carbonate from recovery cycling, and coating materials—settles out by gravity. This sludge amounts to from 4,000 to 7,000 pounds a day. It is pumped from the bottom of the clarifier basin into shallow beds, where it dries as "sludge cake." It is not useful as a soil conditioner because it absorbs nitrogen at a high rate. So it is buried.

The clarified liquid, still carrying dissolved compounds that would impose a heavy oxygen demand on a disposal stream, is skimmed off the top of the primary basin and pumped to a large secondary treatment basin. Here microorganisms—cultivated in an adjacent farm tank—consume the extraneous compounds under the stimulation of churning jets of air. The process is the same as that used for public sewage.

Within a few hours, the organisms complete a life cycle, die, and fall to the bottom of another settling tank. About 6,000 pounds of this residue a day, very nutritive to soil, is drained off and sprayed on an experimental ten-acre hay field which the company maintains.

By the end of this secondary stage, 86 per cent of the oxygen demanding materials have been removed, leaving water only slightly discolored. This water is pumped into a final 51 million gallon control pond for testing before finally being released into the river.

Eighteen eletronic metering systems constantly monitor the processing at different stages. Excessive readings at any point automatically trip an alarm. The refining system's capacity permits diversions to holding basins while irregularities are corrected. One phase of the monitoring is a row of standard aquarium tanks in a small laboratory building where the vitality of inch-long newborn salmon from a state hatchery is constantly observed.

The quality standards set by the state for the discharge include: effluent not to decrease dissolved oxygen in the river by more than .5 parts per million (ppm) at any point, nor reduce oxygen in surface water and spawning gravel below 7 ppm; suspended solids not to exceed 15 tons a day nor cause more than a 3 ppm suspended solid increase in the river; no river temperature alteration unfavorable to salmonoids; no production of discernible bottom deposit, slime, or conspicuous increase in the river's color, taste, or odor.

A typical periodical effluent analysis report prepared by the plant's effluent engineer, Quintin Narum, covering a dozen organic and inorganic constituents, shows ppm readings below those of municipal water supply standards. Biological oxygen demand runs eight to twelve ppm, compared to the river's natural range of five to twenty ppm. Maximum effluent concentration in the discharge area of the river is one part to 160 parts of river water; in high-water periods, the density falls as low as one part to 2,000 parts of river water. Spawning-bound salmon can be observed cavorting within a few yards of the underwater discharge pipe.

The salmon, the California officials, and the company all seem pleased with the results, which have been widely hailed as a major milestone in industry's struggle with pollution problems.

A NEW CENTER FOR PHYSICS

ABDUS SALAM

The director of the newly established international center for theoretical physics describes the experiences of the first year. Abdus Salam is also science adviser to Pakistan and professor of physics, University of London.

The idea of creating, under the aegis of the United Nations, an international center for theoretical physics took shape five years ago. Some three years of hard persuasion at the forum of the International Atomic Energy Agency (IAEA) in Vienna were needed to get it accepted and a further year was required to prepare for its inception in October 1964. The Center has now completed its first academic year and it is time, perhaps, to assess how far the ideals which went into its creation have actually been realized.

The International Center for Theoretical Physics was conceived with two distinct ideals in view. First, as a contribution to international collaboration in science; second, as a contribution to physics in developing countries, particularly through the help it might give to the work of senior physicists there. Theoretical physics happens to be one of those relatively advanced disciplines where decisive advances in recent times have come not only from the physicists from the West and the East, but also those from some of the developing countries—Brazil, China, India, Korea, Lebanon, Pakistan, Turkey, and others. One could hope that a successful theoretical physics institute might possibly set a pattern for a future United Nations university.

The first occasion on which the Center was discussed was the High Energy Physics Conference in September 1960. In his banquet address John McCone, who was then the Chairman of the U.S. Atomic Energy Commission, mentioned with approval a suggestion that nations collaborate in setting up a joint high-energy accelerator. Some of us—Hans Bethe, Robert Sachs, Nicholas Kemmer—who assembled afterward wondered how practical the suggestion might be and if one might not perhaps start on a smaller scale with a modest, truly international center for theoretical physics—financed by one of the U.N. family of organizations.

The same month I had the privilege of being able to voice, on behalf of the Pakistani government, this visionary ideal in the form of a resolution at the annual conference of the IAEA at Vienna. We were fortunate to receive co-sponsorship of the resolution from the governments of Afghanistan, Federal Republic of Germany, Iran, Iraq, Japan, Philippines, Portugal, Thailand, and Turkey. As the list of sponsors indicates, the setting up of such a center was of interest not only to the developed countries, but also to some of the less privileged ones. The hope was that a center of this type, besides providing a venue for collaborative research, might also help in resolving one of the frustrating problems which active scientists in poorer countries face —the problem of isolation. Such men could come fairly frequently to the Center to renew their contacts and engage in active research in fields like nuclear theory, high-energy physics, theory of plasma, and solid state physics.

