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NATIONAL SCIENCE ADVISOR
EXECUTIVE OFFICES OF THE PRESIDENT
WASH, DC

APR 15, 1991

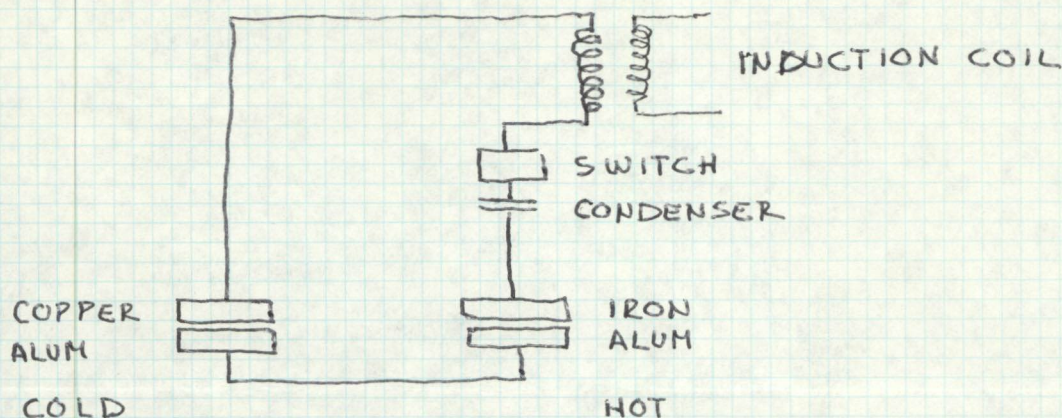
DEAR NATIONAL SCIENCE ADVISOR,

AS PER YOUR SUGGESTION I TALKED TO AN ELECTROCHEMIST ABOUT THE INCLOSED CIRCUIT. IT IS NOT CHEMICAL BUT ELECTRONIC. TALKED TO SEVERAL PROFESSORS ABOUT IT AND NO ONE COULD SAY IF IT WOULD OR WOULD NOT WORK. I AM HOPING YOU COULD FIND OUT.

THE CIRCUIT IS DESIGNED TO TRANSFORM HEAT TO ELECTRIC. SO IT COULD BE A THERMOELECTRIC DEVICE. BUT, IT IS AN ELECTRONIC CIRCUIT WITH A CONDENSER AND INDUCTOR. IF IT IS A CORRECT CIRCUIT IT SHOULD TRANSFORM HEAT AT ANY TEMPERATURE. IN OTHER WORDS IT IS A REFRIGERATOR CIRCUIT.

IN TALKS WITH AN ELECTRONICS PROFESSOR I LEARNED THIS AREA OF SCIENCE IS NOT OF INTEREST TO THE GENERAL RESEARCH BANKS. BUT IT SEEMS TO ME THIS CIRCUIT COULD BE QUITE USEFUL IN SEVERAL HIGH TECH AREAS AS WELL AS FOR REFRIGERATORS. IT ALSO CAN BE USED FOR DISTILLATION AND ELECTRIC POWER GENERATION.

THANK YOU,
James Meyer



WHEN THE SWITCH IS OPEN CHARGE GATHERS AT THE CONDENSER
WHEN CLOSED CHARGE FLOWS OUT THE COIL-OUT OF THE CIRCUIT

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121030

FROM: LANGE, Richard H.: UNC INCORPORATED

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/04/91

SUBJECT: A BOOK REVIEW ON THE RESEARCH THAT HAS GONE ON AT
THE PHYSICS DEPARTMENT AT YALE REGARDING THE PHYSICS
OF BASEBALL.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/08/91

FILE: PHYSICS

P-Physical Sciences-



9121030
RECEIVED

91 APR 8 A 9:39

OFFICE OF THE
DIRECTOR

April 4, 1991

Richard H. Lange
Vice President
General Counsel & Secretary

UNC Incorporated
175 Admiral Cochrane Drive
Annapolis, Maryland 21401-7394
301/266-9103

Dr. D. Allan Bromley
Special Assistant to the President
for Science & Technology
The White House
Washington, D. C. 20500

Dear Allan:

The enclosed book review will bring you up to date on some important research that has gone on at the Physics Department at Yale regarding the physics of baseball.

This work parallels the effort at the Law School, I believe, relating to the common law origins of the infield fly rule.

Best regards.

Sincerely,

Rich

THE PHYSICS OF BASEBALL, by Robert Kemp Adair; Harper & Row; 110 pages; \$16.95 hardcover, \$7.95 paperbound

Mighty Casey, who brought no joy to Mudville, should have read Robert Adair's book before stepping up to the plate. Then he would have known the secret of hitting the ball a country mile. It's just a matter of elementary physics:

Keep your eye on the ball. About two-tenths of a second after the pitcher lets fly, start your swing. (The timing is critical; swing a hundredth of a second too early or too late and you'll hit a foul ball instead of a home run.) Swing upward at an angle of ten degrees from the horizontal, aiming for a spot about three-quarters of an inch below the center of the ball. As the ball crosses the plate, your bat should collide with it at a point about five inches from the end, delivering a force of some 8,000 pounds for a thousandth of a second.

If you've done it all just right, the ball should head toward center field, rising at an angle of thirty-five degrees, arc over the outfield and come to rest in the hands of an exultant hometown rooter, some 350 feet from home plate. If the weather is hot and humid and the barometric pressure is low, you may do even a little better. But don't bother stuffing your bat with cork. Contrary to what you may have heard in the dugout, the corked bat actually might reduce the length of your drive. That's all there is to it.

Granted, Mighty Casey might have found these directions—a distillation of Adair's advice and analysis—difficult to follow to the letter. After all, Adair, for all his love of the game, is a professor of physics at Yale University, not a coach. But baseball admits fans of every stripe, and Adair does not offer his advice unsolicited: he wrote at the behest of the late baseball commissioner—and Adair's former Yale colleague—A. Bartlett Giamatti. Giamatti named Adair the first and only (unofficial) physicist to the National League, and in response Adair has done a lovely study in applied science.

The purpose of the book, Adair writes, is "not to reform baseball, but to understand it"; at that it succeeds on many levels. Students of physics will be surprised to learn how much Newton understood about a game that wasn't even invented until the nineteenth century, more than a hundred years after his death. Players and coaches may be intrigued by the analysis backing up their intuitive sense that timing is everything in baseball. Dyed-in-the-wool fans, who revel in numbers, will learn just how much a

curveball curves (even the curviest deviates no more than three and a half inches from a straight line) and just how fast Nolan Ryan's fastball really is (it has been clocked at 100.7 miles an hour).

And those who love the game but hate the hype now have a readable guide to recognizing baseball malarkey. If someone regales you with tales of 600-foot homers or runners who round the bases at a pace that would win an Olympic sprint, hand your credulous friend a copy of this book. There is a higher law, Adair assures us, than the *Official Baseball Rules*.

THE WHITE HOUSE

WASHINGTON

April 18, 1991

Dear Dick:

Many thanks for sending me a copy of the review of Bob Adair's book on *The Physics of Baseball*. When this first came out I took a copy into the President and was then able to send Bob a picture of the President receiving his book with obvious delight. George Bush appears in a footnote in the book from his days as captain of the Yale Baseball Team where he batted as a left-hander and pitched as a right-hander.

I had the pleasure of seeing Dan and Helene Colussy at the recent talk that the President gave to the American Business Council at the Department of Commerce, and I gather, both from that brief chat and from the excellent annual report that I recently received, that the restructuring of UNC Incorporated is largely complete and that you're now well on your way back to substantial profitability. It has been a long and difficult road and without Dan's leadership we would not have made it.

I find that I miss the fellowship of the UNC Board. It was a remarkable group and I looked forward to each monthly meeting with that group and with all of you in the senior UNC management.

With warmest best wishes,

Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

Mr. Richard H. Lange
Vice President
UNC Incorporated
175 Admiral Cochrane Drive
Annapolis, Maryland 21401-7394

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120787

FROM: SCHMITT, Roland W.: RENSSELAER

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 03/11/91

SUBJECT: A LETTER TO THE EDITOR OF PHYSICS TODAY AND A COPY
OF THE TALK GIVEN AT THE JOINT MEETING OF THE
COUNCILS OF THE NAS/NAE AND THE NSB.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 03/18/91

FILE: PHYSICS

P-Physical Sciences-



Rensselaer RECEIVED

ROLAND W. SCHMITT
President

31 MAR 18 AM 11:42

OFFICE OF THE
DIRECTOR

March 11, 1991

The Honorable D. Allan Bromley
Assistant to the President for Science and Technology
Director of the Office of Science and Technology Policy
Old Executive Office Building
Washington, DC 20506

Dear Allan:

Enclosed is a brief letter to the editor of *Physics Today*, reporting the observation I made to you at the recent meeting of the Academies. I am also enclosing a copy of the talk I gave at the joint meeting of the Councils of the NAS/NAE and the NSB at the Beckman Center last month. It is cast in the form of a "debate" with Leon Lederman so I do not wish it published as is, although I understand it has been getting quite a bit of circulation on the street.

With best personal wishes.

Sincerely,

Encs. (2)

March 11, 1991

Editor - Physics Today

In their article on young physics faculty in 1990 (Physics Today, Feb. 1991, p.37), Czujko, Kleppner and Rice report that there has been a dramatic drop between 1977 and 1990 in the fraction who believe that research funding is adequate. Their report joins a rising tide of complaint about the plight of academic research in the U.S. today. Leon Lederman, President of the AAAS, has also reported on a survey of the views of 250 academic researchers; he, too, found a dismal state of morale among them.

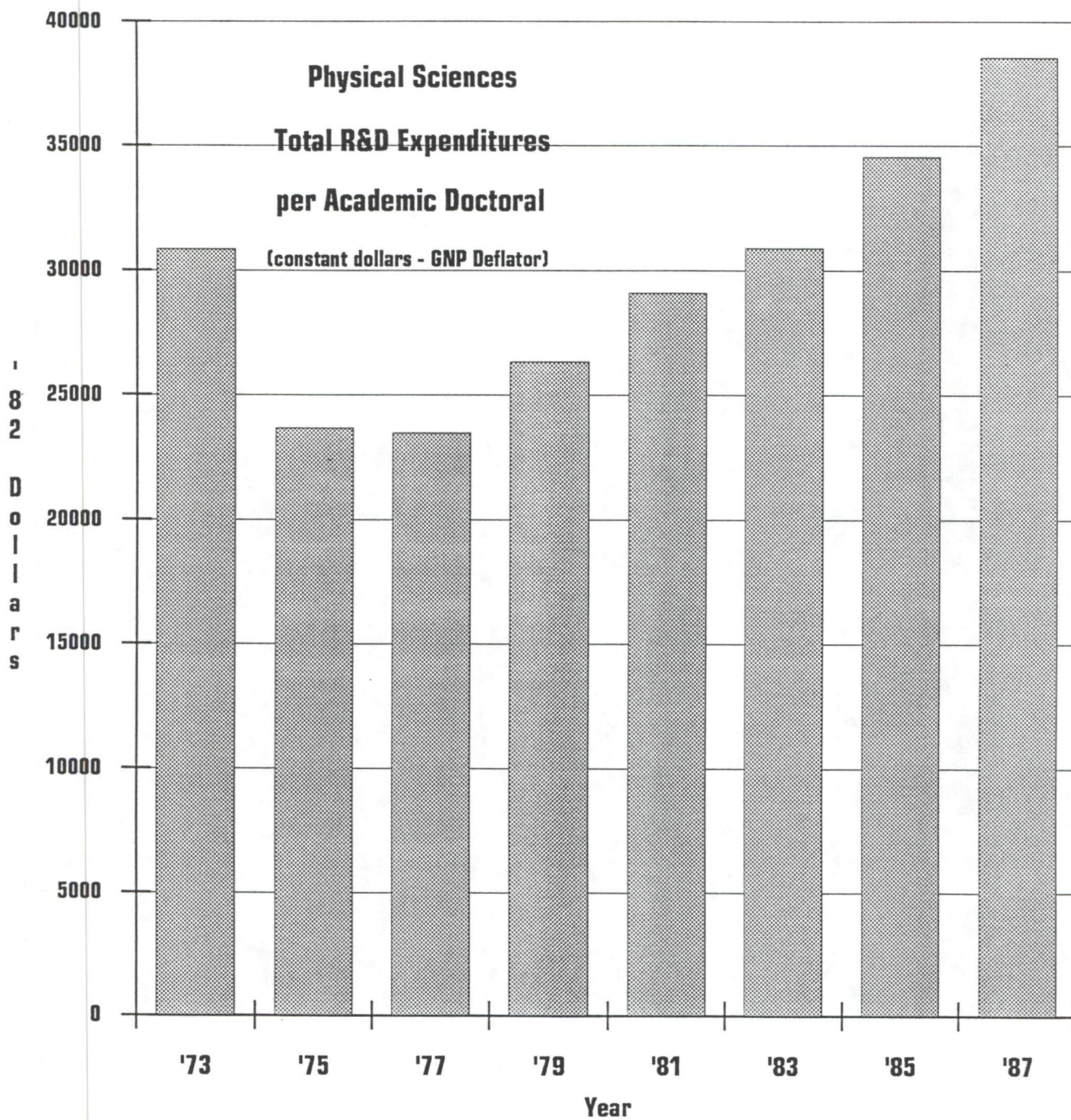
The accompanying chart shows the support trends per academic doctoral in the physical sciences (mainly physics, chemistry and astronomy) from 1973 through 1987. The curious fact is that young physics faculty felt best in 1977, after several years of diminishing support and felt worst after the sustained growth in per capita support during the '80s.

The explanation of this curious phenomenon is not obvious. Similar trends occurred in the support of academic life sciences and other natural sciences. These facts suggest that there may be underlying structural problems in the management and distribution of academic research funds. These may be just as important as constraints on total funding in causing the present malaise among many academic researchers.

Even before understanding these facts, I am apprehensive of arguments for more funding that are based on inward and self

serving views. In the eyes of many Congressmen, it will appear unseemly of us to base our plea for more money on the poor state of our morale. There are too many homeless, returning veterans, AIDS victims and many others waiting in that line, most with more appeal to our elected representatives than we have. We need to focus on the fundamental reasons why our society needs to invest in academic science, i.e. the tremendous economic, social and cultural benefits it brings. In short, we need to concentrate on what we can do for others, not what they should do for us.

Roland W. Schmitt
President
Rensselaer Polytechnic Institute



Sources: NSF 80-316, NSF 90-310, NSF 81-301, NSF 89-326

Draft - Not for Public Release

**Science - The Frontier of Challenge:
Adjusting to Finite Resources**

**Roland W. Schmitt
President, Rensselaer Polytechnic Institute, Troy, NY**

**NAS/NAE/NSB Symposium
Beckman Center, Irvine, CA
February 15, 1991**

To be the counterpoint for Leon Lederman's inspiring and visionary AAAS missive is daunting. When Bob White asked me to take on this assignment I wondered what I'd done wrong! What penance was I being asked to make? But then I remembered the story of the young man who avidly wanted a bicycle. Every night he prayed for one. He prayed and prayed and prayed, but no bicycle appeared. So, finally, in desperation he stole the bicycle and began praying for forgiveness. I'm sure that if the heavens are destined to open and shower us with gifts, it will be because of Leon's devout supplications and I, for one, hope he succeeds. But it's only a hope, not an expectation. So, I take my assignment - my penance, if you like - to be that of devising an alternate strategy--not to steal, mind you, but to acquire as generous a part of the nation's wealth as possible for our enterprise and to apportion it among ourselves in the best possible way.

