of Indian origin, as the gathering here indicates.

### Postscript

After the talk I received very interesting comments and questions during the discussion period, some of which, having had no first hand knowledge of, I could not answer. I was asked many questions about experimental condensed matter physics, the question of how top heavy are most groups, do group leaders allow freedom to juniors, of funding prospects, and whether an individual experimentalist going back, could hope to make a difference. I was asked whether women scientists should expect to face any discrimination. If the reader has any experience in this regard, please write in (to *Curr. Sci.*, also): there definitely is a group of Indian scientists in the US, who want to know the answer.

I was informed that Dr V. Berezinski, to whom I had a 'generic' reference in the talk, had an untimely demise in 1982, after a very brief but brilliant scientific career.

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## OPINION

### Why man has no predator

*M. G. Watve*

The question why carnivores sometimes turn man-eaters has been frequently discussed in the literature<sup>1-3</sup>. It is, however, always taken for granted that man is not the natural prey of any carnivore. The question as to why it is so has never been seriously addressed. The early hominids certainly had predators<sup>4</sup>. In some stage of evolution human ancestors became practically free

of predatory pressures. The various explanations given are habitat partitioning, improved defences, and carnivory by man.

Habitat partitioning, however, has never been complete. Effective self-defence due to improved weapons, fire and shelter could not have been sufficient to ward off predators completely. The present century man-eaters have

demonstrated this. Many man-eaters have entered villages, smashed open doors, and carried their victims. People carrying weapons were also taken effortlessly<sup>3,5,6</sup>. It is therefore unlikely that weapons, fire and shelter were sufficient anti-predator defences. An organized armed group defence may be effective against predators, but slight dispersal during foraging in the forest is sufficient