ICTP in Trieste: Creative research for global development

An international forum for progress in science

by André Hamende

The International Centre for Theoretical Physics (ICTP) in Trieste is 7 years younger than its parent institution. It was inaugurated in 1964 after lengthy consideration by the IAEA Board of Governors and the approval of the General Conference. Prof. Abdus Salam, Nobel Laureate for physics in 1979 along with two other distinguished theoreticians, S. Glashow and S. Weinberg, had suggested the idea of its establishment as early as 1960. He has been its Director since its creation.

ICTP started with the modest budget of US $55 000 from the IAEA, US $278 000 from the Government of Italy, and US $22 000 for fellowships from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Italy had also offered a new building, which was made available in May 1968, and a provisional seat until the new building was finished. During its first year, the Centre welcomed 154 scientists, 60 of them from developing countries. In 1986, 22 years later, 3651 scientists representing 109 countries came. *(See accompanying table for overview.)*

ICTP's scientific reputation was set right at the outset. Professor R. Oppenheimer wrote in 1965:

"It seems to me that the Centre has been successful in these eight or nine months of operation in three important ways. It has cultivated and produced admirable theoretical physics, making it one of the great foci for the development of fundamental understanding of the nature of matter. The Centre has obviously encouraged, stimulated and helped talented visitors from developing countries who, after rather long periods of silence, have begun to write and publish during their visit to the Centre in Trieste. This is true of physicists whom I know from Latin America, from the Middle East, from Eastern Europe, and from Asia. It is doubtless true of others. The Centre has become a focus for the most fruitful and serious collaboration between experts from the United States and those from the Soviet Union on the fundamental problems of the instability of plasmas, and of means for controlling it. Without the Centre in Trieste, it seems to me doubtful that this collaboration would have been initiated or continued. In all the work at the Centre of which I know, very high standards prevail. In less than a year it has become one of the leading institutions in an important, difficult and fundamental field."

Dr Hamende is an officer at the ICTP.

Overview of ICTP activities: scientists and scientific preprints, 1964–86

Year	Scientists		Man-months		Total number of activities	Preprints		Countries represented	
	Total number	% Developing country	Total number	% Developing country		Total number	% Developing country	Total number	% Developing country
1964–65	154	38.9	410	44	3	—	—	—	—
1970	582	37.5	864	45	8	154	52.6	53	66
1971	885	38.5	533	60.7	8	160	78.1	68	54.4
1972	888	45.9	1 214	57.4	7	161	67.1	71	74.6
1973	878	40.5	1 258	58.7	9	194	73.2	64	73.4
1974	862	38.3	854	68.9	11	141	73.8	65	73.8
1975	928	43	1 018	65.2	12	172	82	82	75.6
1976	962	40.2	820	68.7	14	127	80.3	71	76.1
1977	1 331	48.4	1 080	71.9	14	158	68.4	92	77.2
1978	1 327	49.4	1 079	73.3	18	160	72.5	91	76.9
1979	1 470	42.1	961	63.3	18	167	64.7	90	75.6
1980	1 461	42.1	1 296	76.5	22	183	80.9	93	77.1
1981	1 933	49.7	1 533	74.9	18	239	66.5	90	77.8
1982	2 139	45.7	1 749	73.1	19	236	75.8	83	75.9
1983	2 188	53	1 810	77.2	22	238	78.2	99	79.7
1984	2 082	52.2	1 870	76.2	24	249	84.3	96	79.1
1985	2 720	61.4	2 669	81.6	27	313	85	109	81.7
1986	3 651	59.7	3 820	82.3	39	401	80.5	109	78.9

