COPY

March 31, 1982

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

Dear Freeman:

The enclosed will speak for itself. Perhaps you will want to drop a note to Walter about it.

Sincerely yours,

Harry Woolf

Enclosure

ROOM XXXX E51-232
CAMBRIDGE, MASSACHUSETTS 02139

WALTER A. ROSENBLITH

TEL: (617) 253-1990

March 23, 1982

Dr. Harry Woolf
Director
The Institute for Advanced Study
Princeton, New Jersey 08540

Dear Harry:

Do you happen to know whether Freeman Dyson has published anywhere the talk he gave to the Humboldt Fellows; the talk was entitled: "Unfashionable Pursuits".

It was nice to see you, and I hope that we shall stay in closer touch.

Cordially,

Walter

Walter A. Rosenblith
Institute Professor

WAR/je

COPY

March 17, 1982

Dr. Walter A. Rosenblith
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Dear Walter:

Just a quick note to thank you for sending me a copy of the issue of *Tech Talk* with the story on Freeman Dyson's lecture.

Cordially yours,

Harry Woolf

"To Harry Woolf
Director, Inst. f. Adv. Study
(Princeton)

Walter A. Rosenblith

Institute Professor
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
(617) 253-1990

Massachusetts Institute of Technology

TECH TALK

February 24, 1982
Volume 26, Number 26

Alberty reception

A reception honoring Dean and Mrs. Robert A. Alberty will be held Thursday, Feb. 25, 1982, on the occasion of Dr. Alberty's retirement from his post as dean of the MIT School of Science.

All members of the MIT community are invited to join in the reception, which will be from 3:30-6pm in the Forris Jewett Moore Room (6-321).

Dr. Alberty, who has served as dean of science for the last 15 years, last year announced his decision to relinquish his responsibilities as dean, and to return to teaching and research in the Department of Chemistry. He will be succeeded by Dr. John M. Deutch, Arthur C. Cope Professor of Chemistry, effective March 1, 1982.

Watch that mail

The US Postal Service has notified MIT that all nonprofit mailings must include the words "Massachusetts Institute of Technology" as the first line of the return address corner card.

This includes all mail except first class, according to Donald A. Collupy, supervisor of Graphic Arts mail service. The Postal Service has already returned one large mailing in violation of the regulation, he said. He urged large departmental mailers to make arrangements to amend their corner cards until present supplies of stationery run out or can be replaced.

Insurance notice

Once again, MIT students—particularly seniors—are receiving sales calls from insurance company representatives who imply they have a connection with the Institute. MIT does not have agreements with any insurance companies who seek to sell life insurance to undergraduate or graduate students. Company representatives often obtain student names and numbers from the Student Directory, which is for Institute use only, and should not be distributed to anyone outside of MIT.

Energy line

The MIT Chapter of the Massachusetts Voice of Energy can be contacted through James Doyle at x3-8645. The MVOE is a nonprofit organization established as an energy-education resource. It provides no-cost speakers for groups ranging from elementary school to adult level. The organization also has participated in conferences and debates and will train people to be energy educators.

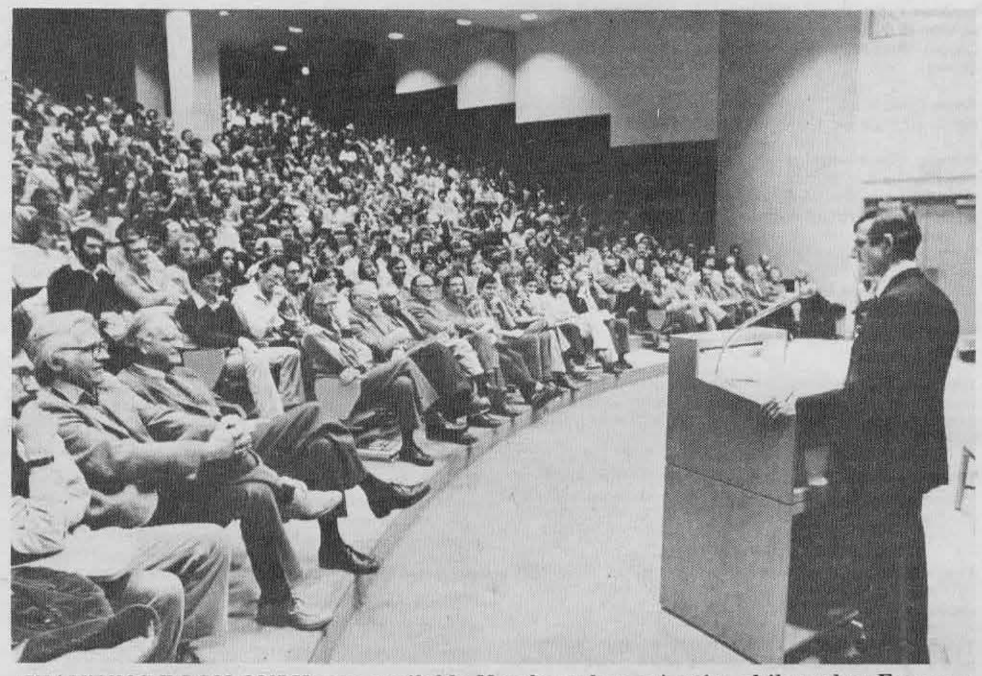
Inside . . .

Holt memorial service Thursday. See page 5.

Is MIT track champ? See page 8.

Spring Blood Drive coming. See pages 3 and 8.

Safer air travel forecast. See page 3.