Let me say at the outset that I agree with many of the arguments in Lederman's AAAS report, especially those that dramatize the great importance of academic research to the U.S. The basic message he puts forth is correct so it is hard for me to stand before you today and fulfill the assignment I've been given. A call to battle is more exciting than a call to regroup. But, unfortunately, we cannot bet our future on the probability that Leon's proposal will succeed - it won't. So my discomfort in appearing to take issue with some of the things Leon puts forth is relieved by my belief that the skill we show in "adjusting to finite resources" will be the crucial element in the future well being of our enterprise.

Leon has said on several occasions that everyone falls into one of two "gangs". "Gang One" is supposed to say "There are finite resources, so science must make hard choices, scientists must not behave like special pleaders" while "Gang Two" says "Science has always been one of the best investments the government can make." If there is one message that I'd like to give today, one

sermon to preach today, one plea to make today, it is this: the future success of our enterprise will depend on our ability to merge those two gangs into one single, unified gang, a gang that understands both the great value of science to our society and the need to fulfill that promise with fewer resources than we'd like. Unless we collectively take that as our challenge, we will fail - fail ourselves and fail the society that depends on what we do. Our clarion call should not be "give me what I'd like to have to make me happy" but "Give me the means to contribute what society needs from me."

In the AAAS report, two quite different arguments are put forth for federal support of academic science. First, it is said that American science and technology will do the following important things for our country:

- provide the basis for new industry
- improve the health of the population
- understand ecological and environmental issues
- develop alternate energy sources and substitute for scarce materials
- enhance our culture

These are good, pragmatic reasons for strongly supporting American science and technology in general and academic research in particular.

Fig 1

Then, in the same document is an "ideological" reason, a reason that argues for "unlimited" support of academic research: ideally, it is said, any talented scientist should be able to obtain research funding if he or she has a good idea and can meet the burden of reasonable review and resistance. Or, as Leon has been quoted as saying elsewhere, "A good criterion for healthy science is that every good scientist can fulfill his desires."

Now the ideological goal is not at all necessary (nor sufficient, for that matter) to fulfill the pragmatic goal. We can provide the basis for new industry, improve the health of our population, etc. without supporting academic scientists to the limits of their desires.

And that is fortunate because the ideological argument is flawed. The appeal that less support than will enable every good scientist to fulfill their desire will so demoralize our constituents that they will become dysfunctional, is first of all probably not true and, secondly, not a very attractive posture. It puts us in the posture of a special interest group that pleads for entitlements without having the political clout to enforce the demand!

To live within finite resources does not mean that we have to accept,

passively, whatever is given us after the other advocates have received their own allotment of resources. We must and should be advocates who persuasively put forth our best case for the resources needed for a healthy, thriving academic research community that makes great and valuable contributions to our society. But we cannot be advocates who base our arguments on an inward look. To do so is not only damaging to the fundamental validity of our case, but in the long run will be demeaning to ourselves.

The challenge to us in arguing for strong support of academic science based on the pragmatic grounds is that we need to fill in the blanks, so to speak. Except for the last item - to enhance our culture - we have to show how it is that academic research actually contributes to the practical results and that it contributes to these in sufficient measure to warrant the level of support we seek. And here we have a problem.

There is a growing question of whether U.S. pre-eminence in pioneering research has brought with it a corresponding pre-eminence in achieving the desired impact on industry, health, environment, energy and the like. In fact, listen to the words in the executive summary of a report on National Technological Priorities that the Council on Competitiveness will soon issue:

"The American people and its leaders have too readily assumed that pre-eminence in science automatically confers technological leadership and commercial success as well. It does not. America assumed that government support for science would be adequate to provide for technology. It is not. In too many sectors, America took technology for granted. Today, the nation is paying the price for that complacency."

So I believe that we have to take the pragmatic goals seriously enough to "fill in the blanks", as I have suggested and strongly relate our research to these interests.

The basic question is whether or not one is intellectually honest in doing so. There is no doubt of the answer to that question. Science and technology, alone among all the enterprises of our society, produce not just new wealth, but new sources of wealth. One great advantage that the U.S. still has in the international competitive arena is a strong ability to explore the frontiers of science and technology based largely on our academic research system, a system that is well connected to the industrial world. Today, without question, the U.S. is still the dominant force in making pioneering new advances in science and technology

and, in fact, in introducing the first products based on these advances.

So good science and good politics, though sometimes uncomfortable with one another, are entirely compatible. As scientists and engineers, we can speak the language of those who must support us without, in the least, prostituting ourselves. The arguments must be soundly based, but they needn't be limited to those we most like ourselves.

And that brings me to some of the practical, political issues involved in federal support of academic research.

The President has just proposed a budget for 1992 that incorporates a 14% increase - of \$9.1B - for science and technology. \$5.4B, or 60% of the increase, will go to military R&D in the face of an overall cut of 1% in military spending. Another \$1.6B or 17% of the increase goes to NASA. Interestingly, the superconducting supercollider - \$291M - and the National Science Foundation gets \$406M. The only difference is that this represents an 18% increase for NSF and a 120% increase of the SSC.

The President's budget for science and technology represents the result of an increasingly coherent priority setting process for R&D in the executive branch. This year, under the auspices of OMB and the President's Science and Technology Advisor, there was a lot of interagency coordination and planning. Interagency initiatives in high performance computing, global change, education and human resources and materials science and engineering all found their way into the budget sent to Capitol Hill.

But the Administration's priorities are unlikely to remain intact in Congress. There are two reasons for this: first, the budget environment set by last year's summit agreement and subsequent events; second, the way the Congressional budget process works, a process that fragments R&D budgets and puts them against unlikely but formidable competitors.

The budget environment for the next few years is established by the summit agreements of 1990. It is complicated but awesome. For example, total, nondefense, discretionary spending in the FY 1993 budget cannot be more than \$40B over the FY 1990 budget. But \$25B, or 60% of this, has already been used up in the FY 1991 budget, the current budget. That means there is only \$15B of increases left for FY 1992 and FY 1993.

How is the allocation of this limited increase going to be determined by Congress. The best answer is "chaotically". The appropriation process in Congress involves 13 separate subcommittees and most of the money for

nondefense science and technology goes through four of these. In one, appropriations for NIST and NOAA go up against the Justice Department, the FBI, and the State Department. In another, NSF and NASA go up against the VA and HUD, (veterans and housing) and the Superfund. NIH goes up against the Department of Labor, Department of Education, and the rest of H&HS. Energy research, including the SSC is funded out of a subcommittee called Energy and Water.

In this environment, talking about priorities among various science and technology programs doesn't mean much. Each subcommittee chairperson is preoccupied with getting the maximum allotment he or she can for their own subcommittee and then distributing it among the disparate programs under their jurisdiction.

Federal appropriations for R&D of the magnitude suggested by the AAAS report are just not in the cards. There are too many homeless, too many AIDS victims, too many environmentalists and on, and on, competing for the same resources, each giving their own special reasons why their claims are the most important. And I would remind you that Senator Mikulski, in one of her first hearings on the NSF budget asked whether academic scientists, in exchange for the public largess they received, shouldn't render public service of some sort during their off hours! Congress, by and large, loves science and technology. But, as Ken Kay, executive director of CORETECH, likes to say, its support is a mile wide and an inch deep.

Science has seldom been strong politically. Except after WWII, when we had produced radar and nuclear weapons, and after Sputnik, when we were frightened by the specter of being surpassed by the Soviet Union, the scientific community has not been a strong political force. Contrast the political clout of the R&D community with that of the agricultural community. There are over 5 million working scientists and engineers in the U.S., under 3 million farm workers. The U.S. government spends about \$70B per year on R&D, only about \$17B in government payments to farms. So by objective measures, the R&D community is bigger and the Federal government has a bigger stake in it than in agriculture. But, by any measure, the farm community is orders of magnitude more influential politically.

We tend to assume that our own enthusiasm for what we do is shared by the public. But, by and large they don't. Too many of them share the view of the former Dutch Queen, Julianna, who once exclaimed, "I don't understand

computers; why, I don't even understand the people who understand computers." The public, by and large, has that view of all of science and scientists.

Nevertheless, we sometimes get generous support because what we ask for is politically attractive. For example, henceforth the SSC is going to stand or fall not because of its potential contributions to our understanding of the first picosecond of the big bang, but because of the political clout of the Texas Congressional delegation and its allies. Look at the record of federal appropriations for facilities, a subject which our community has consistently failed to address effectively. Today, pork barrel appropriations are about \$300 million annually and responsible university presidents have to answer to their trustees why they aren't vigorously pursuing such funds.

We should also note that some of the strong Congressional voices supporting science and its values are no longer in Congress, having lost in the last election. Doug Walgren, Jack Buechner and Claudine Schneider, for example. Doug Walgren was attacked, explicitly, for his support of basic science, which his winning opponent ridiculed by citing examples of "Golden Fleece Awards." Neither academic R&D nor higher education has yet played a significant role--maybe not even an insignificant role--in any race for public office. And I don't have to remind this audience that Msrs. Dingell and Weiss have found fertile soil in attacks on academic science. The public perception of the widely publicized questions about Stanford's indirect cost charges will provide further ammunition for those gentlemen and their colleagues. We no longer live in a political ivory tower and we cannot approach our goals with arguments that appeal to us but no one else.

Let's now look at some data about academic research. We need to correct, in part, the impression left by the AAAS report. Academic research is not quite as bad off as implied. First, the report omits the small amount of development in academic institutions, amounting to \$870M or a little over 6% of campus research expenditures in 1989. But, even more important, total non-federal sources were \$5.8B or 40% of the total in 1989. Moreover, during the 20 year period, 1969 to 1989, federal support grew more slowly than any other source, averaging 8.8% per year compared, for example, to 15.1% from industrial sources and 11.4% from other sources. Incidentally, in every instance the growth rates were faster in the 80's when inflation rates were 2% lower than in the 70's.

Figure 2

The next question is what is the right price deflator for academic R&D. The

AAAS report uses the OMB R&D price deflator. In spite of its name, it was not designed to measure the price of R&D inputs. The GNP price deflator is more commonly used. They differ from one another: during the two decades in question the OMB R&D index grew at 7.2%/year while the GNP index grew at only 6%/year. (The differences between the two deflators, again, were larger in the 70's than the 80's.)

Putting these two things together--total academic R&D expenditures, not just federal expenditures for basic and applied, and the GNP price deflator rather than the OMB R&D deflator--you get quite a different picture from that of the AAAS report. One yields an increase of only 33% in constant dollars, the other yields 101%, or double between '69 and '89. (Had Lederman used the GNP deflator, he would have observed a real increase of 67% in federal support.) The figure below shows a comparison of the two trends.

Figure 3

An item of considerable interest is the rate at which institutions have been increasing the use of their own funds for R&D. As the following chart shows, it has been much faster than the increase in state supported R&D in spite of the publicity that the latter source has received recently. In fact, considering the financial problems that many institutions of higher education are facing today, this may be one of the sources of the troubles of the research community.

Figure 4

The academic funding per doctoral looks very different when you look at total funding than when looking at federal funding only, as the next chart shows.

Figure 5

Just to be sure that there are no prominent anomalous subsets of this data, the next chart shows the expenditures per academic doctoral in three areas. The per capita amounts are quite different but the patterns are all quite similar.

Figure 6

What conclusions can we draw from these data? First, while the total amount of money going into the academic research system is a constraint, it is hard to see that money alone is the problem. We are back to per capita expenditures near those of the "golden era" of the late 60s. It will be said that the per capita expenditures need to be higher now because of the more sophisticated, more expensive equipment and facilities needed today. I agree. But, we've got to be a bit careful with that argument: while the higher capital intensity of research today should imply higher per capita costs of the inputs to research, it ought also

lead to higher productivity and thus lower costs per unit of research output.

In any event, if one is to judge by the level of discontent, the stresses in the academic research system are high. If total money alone can't explain this phenomenon, what other factors might also be contributing? Maybe the system has some structural problems that also need correction. And, if there are structural problems, how can we be sure that pouring more money into the system won't just make matters worse?

During the last two decades, there has been significant growth of the academic research system. It has consisted of two expanding elements: first, the number of institutions engaged in research and second the relative amount of effort devoted to research over teaching. Let's look at each.

The academic research system has spread to a larger number of institutions and federal funding has contributed to this spread. From the '71-'73 period til the '87-'89 period, the number of academic departments receiving federal research money grew about 22% in engineering and almost 50% in the life and physical sciences. The average funding of each unit, in constant dollars, also grew in engineering and life sciences but, surprisingly, dropped in the physical and environmental sciences! (C.23)*

Meanwhile, the research intensity on these campuses was growing. A larger and larger fraction of academic doctorals have become dedicated to research. The number of academic doctorates with R&D as their primary activity has almost doubled in the last 15 years. Further, new doctorals going into academia have increasingly gone into R&D, not teaching positions - especially in doctoral institutions. Moreover, among academic doctorals primarily devoted to research, non-faculty employees are growing the fastest. Meanwhile, the full-time, ranked faculty is aging, the average having grown from 42 to 47 in the last 15 years.

Changes in the deployment of postdoctoral students and of graduate students all point in the same direction. About 90% of all postdocs are used in R&D and these have grown from ~4300 in '73 to ~10300 in '89, a growth of ~6% per year. The next figure shows how the utilization of graduate students has changed.

Figure 7

The fastest growing segment is Research Assistants, where federal support has

* The C#s in parenthesis refer to source documents in my possession. Complete references will be given in any final publication.

contributed to the growth but not by any means caused it all. Teaching Assistants, almost totally funded by non-federal sources, too, have grown but not as rapidly as Research Assistants. Meanwhile, Fellowships and Traineeships have languished with federally supported ones having dropped by about one-third. (C 7,13,14)

What do we conclude from all of this data. Academic research has three essential functions: to contribute to knowledge of value to our society; to educate graduate students via the composite system of advanced, specialized courses and research apprenticeships; and to enrich the education of undergraduate students via teaching by faculty in touch with advancing knowledge. All of the trends we've noted indicate a significant shift to the first function and a significant growth in its size, especially during the last decade. The increase of academic staff devoted to research, the increase of research assistantships which are attached to specific research grants or contracts, the lag of the more flexible fellowships and traineeships which are more closely linked to the educational function, the increase of teaching assistantships that generally relieve faculty of teaching burdens - are all consistent with this trend, a trend that also corresponds to the anecdotal and intuitive observations of many academic researchers. Moreover, one of the problems of support for young, beginning researchers today may stem from the decreasing flexibility that goes along with these shifts. Department heads or deans used to be able to assign trainees and some fellows to young faculty members to help them get started in their research. In fact, today, because of the lag in the number of such positions, it is teaching assistants who may be assigned to younger faculty to help with research, thus turning some of these positions into a further, hidden subsidy of research. There is also a set of S&E academics who are approaching retirement in this decade who came into the system during its period of rapid growth; they have significantly occupied the tenured faculty positions in academic institutions, leaving only limited opportunities for entry into a normal academic career by junior people. This, too, has undoubtedly contributed to these younger peoples' movement into research oriented positions.

I would like to suggest that part of the discontent today and the stresses expressed in many quarters is the pressure to continue evolving further in the same direction. It may be time to pause and ask, is this the best way to go?

During the growth in the academic research enterprise money did not grow as fast as researchers, during the 70's. Only in the last decade has that

begun to turn around - ironically the unhappiness of the community seems to have erupted during the very period when the change has become favorable. Meanwhile, though, academic institutions have had to get increasing amounts of support from industry and from state governments and, especially, have had to put more and more of their own resources into it. And stresses are appearing, today, in all three of those quarters: academic institutions, states, and industries.

