Theory Center Awaits NSF Word on Renewal

A review panel gave the Institute for Theoretical Physics high praise in September, but the National Science Board has the final say next week

Under National Science Foundation (NSF) sponsorship, the Institute for Theoretical Physics opened for business in September 1979 at the University of California's Santa Barbara campus. The original grant covered a 5-year span of operations, and the university has recently submitted a proposal for a second 5-year run to begin in 1984. NSF's governing body, the National Science Board, is scheduled to take up the matter at its mid-March meeting. The case for renewal seems well in hand. In September a review panel made up of several distinguished physicists turned in a glowing report to NSF's physics division: "The reviewers enthusiastically support the proposed continuation of the Institute for a second five-year period." At its 9 October meeting, NSF's physics advisory committee unanimously endorsed continuation, as well.

Nonetheless, renewal is by no means assured. Expense is not the main issue, although the institute has been spending a little over $1 million per year. Formation of the institute required changes in both the traditional ways of funding and doing theoretical physics. The changes were controversial at the time and remain so today.

Santa Barbara won the competition for hosting the institute in January 1979 after several years of discussion marked by the questions of whether an institute was a good idea in principle and, if so, where it should be located. The winning entry was drafted by James Hartle, Raymond Sawyer, Douglas Scalapino, and Robert Sugar. The idea, explained Sugar, was to design an institution that would effectively counteract two diverging trends in physics. One was the increasing specialization of and decreasing communication between subfields of physics. The second was the existence of important physics problems whose study required contributions from more than one specialty.

The solution proposed was a kind of controlled kaleidoscope. A permanent professional staff of four would host a constantly changing melange of a dozen or so post-docs, who would have appointments lasting typically 2 to 3 years, and visiting scientists from academic and other institutions, who would be in residence for periods ranging from a few months to 1 year. The focus for work at the institute would be provided by a succession of long-term "programs." There would be about four of these initiated each year, each lasting several months and addressing itself to a specific area of theoretical physics that has an interdisciplinary character. Except for those post-docs who have longer-term appointments, the visitors would come to participate in a specific program. Associated with the programs would be shorter-term workshops that would bring in a much larger number of physicists—experimentalists as well as theorists—for periods of a few weeks or less.

Walter Kohn, who came from the University of California at San Diego to be the institute's first director, reviewed with *Science* the first 3 years of operation. In living up to its promise of promoting interdisciplinary collaboration in theoretical physics, the institute has fostered two classes of cross-fertilization. One involves physics problems that are inherently interdisciplinary. The overlap between astrophysics and nuclear physics when dealing with the life cycle of stars as they age and sometimes become supernovas comes to mind. And the mixing of astrophysics and elementary-particle physics in the charting of the early history of the universe is another example. In these cases, long-term collaborations that live well beyond the life of an institute program can be just as important as the research accomplished during a program.

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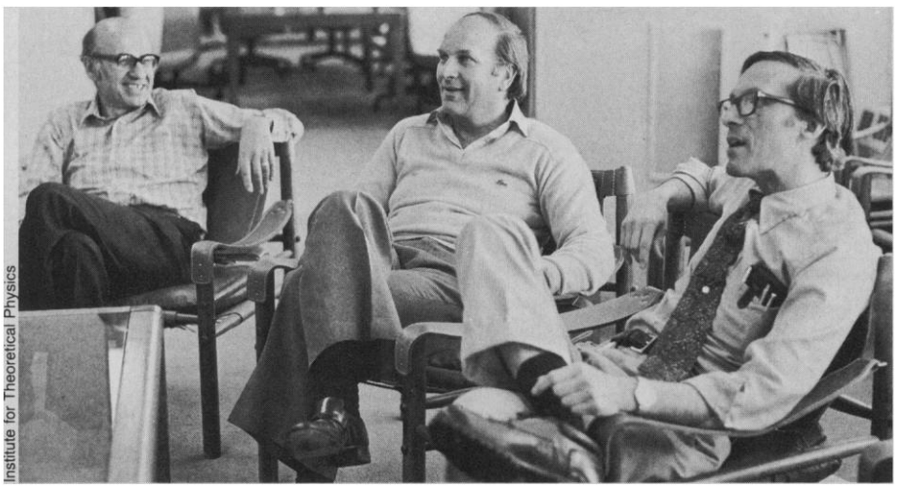
The second kind of cooperation comes when researchers from normally unrelated fields find they have techniques or ideas in common, which they can exchange before going on their separate ways. Over the years, there have been several instances where elementary-particle and condensed-matter theorists have had overlapping interests in field theories.

Kohn says his ideal group composition to obtain these kinds of synergy is about two-thirds common interests and one-third different interests. If there is too high a barrier between group members, then it takes too long to establish communication. But there has to be enough tension and disagreement to stimulate the group.

His favorite example of a program that worked out spectacularly well was a 12-month study of nonequilibrium phenomena that ended last July. Leaders of the program were Pierre Hohenberg of Bell Laboratories and James Langer of Carnegie-Mellon University, who has since accepted a permanent position at the institute. Hohenberg is an expert in fluid dynamics, while Langer specializes in phase transitions in solids. The common area of interest during the course of the program was the means by which physical systems that are maintained far from thermodynamic equilibrium select characteristic "patterns." The convection rolls in fluid cells with a temperature gradient from top to bottom are one type of pattern. The dendritic, snowflake-like crystals growing in a supercooled liquid are another. Also investigated were the transitions from one pattern to another as external conditions changed or even the disappearance of patterns altogether, as in the transition to turbulent fluid flow. Adding further spice to the mixture of fluid and solid-state theorists was the presence of several mathematicians who had been interested in the classes of nonlinear equations that govern the transitions.