STANDING ROOM ONLY was available Monday when scientist-philosopher Freeman Dyson of the Institute for Advanced Study at Princeton, N.J. appeared in Huntington Hall (Rm 10-250) to present the 1982 Karl Taylor Compton Lecture. Speaking on "Fighting for Freedom with the Technologies of Death," Professor Dyson said nuclear weapons, both tactical and strategic, leading, as they do, to defeat, destruction and chaos for all sides, may be politically useful in international relations in peacetime, but they have no useful military purpose in war and the problem for mankind is to persuade soldiers of this. Soldiers, he said, are honor-bound to achieve victories and defend their nations, goals that cannot be achieved with nuclear weapons. It is not enough to have scientists and doctors and clergy and even musicians against nuclear war, he said. What's needed, he said, are captains and generals against nuclear war. There is hope, he concluded, that soldiers will one day rebel against nuclear weapons, not so much out of fear of the consequences, but because "they cannot do their job" with such technologies of death and destruction.

—Photo by Calvin Campbell

Sloan undergoing renovations

Demolition of the interior of the basement and first floors of the Sloan Building is expected to begin around mid-March, heralding the next phase of the renovation of Sloan School facilities. The recently completed E51 project provided new classrooms for the school, and the E40 project new space for the school's research centers.

The renovated Sloan Building space will contain, on the first floor, offices for the staff of the school's regular degree programs (undergraduate, master's and PhD) and Executive Education Programs (the Sloan Fellows and Senior Executive Programs), plus the Sloan Placement Office, the Joint Program in the Management of Technology cosponsored by Sloan and the School of Engineering) and the Sloan School External Relations Office.

The present entrance from the plaza of the Hermann Building will be widened and will lead, in one direction, to an existing tiered classroom and offices and, in another, to the main lobby. This large lobby will become a lounge providing conversation and informal meeting space for students and faculty; it will be flanked on one side by smaller student lounges and message areas and on the other by a new, informal eating facility, successor to the Ploughman's Pub, which will be run by MIT's Dining Service.

The basement will contain a new East Campus Computer Facility (which has been temporarily relocated to the third floor of E52), a Graphic Arts facility for the East Campus (now temporatily located in the basement of E51), space for a computer research project under the direction of Sloan School faculty, and lockers for Sloan School students.

The Faculty Club kitchen, also located in the basement of the Sloan building, will not be disturbed and will continue to function during the renovation.

Work will begin this summer on a portion of the third floor of E52 in the area just off the newly-constructed bridge between E51 and E52. This space will contain a seminar room, a classroom, a remote computer terminal room and offices for the Sloan Management Review.

All the work is expected to be completed by January, 1983. The architect for the project is the firm of Ellenzweig and Moore; the contractor is the Edward R. Marden Corporation; and the project manager is Fay DeAvignon, staff architect in MIT's Office of Architecture, Engineering and Construction.

Dresselhaus to head APS in '84

Dr. Mildred S. Dresselhaus, Abby Rockefeller Mauzé Professor of Electrical Engineering, has been elected vice president of the American Physical Society. She will become president-elect in 1983 and president in 1984.

Professor Dresselhaus, director of the Center for Materials Science and Engineering at MIT since 1977, has made significant research contributions across a broad area of condensed matter physics. She has served in several advisory roles in government and academe and has been a member of the Solid State Sciences Committee of the National Academy of Sciences, the Assembly of Mathematical and Physical Sciences and the Report Review Committee of the National Academy of Sciences, the Naval Research Advisory Committee, the Steering Committee for the Evaluation Panels of the National Bureau of Standards (chairman), the Scientific Advisory Committee to the Allied Corp.

She recently won election to the National Academy of Engineering Council and will be the 1982 Griffin Lecturer of the American Carbon Society.

Dr. Dresselhaus has been a visiting professor of physics at the University of Campinas, Brazil (summer 1971), the Technion, Israel (summer 1972), Nihon University, Japan (summer 1973), and IVIC Caracas, Venezuela (summer 1977).

She joined the MIT faculty in 1967 after spending seven years at Lincoln Laboratory's Solid State Physics Division. She was associate department head for electrical science and engineering from 1972-74. She holds the BA from Hunter College (1951), the MA in physics from Harvard (1953) and the PhD in physics from the University of Chicago (1958). Her honorary degrees are from Worcester Polytechnic Institute (D. Eng. 1976) and Smith College (D. Sc. 1980).

Faculty considers writing proposal

By CHARLES H. BALL
Staff Writer

Motions to establish an undergraduate Writing Requirement and a Standing Faculty Committee to oversee the requirement were presented at the February 17 faculty meeting by the Committee on Educational Policy.

Because the motions require amending the Faculty Rules, they cannot be voted on until the March faculty meeting.

Some preliminary discussion of the motions took place at the Wednesday faculty meeting. President Paul E. Gray and Provost Francis E. Low noted that the Writing Requirement, if adopted, will require a considerable segment of the faculty to concern itself with the writing proficiency of MIT students. The success of the requirement will depend heavily upon the acceptance of a broadly shared, Institute-wide responsibility to emphasize the importance of writing in all subject areas and to provide opportunities for students to write. With this in mind, the President and the Provost urged faculty members to familiarize themselves with the proposal and to participate in the March discussion and vote.

"It would be unfortunate if 50 faculty members embarked the entire faculty on this venture," the Provost told the Wednesday meeting. "If we are to do it, we should have the endorsement of a substantial fraction of the faculty for this important undertaking."