So, what do we do about our condition? First, there are several things that we can't or shouldn't do. Let me list them.

- Reduce the number and distribution of research universities and, like Britain, try to concentrate on a relatively few elite schools. This won't work and can't be done.

- Reduce the number of Ph.Ds awarded to U.S. citizens so as to reduce the alleged "surplus" of researchers.

- Place a tax on high-tech products. This would be a disastrous policy, a quick way to make the U.S. even less competitive in world markets.

What can we do to adjust to finite resources?

There is no single magic bullet or master plan that can solve our problems. Rather, there are many specific actions that need to be strengthened or initiated. They fall into several groups:

- Improving our advocacy in the federal arena and, also, at the state level and with industry.

- Making better use of our resources.

- Improving the linkage and synergy of research and education.

- Devising innovative new initiatives to attract new resources.

Let's take them one by one.

I should tell you that some of my suggestions are strikingly similar to ones given by Bob White and Frank Press at their respective annual meetings. The similarities are not coincidental; both of those talks are well worth rereading.

Advocacy: Our advocacy must be based on the pragmatic reasons for supporting academic research, reasons that represent the societal benefits of our work. The list given in the Lederman\AAAS report is one way to parse these reasons. In supporting science and technology our political and economic systems are strongly biased to such things as the competitiveness of U.S. industry, regional economic development, education and human resources, and governmental functions such as health, defense, environment, etc. In fact, there is little that we do in academic research - outside of astronomy, cosmology and

elementary particles - that isn't relevant to these interest. But we must get better at dramatizing the linkages more concretely and aiming the arguments more precisely.

We also need to become more targeted and sophisticated in how we pursue more funding in Congress. We need to target particular appropriation subcommittees with particular messages on why our enterprise should compete favorably with other, often more understandable, priorities. Concurrently, we might also push for Congressional reorganization of the appropriations subcommittees so that nearly all civilian R&D and related programs be considered by a single appropriations subcommittee. Prosaic sounding stuff - compared to the battle cry of another \$10B - but likely to be more possible and more important in the long run.

The academic community has to argue more forcefully for the 6.1 and 6.2 funding in DOD, for competitive grants in Agriculture, for basic energy sciences in the Department of Energy, for the scientifically oriented programs in NASA, and so on. And each of these arguments has to be carried to particular agencies and particular congressional committees by informed people - preferably constituents - who appreciate the public interest. We should also face up to the issue of priorities, however fragmented Congress is. There are two aspects to this. First, take seriously priorities on critical technologies spelled out by DOD, DOC, the Council on Competitiveness and others as Bob White suggested (p.14). If we disagree with them, argue; but, if not, relate our proposals to them. Second, address the issue of priorities within fields as Frank Press suggested in his talk (p.7).

Resources: Next, we need to make better use of the resources that we do get. There are several dimensions to this. The first is a policy and program management issue. I said earlier that we cannot reverse the spread of research to more and more campuses. But, that doesn't mean that every campus aspiring to eminence in research has to be comprehensive in its research. We ought to be encouraging different clusters of excellence at different campuses. And we can do this if proposals were to be judged not on intrinsic merit alone, but also on context - is the work linked or synergistic to other work on the campus? Will it help to build a steeple of excellence on the campus? It would be a policy conducive to a strong, dispersed academic research system that yet had only a healthy degree of redundancy across all institutions.

Another dimension of resource utilization is the local management of

resources - and by that I mean equipment, space, services, etc., as well as the direct efforts of the research team itself. I am sure that on most campuses there are great opportunities for more sharing of equipment, more effective utilization of space and less expensive ways of procuring needed services. For example, when granting money for new equipment, agencies might ask what the plans are for downstream use of the equipment and for plans to share it. Addressing these issues wisely can help individual researchers yet there are virtually no forces in the academic environment - short of crises - that motivate either the administration or the faculty to address them. I believe that some sort of task force to visit many campuses, to identify the best practices on any of these campuses and to widely disseminate this information would be valuable.

In many instances, reorganization of academic education and research could substantially improve the use of resources and the cost of overhead. Again, Frank Press made this suggestion and pointed out that it might be particularly timely because a generation of faculty is being replaced by a new one.

Research & Education: Turning now to the third group of actions: improving the linkage and synergy of research and education. A lot has been said about this subject recently, including the well-publicized comments of Donald Kennedy, the President of Stanford. And one of the arguments of the AAAS document is that the austere level of funding will discourage graduate students from pursuing research careers in academia. Yet, ironically, as I've pointed out, some of our problems arise from the separation of an increasing portion of academic research from teaching.

Today, it is far better to use non-faculty, doctoral research people on research grants than it is to use graduate students. Why? It produces results more quickly, leading to more publications, earlier, and a better chance of getting future renewals and new grants. The bias is against using research grant money on graduate students, let alone against involving undergraduates. This is a bias that could be corrected by policies of the granting agencies - a shift back to fellowships and traineeships, for example. Or, changes like the recent NSF requirement to submit only the ten top publications plus a list of graduate degrees produced by principal investigators instead of the usual list of dozens or even hundreds of publications. The purpose of this change is to let reviewers see the educational as well as research output of the principal investigator.

There are a lot of other policies of funding agencies that constitute both implicit and explicit biases against the educational function of research in

academe; we should institute some sort of study to identify all of them and then decide on appropriate changes.

But, equally important is the bias on the campuses of research universities against teaching in favor of research. It is reflected in the salaries of faculty. Those who spend as much as 80% of their time teaching at doctoral universities make from 1/10 to 1/3 less than those who spend only 20% teaching. Moreover, the discrepancy increased from 1975 to 1987. The good signals, however, are that the discrepancy seems to be less in the youngest age group and at the most research intensive institutions which, of course, tend to be the largest and richest ones. Nevertheless, there may be hope on this front! (C 77)

Nevertheless, the right balance between research and teaching - both graduate and undergraduate - is a key issue that needs re-examination. The National Science Board is launching such a fresh look and I believe that doing so in the broad context of our discussions today will be productive.

New Ideas: Finally, we need some new ideas. What we must do is to generate new ideas that can be promulgated effectively to OMB, to DOD, to NIH, etc. and that will be persuasive, appropriation subcommittee by appropriation subcommittee in Congress.

At NSF, the invention of the interdisciplinary research centers, the Engineering Research Centers and the Science and Technology Research Centers brought millions and millions of dollars into NSF budgets that would not otherwise be there. Many critics in the academic research community do not want to believe that to be true, but it is. I was lucky enough to accompany Dave Packard and John Young into the West Wing of the White House on the occasion of what I think was the final shove to get the Administration to commit to doubling NSF's budget. The arguments were not about individual investigator initiated per research; they were about the economic impact of academic research; and the President's Chief of Staff wanted to know why the federal labs couldn't do the requisite research!

What are some new ideas? Bob White suggested a couple that sound attractive to me. One is to provide the equivalent of DOD's Independent R&D funds to academic institutions doing federal research - funds equal to a certain percent of federal R&D contracts and awards could be used by the institution for unrelated programs - a stimulus for the exploration of new fields. Or, institutional grants linked to broad goals - not specific research areas - could be awarded competitively, again permitting local flexibility.

Another idea is to ask megaprojects - space station, superconductivity supercollider, strategic defense initiative - to contribute to the development of the human resources that are "consumed" by these large projects.

In the end, one must conclude that money alone in amounts much greater than growth during the 80s may not solve the problems of the academic research system. As things stand, we don't know that pumping another \$10B into the system won't simply intensify the structural problems that have caused the stresses and precipitate a call for another \$10-15B increment down the road. Unfortunately, also, the general call for another \$10B doesn't give anyone, anywhere in positions of responsibility anything to do. It works wonderfully on the billboards and marquees and headlines. It is appealing to the media. Even though the value of that appeal shouldn't be neglected, the real, effective warfare has to be fought in the trenches.

So what do we do? There have been many talks, many news articles, even a few studies, but no one has yet faced up to reexamining the system we have, asking how it can be improved, and coming up with specific recommendations, agency by agency, congressional committee by congressional committee. We should do so and the people in this room are the ones to spearhead such an effort. Which of the suggestions made by Frank Press, by Bob White, by others should really be pushed and how should they be pushed? It's time we quit giving speeches and get moving.

Support of Academic Research

Pragmatic:

- Providing the basis for new industry to enhance the quality of life of our citizens, while extending those benefits to regions and groups that have not yet shared in them;

- Improving the general health of the population while containing the costs of medical care;

- Understanding the complex circumstances surrounding ecological and environmental issues and providing guidance to policymakers in these areas;

- Developing alternate sources of energy and substitutes for scarce natural resources; and

- Enhancing our culture by expanding our understanding of the universe and humanity's place in it.

Ideological:

- The ideal environment is one in which any talented scientist can obtain research funding if he or she has a good idea and can meet the burden of reasonable review and resistance.

Figure 1

Growth Rates of Academic R&D (& Inflation Rates)

	Total	Federal	Indus- trial	Other	GNP Deflator	OMB Deflator
'69-'79	9.2%	8.4%	12.5%	10.7%	7.1%	9.1%
'79-'89	10.4%	9.1%	17.8%	12.0%	5.0%	5.5%
'69-'89	9.8%	8.8%	15.1%	11.4%	6.0%	7.2%

