Seminar on International Research Facilities

The third EPS Seminar in the series designed to present a broad overview of what is happening in big physics was held at the Royal Society in London from 17-19 March 1986. It will be recalled that the inaugural seminar was held in Rome in 1979 and the second in Copenhagen and Risø in 1983. The main criticism that could be levelled at these previous meetings was that the programme was too compressed, giving little opportunity for discussion, while the panel sessions at the end merely repeated in a condensed form what had been said before.

With this in mind the Seminar was held over three days with the last day mainly devoted to separate discussions within working groups followed by presentations of the main conclusions in a plenary session that encouraged a general exchange. About 100 people took part. Detailed organisation was in the capable hands of The Institute of Physics and substantial financial aid was given by UNESCO to help with the subsistence costs of those with currency problems. The invited talks were, almost without exception well thought out and at the right level for a broad physics audience — and quite a number were delivered within the time limit allocated. As a result a great deal of information was exchanged and the *Proceedings* which it is intended to publish rapidly should be a valuable summary of the major facilities being built or planned across the globe. The Seminar was held in collaboration with the American and Japanese physical societies and although the main accent was on European activities, where international cooperation must begin at a much lower level, these were placed in a world context.

Whilst collaboration across frontiers is still in many sectors seen as merely a necessary evil that has to be borne when national funding is limited, a real shift in attitudes towards seeing the benefits of cooperation *per se* can be detected. Similarly, although the tendency for European laboratories to seek partners first in the USA is still much in evidence, Europeans are now talking to each other in more and more fields. Nevertheless to a very great extent these fields remain self-contained, and whereas priorities might be discussed and formulated in specific terms within a field, with the high energy and particle physicists leading the way, noone is yet prepared to venture into the troubled waters of trying to define priorities between fields. Indeed some will argue that it would be highly improper to do so, but as B.F. Burke of MIT pointed out, this has to be done by someone, and in the USA it has proved possible for the scientists to do it — it just takes a lot of hard work and a great deal of time. The end result ought to be better than leaving it solely to the funding agencies, or worse, the politicians.

The wealth of information presented in the invited talks was far too great for any summary to be useful and we shall content ourselves with a review of the final session. First though a comment on costs. It was disconcerting, although no doubt reasonable, for project costs to be quoted within a factor of two or three — without defining whether the unit was dollars, EUA or pounds. People were more interested in an order of magnitude feeling. What did seem to be missing however, was any feel for the number of physicists involved in a project and what would be their interaction with the universities. Also it was not clear that in the evaluation of new projects the provision of measuring equipment and subsequent data handling, was always given the attention it deserved as had characterised CERN's planning for example. Certainly no field could be casual about developments in information technology. Experimentation at a distance involved a quite different apportioning of effort, but modern interactive communication systems and high speed data transfer links could be vital in preserving the actuality of university research.

Nuclear Physics

G. Goldring, Chairman of the Nuclear Physics Division, reporting on the nuclear physics working group re-affirmed the general feeling in this area that scientific collaboration should be largely an *ad hoc* affair with minimum administrative formality. Nuclear physics is a broad field wherein useful work can be done even with relatively modest equipment and there is a clear resistance to concentrating on high performance machines run in centralised institutions which (to the resentment of certain CERN supporters) were identified with oppressive bureaucratic control.

Much of the discussion (as in a previous session) became polarised round the European Hadron Facility (EHF) which an energetic group of physicists was promoting with much vigour. To the extent that little was thus said of the status of the European multi-GeV electron machine and the relativistic heavy ion project (which were the only big new facilities foreseen in the ESF Report on *Nuclear Physics in Europe*, published in 1984) this created an imbalance. Nevertheless it provided a useful pivot round which to discuss today's nuclear physics which is concerned with quark and gluon interactions at one end of the scale and atomic physics at the other. The EHF proponents were very anxious to act as a bridge to high energy physics and keen to have the high energy physicists cooperate. The message coming back however was clear: "our priorities lie elsewhere and if the nuclear physicists want such a facility it is for them to find the backing". Within the nuclear physics field moreover, thought has to be given to the number of such facilities that are needed, bearing in mind the 30 GeV + extension to TRIUMF that is currently before the funding agencies in Canada, in addition to proposals from Los Alamos.