The Writing Requirement would become an official part of the faculty's Rules and Regulations following a favorable vote in March, but its full implementation would be delayed

(continued on page 8)

Two named to science advisory council

By ROBERT M. BYERS
Staff Writer

MIT President Paul E. Gray and Professor Artur K. Kerman, director of the MIT Center for Theoretical Physics, are among 13 leading American scientists and engineers appointed last week to a newly formed White House Science Council organized to provide advice to Dr. George A. Keyworth II, director of the Office of Science and Technology Policy in the Executive Office of the President.

A White House announcement said the Council will deal with specific issues assigned by Dr. Keyworth and will keep Dr. Keyworth informed of changing perspectives in the science and technology communities. The announcement said members of the Council, appointed for one-year terms, will meet up to six times a year at regular intervals and at such other times as they may be called by Dr. Keyworth. In addition, the White House announcement said, subgroups of the Council may be formed to conduct studies on specific issues assigned by Dr. Keyworth.

Council chairman is Solomon J. Buchsbaum, executive vice president of Bell Laboratories, Inc. Vice chairman is Edward Frieman, vice president of Science Applications, Inc. Others appointed are: Harold M. Agnew, president of General Atomic Co.; John Bardeen, emeritus professor of electrical engineering and physics at the University of Illinois, Urbana; D. Allan Bromley, Henry Ford

(continued on page 3)

INSTITUTE NOTICES

Announcements

Jeffrey L. Pressman Award—Political Science. All MIT juniors are eligible for this award of $1,650 for an approved project during the summer months. Application deadline is March 1, 1982. Further information is available in Room 3-234, x3-7752.

Operation Crossroads Africa, Inc.—is a private non-profit, non-governmental organization that promotes work, travel, and study in Africa as a vehicle for cross-cultural exchange and understanding. Participants will spend six weeks in a rural African community and will be involved in a project of vigorous physical labor. Two weeks of travel will follow the project, and the total participation fee is $2,500. For more information, contact the Preprofessional Office, 7-102, x3-4158.

Official Notice-February Degree Candidates—Prepaid postcards enclosed with February degree notice must be returned as soon as received. Please indicate whether diplomas are to be mailed, called for in person, or if attendance at Commencement is planned Tuesday, June 1, 1982.

Overseas Research Students Awards—Available in United Kingdom. Some 500 new ORS Awards will be offered on a competitive basis in 1982 to overseas postgraduate students of outstanding merit and research potential. Award-holders will be overseas graduate students who, in Session 1982-83, are commencing full-time study, as registered research students, at one of the Academic Institutions for a higher degree, or are already undertaking such a course and no not have an ORS Award. They must be liable to pay tuition fees at the "full-cost" rate for overseas students. The only criteria for Awards are outstanding merit and research potential; other factors, such as means, nationality, proposed field and institution of study, will not be taken into account. For further information see Ann Wallace, 5-112, Dean for Student Affairs Office.

The Medical Foundation, Inc. and the Charles A. King Trust—have announced the 1982 Postdoctoral Research Fellowship Applications for investigation in the Bio-Sciences and Community Health. Application deadline is March 15, 1982. For additional information please call Barbara Stowe, x3-3952.

The Office for Career Planning and Placement has received brochures on summer opportunities/jobs in the Federal Government. Some of the filing dates for applications are as early as January 1-15, but most are between March 1 and April 15. Opportunities are limited so applicants are encouraged to apply early. We have addresses of Personnel Management Federal Job Information Centers and addresses of departments and agencies as well to which you may direct inquiries.

February Degree Candidates—If you have loans administered by MIT, notices will be mailed requesting you to schedule an appointment for an Exit Interview with the Student Loan Office. These interviews are mandated by the U.S. Department of Education and are required by the Institute to maintain your good standing on the degree list. The notice also serves to activate the repayment status and terms of the loans. Please contact us at E19-225 or phone x3-4087 if you have any questions.

Bursar's Office-Student Accounts Half-Door—will be open an additional forty-five minutes from 4-4:45pm, Monday-Friday. The exception to these hours will be the first two weeks of Fall and Spring Term registrations when the hours will be 9-4pm. The Account Representative will be available to meet with students during regular office hours of 9-4pm. For further information contact Richard Davidson, Assistant Bursar, 253-4133.

Career Planning and Placement Logistics**— Wed, Feb. 24: **TRW,** 3:30-5:30pm, Rm 4-153. **Intel Corporation,** 4-6pm, Rms 4-149 & 2-136. **Schlumberger Well Services,** 5-7pm, Rm 12-182.

The Junior Year (Term) Abroad Program—is an educational option available to every MIT undergraduate. If you are interested in study in the United Kingdom, please come to meet and address questions to:
Robert Collins, Inter-Study Programs, Monday, March 1, 10:30-noon: Kenneth Humphries, Director, Higher Education in Europe, Tuesday, March 2, 10am-noon: Robin Gilmour, University of Lancaster (Visiting Scholar, Harvard), Tuesday, March 2, 3-5pm. All meetings will be held in the Conference Room, Dean for Student Affairs Office, 7-106.

Club Notes

MIT /DL Bridge Club**—ACBL Duplicate bridge, Tues, 6pm, W20-473. Info: Arthur, x8-1414, Draper.

Nightline**—The on-campus hotline information service is open during its normal hours, 7am-7pm, during IAP. Call x3-7840.

T.W.O. Exercise Class**—Conducted by professional, Patricia Murray, Thursday evenings, through May 6. Held 7:30-8:30pm in Dupont Gym Exercise Room. Single class rate, $2/class for T.W.O. member; $2.50/class for non-T.W.O. member. For more information, contact P. Murray at 253-3351 or 494-8761.