Figure 2

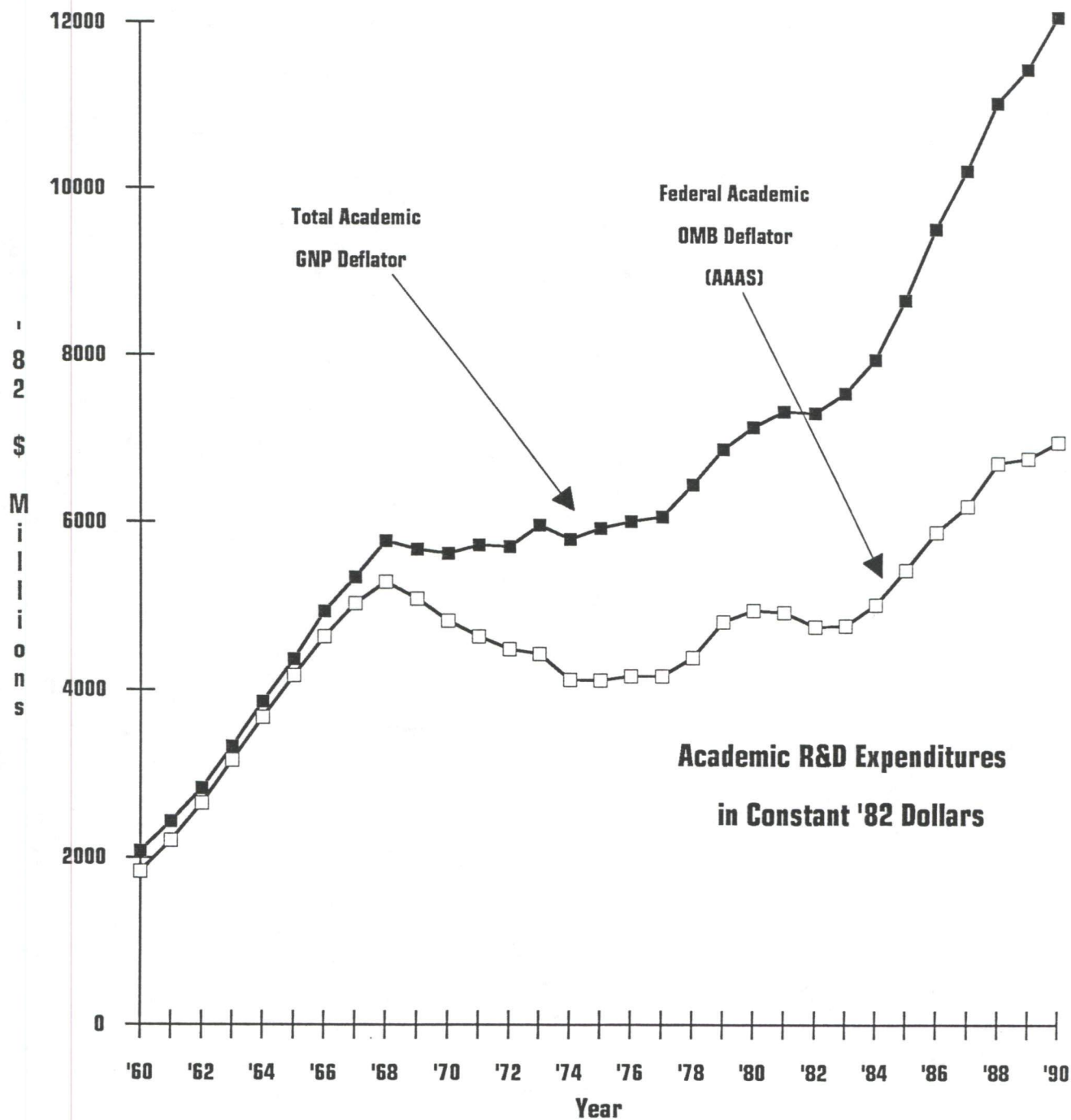


Figure 3

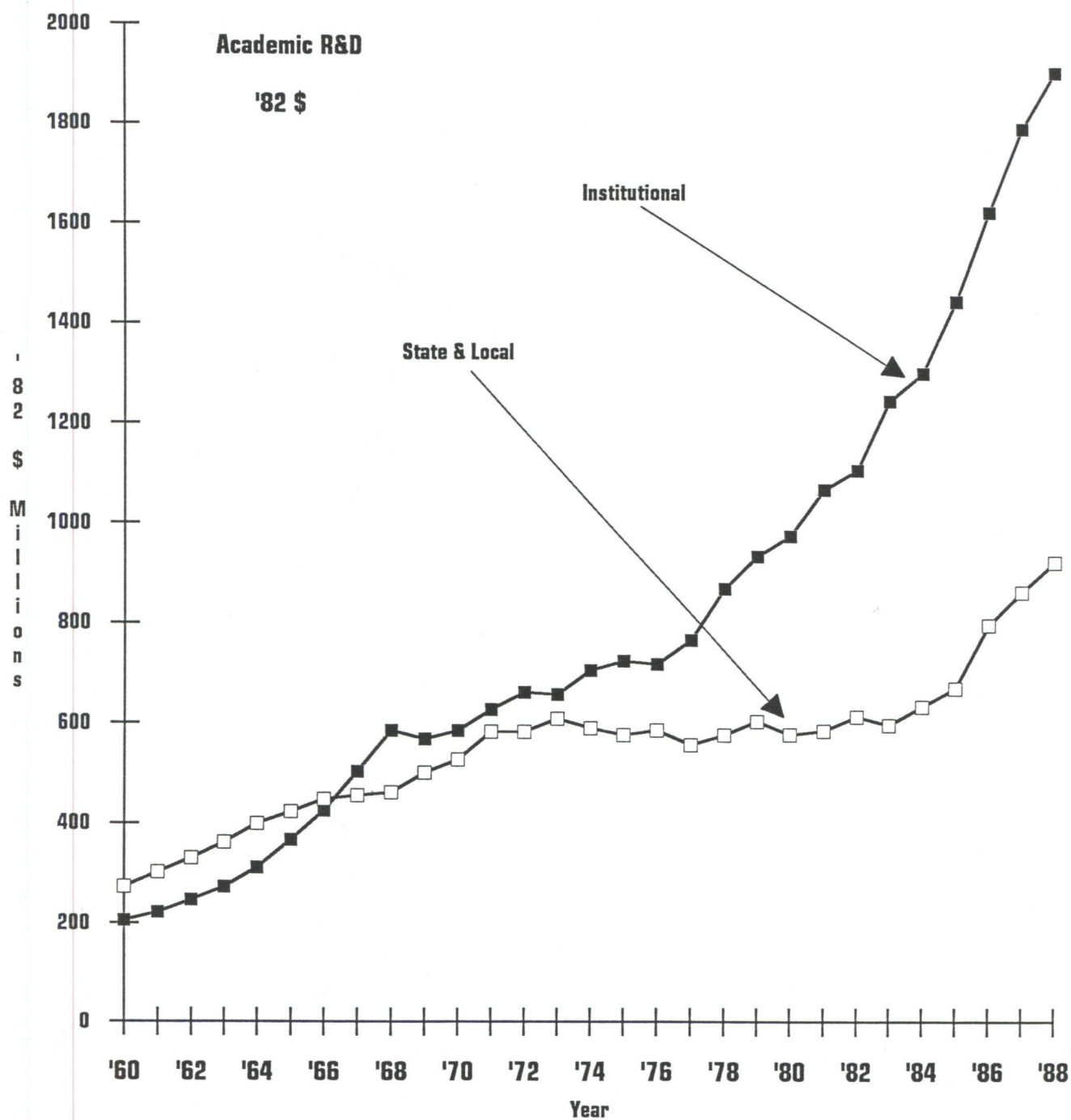
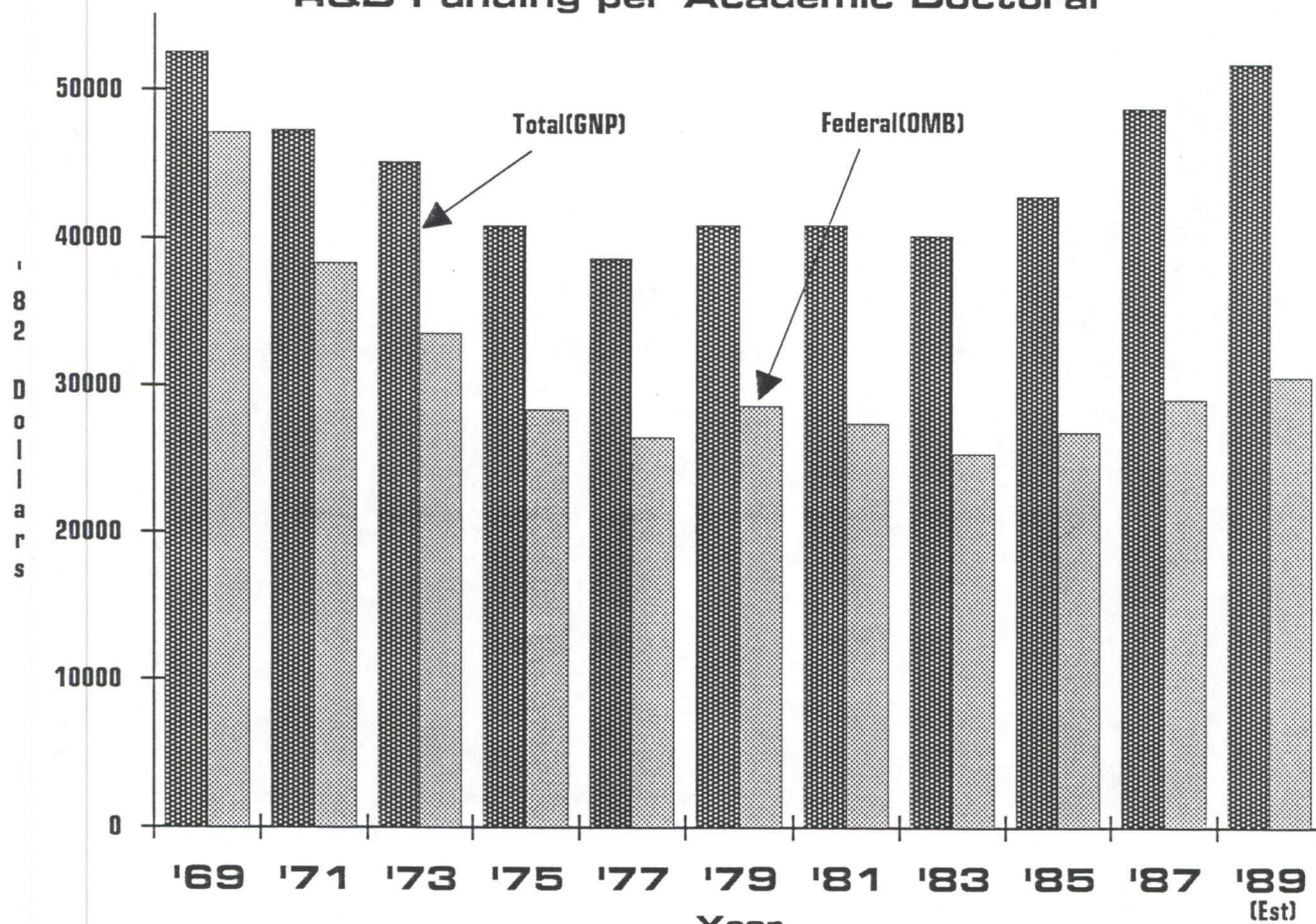


Figure 4

R&D Funding per Academic Doctoral



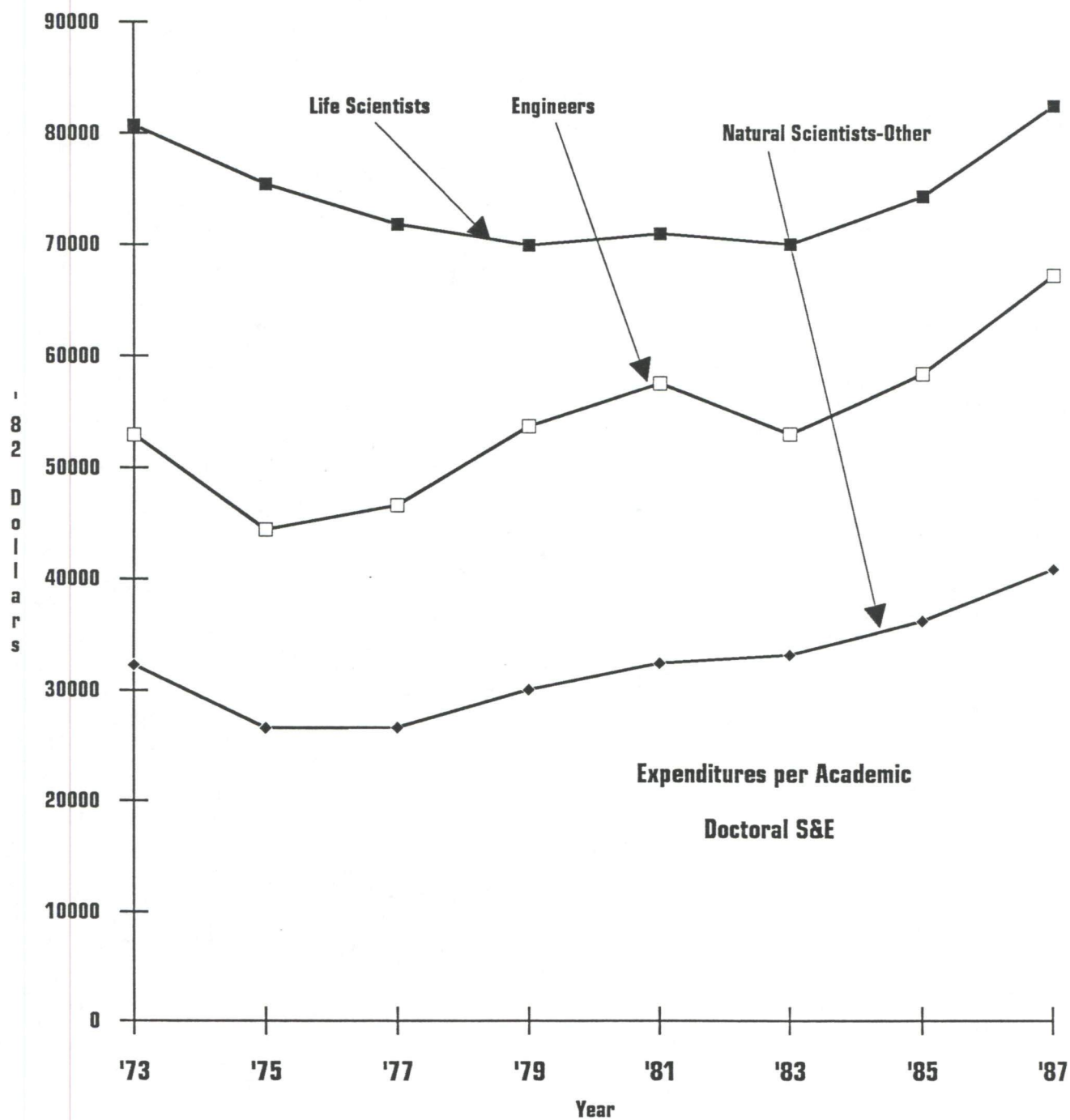


Figure 6

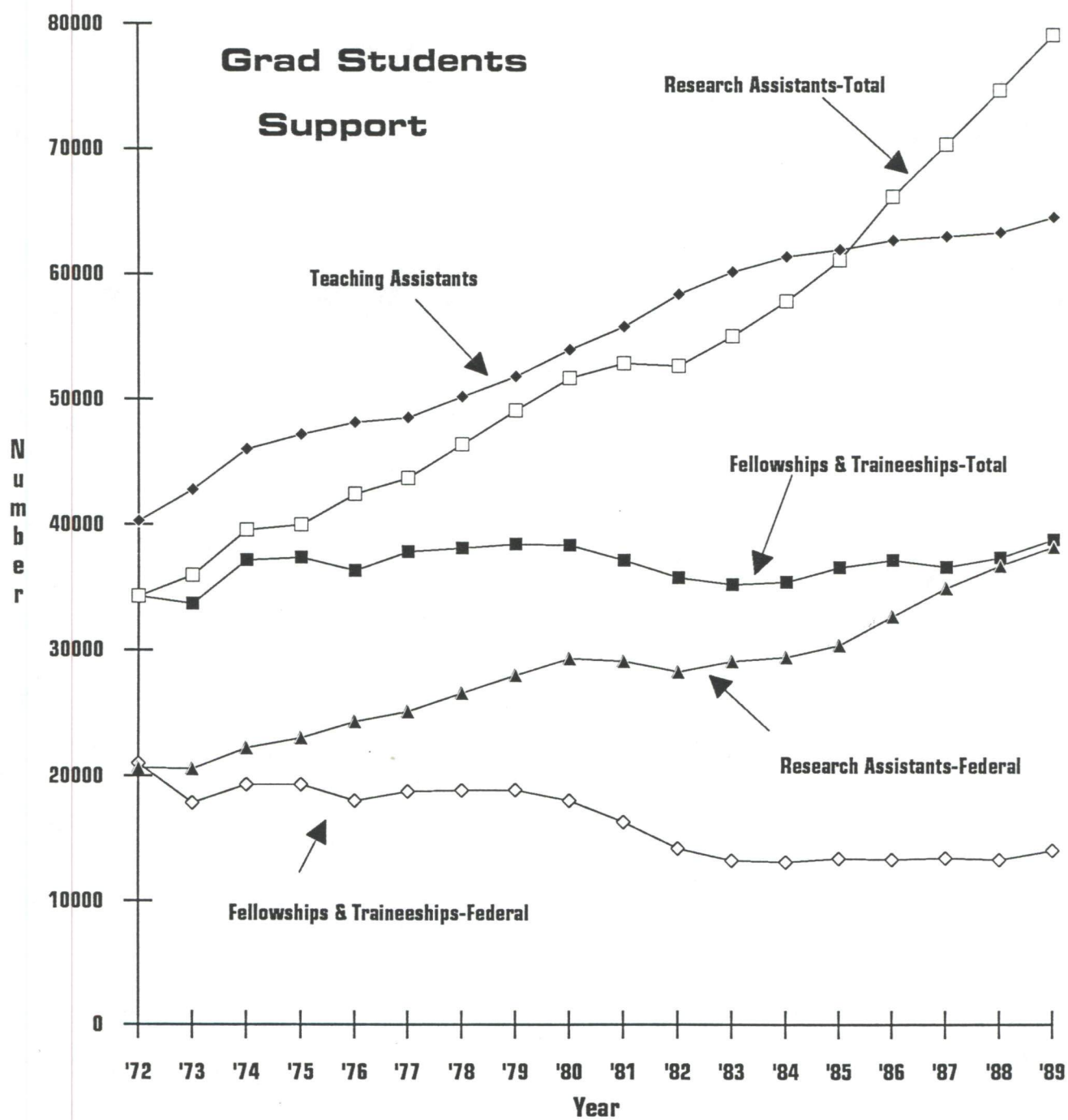


Figure 7

THE WHITE HOUSE
WASHINGTON

March 26, 1991

Dear Ro:

Many thanks for sending me the copy of your letter to **Physics Today** and of your talk to the NAS/NAE and the NSB at the Beckman Center.

With warmest best wishes,

Sincerely yours,

A handwritten signature in dark ink, appearing to read "D. Allan Bromley", with a long, sweeping horizontal line extending to the right.

D. Allan Bromley
Assistant to the President
for
Science and Technology

Professor Roland W. Schmitt
President
Rensselaer Polytechnic Institute
Troy, New York 12180-3590

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120355

FROM: FOUNDATIONS OF PHYSICS: COHEN, PARK, AND VAN DER MERWE

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 02/07/91

SUBJECT: REQUEST TO CONTRIBUTE A RESEARCH PAPER ON ONE OR
MORE SPECIAL ISSUES OF FOUNDATIONS OF PHYSICS.

~~Stal~~
Damar: This
should go to
DAB. I could not
do such a paper.
-Shir

ASSIGNED TO: D. Allan Bromley

ACTION REQUIRED: AS NECESSARY

SENDER'S DUE DATE: OSTP DUE DATE: 03/01/91

DATE COMPLETED: 3/5

COPIES TO:

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 02/11/91

FILE: PHYSICS

p-physical Sciences

Mary — 2/12
would you pls.
reassign this
item as per
KAE's note?
Thx. Sally

Document Originally
Attached to
Following Page

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120355

FROM: FOUNDATIONS OF PHYSICS: COHEN, PARK, AND VAN DER MERWE

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 02/07/91

SUBJECT: REQUEST TO CONTRIBUTE A RESEARCH PAPER ON ONE OR
MORE SPECIAL ISSUES OF FOUNDATIONS OF PHYSICS.

ASSIGNED TO: Dr. Wong

ACTION REQUIRED: AS NECESSARY

SENDER'S DUE DATE: OSTP DUE DATE: 03/01/91

DATE COMPLETED: -----

COPIES TO: D. Allan Bromley

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CONTACT PERSON:

REMARKS:

Only Dr Bromley can respond to this.
OK 2/12/91

DATE RECEIVED: 02/11/91

FILE: PHYSICS

FOUNDATIONS OF PHYSICS

An International Journal Devoted to the Conceptual Bases and Fundamental Theories of
Modern Physics, Biophysics, and Cosmology

Published by Plenum Publishing Corporation, 233 Spring Street, New York, N.Y. 10013-1578

Editor: **ALWYN VAN DER MERWE**
Department of Physics
University of Denver
Denver, Colorado 80208
United States of America

Tel: (303) 871-2021
Fax: (303) 871-2623
(303) 871-4000
(303) 773-6042

(speediest attention)

MARG-1

07 February 1991

Professor Allan Bromley
Science Advisor
The White House
Washington, D. C.