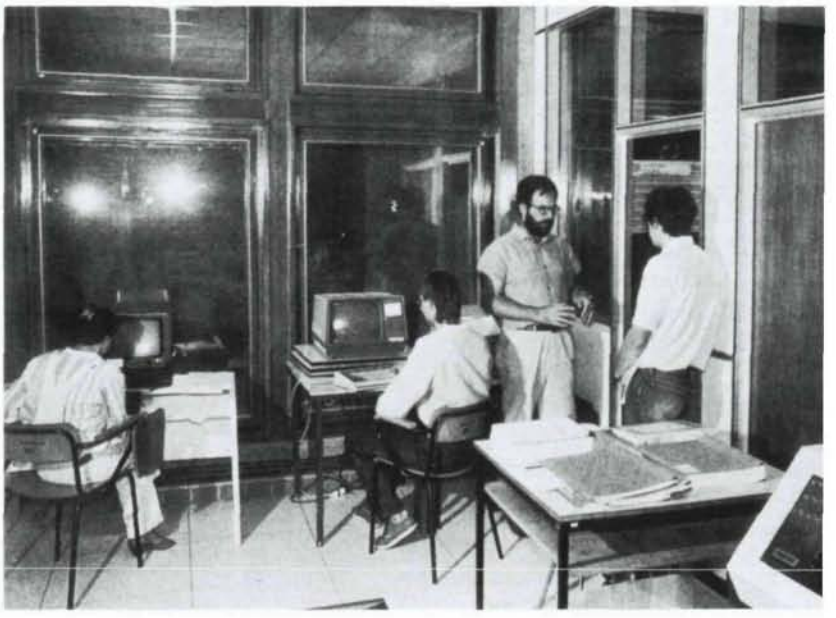
Disciplines offered

In the early years, the Centre focused its efforts on disciplines related to the IAEA's statutory mission, that is, in nuclear and plasma physics and elementary particle physics. Condensed matter physics appeared in the Centre's curriculum in 1967. Thanks to UNESCO's joining the Agency as an equal partner in the operation of the Centre in 1970, applicable mathematics was introduced and condensed matter physics could be strengthened with two 3-year grants from the United Nations Development Programme (UNDP). Nowadays the spectrum of scientific topics covers a very large range including:

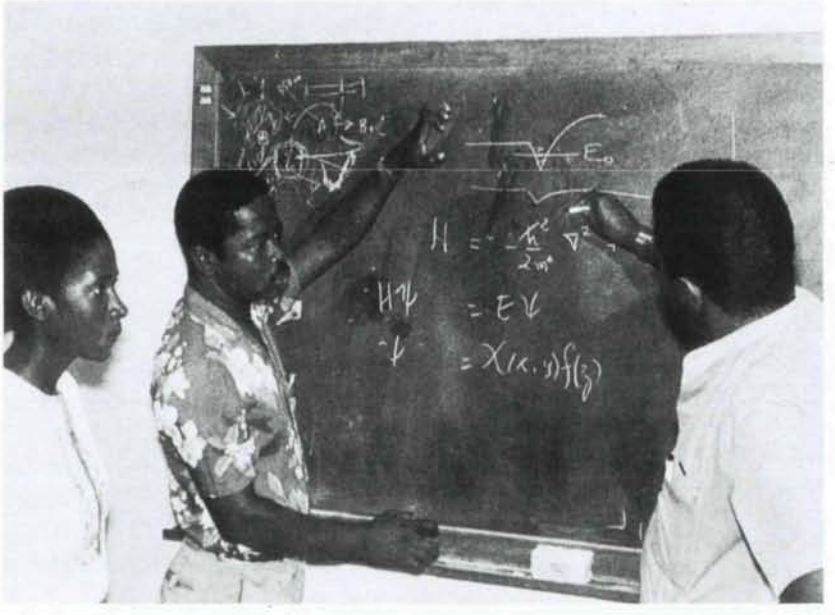
- Physics of condensed matter (condensed matter physics and related; atomic and molecular physics; material science)
- Fundamental physics (high-energy and particle physics; relativity; cosmology and astrophysics)
- Physics and energy (nuclear physics; plasma physics and nuclear fusion; solar energy; wind energy, and others)
- Mathematics (applicable mathematics; system analysis; mathematics of development, mathematics in industry; algebra; geometry; topology differential equations; analysis and mathematical physics)
- Physics and environment (geophysics; soil physics; climatology and meteorology; physics of the oceans; physics of desertification, and physics of the atmosphere, troposphere, magnetosphere, aeronomy)
- Physics teaching
- Physics of the living state (neurophysics; biophysics and medical physics)
- Applied physics (physics in industry; microprocessors; communications instrumentation; synchrotron radiation; non-destructive evaluation; lasers and computational physics)
- Physics of space

Programme components

The present programme covers research; training for research; external activities; and training in Italian laboratories.