The MIT Aikido Club**—The MIT Aikido Club meets for practice Mon, Tues, and Wed, at 5pm; Thurs and Fri, at 7:30am, DuPont exercise room. Aikido is a noncompetitive Japanese Martial Discipline. Beginners are always welcome.

Hobby Shop**—Complete facilities for wood working, metal working and darkroom, Mon - Fri, 10am-6pm, Wed, 10am-9pm, W31-031. Fee: $12/term students; $20/term community. For info call x3-4343.

Hillel General Membership Meeting***—MIT Hillel, Sun, Feb. 28, 3pm, West Lounge, Student Center.

Women's Water Polo Club**—Spring season is currently being planned and will start in March. Any woman, undergraduate, graduate or staff, is welcome. No experience needed. If you are interested please call Karen Fortoul, x3-6799 or Karen Klincewicz, 864- 7240.

Religious Activities

The Chapel is open for private meditation 7am-11pm daily.

Charismatic Prayer Group*—Mon evenings, 6:45, Ashdown Dining Room. Starts with pot-luck supper followed by prayer meeting with Bible sharing, music and praise. Contact Jim Mahoney, x3-3074.

Christian Science Organization at MIT**—Weekly Testimony Meeting, Thursdays, 5:15pm, 6th flr Lounge, Ashdown.

Islamic Society*—Every Friday prayers will be held at 1pm, Ashdown, Basement.

Jewish Services*—Terumah, Mon-Fri, 8am, Beit Knesset (50-010). Friday: Candlelighting 5:10pm; Reform/Conservative, 5:30pm, Hillel Lower Level; Orthodox, 5:15pm Beit Knesset; Ma Tofu's serves at 6pm. Saturday: Orthodox, 9am, Beit Knesset; Egalitarian, 9:30am, Chapel. Shabbat ends 6:12pm. For information call 253-2982.

Lincoln Laboratory Noon Bible Studies*—Tuesdays and Thursdays, M Trailer. Contact Annie Lescard, X262. **Morning Bible Studies**—Fridays, 7:30-8:30am, L-217. For information contact Ed Bayliss x8289, Linc.

Lutheran Episcopal Ministries*—Interdenominational service of Holy Communion, Wednesdays, 5:10pm, MIT Chapel. Supper follows in the basement of 312 Memorial Drive.

Noon Bible Study*—Every Thursday, Rm 3-465, bring your lunch, all welcome. Ralph Burgess, x3-8121. (Since 1965)

Prayer Time*—Friday afternoons, 1-2pm, weekly Bible Class led by Rev. Miriam R. Eccles, founder and director of the Alpha and Omega Missionary Society. Guest speakers, music and refreshments. Rm 20E-207. Welcome!

Catholic Community-Ash Wednesday Services—Feb. 24, MIT Chapel: 12:05pm, Liturgy of the Eucharist with distribution of ashes; 1:05pm, Liturgy of the Word with distribution of ashes; 7pm, Liturgy of the Word with distribution of ashes; 9pm, Liturgy of the Eucharist with distribution of ashes.

Tech Catholic Community*—Sunday liturgies: 9am, 12 noon, 5pm, MIT Chapel. Eucharist on weekdays: Tues, 5:05pm, Thurs, 5:05pm and Fri, 12:05 MIT Chapel. Weekly bible study: contact Bob Scheri, x3-2981.

The Church of Christ in Cambridge*—Christians from MIT/Harvard/BU...Worship and Discussion Group, 1st and 3rd Sunday evening of the month, 6pm, Rm 37-252, Marlar Lounge. For information call Robert Randolph, X3-4861.

Vedanta Society*—Meditation and discourses on the Gita by Swami Sarvagatananda of the Ramakrishna Vedanta Society of Boston. Fridays, 5:15pm, MIT Chapel.

The Gospel of John*—Bible study. How Christ came to be man's life to produce God's dwelling place on earth. Tuesdays, noon-1pm, Rm 8-119.

Graduate Studies

The Massachusetts State Federation of Women's Clubs (MSFWC) is pleased to announce their annual scholarship program for graduate study in the fields of business and dentistry. Applicants must maintain official residence in Massachusetts for at least five years to be considered and obtain a letter of endorsement from local MSFWC Women's Club President. Two scholarships in the amount of $2,000 are being offered. For further information and applications contact Associate Dean Jeanne Richard, x3-136, x4869. Application deadline: March 1, 1982.

The Office of Naval Research announces their graduate fellowships program. Awards will be made to graduate students in the following fields; Electrical Engineering, Computer Software, Materials Science, Naval Architecture, Applied Physics and Aerospace/Mechanical Engineering, who have not completed more than 20 semester hrs of grad study at time of application. Award will provide $8,000 per yr for tuition and fees and a stipend of $1,000 per mo. For further information and application write: American Society for Engineering Education (ASEE), 11 Dupont Circle, Suite #200, Washington, D.C. 20036, (202) 293-7080. Deadline: March 15, 1982.

UROP

For more information on UROP opportunities, MIT undergraduates should call or visit the Undergraduate Research Opportunities Program Office, Rm 20B-141, X3-5049 or x3-4849, unless otherwise specified in the listing. Undergraduates are also urged to check the UROP bulletin boards located in the main corridor of the Institute and in the UROP Office.

Last Call for Proposals—UROP funding is dwindling fast! Soon we will have to limit spring stipends to deal with encroaching summer projects. Proposals for OVERHEAD WAIVER are still being accepted as well. If you have a question of special situation, see us!

Eloranta Summer Fellowship Program—Several summer research fellowships for MIT undergraduates will be awarded this spring under the Eloranta Fellowship Program. The fellowships are intended to support summer research or study projects and associated travel. Deadline: April 5, 1982.