Dear Professor:

We are pleased to invite you to join a select group of scholars honoring Professor Henry Margenau by contributing an appropriate research paper, ca. 2,000 to 10,000 words in length, to one or more special issues of FOUNDATIONS OF PHYSICS which have been set aside during the first quarter of 1992 to mark his ninetieth birthday (on April 30, 1991).

The latest date for manuscript copy to reach our Denver office would be mid-October 1991. In view of the limited page budget of FOUNDATIONS OF PHYSICS, which has to be carefully apportioned among the contributors to the special issues, we should deeply appreciate if you would inform us, at the above address and as soon as possible, whether you are able to accept our invitation and what the topic and approximate length (in number of words) of your contribution would be.

We thank you in anticipation, if we may, for your kind cooperation.

Very cordially yours,

Leon Cohen
Leon Cohen /bg

James Park
James Park /bg

Alwyn van der Merwe
Alwyn van der Merwe /bg

vdM/bg

THE WHITE HOUSE
WASHINGTON

March 5, 1991

Gentlemen:

Many thanks for your note of February 7 in which you invite me to contribute an appropriate research paper to one or more special issues of your publication **Foundations of Physics** which have been set aside to mark the occasion of the 90th birthday of my old friend and colleague, Henry Margenau.

Much as I would be delighted to join you in this venture, because Henry has indeed been an old friend, I regret to say that since moving to Washington I have had absolutely no time whatsoever for personal research and therefore, am unable to comply with your invitation.

Many thanks for thinking of me in connection with this activity and every success in pulling a collection of papers worthy of Henry's contributions to physics and to philosophy.

With all best wishes,

Sincerely yours,

A handwritten signature in dark ink, appearing to read "D. Allan Bromley". The signature is fluid and cursive, with the first name "D. Allan" written in a more compact, stylized manner, and "Bromley" written in a more expansive, flowing script.

D. Allan Bromley
Assistant to the President
for
Science and Technology

Messrs Leon Cohen, James Park and Alwyn van der Merwe
Foundations of Physics
University of Physics
University of Denver
Denver, Colorado 80208

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120299

FROM: MERZBACHER, EUGEN

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/24/91

SUBJECT: AN UPDATE ON APS PHYSICS PLANNING COMMITTEE
ACTIVITIES

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 01/28/91

FILE: PHYSICS

p-Physical Sciences-

THE WHITE HOUSE
WASHINGTON

February 21, 1991

Dear Eugen:

Many thanks for your letter of January 24 which was delayed substantially in reaching me in which you tell me about the activities of the Physics Planning Committee and in particular, the meeting that you have planned for April 25. You and the physics community have shown real leadership in organizing to support Congressional action on the President's budgets and that support is very much appreciated here in addition to being, in my opinion, very productive in the appropriations process.

I would also thank you for the statements of the APS Council relating to the Manned Space Station and the SSC. It would be inappropriate for me to comment in any formal sense on these statements, but I appreciate having them as the considered view of a very distinguished group.

I hope that you will agree that in the 16% increase for basic sciences that we have requested in the NSF, and the 9% increase for investigator funded projects that has been requested in NIH, we have at least begun to respond to the well-documented plight of the individual and small group investigators throughout the community. I would have to add, as I am sure you would agree, that there is no realistic possibility of our being able to respond to Leon Lederman's demand for a more or less immediate doubling of our investment in the support of science and technology, although I am happy to be able to report to you that there is a wide spread impression, both within the Administration and within the Congress, that we as a nation are still under investing seriously in that area. Our 1992 budget reflects the President's deep commitment both to education and research and development and I have every reason to anticipate that that support will remain strong throughout the Bush Administration.

It was good to hear from you and I shall look forward to seeing you at the APS banquet on Tuesday, April 23 if not before.

With all best wishes,

Sincerely yours,

A handwritten signature in dark ink, appearing to read 'D. Allan Bromley', with a stylized flourish at the end.

D. Allan Bromley
Assistant to the President
for
Science and Technology

Dr. Eugen Merzbacher
Chairman
APS Committee on Physics Planning
Department of Physics and Astronomy
The University of North Carolina
Chapel Hill, North Carolina 27514



THE UNIVERSITY OF NORTH CAROLINA
AT
CHAPEL HILL

Department of
Physics and Astronomy

24 January 1991

RECEIVED
91 JAN 28 P12:43

The University of North Carolina at Chapel Hill
Phillips Hall 039 A
Chapel Hill, N.C. 27514

OFFICE OF THE
DIRECTOR

Dr. D. Allan Bromley
Assistant to the President for Science and Technology
The White House
Washington, DC 20506

Dear Allan:

I thought that you might be interested in seeing the final wording of two statements which the APS Council approved at its meeting in San Antonio last Sunday. The extended Council debate was exceptionally supportive and constructive, and both resolutions passed eventually with almost no dissent.

As you know, the APS Council issues policy statements like this only sparingly and only after careful consideration by several committees. The statement on Physics Funding and the SSC also benefitted from the conversation you and Tina Kaarsberg had a few days ago. We were careful to avoid the untenable claim that science funding had declined in "real terms", whatever that phrase may be interpreted to mean. Nor is it helpful to build our case on the mere numerical growth of the science community.

What is undeniable is that, for a variety of reasons, "broadly based physics research" has suffered from neglect in recent years. At the Council, there was heartening unanimity - from the representatives of high energy physics and astrophysics to condensed matter physics - that physics done with large facilities cannot be sustained without the strong base underneath, especially as it is cultivated in universities. We were pleased to hear that your office has made considerable efforts to redress the balance by giving greater emphasis in the President's 1992 budget to the support of individual research projects. We all hope that this policy will prevail.

The Physics Planning Committee continues its efforts to make the case for a strong national science program. As you have often reminded us, we must make ourselves heard, without appearing to be "whining". The enclosed brief report on what went on at the Council meeting gives you an update on PPC activities. We very much look forward to seeing you at the APS banquet on Tuesday, 23 April.

With best wishes,

Sincerely,

Eugen Merzbacher
Kenan Professor of Physics
Chair, APS Committee on Physics Planning

cc: N. Bloembergen, H. Ehrenreich, T. M. Kaarsberg, R. L. Park,
N. R. Werthamer

TO: APS Physics Planning Committee

FROM: Eugen Merzbacher

DATE: 24 January 1991

SUBJECT: Report on Council Meeting

On 20 January, the APS Council approved the attached statements on the Space Station and on the SSC in relation to funding for broadly based research. The Council debate was constructive and sympathetic to the position presented by the PPC. The SSC funding statement was improved by several revisions made during the meeting. Both statements now are official APS policy. They will be widely distributed.

The report on the 1990 Survey of Young Physics Faculty, entitled "Their Most Productive Years", will be published in the February issue of PHYSICS TODAY under the authorship of Czujko, Kleppner, and Rice, and with a PPC byline. Tina Kaarsberg will mail a copy of the final report to all PPC members. Additional copies are available on request from the Washington office.

Preparations for "Congressional Day" on Thursday, 25 April, in Washington, are moving forward. Tina Kaarsberg and Mike Lubell (CCNY) are taking the lead in making the arrangements. The APS President will send a letter to all subunits of the Society, urging them to dispatch at least one distinguished physicist as representative to a reception that will be hosted late Thursday afternoon by Rep. George Brown, the new chair of the House Committee on Science, Space, and Technology. There has also been a suggestion that a few interesting physics exhibits be put on display at this reception, but this requires some volunteer work for which no obvious candidate has yet emerged. Suggestions are welcome.

A "pep rally" for Congressional Day will take place from 5 to 6, immediately after the Unity Day session at the Spring meeting on Tuesday, 23 April, and just before the APS reception and banquet.

Andy Sessler has, correctly, reminded the PPC that it must not rest on its laurels and should think ahead to initiate new projects in the pursuit of its charge from Council. This will certainly be a high-priority agenda item at the next PPC meeting on **Friday, 26 April**, in Washington. Please mark your calendar, and consider coming to the reception on Capitol Hill on Thursday afternoon.

AMERICAN PHYSICAL SOCIETY COUNCIL STATEMENT ON THE MANNED SPACE STATION

20 January 1991

The Council of the American Physical Society is concerned that there remains widespread public and governmental misunderstanding of the justification for the Manned Space Station. After a review of the experimental program proposed for the Space Station, the Council is issuing the following Statement:

"It is the view of the Council of the American Physical Society that scientific justification is lacking for a permanently manned space station in earth orbit. We are concerned that the potential contributions of a manned space station to the physical sciences have been greatly overstated and that many of the scientific objectives currently planned for the space station could be accomplished more effectively and at a much lower cost on earth, on unmanned robotic platforms, or on the shuttle.

The United States needs a vigorous space science program, but such a program can be implemented for the foreseeable future without the proposed manned space station."

(This statement is an edited version of a statement which was drafted and approved by the APS Panel on Public Affairs. It was also reviewed and endorsed by the APS Physics Planning Committee.)

AMERICAN PHYSICAL SOCIETY COUNCIL STATEMENT ON PHYSICS FUNDING AND THE SSC

20 January 1991

"To assure that the United States can educate an adequate supply of professional scientists and to provide the scientific underpinnings for a sound technological foundation, it is imperative that scientific research be broadly based. The rising cost of front-line scientific research and the creation of promising new fields of physics has, during the last decade, rendered inadequate the support for broadly based physics research. Reversing this trend and strengthening the support for individual investigators must have the highest priority; it is essential to the scientific and technological future of the nation.

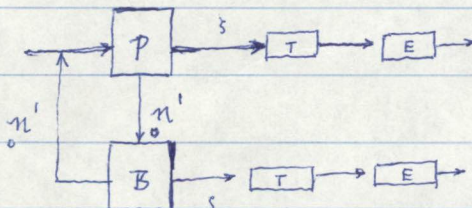
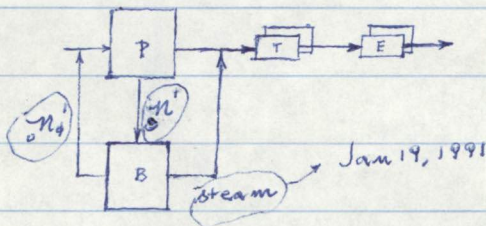
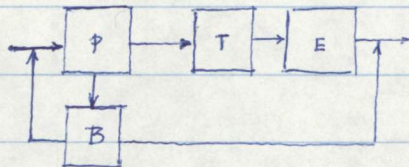
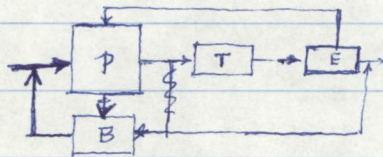
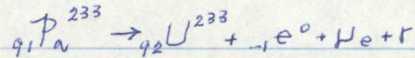
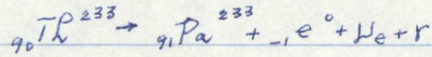
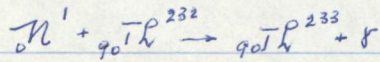
A vigorous research program is comprised of both a broad base and major research facilities, like the Superconducting Super Collider (SSC). The SSC will probe fundamental questions about the nature of matter and allow the US to remain at the forefront of elementary particle physics. The SSC should be built in a timely fashion, but the funding required to achieve this goal must not be at the expense of the broadly based scientific research program of the U. S."

(This statement is a revised version of a draft which was proposed by the APS Physics Planning Committee and reviewed and approved by the APS Panel on Public Affairs. The Statement was approved by Council with one opposing vote and one abstention.)

To

Science advisor,
The White House
Washington D.C. 20500

Breeder reactor



power reactor and breeder
reactor configuration.

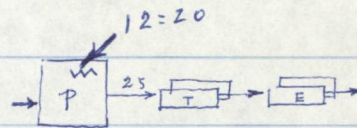
Dear Sir; Breeder reactor,
(Ref. H.E. White, Modern college physics)
Can extend uranium ore reserves by using
from 60 to 90% of the metal. This compared
with the 1% realized without the
breeder facility is a tremendous
saving; Could also be a solution to
Indian Point 2, reported by The west
side spirit. Through Jan 15, 1991. Configu-
ration of thoughts regarding breeder
facility is shown bottom of the page.
Thought it worth noting by your office.

Enclosure;
pg 1, pg 4, pg 20

Sincerely yours,
Tsang-Chih Huang, Terry

The west side spirit. TSANG C. HUANG alias JERRY
HUANG, PH.D., U.S. CITIZEN
PRESIDENT, COMPUTING DIALOGUE INC.
P.O. BOX 924
NEW YORK, N.Y. 10009-0924

JAN. 17, 1991



2:16, Jan. 19, 1991

DIRECTOR
OFFICE OF THE

91 JAN 24 AIO: 09

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TO: DIRECTOR, FBI
FROM: SAC, NEW YORK
SUBJECT: [Illegible]
[Illegible text block containing several lines of typed information, possibly a memorandum or report header.]

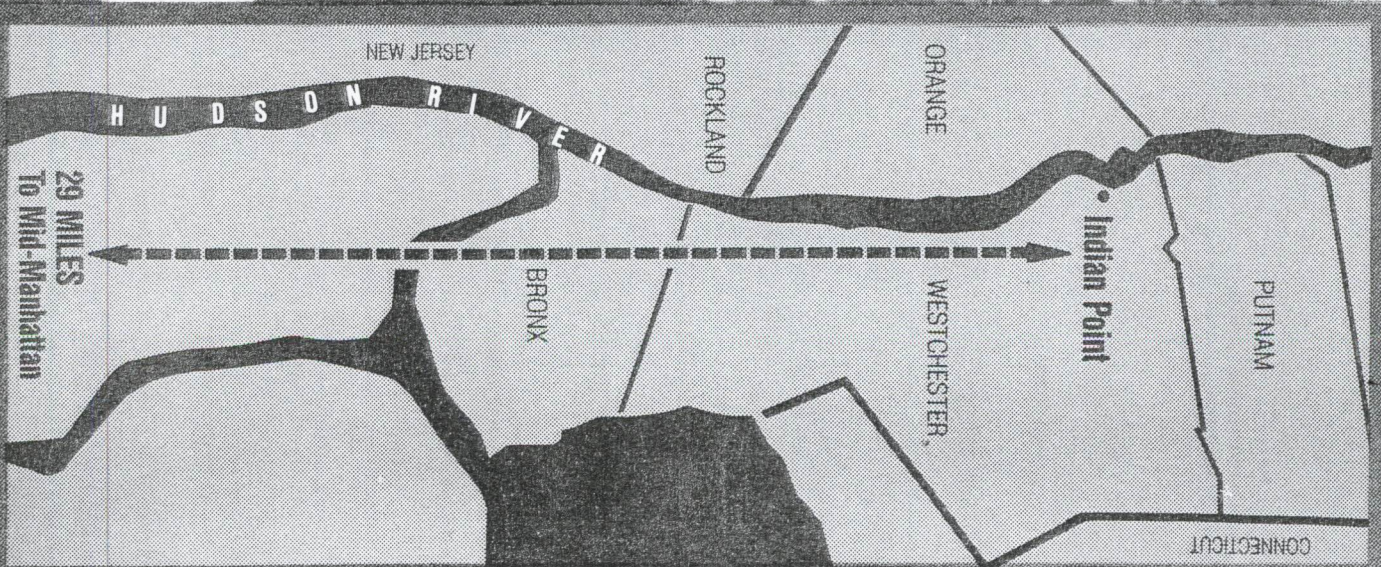
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CHERNOBYL ON THE HUDSON?