Finally, Kohn delights in pointing out, running in parallel with the nonequilibrium phenomena program was one on electrically conducting polymers. "There was an enormous amount of interaction between the two programs," he says, "reflected in joint attendance at one another's seminars and joint authorship of papers."

The dynamic structure of the programs, coupled with the constant coming and going of short- and long-term visitors, gives the institute what Kohn calls its special feature: "permanent self-renewal and refreshment." He carries the principle to its logical conclusion by applying it to himself. He will give up the directorship of the institute after his 5-year term expires and take up a regular position on the Santa Barbara physics faculty. "A new person will bring changes in philosophy, taste, and style



Theorists at work

Walter Kohn (director of the Institute for Theoretical Physics), J. Robert Schrieffer, and James Langer in the institute's commons room.

and prevent settling in to a sameness," says Kohn. A search committee has already turned in a preliminary report to the institute's steering committee, a five-person truncated version of the full advisory committee comprising 16 theorists from around the United States.

The institute has been more successful than skeptics thought possible in recruiting a permanent staff of exceptionally high caliber. The university has helped by providing tenured faculty positions for the director and staff. The institute's first "acquisition" was elementary-particle theorist Frank Wilczek from Princeton University in 1980. Langer joined last year. And very recently, astrophysicist Douglas Eardley of Harvard University has signed on. Kohn emphasizes that none of these people were obtained by outbidding the competition, attesting to the attractiveness of the institute to physicists. An extra bonus is the one-third time participation of Nobel laureate J. Robert Schrieffer, who left the University of Pennsylvania in 1980 to join the Santa Barbara faculty. If the National Science Board approves the renewal proposal, the institute will add a fourth permanent staff person.

"The influence of the institute on the campus has been tremendously positive and far outweighs the small price paid in giving faculty positions to the institute permanent staff," says Sawyer, who is now vice-chancellor at Santa Barbara. Recruiting faculty is one obvious example. The university has been able to establish a new macromolecular sciences program with an Institute for Polymers and Organic Solids headed by Alan Heeger, formerly of Pennsylvania. Materials scientist Frederick Wudl from Bell Laboratories will be deputy director. Günter Ahlers, a low-temperature experimental physicist also from Bell Laboratories, is now at Santa Barbara, as is George Benedek, a biophysicist from the Massachusetts Institute of Technology. Says Michael Nauenberg, who is on leave from the University of California at Santa Cruz for 2 years to be deputy director of the institute, "Santa Barbara has gotten half a dozen new physicists, any one of whom would be a great asset for any physics department."

The preliminary draft of the report turned in by NSF's review committee was extremely positive. "The . . . reviewers found the physics program of the Institute to be truly outstanding and of the highest quality. They were strongly impressed by the remarkable effectiveness of the Institute in providing cross-fertilization between many different areas of physics. In the few years of its existence the Institute has emerged as a leading national facility with programs and research at the forefront of virtually every field of theoretical physics." Peter Carruthers of the Los Alamos National Laboratory, chairman of the review panel, confirmed that "The enthusiasm on the committee was unanimous."

Carruthers' committee did find some areas in which the institute could improve, however. Chief among these was the use of computers. At present, institute members have time-sharing access to two medium-sized computers located elsewhere on the Santa Barbara campus. Three years ago they were largely unused by anyone. Today they are both oversubscribed, leading to a certain amount of frustration. Both Nauenberg and Langer agree that the problem is not so much lack of access to supercomputers or number crunchers, although the need for this type of machine does come up in certain fields. Instead, there are a number of very deep problems in theoretical physics for which analytical mathematical techniques can take one only so far. But the ability to do numerical simulations on a computer makes the problems tractable.

Kohn says that the institute will shortly be acquiring a medium-sized (supermini) computer, which will handle the most pressing needs. Longer-term solutions are being investigated, including the use of a supercomputer at the Los Alamos National Laboratory.

When the National Science Board considers renewal of the institute at its 17–18 March meeting, it will be rehashing some of the arguments made against the institute before it was approved as an experiment in early 1979. Some of these arguments flow from a zero-sum game mentality. There are, for example, only so many topflight theoretical physicists available. If Santa Barbara has benefited mightily from picking some plums, what of the institutions that lost faculty? "It is not clear that it is good for physics to reshuffle top faculty in this way," says one skeptic. A zero-sum argument that should not have much influence is the financial one. As Boris Kayser, who is the NSF program director with responsibility for the institute, points out emphatically, most of the money to establish the institute did not come from the NSF theoretical physics budget in the first place and it would not likely stay there if the institute were disbanded.

There are also physicists who feel the review committee failed to consider the institute in relation to the overall health of American physics, so that a number of questions are still unanswered. For example, despite the institute's undoubted successes, could other forms of interdisciplinary collaboration, such as the large groups in the best universities, have done better? The effects on university departments of losing faculty, if only temporarily as visitors to the institute, and of being outbid for post-docs should also have been evaluated, says one theorist.

Finally, there are issues revolving around the institute's structure. One is whether the short-term focus of institute programs permits the sustained, long-term effort necessary to solve the truly difficult, rather than the merely fashionable, physics problems. Another is a dispute left over from the early discussions leading up to an NSF call for proposals. Some physicists preferred a floating institute in which each program would be sited at a university where a core of expertise already exists.

—ARTHUR L. ROBINSON