Advance Information for Summer—Summer proposals will be accepted beginning March 29. See us now for information concerning how to begin, how to receive credit or wages, etc.

Kerr Electro-Optic Field Mapping Measurements—Some dielectric liquids become electrically birefringent when stressed by high voltage. The change in the index of refraction is proportional to the square of the local electric field. By easily measuring the refractive index change using a circular polariscope configuation the electric field distribution is easily determined by taking a picture or by using a photomultiplier tube. A few students are needed to perform these measurements in various materials. Contact Prof. Markus Zahn, N-10, 155 Mass. Ave., x3-4688.

Hepatic Collagen Synthesis in a Rat Model of Cirrhosis—We will study the time course of changes in enzyme activity and collagen biosynthesis in an animal model of cirrhosis. These studies will include enzyme assays, collagen synthesis, amino acid analysis and liver DNA synthesis in rats fed diets which include an alcoholic type cirrhosis. Min. of 12 hr/wk and will work with experimental animals. Background in analytical lab work and instrumentation needed. FRESHMEN WELCOME. Credit. Contact Prof. Paul Newberne, E18-611, x3-6243 or 6241.

Theatre of the Senses—The LOON & HERON THEATRE FOR CHILDREN & CAMBRIDGE 7 ASSOCIATES are developing a new form of theatre and theatre facility designed to meet the accessibility needs of blind performers and audiences. Students are sought for 3 research and design possibilities such as designing a simple, cost effective system or equipment to enhance sensory communication between performers and audience, etc. Credit Only.

Computer language Design—Work at LIDS under Profs. Bertsekas and Gallager. A multiprocessor computer is being designed for use in a local network to study communications problems. Project is to design and implement a language in firmware. Should have 6.035 or similar experience. Pay Available. Contact Dan Helman, 35-417, x3-2346.

Logo and Dyslexic Children—We are interested in attracting students to participate in a project involving the use of microcomputers in the education of children with dyslexia. An interest in working with children is essential. A background in psychology, language acquisition and/or computing would be an advantage. Will be expected to spend 1-2 mornings/wk. with teachers and pupils of the Carroll School in Lincoln, under supervision. Contact Dr. Sylvia Weir, DSRE, 20C-113, x3-7368.

Impact 1 1/2 Project—Prop. 2 1/2 is a measure that limits the Mass. property tax to 1 1/2% of property value. The project is looking for students interested in public sector operations and management. Tasks will involve data collection and analysis. (Computer skills helpful but not necessary). Freshmen Welcome. Contact Karl Kim, x3-1308 or x3-1307. Faculty Supervisor: Prof. L. Susskind.

Human Visual Perception—This is an exciting project, but the nature of research on human subjects requires great patience and care in the testing and plotting of data, often on repetitive tasks. Must have excellent command of English and be available every afternoon for an average of 15 hr/wk. Freshmen Welcome. Contact Dr. Sakitt, x3-5747, stating your name, phone number, and best hours to be reached.

Non-Invasive Biomedical Monitoring—We are seeking a Jr. to begin during the spring term, with a good posibility of summer UROP and a subsequent BS thesis. Since simultaneous monitoring of several chemical species and real time computation based on physiological models are sought, previous experience with computers is desirable. Contact Dr. James Weaver, HST, 20A-128, x3-4194.

Studies on the Interaction of Diet and Cancer—This study will investigate the effect of polyunsaturated fats fed at low and high levels on 1,2 Dimethlhydrazine induced colon tumors in the rat. The student will participate in diet preparation, daily animal care, data collection and necropsy procedures. Requires at least 12 hr/wk preferably in 3 hr blocks. Freshmen Welcome. Contact Mary Locniskar, x3-6230. Faculty supervisor: Dr. Paul Newberne.

Race Car Aerfoil Project—We are studying the design criteria for the negative-lift aerofoils used on race cars begun last year, sponsored by Ensign Racing Ltd. of England. 3 students are needed, 1 with knowledge of Fluid Dynamics, one with a good knowledge of digital electronics and computer programming, and one preferably with machine shop experience to help in construction of experimental apparatus. Contact Anthony Purnell, 491-3362. Faculty Supervisor: Prof. Larrabee.

Energy Conservation in Manufacturing—As energy costs rise, many manufacturing operations are being closely examined to eliminate waste and improve productivity. Students are needed to work on solvent separation in the rubber industry. Interested students in Crs. 5,10, 2 3 and other related areas are needed to help in building and testing experimental apparatus and the design and execution of thermodynamic measurements and data analysis. Suitable for Some Freshmen. Credit Only. Contact Prof. T. Gutowski, LMP, 35-014, x3-2034.

Placement

The following companies will be recruiting in the Career Planning and Placement Office, Rm 12-170, on these dates:

February 24: Ampex Corp; GE/Calma Co; General Electric Co; General Motors Technocal Center; Institute for Defense Analyses.

February 25: Intel Corp; Schlumberger Well Services; TRW.

February 26: Anser (Analytic Services Inc.); Bolt Beranek and Newman Inc.; Combustion Engineering, Inc.; GPU Nuclear; The Maryland-National Capital Park and Planning Commission; Metcalf & Eddy, Inc.; The MITRE Corp; Naval Civilian Personnel Command; NUTECH, Inc.; Rogers Corp.; Rolm Corp.; TASC (The Analytic Sciences Corp.)