Indian Point:
Recent Discovery Of Major Flaws—
How Serious The Hazard?

By Janet Wickenhaver and Noelle Veale, P. 4



COVER STORY

Black Rain On Manhattan?

**By Janet Wickenhaver
And Noelle Veale**

Indian Point nuclear power plant in Buchanan, New York, is 24 miles up the Hudson from Manhattan—less than 30 miles from Times Square.

It is the closest nuclear facility to a major metropolitan area in the country. To put it another way, 10 percent of the nation's population live within 60 miles of Indian Point. Manhattan is downriver and, especially in winter, say climatologists, downwind. The Nuclear Regulatory Commission acknowledges that its proximity to heavily populated New York City makes Indian Point the most hazardous site in the country in the event of a radiation release.

Four years ago, the NRC concluded that such an event was unlikely. That was just before Chernobyl, before serious nuclear plant accidents were thinkable.

Now, there is new evidence that some of the equipment at Indian Point has become worn with age, or that some safety machinery was built with substandard parts.

Cracks And Counterfeit

Cracks inside the four 65-foot steam generators at Indian Point 2 are the severest the NRC has seen and have worsened since their discovery in 1987, although Consolidated Edison, the plant's owner, recently patched them up to meet NRC standards. For now.

And a Congressional report released in November revealed that Indian Point (along

with two-thirds of the nation's nuclear power plants) installed counterfeit, fraudulently produced and substandard parts. "Non-conforming parts can fail and result in death or injury to the public and workers," read the General Accounting Office report. The GAO also took the NRC to task for "deferring its regulatory res-

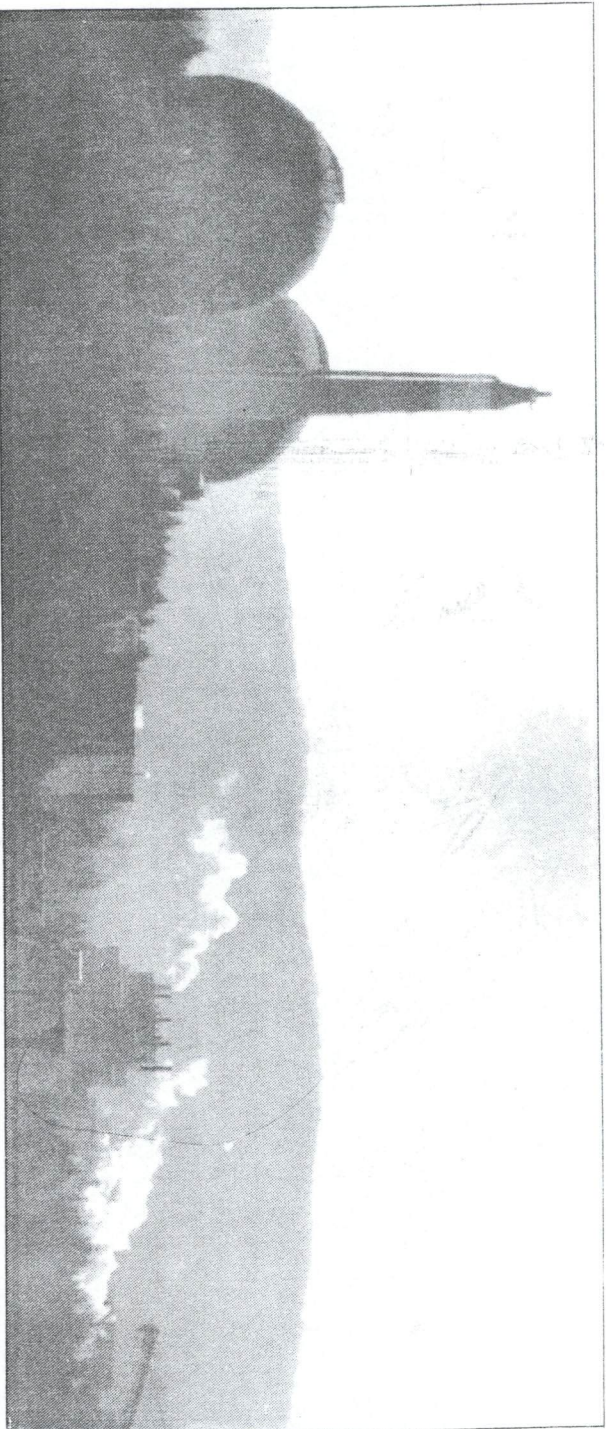
on counterfeit parts in nuclear power plants at presstime, although they said that the issue of substandard parts in plants was about two years old. That is small comfort to area residents. As for what will be done to ensure that the parts are either up to code or removed, Glenn Meyer, reactor project manager for Indian Point 3, said, "For parts that are installed, they will be evaluated part by part."

Accidental Odds

The NRC itself said in 1985 that there is

Point will be the site of this serious accident, a major problem at Indian Point would have worse consequences than one at any other nuclear site in the country.

In a study commissioned by the NRC and conducted by Sandia National Laboratories, the "Calculation of Reactor Accident Consequences," the estimated casualties for Indian Point were 56,600 early deaths, 227,000 injuries, 15,600 cancer deaths and at least \$314 billion in property damage. Because of the price of real estate around New York,



Indian Point nuclear reactors supply New York City with 15-20 percent of its electricity.

possibility." The reactors at Indian Point were found to have counterfeit and substandard fasteners (nuts, bolts, etc.) and fuses.

The NRC's project managers for Indian Points 2 and 3 had not read the GAO report

a 45 percent chance of a major nuclear accident in the next 20 years at one of the country's 113 plants. Although the fact that this disturbing prognosis was made does not in itself make it any more likely that Indian

the figure for property damage is the highest in the country. The same study said that the injury radius for Indian Point was estimated at 50 miles.

continued on page 20

Chernobyl on the Hudson?

continued from page 4

"There is no question that a major accident at Indian Point can have a major impact beyond the 10-mile emergency safety zone around the plant," said Robert Pollard, a nuclear safety engineer with the Union of Concerned Scientists. Once a safety inspector for the NRC at Indian Point, Pollard resigned in 1976. "I considered it would be a matter of luck if at some point Indian Point didn't have a major accident," he said. "I feel that way even more strongly now."

Planning For Disaster

While working with the NRC, Pollard was assigned to review the plant design of all three Indian Point facilities. He contributed to the decision not to allow Indian Point 1 to operate anymore. When he resigned from the NRC in 1976, he used Indian Point as an example of his growing feeling that the NRC was more concerned about the nuclear industry's health than the public's. "We were going to license the plant knowing there were no workable emergency plans," he said. "They still have no workable emergency plans."

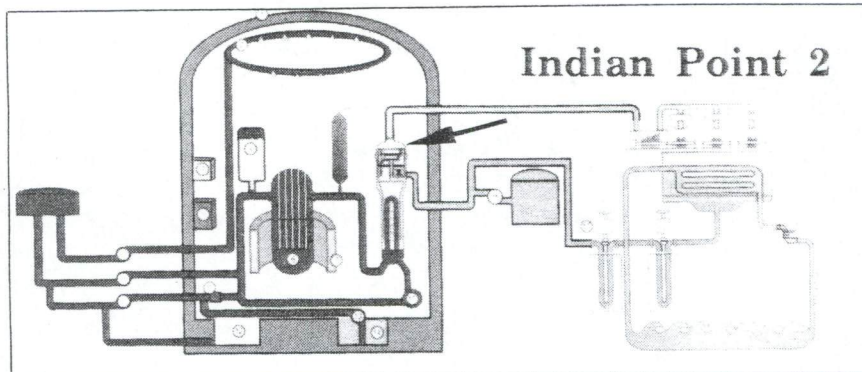
The accident (meltdown) at Three Mile Island in 1979 changed some of the official ideas about the importance and desired range of evacuation plans. The Kenemy Report issued in the wake of Three Mile Island suggested that each plant should have an evacuation plan for a 10-mile rather than two-mile radius. The lack of such a plan for Indian Point became the focus of a protracted legal battle in the mid-'80s.

A coalition of citizens and anti-nuclear groups from all along the Hudson, as well as New York City Councilmembers led by Ruth Messinger, challenged the workability of Indian Point's evacuation plan, eventually losing. In a close three-to-two vote, the NRC extended Indian Point's license and gave it another chance to meet evacuation requirements. "Had Chernobyl already occurred we would have had a better case," said Joan Holt, who led the New York Public Interest Research Group's anti-nuclear efforts.

Opponents sounded the alarm again last summer when Con Ed applied for and received permission from the NRC to increase its power output by 12.9 percent, from 873 to about 986 megawatts, to meet increased electricity needs in the Summer.

Critics of the plant, like Pollard and others, say that increasing the power level reduces the safety margin in the event of an accident. The increase was delayed, however, when the cracks in the steam generators were discovered last February.

Those cracks are the most alarming problem at Indian Point, according to Pollard, in part because no one is entirely sure what caused them. The cost to Con Edison of replacing the steam generators could be upwards of \$122 million. The replacements have already been bought and are being



Cracks in Indian Point 2's steam generator are the worst the NRC has seen.

stored on site.

A spokeswoman for Con Edison responded tersely that the utility company was not replacing the steam generators because "we don't need to replace them," and explained that the "cracking and pitting" had been repaired by welding and grinding. "Replacement won't be necessary," said spokeswoman Bea Meltzer, "until 1993." According to her, the cracking and pitting on the generators is caused by "water chemistry and thermal pressure," caused by repeated heating and cooling.

Pollard questioned the logic of why, if the generators needed replacing in three years, they didn't need replacing now.

Escape From Manhattan?

Although the NRC only requires an evacuation plan for the 280,000 Westchester residents living within a 10-mile radius of the plant, many experts say, depending on the severity of the accident, it is possible that Manhattanites, too, would require evacuation. "Just the thought of evacuating

Manhattan boggles the mind," said Pollard.

In the post-Chernobyl world, another thought boggles the minds of scientists. Even if immediate evacuation were not necessary, how would the soil and water for many miles around be decontaminated? Also, radioactive particles hang in the atmosphere, descending only in the rain, which would fall on Manhattan and environs.

That there would be longer-term consequences of an accident for New York City was documented in a report by Dr. Leonard Solon, the City Health Department's director of radiation control. The instances of thyroid cancer in the event of a meltdown would be approximately 17,000, 25 to 50 miles away, Solon wrote. He also said that

an accident could have "devastating consequences" for New York City.

History Of Glitches

Indian Point 2, which is owned by Con Ed, and Unit 3, which is owned by the New York Power Authority, have had their share of glitches in the past. There have been any number of "minor" incidents/accidents there in the past year, including operators who were fined for falling asleep on the job (or "resting their eyes"), and a recent mishap when a fuel rod was dropped ten feet during a routine refueling procedure at Unit 3 last October. Although this accident posed no danger to the public, according to New York Power Authority and nuclear critics as well, it should not have happened. The plant just resumed full operation on the Sunday before Christmas in the aftermath of that incident.

"They seem to be getting sloppy," said Barbara Hickernell of the Alliance to Close Indian Point. "That's the thing with nuclear power plants. There's no margin for error."

January 15, 1991

COVER STORY

1 the Hudson?

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"Another little wrinkle," said Karl Grossman, a Long Island investigative reporter who has written two books on Shoreham, "is that all the nuclear waste is stored at Indian Point in pools covered with corrugated metal." The plant has not been able to find suitable dumping grounds for the waste. "If you had an accident, you'd be leaving thousands of pounds of high level waste."

The worst nuclear accident case scenario, said Grossman is not a core meltdown, such as that at Three Mile Island, but what is called a "nuclear runaway," a steam explosion, such as that at Chernobyl. "If you had a steam explosion, you'd have no time to evacuate," said Grossman.

The Aging Issue

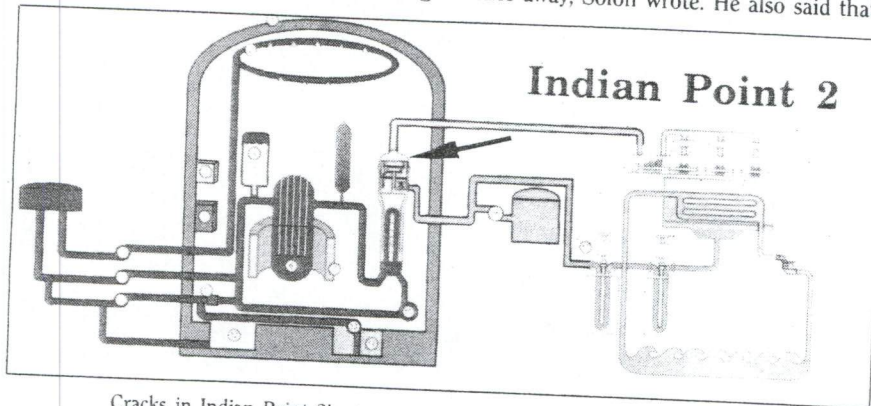
Since there has been no new nuclear construction in the U.S. in recent years, the issue of aging plants is coming to the fore. Two years ago, NRC Commissioner Kenneth C. Rogers said that the aging of nuclear power plants is one of the most important issues facing the nuclear industry. Indian Point 2 has been running since 1974; Indian Point 3, since 1976. According to scientists, there is not a lot of information about how materials used in the construction of nuclear power plants withstand aging, particularly under the extreme thermal and radioactive conditions in which they operate.

"When they first opened nuclear power plants, the NRC said that in 10 years, plants would become old," said Anna Mayo, who covered the nuclear beat for the *Village Voice*. "But they realized that it would be prohibitively expensive to close them down after 10 years, so they kept pushing it back."

The anti-nuclear forces and groups seem to have lost heart and momentum since their defeat in the mid-'80s, and "No Nukes" is a cry seldom heard anymore. They know that without an effort on the part of Governor Cuomo on the order of his fight against Shoreham nuclear power plant in Long Island, they cannot win. According to Cuomo's office, his reasons for opposing Shoreham, which were that Long Island cannot be evacuated, do not apply to Indian Point.

NYPIRG's Holt, who has since moved out of the area for the most part, said that nothing short of a massive civil disobedience movement would work.

There is little evidence of that.



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THE WHITE HOUSE
WASHINGTON

July 31, 1991

Dear Jean-Pierre:

Many thanks for sending me a copy of your invited talk as given at the 7th Adriatic International Conference on Nuclear Physics. This is an excellent overview of the field and demonstrates very clearly that you and your colleagues are playing an ever more important role in this particular part of modern nuclear physics. I was delighted to get the overview because, as you I am sure will appreciate these days, I only have time to read a few papers in each issue of **Physical Review Letters** and to glance through **Physical Review C** so that I have frequently the feeling that I am completely losing touch with my professional roots. A beautifully prepared overview of this sort allows me to catch up in one part of the field in almost painless fashion and I am much indebted to you for it.

As I have told President Laustriat and Professor Gallmann, it is my intent to be in Strasbourg for the honorary degree celebrations on December 6th. I would expect to arrive sometime on December 5th and probably leave on December 7th or on the 8th at the latest. It will be a great pleasure for me to have the opportunity to see you and Jacqueline again and I very much look forward to it.

