

The  
Institute for  
Physical  
Science and  
Technology

Fiftieth  
Anniversary  
History  
(1949-1999)

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**Submitted to:**

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## IPST History

### I. Introduction

The Institute for Physical Science and Technology (IPST) has its origins in two organizations, the Institute for Fluid Dynamics and Applied Mathematics (IFDAM) and the Institute for Molecular Physics (IMP). Both these institutes were created during the presidency of Harry Clifton (“Curly”) Byrd in the late nineteen-forties and early fifties.

Byrd was at the time considered to be a charismatic, politically astute, and (generally) popular figure who was seen as having rescued a troubled University of Maryland from academic and financial decline.

### II. The Inception of IFDAM

Byrd’s rise to the Presidency, was largely through the field of athletics making it all the more remarkable that, in the late 1940’s, this man took it upon himself as a high priority to create at the UM College Park campus an institution dedicated solely to scientific research: The Institute of Fluid Dynamics and Applied Mathematics (IFDAM), a precursor to IPST.

Byrd actively pursued private sources of funding. As a result of the University's providing special courses for the training of aircraft workers, starting in 1944 Byrd received funds totaling almost \$5 million from the Glenn L. Martin Co., a Baltimore aircraft manufacturer. This made possible the construction of the Engineering Building (named after Glenn L. Martin) and laboratories, and the Wind Tunnel. With additional funding support from the Office of Naval Research (ONR) and the Naval Ordnance Laboratory (NOL), Byrd was able to create a new research institute, the Institute for Fluid Dynamics and Applied Mathematics (IFDAM).

Monroe H. Martin, the first Director of IFDAM (and an influential leader and promoter of the Institute himself), asserts that the Institute was entirely "Byrd's innovation." According to Martin, Byrd felt that he had, "put UM on the map." To that end, Byrd made it his custom to spend time with the deans of the other universities in search of ideas as to how to increase the academic standing of the University. Martin speculates that Byrd may have picked up the idea for a pure research Institute during one of these meetings.

### III. IFDAM: Early Developments

In post-World War II 1949, the Navy supported scientific research in areas with potential military applications. To take advantage of this funding opportunity, Byrd

established a liaison between IFDAM, headed by Martin, and the White Oak Naval Ordnance Lab (NOL).

In addition, Martin worked with the Deputy Director of Aeronautical Sciences for the Air Force Office of Scientific Research to establish research programs in turbulence, magnetogasdynamics, compressible flows, and non-equilibrium effects. As well as the obvious military applications of such research, these areas of investigation became relevant in non-military areas such as environmental and space science. S. Fred Singer recalled in a 1972 letter on the occasion of Martin's retirement from the University that it was during his time at IFDAM in 1954-56 that he first formulated his ideas on a hydromagnetic theory of geomagnetic storms.

Similarly, Lt. Jg. Bert Hubbard recalled that upon his release from active duty in the Navy in the mid-fifties, he was told that "anyone interested in applied mathematics should consider Maryland" because of the presence of IFDAM. Hubbard became a student at UM while working part-time at NOL. At IFDAM he studied fluid dynamics, elasticity, variational methods, and partial differential equations. Hubbard recalls:

"Professor Martin, as Director, encouraged the bringing together of the academic community with the mathematical problems arising in the various laboratories in the Washington area both by encouraging faculty members to act as consultants, and through the late afternoon courses offered to employees of these laboratories. He sensed very early the need for research in computer oriented methods for solving differential equations and obtained faculty positions for

research and teaching in this area. It was this push which made possible the present group of numerical analysts at the University.”

Many distinguished foreign researchers were attracted to UM by IFDAM. In 1955, Martin successfully recruited Johannes M. Burgers, a distinguished Dutch Physicist and leading authority on fluid dynamics who immigrated to the US with wife. In the Netherlands, Burgers had made important contributions to the theory of turbulence, establishing “the Burgers equation” relating flow velocity to fluid viscosity and applied force. While at IFDAM, Burgers conducted research in gas dynamics, plasma physics, shock waves, and related phenomena, continuing to make major contributions in these fields long after his official retirement.

The atmosphere at that time is described in a letter to Martin from Klaus Oswatitsch, a German physicist who visited IFDAM in 1955:

“From the beginning of my first visit during the year 1955 my intimate connection with the United States was influenced by the atmosphere of the University of Maryland and specifically by your Institute. There I encountered from the very first day a spirit of open-mindedness which taught me to be very fond of your country...”