March 1: Albany International Corp; Atex, Inc.; BBN Computer Corp.; DATA General Corp.; EDS Nuclear Inc.; E-Systems, Inc. Melpar Division; Ford Motor Co.; Goodyear Tire and Rubber Co.; Northern Research and Engineering Corp.; Pratt & Whitney Aircraft Group/Div. United Technologies; Rohm and Haas Co.; Sprague Electric Co-Semiconductor Division; Storage Technology Corp.; URS/John A. Blume & Assoc., Engineers; Ungermann-Bass, Inc.; Xerergy Inc.

Internships

National Trust For Historic Preservation, Chesterwood—Stockbridge, MA. Volunteer intern program for undergraduate, graduate students in architectural history, marketing, art history, archaeology, drama education, landscape architecture, and history to assist in landmark property in carrying out its history-related activities. Deadline: March 15 for summer.

Lake Michigan Federation-Environmental Internship Program—Chicago, ILL. Full and part-time interns to work on Michigan issue. Non-paid but it is possible to hire a work-study student on part-time basis. Backgrounds in the natural, physical, and social sciences.

Management Internship Recruitment Program—Long Beach, CA. Openings for 5 Management Intern positions. For individuals interested in a career in local government. Must have completed Master's degree in Public or Business Administration by July 1982. Salary for the program is $1,629 per month ($19,548 annually). Deadline: March 8, 1982.

Massachusetts Internship Office—Boston, MA. Currently has internship opportunities in: Applied Sciences, Arts, Communication and Media, Counseling, Education, Environmental Affairs, Health, Law and Government, and Management. For more information, contact Mass. Internship Office at 727-8688.

Environmental Intern Program—Boston, MA. Full-time engineering assistant needed in the planning and implementation of an energy conservation program at a major woolens manufacturing firm, located near Sugarloaf/USA. 26-52 weeks long, Stipend: $350-$600/week. For more information call 426-4783.

The Maryland-National Capital and Planning Commission—Silver Spring, Maryland. A representative will speak with students in the design and planning disciplines on Friday, Feb. 26. Paid summer and term time internships are available. For more information contact Joanne Briggs, x3-4737.

The Commonwealth of Massachusetts, Department of The State Secretary—has opportunities for volunteer interns or work study students. Positions open from Jan.-May, 1982. Apply immediately. Jobs available in fields such as communications, political science, history, public relations and in computer use. For information call Joanne Briggs, x3-4737.

The City of New York: The New York City Urban Fellows Program and the Summer Management Intern Program—selects 20 seniors, recent grads, and grad students to work on a full-time basis from Sept-June. Each fellow receives a $6,00 tax-free stipend. The Summer Management Intern Program allows upper classmen and recent grads to work in city government full-time from mid-June until mid-August. Must have a permanent address in New York City. For information call x3-4737.

American Film Institute and Sony National Video Festival—Cambridge, MA. is offering two internships to start immediately in the following areas: Intern Coordinators for American Film Institute and Sony National Video Festival. 12 hrs per wk. Also eligibility for AFI/SONY Competition. Call Jan Crocker or Carolyn Oliver at 253-7612.

Multivision, Inc.—Needham, MA. Internship in video production. Requires a strong interest in broadcast quality video production and minimum of 10/hr/wk, spring or summer available and car is important. For information call Catherine McCabe or Jay Loewe at 449-5830.

Massachusetts Advanced Studies Program, Milton Academy—for juniors, seniors, or master's candidates interested in teaching. Assist in teaching one course. Anthropology and art couses are also available. For information call Joanne Briggs, x3-4737.

UROP has published a guide to various Institute-based, off campus-oriented programs, both academic and non-academic, summer and non-summer. These include internship/cooperative programs in the School of Engineering, various other academic programs, the Industrial Liaison Program and the Community Service Fund. For a copy of the guide of more information get in touch with Clifford Truesdell, 20B-141, x3-5049.

WGBH Educational Foundation—Boston, MA. announces their internship and workstudy positions open for the Spring '82 semester. Requires 20 hrs per wk without pay, but interns could receive college credit for their work at the station. Apply immediately. For information call x3-4737.

National Aeronautics and Space Administration—Lyndon B. Johnson Space Center, Houston, Texas, announces their summer internship. Seeking undergraduate students, grad students, or students who have successfully completed Bachelor's program and will be entering grad school in the fall. Provides opportunity to work in aerospace field. Medical Intern portion of the program is also avail. Salaries based on academic achievement. GS-4, GS-7, GS-9 avail. Call x3-4737.

Student Jobs

More jobs are available. Contact Student Employment Office, Rm 5-119.

The 1982 Summer Employment Directory is now available in the Student Employment Office, 5-119. Summer jobs are posted there also.

Two students needed to share a maintenance/messenger position. Duties include: light maintenance service for classrooms, setting up rooms and running errands for special functions, and other miscellaneous errands as required. Hours: Mon-Fri, noon-4:30pm. Salary: to be determined. For an interview appointment, call Michelle Kamin, Dean's Office, Finance and Administration Program Offices, 253-2152.

Cable Television Schedule
February 24-March 2

Wednesday, February 24
Channel 8:
12:30-1pm MIT IN MOTION A weekly program about people, life and work at MIT. A new show premiers every Sunday night at 9pm. If you or your organization have an idea for a program segment call x7431 or x3625.
1-3pm CLASSIC FILM FEATURE - "METROPOLIS" - Directed by Fritz Lang. A look at future society from the viewpoint of 1926.
3-5pm MEDIA DESIGN - A live program about today's media and their artistic use.
7:30-8pm NEWSFILE - A rebroadcast of the 7pm CBS News
8-8:30pm MIT IN MOTION - See 12:30pm
8:30-10:30pm CLASSIC FILM FEATURE - "METROPOLIS" See 1pm

Thursday, February 25
Channel 8:
12:30-1pm MIT IN MOTION - See Wednesday, 12:30pm
1-3pm CLASSIC FILM FEATURE - "THREEPENNEY OPERA" Directed by F. W. Murnau. The filmic adaptation of Bracht's classic play about the underground world of Mack the Knife and Pirate Jenny.
7:30-8pm NEWSFILE - A rebroadcast of the 7pm CBS News
8-9pm PHYSICS 8.02 LECTURE - Recorded 2/25/82
9-11pm CLASSIC FILM FEATURE - "THREEPENNEY OPERA" See 1pm.

