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GUEST EDITORIAL

Helping university and college teachers

The year 2017 was an absolute thriller for workers in gravitation and astrophysics. There were two announcements in August from LIGO collaborations, which now include the Virgo collaboration in Pisa (Italy), apart from the two at Hanford and Livingston (USA). The first observation was that of another black holes' merger. The second was the merger of two neutron stars, which was communicated to instruments sensitive to different areas of the electromagnetic spectrum, like radio waves, optical, gamma rays and so on. Amazingly, these instruments were also able to see the event. The combined data, helped in the recovery of more details of the merger. As Stephen Hawking mentioned in his last BBC interview: 'We are still rubbing our eyes, or rather ears, as we have just woken up to the sound of gravitational waves.'

It was almost as if nature had come forward to confirm what the scientists working in these areas thought was going on, very hesitatingly though. It was a bit like what happened when the cosmic microwave background radiation (CMBR) was discovered by Penzias and Wilson in 1965. The results of Gamow, Alpher and Herman, which were considered speculative, suddenly turned out to be correct. The neutron stars were discovered in 1967 by Burnell and Hewish and named 'pulsars', as they emit precisely timed pulses. We still do not understand, in detail, the pulse mechanism. However, 50 years later, we understand how they merge. In 2015, black hole merger proved Vishveshwara's calculations of quasi-normal modes of black holes, done, when no one even believed in black hole's existence. However, the gravitational wave displacements are much smaller than even the size of protons. There is a sense of disquiet about what we are seeing. The simultaneous observation of radio, optical and high-energy signals, however, confirms that gravity waves are formed from the merger of neutron stars and we have, indeed, a new window to the universe.

While the results of 2015 (which resulted in a Nobel Prize) were those of LIGO only, the 2017 results were a combination of LIGO and the Virgo group. This helped in localizing the event more precisely in space. In another few years India will also, hopefully, have its own LIGO (INDIGO) and be part of this collaboration. The signifi-

cance of the discovery of gravitational waves as a new window for observation is obvious to most of us, as articulated by Hawking above.

In a parallel development, Indian scientists at the Inter University Centre for Astronomy and Astrophysics (IUCAA) in Pune and Raman Research Institute (RRI), in Bengaluru, as well as a few other places in India, were working as part of thousands of researchers all over the world in the area of gravitational waves. At IUCAA, Narlikar encouraged the study of gravitational waves right from the beginning. Dhurandhar and collaborators came up with the idea of using templates for signals which could be filtered out from the highly complicated noisy background. There was collaboration with institutions in Australia and USA. At RRI, Bala Iyer and his group used post-Newtonian methods to study solutions of gravitational equations and calculate the results of merger of stars. Iyer was helped by Indo-French collaboration programmes to work with Damour and his group in France. I was the thesis examiner for some of his students. Naively, I used to wonder (worry) where these students would get jobs? Now these scientists are at the core of the collaborations in India. The International Centre for Theoretical Sciences (ICTS), Bengaluru (a part of TIFR) has now become a major centre in this area. Tarun Souradeep has taken charge of the IUCAA group in Pune as well as that for whole of India for gravitational waves research and setting up of INDIGO. There are quite a few active workers in universities and colleges, in astrophysics and general relativity; many visiting IUCAA. Universities have played a major role in scientific research in the past. Their importance has, however, been decreasing drastically after independence. In the West, especially in the UK and USA, the universities play an active role in both teaching and research. Why is this not so in India now?

One reason may be, the generally low standards of research in the country. However, the universities seem to fall even lower than the average. There are two broad reasons for this: one administrative and the other teaching method. Very few universities have long-term planning groups. Often the Vice-Chancellor comes from outside the university and chooses his team from the faculty of

the university with hastily obtained knowledge. Very few faculty have the required overview to help in long-term planning. This results in lack of continuity and five years is not enough for a vice-chancellor to improve or even sustain the standard of various departments. Appointments, even when held in time and impartially, are a lottery, depending on candidates available at that time. The other reason is the teaching method, which insists on giving information to the student at a level which is far above his attainments. This coupled with insufficient tutorials for the very large numbers of students, almost forces them to practice rote learning. Students rarely experience the satisfaction and joy, coming from understanding something new and fitting it in their world view. Examinations, even those conducted internally, are based largely on well-known descriptive questions which require rapid transfer of answers from memory. All this results in an output of students, who often end up becoming teachers (at all levels from schools to colleges) doing the same kind of things their teachers did.