In addition to Burgers, in 1956 Martin recruited Werner Rheinboldt, then a recent Ph.D. in applied mathematics from the University of Freiberg in Germany. Martin, impressed by Rheinboldt’s dissertation, invited him to spend a postdoctoral year at IFDAM. Following that year, Rheinboldt became interested in the computer field, and took a post as Director of the Computing Center at Syracuse University.

In 1962, the University of Maryland decided that it should create a computing center. Martin chaired the search committee for a Director of the center, and was instrumental in recruiting Rheinboldt for this position, in addition to a joint appointment as Research Associate Professor in IFDAM.

University funding was limited for the computing center. Rheinboldt recalls:

“We had decided on an IBM-7094 as the first computer system, at that time the largest system offered by IBM. Over and above their usual university discount, I managed to get a special \$300,000 grant from the company for the center. At the time, I had established contacts with the nearby Goddard Space Center and...succeeded in getting a grant for ‘Computer-Oriented Research in Space-Related Sciences’ with the aim of establishing beside the computing facility also a research program in, what we might now call, applied computer science...”

Rheinboldt notes that the research orientation of the program was “a significant modification” from the original plan for the center, which has been intended to be simply a computing facility. This change was reflected in the choice of the name “Computer Science Center,” which Martin helped to finalize.

A new building was constructed to house the Computer Science Center. In Rheinboldt’s words:

“A special building for the Computer Science Center was built on land that housed at the time some pens for animal research. This formed the first two-thirds

of the ground floor of the present computer science building. The NASA grant, which turned out to continue for the ten year period of 1963 to 1973 and amounted to a total grant award of \$2,620,000 for the period, allowed us to look from the beginning for some research faculty in the center, of course, in addition to the staff for operating the facility. In the early years we could only pursue more or less formal arrangements with faculty members of other departments throughout the university. At the same time we also began the support of graduate research students for their doctoral research work. Then after the center had achieved a certain reputation we succeeded in making research faculty appointments directly in the Center. One of the first was A. Rosenfeld who established his by now internationally known research program in picture processing and related areas. Over the years many others followed and the center became well known for its research in programming systems, picture processing, and numerical mathematics...”

Rheinboldt further recalls that cooperative efforts between IFDAM and Computer Science Center personnel resulted in a large federal construction grant that made possible the Space Science Building which served as the home of IFDAM, and later the completion of the Computer Science Building and the connecting wing.

Rheinboldt was a founding member of the Association for Computing Machinery (ACM) and in the 1960’s served on a committee of that organization to study the question of establishing educational programs in computer science. The chairman of the committee,

W. Atchison, was director of the computing center at Georgia Institute of Technology. This committee generated two reports which were subsequently regarded as crucial to the then-nascent field of computer science education. Several members of the ACM joined the UMCP Computing Center: Atchison succeeded Rheinboldt as Director, and R. Austing joined as Research Professor. This influx of faculty interested in computer science education programs soon resulted in the creation of a graduate program in Computer Science at UMCP in the fall of 1967, the first program of its kind in the Washington, D.C. area. In response to the growing need for computer skills in the workplace, the graduate program was rapidly followed by an undergraduate computer science program, both of which culminated in the creation of a separate computer science department in 1974. The program is currently ranked among the top 12 nationally.

Elliot Waters Montroll, an American, was another distinguished researcher at IFDAM. Montroll joined IFDAM in 1951. Prior to that appointment, he had made important contributions to the two-dimensional Lenz-Ising model of ferromagnetism, possibly being the first to obtain an exact expression for the transition temperature for spontaneous magnetization, using an ingenious symmetry argument.

From 1948-1950, Montroll was Head of the Physics Branch at the Office of Naval Research. While at IFDAM, from 1951-1960, he did important work in biomathematics and biophysics, as well as other topics in applied mathematics. According to a biography in the Montroll Memorial Lecture Series in Mathematical Physics established in his honor, among Montroll's most significant contributions were: (1) the diagrammatic resummation

procedure; (2) the introduction of the moment trace method for evaluating the vibrational frequency spectrum of a lattice; (3) the transfer matrix method for calculation the partition function of an interacting lattice system; (4) major contributions to random walk theory and its application to physical and chemical problems (for example, photosynthesis); and (5) the notion of a continuous-time random walk which led to “ground-breaking advances in the theory of transport and relaxation in disordered systems.”

In 1960, Montroll left IFDAM to serve as Director of General Sciences for the IBM Research Center. Also in 1960, he became founding editor of the Journal of Mathematical Physics. From 1966 to 1981, Montroll was Einstein Professor of Physics and Chemistry, and Director of the Institute of Fundamental Studies at the University of Rochester.