Friday, February 26
Channel 8:
12-2pm CANNED GOODS - A weekly collection of independent film and video projects from the Greater Boston Area.
7:30-8pm NEWSFILE - A rebroadcast of the 7pm CBS News.

Sunday, February 28
Channel 8:
8-9pm PHYSICS 8.02 LECTURE - Recorded 2/26/82
9-9:30pm MIT IN MOTION - See Wednesday, 12:30pm.
9:30-11:30pm CLASSIC FILM DOUBLE FEATURE - "THE LAST LAUGH" "THE CABINET OF DR. CALIGARI" Two early expressionist films from the 1920s Germany.

Monday, March 1
Channel 8:
7:30-8pm NEWSFILE - A rebroadcast of the 7pm CBS News.
8-8:30pm MIT IN MOTION - See Wednesday, 12:30pm.
Channel 12:
7-11pm 6.003 REVIEW TAPE Q2 - The one hour long review tape will be run four times during this time period.

Tuesday, March 2
Channel 8:
12:30-1pm MIT IN MOTION - See Wednesday, 12:30pm
1-3pm CLASSIC FILM FEATURE - "TRIUMPH OF THE WILL" Directed by Leni Riefenstahl. This is a Nazi propaganda film produced in 1934. It is a fanatical expression of devotion to the Third Reich.
4:30-6pm MIT BIOLOGY DEPARTMENT SEMINAR - Live from Rm 6-120.
7:30-8pm NEWSFILE - A rebroadcast of the 7pm CBS News.
8-9pm PHYSICS 8.02 LECTURE - Recorded 3/1/82.
9-11pm CLASSIC FILM FEATURE - "TRIUMPH OF THE WILL" See 1pm.

TECH TALK

February 24, 1982
Volume 26
Number 26

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DYSON

The original [illegible] 1981-82

PRINCETON PACKET, 21 October 1981

Wolf physics prize to Institute's Dyson

TheWolf Foundation has awarded the 1981 Wolf Prize in Physics to Freeman J. Dyson of the Institute for Advanced Study where Professor Dyson is a member of the faculty of the School of Natural Sciences.

The $100,000 prize, which Professor Dyson shares with Professor Gerard 't Hooft of the University of Utrecht and Professor Victor Weisskopf of the Massachusetts Institute of Technology, will be presented to the recipients at the Knesset of the State of Israel in March 1982.

Professor Dyson was born in England in 1923 and joined the faculty of the institute in 1953. He is known for major contributions to many different areas of physics and technology in which he has made effective use of his deep knowledge of mathematics. His wide-ranging interests extend from biology to astrophysics, including such technological areas as nuclear reactors and solar energy.

Through his writings he has contributed greatly to the public understanding of science, a notable recent example being "disturbing the Universe" (Harper Row, 1979). The Wolf Prize citation noted in particular Professor Dyson's "outstanding contributions to theoretical physics, especially in the development and application of the quantum theory of fields."

Among Professor Dyson's other awards are the Danny Heineman Prize by the American Institute of Physics (1965), the Lorentz Medal of the Royal Netherlands Academy (1966), the Hughes Medal of the Royal Society, London (1968), the Max Planck Medal of the German Physical Society (1969), and the Harvey Prize of the Technion, Israel (1977).

Founded in 1930, the Institute for Advanced Study consists of the Schools of Historical Studies, Mathematics, Natural Sciences, and Social Sciences. Each school has a small permanent faculty, and some 160 fellowships are awarded each year to visiting scholars from other universities and research institutions. In 1981-82, visiting members in residence come from 110 institutions in 23 countries.

JH:

Prof. Dyson is sharing the 1981 Wolf Prize with 't Hooft and Weisskopf. 't Hooft ~~has been~~ was a visitor in Natural Sciences (Nov 1973 and Spring 1976).

Among other Wolf Prize winners this year, Ahlfors was a member in Math in 1966-67, and Zariski was a member in Math from Sept 1960 thru January 1961.

Would you pls return these materials for the 1980-81 AR. Thanks.

J.

THE INSTITUTE FOR ADVANCED STUDY

NEWS RELEASE

For immediate release

For additional information:

Dr Harry Woolf
Director
609-734-8203

Princeton, NJ, October 13, 1981 -- The Wolf Foundation has awarded the 1981 Wolf Prize in Physics to Freeman J. Dyson of the Institute for Advanced Study where Professor Dyson is a member of the Faculty of the School of Natural Sciences. The $100,000 prize, which Professor Dyson shares with Professor Gerard 't Hooft of the University of Utrecht and Professor Victor Weisskopf of the Massachusetts Institute of Technology, will be presented to the recipients at the Knesset of the State of Israel in March 1982.

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The Institute for Advanced Study is completely independent, though relations with other institutions are numerous and mutually beneficial.

for AR 80-81

THE WOLF FOUNDATION

P. O. BOX 398
HERZLIA 46 103 (ISRAEL)
TELEPHONE 052-77723
CABLES: FOUNDATION-HERZLIYYA

September 23, 1981

Messrs.
INSTITUTE FOR ADVANCED STUDY
Olden Lane,
Princeton, New Jersey 08540
U. S. A.