Right from the beginning we received enthusiastic support from the

IAEA's directorate and from the physics community. Niels Bohr, before his death, expressed his wholehearted support; scientific panels convened in 1961 and again in 1963 by the Agency's Director General, S. Eklund, forcefully recommended its creation. (Members of the panels were Aage Bohr, P. Budini, B. T. Feld, L. Infeld, N. Kemmer, L. S. Kothari, M. N. Levy, R. E. Marshak, A. Salam, W. Thirring, J. Tiomno, and L. Van Hove.) Unfortunately there was not the same unanimous response from all atomic energy commissions around the world. At the 1962 annual conference of the IAEA (where these commissions are represented), even though the creation of a center was accepted in principle, the feeling of the IAEA's decisionmaking organ, the Board of Governors, was that it could not recommend committing IAEA funds toward it without other funds, at least to start with. Additional offers of financial assistance from interested member states were solicited; of the four received (from the government of Italy, for a center to be located in Trieste, from Denmark for Copenhagen, from Pakistan for Lahore, and from Turkey for Ankara), the most generous was the Italian government's offer, with P. Budini, professor of physics at the University of Trieste, as the moving spirit behind it. This was accepted in June 1963 and the Center started functioning October 1, 1964 with a charter for four years.

The first year's activity at the Center covered two disciplines in theoretical physics: physics of elementary particles and plasma physics. The Center had a staff of 52, made up of 28 nationalities. This included 25 postgraduate and postdoctoral fellows, sponsored by the IAEA and Unesco, most with previous research experience, the majority coming from countries in South America, East Europe, Africa, and Asia. Among the senior physicists who spent one or more terms at the Center during its first academic year were: A. O. Barut (Turkey, U.S.), S. M. Berman (U.S.), M. Fayyazuddin (Pakistan), C. Fronsdal (Norway), J. J. Giambiagi (Argentina), E. Inönü (Turkey), F. Janouch (Czechoslovakia), S. Kamefuchi (Japan), T. W. B. Kibble (U.K.), H. J. Lipkin (Israel), K. Nishijima (Japan, U.S.), C. R. Oberman (U.S.), J. Polkinghorne (U.K.), I. Saavedra (Chile), H. Stapp (U.S.), A. Tavkhelidze (USSR), S. Tzitzeica (Romania), B. M. Udgaonkar (India), J. Werle (Poland), Y. Yamaguchi (Japan).

In addition to a normal research program the Center organized an extended seminar for each of the disciplines covered, particularly organized for those who had lived away from active centers for long periods; on plasma physics in October 1964 lasting four weeks and on high energy physics during May and June 1965. The plasma physics seminar (with 21 lecturers and 80 other participants) was co-directed by M. N. Rosenbluth (U.S.), B. B. Kadomtsev (USSR), and W. B. Thompson (U.K.). This must be the first occasion when all three major schools of plasma physics—the U.S., the Soviet, and the European—collaborated in running an extended joint advanced course. The seminar on high-energy physics brought together for eight weeks 33 lecturers and 120 other participants—altogether from 29 countries. Again we were exceedingly fortunate in that some of the world's most active physicists could come to stay and lecture in Trieste.

• *THE FIRST YEAR*

It is not for me to speak of the quality of research contributions from the Center. All I can say is: we were very fortunate. In Weisskopf's eloquent words, the Center's contributions included some of the decisive achievements of physics during the last year. One can never budget for this; perhaps the men who had lived away from active centers for two or three years were bottling up ideas which they feverishly poured forth and developed at the earliest opportunity that came to them.

At the last meeting of its Scientific Council, Van Hove most generously paid the Center the following tribute:

"When one sets up an institute one expects a period of gradual start where people gather, where people begin to select their problems, and where gradually the time of original contribution to the field develops. We have here seen this whole process in a not only very accelerated but very successful form. Within a span of time of less than an academic year the Center at Trieste has succeeded in gathering a considerable number of people, very active in various parts of theoretical physics, and has right away, despite the material difficulties which are encountered in a beginning period, succeeded to cohere them in a manner that a flow of extremely important and extremely original contributions came out and established the scientific reputation of the Center all over the world in all the established places beyond any shadow of doubt. The contributions have been of such utmost importance that it has become very natural for scientists from all over the world to pass through Trieste when they are traveling, or to come to Trieste whenever some opportunity offers itself.