Subsequently he returned to UM to take an appointment as Professor in the Institute for Physical Science and Technology, IFDAM’s successor institute. Montroll’s many awards include membership in the National Academy of Sciences and the Lancaster Prize (with Robert Herman).

In the late 1950’s and 1960’s, the national funding climate was gradually changing from military-driven to general technological and environmental concerns. During this period, IFDAM’s focus in fluid dynamics and applied mathematics became highly relevant to climatology, meteorology, and geophysics. Helmut Landsberg, a German geophysicist who had immigrated to the US in 1934, joined IFDAM on a part-time basis in 1964 to work in these areas.

Landsberg had done his share of research for military applications, serving as Operations Analyst with the U.S. Air Force (then the U.S Army Air Corps) during 1942-1945. In this capacity, he applied his knowledge of meteorology to assist military strategists in determining climatic conditions in various theaters of war. Following World War II, he turned to civilian service with research positions in geophysics and meteorology. In 1965, he was appointed Director of the newly formed Environmental Sciences Service Administration.

Landsberg became full-time Professor at IFDAM in 1967, serving as Director of IFDAM from 1974-1976. He is widely considered to be the founder of modern climatology by virtue of his statistical analysis of climate. His broad research interests included the effects of urbanization on the environment and the effects of climate on human health and behavior, now called biometeorology.

Landsberg's efforts in IFDAM resulted in the creation of the Meteorology department at UM. That began as a proposed graduate program in meteorology/atmospheric sciences in 1965. In the proposal, Landsberg states:

"The Institute for Fluid Dynamics and Applied Mathematics has a tradition of theoretical and experimental research in fluid dynamics. Recently, the Institute has entered upon a research program whose aim is to apply basic fluid dynamical principles to further our understanding of meteorological and oceanographical circulations. Such a research program leads naturally to the conception of a course of graduate study in the general field of atmospheric sciences... Although the staff

of the Institute has research as its primary aim, it is dedicated to the proposition that research and teaching should go hand-in-hand...”

“The introduction of a curriculum of graduate work in Meteorology will broaden the base of the University’s scientific interests. Not only will it open up an interesting and important new area of interest to our students, but it will also fill a recognized need for education and training in Meteorology...”

Another notable member of IFDAM, and later IPST, was Robert W. Zwanzig who joined IFDAM as Research Professor. In 1976, he was named Distinguished University Professor of Physical Science. According to a biography appearing in a special Festschrift issue of the *Journal of Physical Chemistry* in his honor, chief among Zwanzig’s important contributions to chemical physics was the introduction of the projection operator technique into nonequilibrium statistical mechanics and the application of perturbation theory in fluid dynamics. Biographers note that “in the three decades that have passed since this work [on the projection operator technique] appeared, the number of applications of this method has grown dramatically ... indeed the use of the projection operator method has now become so common that Bob’s original papers are not always duly cited.”

Additional important contributions by Zwanzig include (but are not limited to): (1) perturbation theory as a route to obtain thermodynamic properties of gases and liquids; (2) collisional energy transfer to surfaces; (3) electronic excitation transfer in disordered media; (4) theory of surface tension; (5) polymer morphology.

#### IV . IFDAM's and Institute of Molecular Physics' evolution into IPST

In 1970, the University underwent an overall restructuring. This process began with the creation of a new campus-level chief administrative position, the Chancellor, on June 26, 1970. The first Chancellor, Charles E. Bishop, appointed an Academic Organization Study Committee to collect and study input from faculty, staff, and students in order to provide guidance in proposing some options for restructuring. On March 8, 1972, the College Park campus was reorganized into five academic Divisions, each headed by a Provost. Both IFDAM and IMP became components of the Division of Mathematical and Physical Sciences and Engineering; IFDAM was administratively part of the Engineering Department.

In 1986, under Chancellor John B. Slaughter, a second reorganization took place: the five divisions were divided into twelve colleges and two schools, each headed by a dean who reported directly to the Vice Chancellor for Academic Affairs. The latter became the campus Provost under the new system. (Currently the number of colleges is thirteen.)

Although IFDAM and IMP did not merge until 1976, as early as 1971 a need was felt to combine them. Leon Cohen, in a letter to Thomas Day, Chair of the Academic Organization Study Committee, advocated combining these and other appropriate

institutes into a “University of Maryland Institute for Advanced Study” in order to “provide a focus for research at the highest level in the University.”