ICTP today occupies a 3000-square-metre building made available by the Trieste local authorities, with 2 lecture halls, a 30 000-book library, a cafeteria, a computer facility, and 80 office rooms. An additional building, equal in size and presently under construction, will be ready for occupancy in about 2 years. Another building, a former elementary school, has been rented for housing the microprocessor laboratory.
(Credit: Bernardy for IAEA)



Research is carried out throughout the year in elementary particle physics, condensed matter physics, and mathematics by members of the scientific staff and visiting scientists with the collaboration of the faculty of the Department of Physics and of the International School for Advanced Studies of the University of Trieste. In terms of man-months, research accounts for 28% of the total. The majority of the 400 preprints issued in 1986 originate from this group. Other research groups in low-power laser and in plasma physics are planned. Training for research activities includes extended high-level courses and workshops, conferences, and topical meetings in all the disciplines listed above. Their average duration is of the order of 3 weeks; some may last as long as 10 weeks while others last just

1 week. There are now 35 of these meetings each year, whereas 15 years ago there were only 3 or 4. In 1986, 3091 scientists (1705 from developing countries) took part in them.

This component of the Centre's programme plays an essential role in the transferring of the *science underlying technology* from the North to the South. It gives scientists from developing countries opportunities to learn about the latest developments in their own speciality and to meet the finest international experts for discussion and for further collaboration.

The third component of the programme, the Office of External Activities, was established in 1985 through a special contribution of the Dipartimento per la Cooperazione allo Sviluppo of the Italian Ministry for Foreign Affairs, in order to encourage scientists from the Third World to build up scientific communities in their home countries. It provides financial and intellectual support to selected meetings, schools, conferences, and research workshops in the developing countries. In 1986, 54 such activities were sponsored in 23 countries. Some activities which are normally held at the Centre are replicated, with some adjustments, in the developing countries themselves under the auspices of the same office. The workshop on microprocessors is one of these and is held every second year in a developing country. It was held in Hefei, China, in 1986 and will be held in Yamoussoukro, Côte d'Ivoire, in 1988. These workshops involve the shipment of some 2 tons of computer equipment for the practical demonstrations.

The fourth component is the training of experimentalists in Italian laboratories, which started in 1983. As ICTP has no permanent experimental facilities except for the microprocessor laboratory, it has concluded agreements with some 150 Italian university laboratories where experimental physicists from developing countries are placed for periods of the order of 10 months.* Experimental research can be done in a wide range of subjects: low-power laser, optical fibres, nonconventional energy, geophysics, meteorology, nuclear physics and many others. Since the inception of the programme, 207 scientists have benefited from the scheme.

Other scientific enterprises

The Centre's reputation and success has provided a stimulus for other scientific enterprises in Trieste. The first of them is the International School for Advanced Studies (ISAS), an autonomous department of the University of Trieste, founded in 1978 by Professor Paolo Budinich, former Deputy Director of the Centre, and the moving spirit of those who brought ICTP to Trieste. ISAS is a graduate school and awards the degrees of M.Sc. and Ph.D. in several specialities of physics and mathematics. A conspicuous fraction of its students is from developing countries.

The second is the new International Centre for Genetic Engineering and Biotechnology (ICGEB), created under the aegis of the United Nations Industrial Development Organization (UNIDO). Operation starts this summer. ICGEB has in fact two seats, one in Trieste and one in New Delhi, India. Its creation, modelled on ICTP, was suggested by the former Secretary-General of UNIDO, Mr Abd-El Rahman Khane, after a visit to Trieste.

The third is the Synchrotron Light Radiation Laboratory, the facilities of which will be accessible to scientists from developing countries. It is headed by Prof. Carlo Rubbia, Nobel Laureate for Physics in 1984, and is expected to start functioning in about 5 years.

International links

In 23 years, ICTP has considerably expanded its international links, both at the individual and at the institutional level, through its associateship and federation schemes. Associate members are scientists from, and working in, developing countries who have the right of paying 3 scientific visits to the Centre in 6 years for periods of 6 weeks to 3 months. Associates are selected by the Scientific Council of the Centre. The scheme was created in 1964 as a measure to combat the brain drain. It provides regular opportunities for scientists in developing countries to renew their contact with science in progress, with new ideas on which they can elaborate once they are back home. The Centre had four associate members in 1964; they numbered 349 in 1986.