In the meantime, again my thanks for the report, and with all best wishes for every success and happiness,

Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

Professor J. P. Coffin
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France

Liquid-Vapor phase transition, collective flow and
entropy determination from future measurements
of intermediate mass fragments

J.P. COFFIN

*Centre de Recherches Nucléaires, IN2P3-CNRS/Université Louis Pasteur
B.P. 20, F-67037 STRASBOURG CEDEX, France*

*Invited talk given at the
7th Adriatic International Conference on Nuclear Physics
HEAVY-ION PHYSICS - TODAY AND TOMORROW
Islands of Brioni, May 27 - June 1, 1991*



**CENTRE DE RECHERCHES NUCLEAIRES
STRASBOURG**

LIQUID-VAPOR PHASE TRANSITION, COLLECTIVE FLOW AND ENTROPY DETERMINATION FROM FUTURE MEASUREMENTS OF INTERMEDIATE MASS FRAGMENTS.

J.P. COFFIN

*Centre de Recherches Nucléaires, IN2P3-CNRS/Université Louis Pasteur
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Some global variables reflecting the highly collective character of nuclear matter produced in relativistic heavy-ion collisions are briefly reviewed on the basis of presently available experimental results and of Quantum Statistical Model and Quantum Molecular Dynamic Model predictions relative to intermediate mass fragments. Possible future measurements are suggested.

1. INTRODUCTION :

The first predictions for strong collective phenomena in hot and compressed nuclear matter, produced in violent relativistic heavy-ion collisions, have been made more than two decades ago. Since, developments¹⁾ along this line, supported and suggested by results from an intense experimental activity^{1,2)} over the past fifteen years, have not ceased. It is now time for a critical and detailed evaluation in order to determine the route to follow for future studies. This is, of course, far beyond the claim of the present contribution which is simply aimed to review rapidly some major discoveries and their implication and to sketch a few experiments to perform on new facilities like the 4π -detector at SIS (Darmstadt).

Within the $0.1 \lesssim E \lesssim 2$ A GeV projectile energy domain, (so far essentially studied at the GSI-LBL Plastic Ball/Wall, at Diogenes (Saclay) and MSU), it is a frequent approach to assume that, due to the high projectile velocity (20 to 30% of the light velocity), for central collisions a wave-like shock can propagate in the nuclear medium. This leads to a locally strongly compressed and excited nuclear matter which decays by multifragmentation, i.e. by a copious emission of light particles (LP) and intermediate mass fragments (IMF). The study of multifragmentation has permitted i) to demonstrate the existence of a strong nuclear stopping of nuclear matter,

ii) to show an important collective flow of nuclear matter in and out of the reaction plane, iii) to raise the question of the possible existence of a liquid-vapor phase transition, iv) to approach a determination of the Entropy. This allows some steps to be made toward the Equation of State (EoS) determination. Moreover, as shown by the Quantum Statistical Model (QSM)^{3,4)} and by the Quantum Molecular Dynamic Model (QMD)^{5,6)} calculations, IMF are formed at the early post-compression stage of the reaction and so provide a good probe for studying it.

In the light of recent results, we examine rapidly some aspects of a conjectural liquid-vapor phase transition, of the collective flow and of Entropy and their dependence on EoS. Some suggestions for future measurements are tempted.

2. MULTIFRAGMENTATION AND LIQUID-VAPOR PHASE TRANSITION :

The multifragmentation is a complex phenomenon whose the nature is not yet completely understood by far. It may result from various effects because it is difficult to determine a time scale for the IMF emission : It is not easy to distinguish between prompt and other emissions. It may also be from different origins depending on the projectile energy and on the impact parameter (b). However, multifragmentation has been frequently related to a possible liquid-vapor phase transition⁷⁾, i.e. for certain combinations of temperature and density, nuclear matter may exist as a liquid-gas mixture exhibiting phase instabilities. A schematic explanation which has been advanced⁸⁾ for such an effect is that a nuclear system, strongly compressed and excited, evolves nearly isentropically in the pressure-density space of EoS toward a low density region (the so-called spinodal zone) mechanically unstable. Any fluctuation, magnified by the nuclear mean field, may provoke the explosion of the system; other approaches relying upon statistical multifragmentation models⁹⁾ or sequential binary decay¹⁰⁾ have also been advanced. This thermodynamical description was suggested by the fact that the IMF yields, measured experimentally, show a mass (A_{IMF}) or an atomic number (Z_{IMF}) power law dependence $Y_{\text{IMF}} = (A_{\text{IMF}}, Z_{\text{IMF}})^{-\tau}$, the exponent τ is found^{11,12)} to be ranging between 1.5 and 3 depending on the reaction and on the projectile energy. These inclusive A_{IMF} or Z_{IMF} distributions seem to be a universal characteristic of the fragmentation process, suggesting a common mechanism for the

fragment production. Fig. 1 shows a recent example of Z_{IMF} distribution measured at the SIS 4 π -Facility, for the Au (100 A MeV) + Au reaction¹³⁾ with the *Parabola*¹⁴⁾ over the 7°-30° polar-angle range. One sees that the distribution extends to $Z_{\text{IMF}} \sim 13$ (i.e. $A_{\text{IMF}} \sim 30$) and evolves as a power law (solid curve in Fig. 1) for which $\tau = 2.4$. Comparable behaviour is predicted by QMD calculations^{5,6)}, however, they also show that the IMF yield distributions exhibit different shapes and slopes depending on the impact parameter (see Fig. 2). Hence, it would seem that this power dependence is simply accidental as the result of averaging impact parameters and cannot subsequently interpret a phase transition. Exclusive measurements¹²⁾, where the charged particle multiplicity (M_c) is used to express the b influence, have confirmed the IMF yield dependence on b . This common way to describe the centrality of the reaction is, however, questionable being not selective enough as recently shown for the Au + Au reaction measured at SIS¹³⁾.

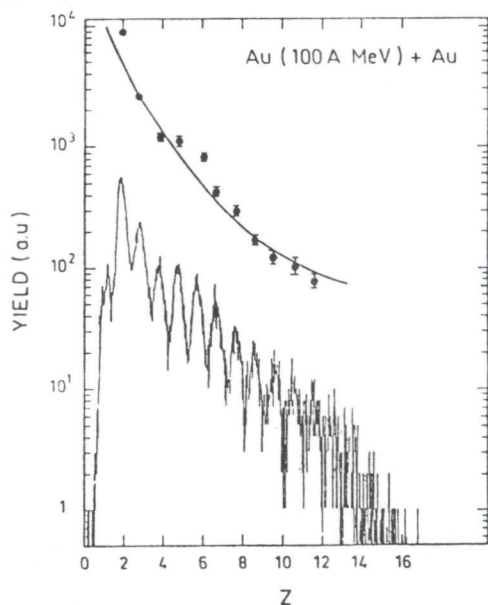


Fig. 1

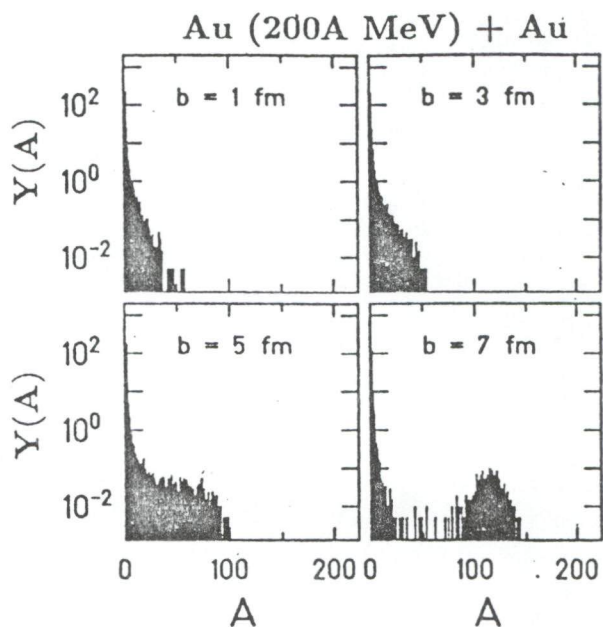


Fig. 2

Thus, in the future one should study the Liquid-Vapor phase transition by finding an additional trigger which allows the selection of very central collisions in order to deal with large stopping power, full disintegration of the projectile and of the target and similar rapidity for all the IMF. This triggering aspect will be discussed again in the next Section concerning the

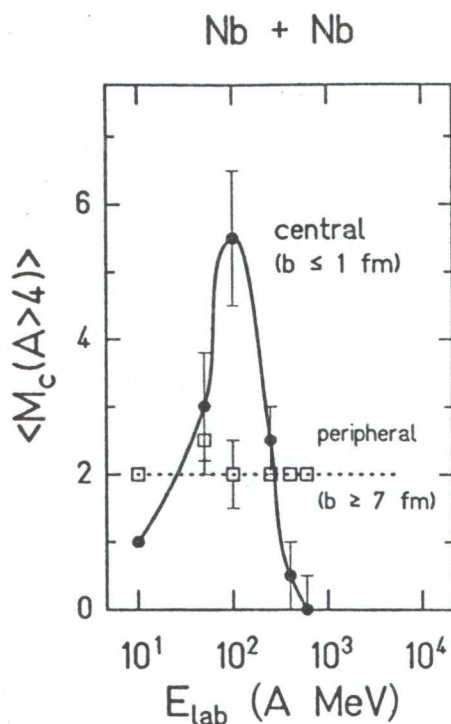


Fig. 3

effects result from momentum dependent interactions and reduced in-medium nucleon-nucleon scattering cross-section due to Pauli blocking. They lead to the formation of heavier mass IMF, hence an accurate measurement of the IMF mass distribution could help to establish experimentally the in-medium cross-section. The slope of $Y_{IMF} = (A_{IMF}, Z_{IMF})^{-\tau}$ increases with the bombarding energy and can be related to the Entropy^{6, 11)}. Finally, let us notice that the IMF yield is not very dependent on the EoS according to QMD and does not provide a relevant way to determine it.

3. THE DIRECTED FLOW OF NUCLEAR MATTER :

The directed flow is one of the most spectacular effect of collectivity of nuclear matter. It is also a proof for strong compression energy in relativistic Heavy-Ion collisions. Long time predicted by early hydrodynamical calculations¹⁵⁾, it has been confirmed by experiments. Based on the sphericity tensor¹⁶⁾ then on the transverse momentum¹⁷⁾ analyses, the flow has been observed in and out of the reaction plane (the so-called side-splash¹⁸⁾ and squeeze-out¹⁹⁾ effects, respectively). Great theoretical efforts have been made to study numerous aspects of this phenomenon. One can summarize⁶⁾ the main predictions as follows : i) the flow increases with

directed flow. The phase transition should also be examined by utilizing very heavy projectiles and should be measured over the 80-600 A MeV projectile energy range. According to QMD predictions⁶⁾ the IMF multiplicity, like in the case of Nb + Nb, should increase from 80 to about 100 A MeV and then should decrease to vanish around 600 A MeV (Fig. 3). So far, such an excitation function has not been really measured and this will hopefully be done soon at SIS. Let us notice also that, according to QMD, the extension and the slope of the $Y_{IMF} = (A_{IMF}, Z_{IMF})^{-\tau}$ can provide some information about the in-medium effects and the Entropy of the system⁶⁾. The most important in-medium

the mass of the system, with the mass of the LP and of the IMF (at least up to $A_{\text{IMF}} \approx 20$, the flow disappears for fragments with mass-like projectile and target) and as b diminishes. ii) The flow increases with projectile energy and may change its sign around 75 A MeV^{20,21)}.

Several of these predictions have been confirmed by experiments which have even some times preceded the theoretical speculations, like for the case of the low-energy-flow characteristics. However, due to the immensity of the field of investigation, the experimental results remain fragmentary. They are, to a large extent, for the Au + Au reaction at 200 A MeV and are mostly relative to LP, IMF data being only fragmentary.

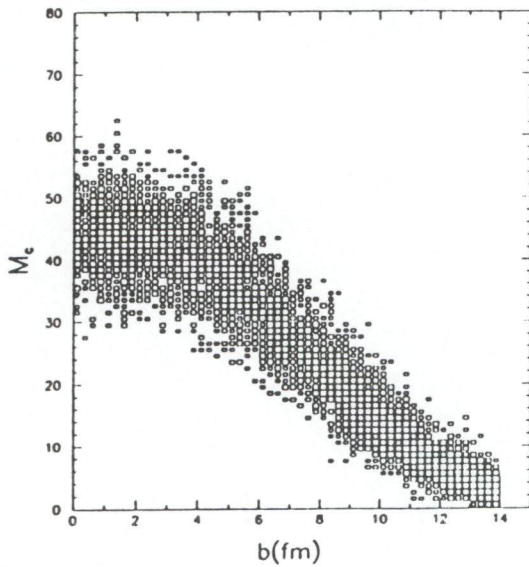


Fig. 4

It is important to analyze in detail the IMF contribution to the flow in very central collisions. This raises again the question of relevant triggers for strong centrality already mentioned in the previous Section. In Fig. 4 is presented the charged-particle multiplicity M_c (over the $7^\circ \leq \Theta \leq 30^\circ$ polar angle domain) against b for the Au (150 A MeV) + Au reaction¹³⁾ calculated with the filtered QMD using event by event technique²²⁾. One clearly sees that even for multiplicity $M_c \geq 45$,

such a trigger is not very determinant in terms of b (there, $b \lesssim 4$ fm), i.e. central and semi-central collisions are involved. More selective triggers are needed and a step in this direction has been made by constraining the sum $R = |\Sigma \vec{p}_t|$ of transverse momentum over all the particles with rapidity $Y > Y_{\text{cm}}$ (in the considered angular Θ domain) to be low since centrality implies close isotropy for the particles. The transverse momenta p_t / mc plotted against Y / Y_p (where Y_p is the projectile rapidity) for $M_c > 37$ (MUL 5)²³⁾ and for $Z_{\text{IMF}} = 4$, as measured for the Au (150 A MeV) + Au reaction¹³⁾, is shown in Fig. 5 (left hand side). The bulk of IMF is located close to Y_p showing that IMF, related to projectile spectator, participate. A shift toward lower rapidity is obvious when the condition $R \lesssim 2.5$ GeV/c is superimposed (right hand side of Fig. 5). Notice

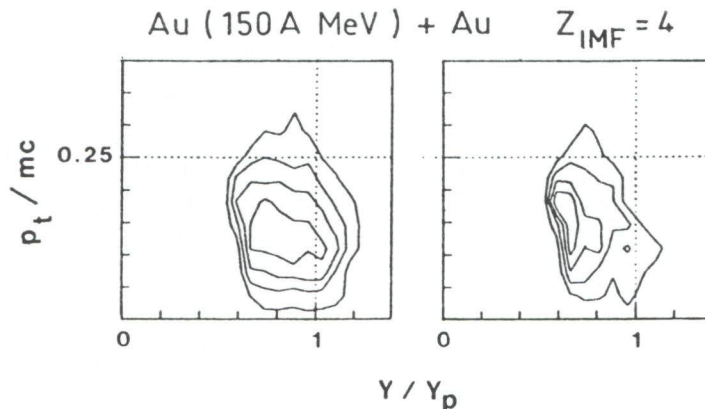


Fig. 5

also that, due to the fact that the data from the *Parabola* of the 4π -Facility^{13,14)} are not included here, there is an experimental cut-off on the low Y side, particularly visible in the right hand side of Fig. 5.