We return now to the final years of IFDAM as an independent group. In 1968, Monroe Martin stepped down as Director; George Trytten served as Acting Director until Langdon T. Crane was appointed Director, serving from 1969-1974. During this time IFDAM comprised a growing group of faculty whose research interests fell loosely into four broad categories: applied mathematics, meteorology, atomic and molecular physics, and fluid dynamics. By this time, the number of faculty working in meteorology had grown from two (Landsberg and Alan J. Faller) in 1965, to eleven (with the addition of Bonner, Fritz, Gage, Gerrity, Israel, Kaylor, Rodenhuis, Thompson, and Vernekar). This group would soon form the independent Department of Meteorology (see below).

In 1974, Crane left and there was some initial uncertainty as to who would take the Directorship of IFDAM; Landsberg eventually agreed to take the post. It was around this time that, due to the international oil crisis and domestic economic difficulties, both federal and state funding were becoming even more scarce, and pressure was being put on the University to justify what funding it did receive. This requirement was passed on to faculty in the form of documentation as to how their time and efforts were being spent. Landsberg, a feisty writer, responded with a sharply worded letter to then-Provost of the Division of Mathematics and Physical Sciences and Engineering, Joseph Marchello:

“...Since becoming acting director of the Institute my attention has focused on attitudes and personnel problems. Need I stress that, in my opinion, morale is

very low. This is the result of the apparent attempt to downgrade this campus of the University to an inferior intellectual status.

In my view and that of my colleagues the creeping, if not systematic, downgrading of research is alarming. Asinine evaluation formulas, based on classroom hours, and mechanically applied by accountants, downgrade advanced education in a way that can only be designated as anti-intellectual..."

Unless there is a drastic change in attitude at the State level, the idea of excellence can be safely laid to rest..."

In addition, the State legislature passed a law to the effect that no state-funded faculty member could receive tenure through a research Institute such as IFDAM. On October 21, 1974, Marchello appointed a Research Organization Study Committee, chaired by Joseph Silverman, then Head of the Laboratory for Radiation and Polymer Science (LRPS) in the Engineering Department, to consider how to restructure the Institute to address economic and research concerns and to allow for long-term positions for research faculty.

One of Marchello's concerns was that, despite IFDAM's original status as a research arm of the Engineering Department, the technology focus had never really taken hold. Instead, the research had focused primarily on areas in physics and applied mathematics. In an attempt to regain an engineering foothold in the Institute, it was decided to name the new institute the Institute for Physical Science and Technology. Along with the name change, and the inclusion of the former Institute for Molecular Physics (IMP) into IPST, the

Institute's charter stipulated that all permanent faculty appointments would have to be joint with a regular department in the then College of Mathematical and Physical Sciences and Engineering (MPSE), and that tenure would only be granted through that department.

The restructuring resulted in the amalgamation of IFDAM and IMP into a new entity: the Institute for Physical Science and Technology (IPST). IPST's official inception took place on June 25, 1976. The committee's approved proposal said, in part:

"...the Institute [for Physical Sciences and Technology] will serve to strengthen traditional disciplines while stimulating faculty and student involvement across a wide range of disciplines...it will give the division an Institute at the forefront of science and technology which can follow the changing emphases in interdisciplinary research areas over the years..."

It was at this time that the Meteorology program, created by Landsberg and Faller in 1965, separated from IFDAM/IPST and was inaugurated as a new department under MPSE with Ferdinand Baer serving as the first Chair.

Joseph Silverman, who had chaired the restructuring committee, served as the first Director of IPST. He was assisted by Associate Director Alfred J. Fay, who had previously served as Associate Director of IFDAM starting in October, 1967. Silverman recalls that his goal was to "expand on the wonderful academic atmosphere that Monroe Martin had established." In 1967, when state auditors inquired as to the role of IPST, Silverman merely had to cite the fact that Landsberg and Zwangzig, both members of the National Academy

of Sciences, conducted research at the Institute, and they were satisfied that funding of the Institute was worthwhile. Furthermore, in 1981, Silverman was able to attract Montroull away from his post at Rochester to return to IPST as Research Professor.

In 1981, a faculty review committee, chaired by George Dieter, was appointed to review IPST's progress as a new Institute. One of its recommendations was that IPST be allowed to make new permanent appointments, since it was felt that scientific viability of certain programs often require a long-term arrangement (especially in the case of experimental research). At the same time, it was viewed as important to keep strong interactions between IPST and the various departments. It was decided that most new appointments must have an affiliation with an academic department, to which they would move after termination of their IPST appointment. In rare cases, where strong scientific reasons are given, tenure-track appointments to the Institute would be permitted.