How do we change this? In my view we can take a lesson from the IITs. Provide a governing body for each faculty, so that there is a continuity of, and direction to, its policies. Ideally the heads of departments or deans of faculties should provide this leadership. However, with seniority being the criterion for appointment of heads at most universities, the leadership qualities of most heads are limited. A combination of good executive head with innovative governing body would be ideal, as was seen in the case of IUCAA. The director was assisted by an international committee of experts from the West, especially the UK. At the Inter University Accelerator Centre (IUAC) in Delhi, there were enthusiastic NRIs from USA who were advising and helping it. Who will bell the cat now? UGC, universities, the Ministry of Human Resources Development, Government of India or the Science Academies?

In fact, the UGC has already done something good as discussed above. The fact that so many of us from the universities, including me, got involved with cosmology, gravitational waves, and earlier with Ashtekar variables and quantum gravity was because of the inter-university centre (IUCAA) set-up by UGC. IUCAA, set up in Pune in the late 1980s, was headed by Narlikar who persuaded Charles Correa, the famous architect, to design the Centre's building. This was combining science and technology with liberal arts as Steve Jobs put it. Another centre, IUAC of UGC that I also interacted with, was headed by Girijesh Mehta, a nuclear physicist from IIT Kanpur, and was right in Delhi, inside the Jawaharlal Nehru University (JNU) campus. Unlike the Pune building with its open circles and squares, the Delhi building is marked by a tall tower which houses its accelerator 'Pelletron'. To set up these centres, Rais Ahmed had to get the UGC Act amended by Parliament, when he was vice-chairperson of UGC. Yash Pal really got things moving when he was

chairperson of UGC. Thanks to these two centres and a third one at Indore, scientists from universities can spend weeks interacting with experts and learning of latest advancements in the field. The expenses for their stay are taken care of by the UGC Centre.

Fresh PhDs, who had gone back to their institutions (like my student from Nepal), visited these centres and were given advice by senior faculty there. Some visitors learnt how to work with data from telescopes. The location of the National Centre for Radio Astrophysics of TIFR in Pune also helps. Govind Swarup was always pushing universities to send students and teachers to learn about the subject and data analysis. Faculty members from Delhi University benefitted by such help. At IUAC, every project had to involve teachers from universities and/or colleges. IUAC is introducing nuclear scientists to applications, earlier in condensed matter physics, and now in biology. There is a need to sustain and strengthen the influence of these inter-university centres among universities and colleges.

We should also set-up centres for interdisciplinary projects like garbage disposal, river cleaning, replacement of bad agricultural practices like stubble burning, etc. We are developing expertise in these areas at the Indian Institute of Science, Bengaluru, IITs, etc. During their careers many teachers lose interest in the problems of their PhD, which have ceased to be of importance now. Some pay attention to problems of societal interest.

Finally, the role of academies and societies is also important in producing a sense of bonding and belonging. The Astronomical Society of India and the Indian Association for General Relativity and Gravitation have played a useful role in my fields of interest in an inclusive way. The presence of university and college teachers of the calibre of P. C. Vaidya and A. K. Raychaudhuri was deeply inspirational. The annual or biannual meetings of high energy and nuclear physics groups were also extremely useful and business-like. The Indian Physics Association started by A. S. Divatia, B. M. Udgaonkar and others was quite ambitious, but has not been able to develop like its US counterpart. I must also mention the role of grants from the Department of Science and Technology (DST) which, besides experimental work, also supported theoretical work in astroparticle physics at Delhi, with a rather big grant (courtesy N. Mukunda). The recent report of the national rating agency (NIRF) has positive things to say about several universities. However, there is a long way to go. What is needed is more cooperation amongst all, research institutions and universities, apart from better ability to spot and nurture talent.

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