Some of these associates with exceptional scientific records may be appointed as senior associates for 5 years. A fixed sum is reserved for them out of which they can draw for subsidizing their visits to the Centre. The title of honorary associate has also been awarded in a very few cases. A quarter of the 1986 preprints was produced by the associates.

For younger scientists, the Centre has set up the junior associateship, which provides small grants for purchasing scientific books or subscriptions to periodicals. Junior associates are eligible for appointment as a regular associate after their 4-year appointments; this is not, however, automatic.

Federation agreements are the instrument for contacts with institutions, i.e. physics and mathematics departments in universities or

* The microprocessor laboratory uses the same equipment needed for the workshops on the physics and technology of microprocessors. It welcomes scientists from the Third World wishing to develop their microprocessor-based systems projects for subsequent implementation in their home country. It is operated in conjunction with the Department of Experimental Physics of the University of Trieste and of the Instituto Nazionale di Fisica Nucleare of Italy. Other temporary laboratories are created as a back-up to extended courses, e.g. for low-power laser physics, fibre optics, and others with equipment received on loan from universities or research institutions.

ICTP: International links

Year	1964	1970	1980	1984	1985	1986	1987
Number of associate members since 1964							
Regular	4	44	70	206	266	349	313
Senior	—	—	22	40	47	47	31
Junior	—	11	34	75	96	119	122
Honorary	—	—	2	3	3	4	5
Number of federation agreements since 1964							
Number of agreements	8	16	55	103	137	196	264

research centres in developing countries, whereby each of these institutions may send their younger scientists on a cost-sharing basis for 40 to 120 days, depending on the location of the institution itself with respect to Trieste. This arrangement provides the opportunity to take part in any of the Centre's programmes of interest to the federated institutions. The Centre has concluded 264 such agreements.

Financial aspects

ICTP's regular annual budget is made up of contributions from the IAEA, UNESCO, and the Italian Government. From an annual budget of US $355 000 the budget has grown, in 1987, to about US $13 million, i.e. a factor of 36! This calls for clarification. Most expenditures are in Italian lira, and during this time, the US $/lira exchange rate — which was very stable until the early 1970s at 620 lira to the dollar — went as high as 2000-to-1 in 1985. Moreover, inflation in Italy was a two-digit figure from 1972-85. If one takes inflation into account, 1970 prices (in Italian lira) have to be multiplied by a factor of eight. Accounting for inflation, it is worth noting that the overall cost of one man-month for one scientist has remained essentially the same — approximately US $2900 at 1987 prices. *(See table.)*

Other contributions were received from many other sources. Three of them were crucial for the survival of the Centre in the 1960s and early 1970s: the Ford Foundation, UNDP, and the Swedish International Development Agency (SIDA) in support of the associateship and extended courses programme. The Swedish grant is still active and is presently handled by the Swedish Agency for Research Co-operation with Developing Countries (SAREC). The Centre's budget has also been augmented by contributions from Canada, Denmark, Federal Republic of Germany, Iran, Japan, Kuwait, Libyan Arab Jamahiriya, Qatar, United States, and several international organizations.

It is remarkable that ICTP has expanded since 1970 (by a factor of about 4.5) in a period of imperative "zero-growth" in the UN family of international organizations. The reasons for this success are the scientific standard set by its Director, its efficiency in transferring the science which is at the roots of technology so much needed by the Third World, its cost-effectiveness, and the support and response from the world scientific community from countries of the North and South alike. Each year, for instance, several Nobel Prize Laureates visit the Centre. Other prominent visitors have included the Secretary-General of the United Nations, Mr J. Pérez de Cuéllar; the Italian Minister for Foreign Affairs, Mr Giulio Andreotti; and the Italian Minister for Scientific and Technological Research, Mr Luigi Granelli. It is in fact thanks to the extraordinary generosity of the host government that the Centre has reached the present level of activity.*