Silverman was succeeded by J. Robert Dorfman, who served as Director from 1983-1985. Dorfman recalls that one of his main concerns was to obtain more joint appointments with Engineering. He hired Howard Milchberg whose work in high energy lasers spanned both optical physics and engineering, but was unable to find additional appointments in engineering who satisfied the rather stringent criteria of Marchello's formulation. Thus the Institute seemed to be moving in the direction of pure and applied physical science rather than technology. In addition, there were tensions between IPST and the Engineering department (largely due to the preceding situation, as well as funding competition) and between IPST and the Physics Department. The latter especially resented

the fact that IPST faculty carried little or no teaching duties. Dorfman decided that in order to resolve these tensions, IPST faculty needed to take on significant teaching duties. As it turned out, most of these distinguished researchers enjoyed teaching; so this change in policy was, for the most part, a successful one.

James A. Yorke, who received his Ph.D. in mathematics from UM in 1966, became Acting Director in 1985, and official Director in 1988. Yorke is widely recognized as a seminal leader in chaos theory. Under his leadership, UMCP's chaos group ranked first in the nation.

#### V I. IPST: its continuing mission

IPST, in the form of its predecessor institutes IFDAM and IMP, began as an institute of pure research. Driven by the necessity to upgrade the University of Maryland's academic stature, and the need for defense-oriented research in the post-World War II era. Top research talent has been attracted to the University by way of the Institute and fertile new areas of research have been uncovered and developed, often leading to new departments.

One key reason for the success of the Institute has been its interdisciplinary nature. This feature and the overall guiding philosophy of IPST are probably best summed up in the following excerpt from a speech given by Helmut Landsberg to the 1985 graduates of the then-MPSE Division:

“...Remember that science is not only the ‘endless frontier’ but it is also a continuous transformation. Old precepts are changed in the light of new discoveries, concepts are broadened, and some are discarded. Dogma has no place in science and technology. We must always be ready to give up long-held cherished ideas and accept new knowledge. Much of that new knowledge is not acquired in the core of a discipline. It is found at the fringes. Quite often it is made possible by a development in another field, by a refined or new measuring technique, or a chance observation...”

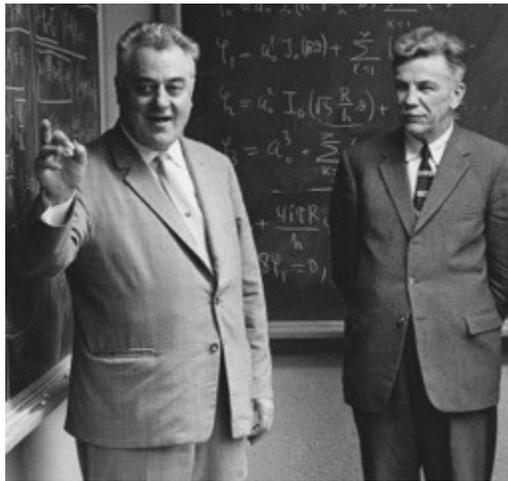
One final note: it is useful to look at the number of Distinguished University Professors and members of the National Academy of Sciences who are IPST faculty. Of thirty-one Distinguished University Professors at UMCP overall, as of this writing, fully one-third are from IPST. They are: Robert W. Zwanzig (deceased), Roald Z. Sagdeev, James A. Yorke (retired), John D. Weeks, Stephen G. Brush (retired), Ivo Babuska, Jan V. Sengers (retired), Sergei P. Novikov, George Gloeckler, Michael E. Fisher (retired), Millard Alexander, Jeffrey Bub, James Drake, Christopher Jarzynski, Eugenia Kalnay, George Lorimer, Eitan Tadmor and Devarajan Thirumalai.

Members of the National Academy of Sciences at IPST include: Helmut Landsberg (deceased), Elliot W. Montroll (deceased), Michael E. Fisher (foreign associate), Sergei Novikov (foreign associate), George Gloeckler, Roald Sagdeev, Frank McDonald (deceased), John Weeks and Ellen Williams.

Other important awards are:

Japan Prize- James Yorke.

Wolf Prize- Michael Fisher and Sergei Novikov.



Werner Reinboldt (left) and Monroe Martin (right). Reinboldt was a member of IFDAM from 1956 to 1967 and help found the Computer Science Center and Computer Science Department at the University. Martin, Director of IFDAM from 1949 to 1968 was responsible for hiring many distinguished faculty who made significant contributions to research and graduate instruction at Maryland.