"One should realize what this means for the Fellows, for the young people who are here. Although the place is very young, just in its period of build-up, most of them had the opportunity to meet leading scientists in the field, to listen to lectures, to discuss points in these lectures, to discuss points in the literature with the best specialists. One can, I think, regard the seminar on elementary particle physics which is going on now as some kind of brilliant culmination of this period of activity. Everything that is important in the field, everybody who makes contributions of some evidence in the field will have passed through Trieste, will have discussed in Trieste, and for the people who are here as members of the Center, in particular for the people who come here to get first-hand contact with the field, contact which they cannot get in their own country, I think the opportunities of education and research which have been offered are truly remarkable."

To summarize then, in all humility, we can take pride in that the Center succeeded during its first academic year in three crucial ways:

1. It encouraged good physics, not in just one field of theoretical physics, but in an interdisciplinary manner. To maintain this interdisciplinary tradition the plans for 1967 include an extended seminar ranging over the entire spectrum of theoretical physics; this to recognize again its essential unity—something which has not been attempted on this scale for a long time.

2. We could, here, lay foundations of an active, a lasting, and a prolonged cooperation between physicists from the East and West. During 1964–65

a total of 18 physicists—senior and junior, working for periods from two months to a full year—came to the Center from East Europe. During 1965–66 the collaboration will take a still sharper form when two groups of plasma physicists, the Soviet and the American (some 25 senior men) meet and work together for a full year. This type of collaboration is impossible, at present, to achieve elsewhere.

3. The Center has helped physicists from developing countries who, after long periods of silence, have begun to write and publish during their visits to Trieste. Specifically for them, the Center has instituted a new scheme of associateships. The idea is to give selected active men from developing countries the privilege of coming to the Center for one to four months every year. The Center pays for their travel and living expenses in Trieste. The times (and indeed the frequency of the visits) are left completely to the associates. So far eight associates have been elected. The plan is to extend the privilege to some forty more leaders of research in developing countries. This may cover nearly all the first-rate men. One may hope that this (financially guaranteed) possibility of remaining in touch (even while they are permanently located in their own countries) might persuade some of the best physicists from less privileged countries not to exile themselves permanently abroad. There is no claim that this is the only way to halve the brain drain, but this is one way and it is worth trying.

• *FOR THE FUTURE*

As I said earlier, the Center was created for a period of four years. The decision if it should continue at all—and where—will be taken at the IAEA's Board of Governors meeting next year. In the final analysis then, its continued existence depends on the atomic energy commissions of the IAEA's member states. Basically the problem, as always, is financial. At present nearly two-thirds of the Center's normal annual budget of $400;000 comes from just one source—the host government, contributing through the IAEA. The rest comes from the IAEA itself, with a smaller share from Unesco. The Center's present mandate (and its sources of finance) run out in 1968. We must find new sponsors, within the IAEA, within the atomic energy commissions of the world, and among foundations outside, if the initiative taken in creating this first faculty of a future U.N. university is to endure.

The Center is fortunate in having a Scientific Council consisting of Professors S. Vallarta, J. R. Oppenheimer, V. Weisskopf, A. Bohr, V. G. Soloviev, and A. Matveyev. It could never have come into existence or run as it does with no administrative problems but for the warm, consistent, and enthusiastic support of IAEA's Director General, S. Eklund. Two university institutions, the University of Trieste and Imperial College, London have liberally and generously contributed to its success by giving the Center its staff. The Center's inception and its organization mark it as a new type of venture—an assay in collaboration between the East and the West, and the poorer nations; an assay in collaboration for pure science organized under the aegis of the United Nations. The idea is the embodiment of the international ideal; it must succeed.

Senior men at the plasma seminar included R. Balescu (Belgium), J. W. Dungey (U.K.), S. F. Edwards (U.K.), G. Francis (U.K.), H. P. Furth (U.S.), M. S. Ioffe (USSR), M. Kruskal (U.S.), C. R. Oberman (U.S.), R. Z. Sagdeev (USSR), A. Simon (U.S.), and J. B. Taylor (U.K.). Those who lectured at the seminar on high energy physics included Professors Amati (Cern), Bernardini (Cern), Cutkosky (U.S.), Fubini (Italy), Gell-Mann (U.S.), Gürsey (Turkey), Heisenberg (Federal Republic of Germany), Jaksic (Yugoslavia), Joos (Federal Republic of Germany), Källén (Sweden), Khuri (Lebanon), B. W. Lee (U.S., Korea), Lipkin (Israel), Lopes (Brazil), MacDowell (Brazil), Mahanthappa (India), Mandelstam (U.S.), Marshak (U.S.), Matthews (U.K.), Oehme (U.S., Austria), Okun (USSR), Polivanov (USSR), Ramakrishnan (India), Regge (Italy), Sachs (U.S.), Schwinger (U.S.), Shirkov (USSR), Stein (U.S.), Sudarshan (U.S.), Tavkhelidze (USSR), Toll (U.S.), Udgaonkar (India), Van Hove (Cern).

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Artists in this issue: William Dempster, page 2; Martyl, page 12.