Comments were also made on the need to study more systematically how existing facilities originally developed for other purposes could be more effectively exploited. Existing storage rings in Europe could provide electron beams for nuclear physics and CERN was a resource that should be investigated for hadron beams. In part, the closing of the kaon beam line at CERN had triggered the pressure for a dedicated facility, which emphasised the point that if one traditional sector wanted to make use of facilities originating in another then the demand had to be formulated. This echoes a frequent comment made in dis-

cussions of the problems of peripheral countries: ask and you will probably get a sympathetic response, but you cannot expect the initiative to come from the host.

To paraphrase the President's summing up: one saw in nuclear physics a great broadening of horizons and whilst the desire to retain a wide spectrum of facilities could be understood, the nuclear physicists had to get together to work out where the community's priorities lay.

Astrophysics

E. Preuss, Chairman of the Astronomy and Astrophysics Division sketched out the changes in approach that had occurred since Copenhagen which he interpreted as a sign of maturity. Whereas at the last Seminar, the tendency was to classify research as either ground- or space-based, now it was a question of spectral range with complementary observations being made from Earth and from space. For example, a few years ago cm astronomy would have been considered as essentially ground-based because of the generous windows through the atmosphere, but now it was appreciated in Very Long Base-line Interferometry how a space-borne telescope could greatly extend the base length and hence the power of the technique. Whatever the wavelength, the demand as always was for higher sensitivity and higher resolution and this was a time when the technology was going through a period of rapid change. Until recently a large optical telescope array would have been designed on the basis of say 2m instruments but with the development of dynamic control of reflector surfaces, the optimum unit is now more like 8m.

The astronomic scene as painted by Preuss seemed to be remarkbly coherent and ambitious with a wide range of instruments planned to cover the spectral range from dm to UV on the ground and in space, and then space only instruments for the X- and γ-ray regions. In addition, the astrophysicists were involved in neutrino and gravitational wave research although photons were still their prime probe.

A feature of the field is the extensive consultation that goes on even if a facility is essentially for national use. The argument for an international approach was not closely related to project cost; it was applied to quite small projects as well as the very big (encouraged by the specialisation that followed the increasing complexity of the technology). Co-operation took many forms: a formal and permanent international centre

such as ESO, long-term bi- and multilateral collaborations and shorter-term collaborations for specific projects.

Despite ESA's science budget being only one quarter that of the USA, Preuss saw plenty of opportunity in Europe for space-based instruments, riding on the back of technology-driven space programmes. International collaboration was, of course a key factor within ESA itself, and between ESA and NASA. In the main, the infrastructure worked well. There was nevertheless a need for priority evaluations and EPS could play a role in this.

High Energy and Particle Physics

R. Salmeron, Chairman of the HEPP Division summarised the topics that had occupied the minds of the working group as:

1. The reasons for the tradition and the success of international collaboration in HEPP: they are the result of a long evolutionary process: they had meant great internal discipline with priority concessions on national facilities; international operation was found to be "a workable way to live that is not bad"; it was a dynamic state needing constant revision; in the last analysis, it was a must.

2. How to obtain a good balance between the national and international effort: discipline was the critical element.

3. Interaction with the universities: the aim was to provide and receive intellectual stimulation; to up-grade the technical potential of the universities; improve contacts with industry and in some countries to generate funding channels.

4. Formation of young people: the size and time-scale of modern experiments demanded new techniques wherein, *e.g.*, young physicists could gain the experience of joining a team building an experiment, but in parallel analyse data taken in a previous experiment, so as to avoid a narrow training that was 90% engineering.