"Significant" contributions

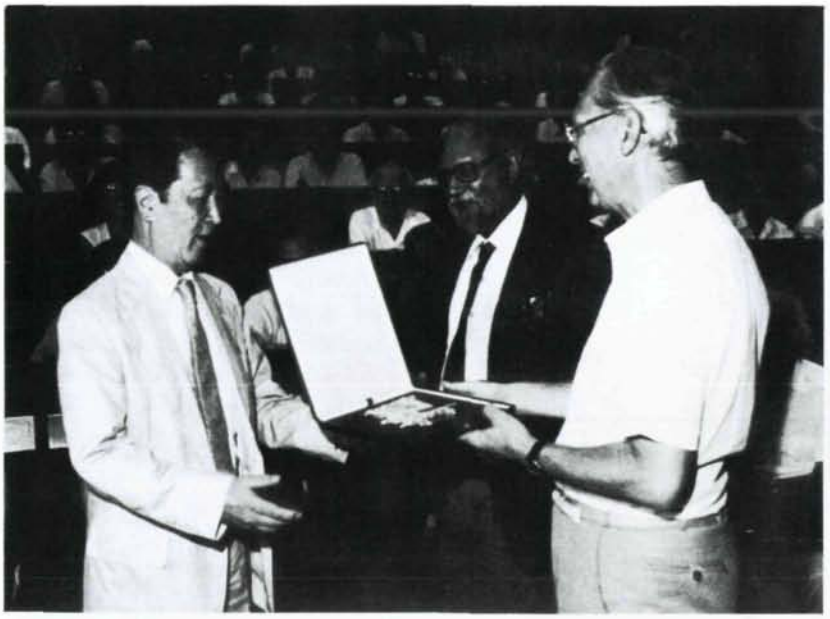
The Centre's programmes and modes of operation were reviewed by independent ad-hoc committees

* In addition to the basic operational funding being provided, the Dipartimento per la Cooperazione allo Sviluppo of the Italian Ministry for Foreign Affairs provides substantial funding for various activities carried out at the Centre and in developing countries, and for the programme of visits to Italian laboratories.

ICTP cost effectiveness

Year	Budget in US $	Budget in lira	Exchange rate (lira/1 US $)	Budget in constant lira (Base: 1986)	Scientists (man-months)	Cost per man-month in lira	Cost per man-month in current US $ (US $1 = 1295 lira)
1970	650 000	403 000 000	620	3 252 210 000	864	3 764 000	2907
1986	9 446 000	13 791 160 000	1460	13 791 160 000	3820	3 610 000	2788

Notes: The ratio of the 1986 to the 1970 budget, after correction for the impact of inflation and exchange rate fluctuations, is 4.25. The ratio of total scientist man-months for 1986 in relation to 1970 is 4.42.



ICTP annually awards the Dirac Medal for significant achievements. Prof. Yoichiro Nambu of China (left) is shown here receiving the 1986 award from ICTP Director Abdus Salam (center) and Prof. Herwig Schopper, Director General of CERN in Geneva. Also receiving the 1986 medal was Prof. A. Polyakov of the USSR.

appointed by the Directors General of the IAEA and UNESCO in 1963, 1974, and 1983. Each meeting had an important impact on activities. The first of them, presided over by Prof. H. Casimir from Netherlands, recommended the introduction of mathematics and condensed matter physics as regular segments of the Centre's activity. The second, headed by Prof. L. Van Hove of the European Centre for Research (CERN), recommended a further extension of the programme to other disciplines, such as geophysics and physics of the living state, and a strengthening of the atomic, molecular, and laser physics component. The last one, chaired by the late Prof. P. Matthews, focused on the need for a continuity of scientific staff, for training facilities for experimentalists in Italian laboratories and/or in small laboratories to be set up at the Centre, and for helping to build up scientific communities in the Third World through appropriate action. The concluding remarks of the last review committee were particularly encouraging:

"(T)he Committee would like to put on record its profound admiration for the remarkable achievements of the Centre during the period under review... The Centre has operated with a very small permanent scientific staff and has worked to a very tight budget. It has made a very significant contribution to research of the highest quality in the physical sciences at the international level; it has provided opportunities for a large number of physicists from developing countries to maintain their activities in this international field in such a way that it has also enhanced the contribution which they could make in their home countries; in recent years it has taken specific action to stimulate the growth of scientific communities within the developing countries themselves and the involvement of these communities with the development process. Individuals and organizations from over one hundred different countries have been involved in this remarkably harmonious exercise. Thus, in a wider context, the activities of the Centre can be read as an impressive example of international collaboration, which redounds greatly to the credit of its two international sponsors, IAEA and UNESCO and to the Italian Government. We would also like to express our appreciation of the wisdom shown by the IAEA, UNESCO, and the Italian Government for providing the basic financial support which has made this programme possible".