Recent calculations²⁴⁾ have shown that **LP** and **IMF** from the low density part of the interacting nuclear system (spectator matter) contribute the most to the in-plane flow, a conclusion supported by recent data¹¹⁾. On the contrary, the out-of-plane flow is dominated by hot participant matter and increases linearly with the mass. Thus, the squeeze-out which allows a direct insight into the hot compression region should be studied in close detail. Coming back to the in-plane flow conclusion, it is largely due to the fact that heavy **IMF** with low Y have appreciable cross-section only at very low b which do not contribute much to the cross-section. However, it is of interest once again to elaborate in the future a relevant trigger to select high centrality to look at the actual involvement of compressed matter in the in-plane directed flow.

Finally, it is important to keep in mind that the **QMD** predictions about flow are different for a hard and a soft **EoS** since the flow depends on the nucleon-nucleon cross-section and on the compression parameter. Thus, its study should contribute to a better determination of these two parameters.

4. THE ENTROPY :

During the initial stage of the reaction, a great deal of entropy is created due to compression and thermal excitation. This is followed by an

expansion phase in which only little additional entropy is generated by viscous forces and by thermal conduction. Then, the conditions are frozen and remain the same until LP and IMF are eventually detected; hence, entropy does not increase much after the initial stage of the reaction and so is a powerful probe of the early phase of the reaction. The initial definition²⁵⁾ of baryonic entropy $S/A = 3.95 - \ln R_{dp}$, governed by the deuteron to proton ratio R_{dp} , was amended by substituting a d-like to p-like ratio ($\tilde{R}_{dp}$) to R_{dp} in order to include t, ^3He and ^4He emission²⁶⁾. Then, it was further demonstrated that IMF should also be included^{3,4)}, not only as such, but also, because being particle unstable, their inclusion modifies substantially the final LP yield. Hence, the determination of entropy requires a quantum statistical treatment based on a realistic approach including the binding energies and the emission of unstable IMF. The QSM and the QMD make various predictions on S/A ³⁻⁶⁾ and suggest alternative methods to determine S/A from IMF measurements. The baryonic entropy is expected to increase with the projectile energy. However, the entropy residing in IMF shows only loose dependence on the projectile energy²⁷⁾. We review rapidly three possible approaches to entropy.

4.1 Multiplicity of IMF :

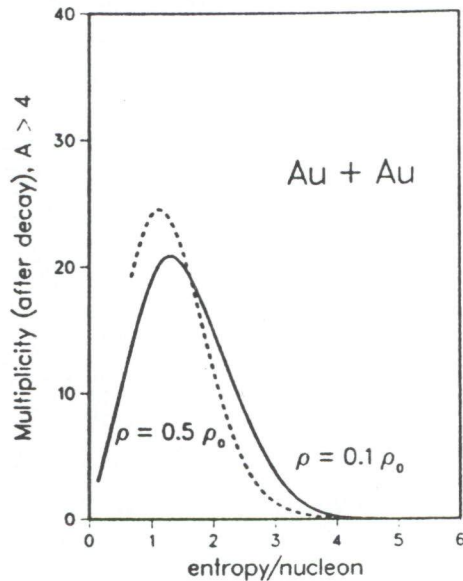


Fig. 6

The QSM^{3,4)} predicts a strong dependence of the IMF ($A_{\text{IMF}} > 4$) multiplicity on S/A after the IMF have decayed as illustrated in Fig. 6 for Au + Au and for two different values of the break-up density ρ ($\rho_0 = 0.15$ nucleon/fm³ is the ground state density). The multiplicity goes through a maximum around $S/A \sim 1.5$ then decreases and vanishes at $S/A \sim 4$. It is very worth, as already stated, to measure the IMF multiplicity excitation function which should increase and then decrease between

100 and 600 A MeV (see Fig. 3). This should provide a very sensitive test of the QSM and the QMD predictions about S/A . Conversely, if S/A shows only little dependence on projectile energy, the IMF multiplicity should

remain practically unchanged. Here again, genuine centrality may be the clue. Two solutions in terms of S/A correspond to one IMF multiplicity (see Fig. 6) but the n/p ratio^{3,4)} simultaneously measured should alleviate any ambiguity.

4.2 Average mass of IMF distribution :

QSM calculations show that the average mass of IMF distribution depends strongly on S/A ^{3,4)} as illustrated in Fig. 7 for Ca + Ca. This behaviour is not expected to be much different for Au + Au. A determination of such an average mass from careful measurement of IMF distribution should provide a subsequent evaluation of the entropy, more specifically in the $1.5 \lesssim S/A \lesssim 3$ domain. Alternately, as mentioned in Sec. 2, S/A depends also on the slope of the IMF mass distribution, the QSM provides equally predictions for a relationship between the baryonic entropy and the IMF-yield-distribution slope parameter⁴⁾.

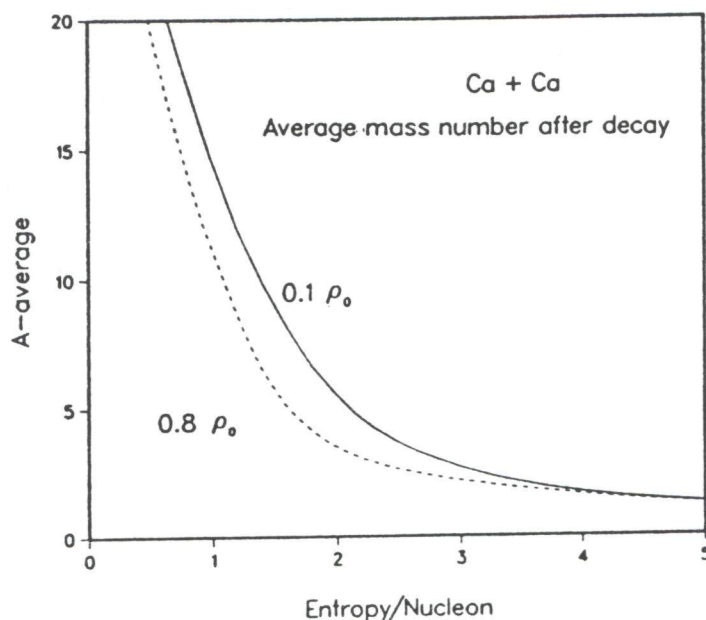


Fig. 7

4.3 Yield dependence of IMF and IMF/proton ratios :

When using $\tilde{R}_{dp}$ one loses the richness of information contained in the various IMF species which can be used as independent observables to

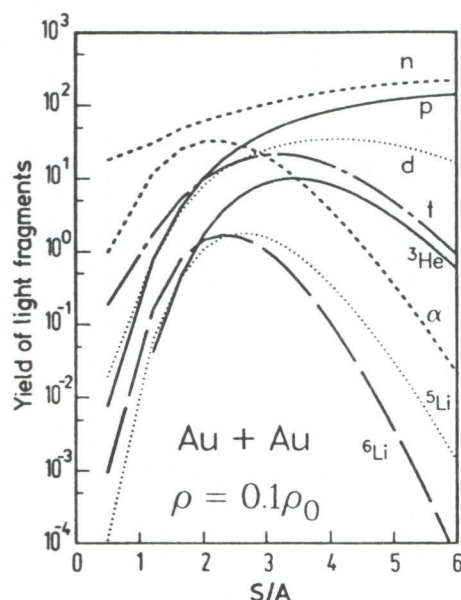


Fig. 8

compressed nuclear matter. Among the large number of detailed predictions made by the QSM and the QMD some have received enlightening confirmation from experimental results, unfortunately these latter remain too fragmentary. A need for numerous and detailed further experiments is urgently required in order to provide sensitive and extended tests for these models. The experiments will be also very useful to investigate the problem of the IMF formation and their very nature^{9, 10)}

The author is indebted to Prof. N. Cindro and C. Cerruti^a and to Dr. P. Wagner for fruitful discussion and interesting suggestions.

6. REFERENCES

- 1) For a review see the Proc. of a NATO Advanced Study Institute on the Nuclear Equation of State, Peñíscola, Spain; Ed. by W. Greiner and H. Stöcker, NATO ASI Series B : Physics 216 A and B (1989).
- 2) High Energy Nuclear Collisions, Ed. by H.H. Gutbrod, A. Sandoval and R. Stock, Report GSI-87-10 (1987) and Ref. therein.
- 3) D. Hahn and H. Stöcker, Phys. Rev. **C37**, 1048 (1988).
- 4) D. Hahn and H. Stöcker, Nucl. Phys. **A476**, 718 (1988).
- 5) J. Aichelin and H. Stöcker, Phys. Lett. **B176**, 14 (1986).
- 6) G. Peilert et al., Phys. Rev. **C39**, 1402 (1989) and Ref. therein.

determine the entropy. The QSM predictions for LP and light IMF yield as a function of S/A are shown in Fig. 8 for Au + Au. Similar calculations can also be performed for heavier IMF. Comparisons with experimental yields measured at different projectile energies, hence, different entropies, should furnish another sensitive test of the S/A dependence on incident energy predicted by the QMD.

5. CONCLUSION :

We have briefly reviewed some global variables expressing the highly collective character of the hot and

- 7) L. Csernai and J. Kapusta, Phys. Rep. **131**, 223 (1986) and Ref. therein.
- 8) C.J. Pethick and D.G. Ravenhall, Phys. Rev. Lett. **61**, 818 (1988) and Ref. therein.
- 9) J.P. Bondorf et al., Nucl. Phys. **A443**, 321 (1985) and Nucl. Phys. **A444**, 460 (1985)
D.H.E. Gross et al., Phys. Rev. Lett. **56**, 1544 (1986).
- 10) W.A. Friedman and W.G. Lynch, Phys. Rev. **C28**, 16 (1983).
- 11) For example U. Milkau et al., Report GSI-91-08 (1991).
- 12) For example C.A. Ogilvie et al., Report GSI-91-18 (1991).
- 13) The 4π -Collaboration, GSI Nachrichten 5-91.
- 14) F. Jundt and the 4π -Collaboration, Proc. of the First European Biennial Workshop on Nuclear Physics, Megève (1991)
K. Hildenbrand and the 4π -Collaboration, this Conference.
- 15) W. Scheid et al., Phys. Rev. Lett. **32**, 741 (1974).
- 16) J. Cugnon et al., Phys. Lett. **109B**, 167 (1982).
- 17) P. Danielewicz and G. Odyniec, Phys. Lett. **129B**, 146 (1985).
- 18) K.G.R. Doss et al., Phys. Rev. Lett. **59**, 2720 (1987) and Ref. therein.
- 19) H.H. Gutbrod et al., Phys. Lett. **216B**, 267 (1989).
- 20) C.A. Ogilvie et al., Phys. Rev. **C43**, R10 (1990).
- 21) J.P. Sullivan et al., Phys. Lett. **B249**, 8 (1990) and J. Peter et al., Nucl. Phys. **A519**, 127c (1990).
- 22) J. Aichelin et al., Phys. Rev. **C37**, 2451 (1988).
- 23) K.G.R. Doss et al., Phys. Rev. Lett. **57**, 302 (1986).
- 24) C. Hartnack et al., in Proc. of the IXXX Winter Meeting on Nucl. Phys., Bormio (1991).
- 25) P. Siemens and J.I. Kapusta, Phys. Rev. Lett. **43**, 1486 (1979).
- 26) G. Bertsch and J. Cugnon, Phys. Rev. **C24**, 2514 (1981).
- 27) K.G.R. Doss et al., Phys. Rev. **C32**, 116 (1985).

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FROM: KAZANJIAN, MICHAEL

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/02/91

SUBJECT: EINSTEIN'S NOTION OF UNIFIED FIELD THEORY

ASSIGNED TO: Dr. Wong

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FILE: PHYSICS

p-physical Sciences -

114

Michael M. Kazanjian
DePaul University
2330 N. Kenmore
Chicago, IL 60614

2 January 1991

D. Allan Bromley, Ph.D.
Science Advisor to the President
The White House
Washington, D. C.

Dear Dr. Bromley:

Please accept for your consideration my enclosed article concerning Einstein's notion of a unified field theory. I approach the topic from an interdisciplinary perspective based upon a generalization of quantum theory.

Just as quantum physics says that particle measurement is influenced by observer's act of measurement, my position is that a more complex, cultural basis suggests that a generic unified field theory consists of homologic, isomorphic ideas in a theory of work setting the social and economic situations enabling a quantitative unified field theory and any scientific development.

The quantitative uniting of relativity and quantum, important as it is, will nonetheless require intellectual uniting of qualitative, cultural frameworks and the quantitative. The qualitative framework(s) would constitute the general, social and economic situations bringing forth scientific progress.

Sincerely,

A handwritten signature in blue ink, reading "Michael M. Kazanjian", with a long horizontal flourish extending to the right.

Michael M. Kazanjian

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Helping to discover, clarify, solve, and disseminate solutions to the contemporary and future reality-oriented philosophic problems of humankind.

Einstein's Goal

Michael M. Kazanjian
Chicago, Illinois

Physicists especially since Albert Einstein have been trying to solve one of science's biggest and most difficult problems. That is to find something like a set of the universe's fundamental laws. Einstein and his contemporaries called it a Unifying Field Theory; current physicists tend to call it a Grand Unified Theory (GUT). This would integrate Newtonian or deterministic and Heisenbergian or indeterministic physics. It would bring together scientific predictability and scientific probability.

The Superconducting Super Collider (SSC) will be science's most recent and sophisticated effort toward building such a unifying theory. But an integrative philosophy provides the best solution to that problem by showing that the universe's fundamental law concerns the philosophic unification of science as such and humanities.

Science's endeavor to unify scientific or numeric determinism and scientific or numeric indeterminism still gives us only a quantitative, numeric or scientific theory. Whatever science's final set of laws or law beyond which science may feel incapable of progressing, these will remain only a restricted, special case of the broader, interdisciplinary and philosophical unity which the philosopher can develop.

Philosophy generalizes numeric or scientific determinism into the numeric or scientific as general determinism. Philosophy generalizes numeric or scientific indeterminism into the nonnumeric or humanistic as general indeterminism. Where numeric determinism predicts natural objects and numeric indeterminism shows us the unpredictability of natural particles, the numeric as general determinism tends to show us the predictability of human beings while the nonnumeric as general indeterminism details for us the unpredictability of human beings.

A fundamental law of the universe, then, becomes a philosophic law integrating human predictability and

probability as such. This means the unification of science and humanism, of science and art. Einstein himself spoke of the importance of integrating the coldly scientific and the warmly artistic. It is insufficient to try to bring together two scientific, quantitative poles as in scientific Newtonianism and scientific Heisenbergianism. That unity still speaks only of the purely natural environment. But philosophy broadens that view and speaks of man's holistic life and the need for a science that does not fly off to become mere positivism and for a humanities that does not simply fall inward to become a mere extreme romanticism devoid of science.

The physicist Niels Bohr has noted the fact that "we are both spectators and actors in the drama of human existence." Within physics this suggests we can both predict and only guess at natural factors. But more widely, the scientist himself tends to be the spectator attempting to predict people and events, and the humanist himself tends to be the actor realizing that people are also unpredictable. Thus, any field theory, any unifying theory of knowledge must go beyond science and find that the most fundamental polarity to unify is not scientific determinism and probability, but indeed science and the humanities as such.

MIT's Jerome Weisner has indicated that scientists must learn science. This broad, philosophical concern shows that knowledge is not mere science but the holistic, interdisciplinary framework including scientific and humanistic thinking.

Interestingly, the increasingly important area of ergonomics or "laws of work" argues that we must design environments to include the human factor. We must, therefore, design the scientific to adjust to or consider the humanities. A unifying theory designs the numeric so that the numeric matches, considers, or takes into account the nonnumeric or humanistic.