5. European attitude to the SSC (the US Superconducting Super Collider which is a project for a 40 TeV $p\bar{p}$ collider in a ring 83 km round, equipped with 8000 17 m long superconducting magnets, estimated to cost around 3G $ while a single 4π detector might run out between 100M $ and 200M $). Invitations to participate in kind had been sent to Europe, but for the present it looked as if LEP I & II and HERA would absorb all the current new project funding. Politeness perhaps ruled against referring in the same breath to the European proposal that is emerging for a Large Hadron Collider to be built in the LEP tunnel which would allow a wide range of collision processes starting with a 8.5 TeV beam. All this for a mere 1G SFR.

6. The European Hadron Facility: fully committed to other priority projects.

7. Technology and new methods of acceleration: whereas in the past improvements in established technology such as the introduction of superconducting cavities and magnets had paid the best dividends, there was now financial pressure to put much more effort into research into alternative methods. A pluridisciplinary approach was needed with full university participation: a role for EPS.

In the ensuing discussion the EHF promoters again dominated the debate, but the HEPP priorities were clear; it was for the nuclear physicists to come together and decide what they wanted and what they would give up.

Condensed Matter

Probably the most difficult working party to contain was that of Condensed Matter which as its Chairman, E.R. Dobbs emphasized, was a very broad field requiring a wide range of big and little facilities. Amongst the big facilities, neutron and synchrotron radiation sources stood out as needing international funding and concern was expressed that still only three countries were involved in ILL (F, D, UK) and only five, so far, in the European Synchrotron Radiation Facility (F, D, I, UK, E) that is to be built at Grenoble. ILL had invited other countries to participate as Associate Members, so perhaps the position there will be improved.

With the spallation source ISIS at the Rutherford and Appleton Laboratory being opened to European partners, Europe could be reasonably content with its research potential in this area. However, the full value of the machines can be exploited only if they are well-funded and only if a real effort is made to optimise the experimental programmes of the different facilities. This was particularly important as ILL and present SR sources are over-subscribed with the consequence that the more adventurous and possibly the most interesting experiments tended to be left out.

Come the '90s and we shall be needing more powerful facilities and the time to start planning these was now, starting with the ESRF itself where only 10 experimental stations were currently foreseen; the number of these should be increased as quickly as possible. Europe must also react to the lack of industrial involvement in SR experimental programmes and planning, in sharp contrast to the US and Japan where industry hires beam time (at say 200-300 $/h), mounts joint programmes with the centre or a university, or in some cases builds its own beam lines. The oft-quoted problem of commercial secrecy *versus* the academic obligation to publish does not seem an inhibiting factor.

Some thought had been given to areas of research where collaboration (notably E-W) could be enhanced and the development of materials suitable for fusion devices had been identified. R.S. Pease had given the Seminar a rapid survey of the present state of fusion research and whilst some of the basic physics of confinement is still not understood, empirical progress is being made towards the fusion goal. The moment ignition is reached, the materials problem will become a priority.

The Seminar had also been treated to a review of high magnetic field facilities, by P. Wyder, the centres at Grenoble and Nijmegen being particularly important. About 30T is the present technological limit for steady state operation and whilst this may not be a particularly significant figure scientifically in terms of new phenomena appearing, interesting effects were more easily observed in big fields, following which experiments at lower field strengths could be designed. The point was made though, that having a big field available was not enough: one needed an infrastructure and an array of advanced equipment to go with it.

Dobb's conclusion was that in condensed matter physics, there was plenty of scope for cooperation at a European level and we now had in the EPS General Condensed Matter Physics Conference a forum where plans and priorities could be discussed. The opportunity should not be lost.

Conclusion

In summarising his impressions of the Seminar, the President spoke of the evident vigour of physics. It was vital that we studied possible future developments very carefully and that from time to time the different disciplines came together. Apart from understanding each other's preoccupations we had common concerns, of which bringing on the young stood high on the list. Moreover, we had to face the consequences of the expanding scale of expenditure and the need to establish priorities. It was, therefore, of the greatest importance to establish the scientific case for projects; that was very much our responsibility.