Attn.: The President

Dear Mr. President:

Heartiest congratulations to you and your Institute on the selection of Prof. Freeman J. DYSON as recipient of the 1981 WOLF PRIZE in PHYSICS.

Our Foundation is very honoured and proud to award this prize to such a distinguished scientist as Professor Dyson, of the highest international standing.

The solemn prize-awarding ceremony shall take place at the Knesset in March 1982, to coincide with the first anniversary of the passing of Dr. and Mrs. R. Wolf, the founders of The Wolf Foundation. The President of the State of Israel shall hand the prizes to their recipients, in the presence of various Ministers, national and foreign dignitaries and academic authorities.

Enclosed herewith is a copy of the material released to the media by the Minister of Education and Culture of Israel, chairman of the Council of our Foundation. Your Institute may freely publish all or any part thereof and we would appreciate receiving a copy of your publications, for our records.

Please do not hesitate to request any additional information you may require. With kindest greetings, we are pleased to remain,

Respectfully yours,

Y. Gruder
Director General

encls.

YG/do.-

THE WOLF FOUNDATION

קרן וולף

P.O. BOX 398
HERZLIA BET - ISRAEL

ת.ד. 398 - הרצליה ב'

RECIPIENTS OF THE "WOLF PRIZES - 1981"

AGRICULTURE - equally shared by:

Professor John O. ALMQUIST - Pennsylvania State University, U.S.A.
for his significant contributions to the application of artificial insemination to livestock improvement.

Professor Henry A. LARDY - University of Wisconsin, Madison, U.S.A.
for his pioneering research on storage and preservation of spermatozoa thus enabling artificial insemination to become a universal practice.

Professor Glen W. SALISBURY - University of Illinois, Urbana, U.S.A.
for his outstanding achievements in basic and applied research on artificial insemination

MATHEMATICS - equally shared by:

Emeritus Professor Lars V. AHLFORS - Harvard University, Mass., U.S.A.
for seminal discoveries and the creation of powerful new methods in geometric function theory.

Emeritus Professor Oscar ZARISKI - Harvard University, Mass., U.S.A.
Creator of the modern approach to Algebraic geometry, by its fusion with Commutative algebra.

CHEMISTRY -

Professor Joseph CHATT - University of Sussex, Brighton, England
for pioneering and fundamental contributions to synthetic transition metal chemistry, particularly transition metal hydrides and dinitrogen complexes.

PHYSICS - equally shared by:

Professor Freeman J. DYSON - Institute for Advanced Study, Princeton, N.J. - U.S.A.

Professor Gerard't HOOFT - University of Utrecht, The Netherlands

Professor Victor F. WEISSKOPF - M.I.T., Cambridge, MA. - U.S.A.

for their outstanding contributions to theoretical physics, especially in the development and application of the quantum theory of fields.

MEDICINE - equally shared by:

Dr. Barbara McCLINTOCK - Carnegie Inst.of Washington, Cold Spring Harbor Lab., U.S.A.
for her imaginative and important contributions to our understanding of chromosome structure behaviour and function, and for her identification and description of transposable genetic (mobile) elements.

Professor Stanley N. COHEN - Stanford Univ. School of Medicine, Stanford, CA.,U.S.A.
for his concepts underlying genetic engineering; for constructing a biologically functional hybrid plasmid, and for achieving actual expression of a foreign gene implanted in E. Coli by the recombinant DNA method.

THE WOLF PRIZES.- US$ 500.000.- are distributed every year since 1978 for outstanding contributions on behalf of mankind. The Prize consists of US$ 100.000.- in each of the aforementioned 5 areas. In the event of 2 or even 3 scientists sharing one Prize, the honorarium shall be equally divided among them.

THE PRIZE COMMITTEES.- Five Prize Committees, one for every area indicated above and consisting of 3 members each, are appointed with worldwide renowned scientists in their respective fields of science and have included also this year 6 Nobel Laureates. The decisions of the Prize Committees are final and irrevocable.

The prize-awarding ceremony shall take place in March 1982, to coincide with the first anniversary of the passing of Dr. and Mrs. Ricardo Wolf, founders of The Wolf Foundation.

SPECIAL PRIZE IN ARTS.- In homage to the Founders and to mark the first anniversary of their passing, it has been decided to add this year a sixth prize in Arts. The decision of the respective Prize Committee shall be announced in the near future.

September 1981

DECISIONS OF THE 5 PRIZE COMMITTEES SET UP FOR THE AWARD OF THE

1981 "WOLF PRIZES" IN THE FOLLOWING FIELDS OF SCIENCE:

AGRICULTURE - MATHEMATICS - CHEMISTRY - PHYSICS - MEDICINE

AGRICULTURE

The Prize Committee has unanimously agreed that the Wolf Foundation Prize in Agriculture for 1981 should be awarded equally to:

Prof. John O. ALMQUIST	Prof. Henry A. LARDY	Prof. Glenn W. SALISBURY
Pennsylvania State Univ.	University of Wisconsin	University of Illinois
University Park, U.S.A.	Madison, U.S.A.	Urbana, U.S.A.

Prof. John O. ALMQUIST (born 1921 - U.S.A.) - for his significant contributions to the application of artificial insemination to livestock improvement.

Prof. Almquist's early work on the addition of antibiotics to bull semen resulted in substantial increases in breeding efficiency. This, coupled with his remarkable achievements in developing methods for processing, freezing, and thawing of frozen semen, significantly enhanced the practical utilization of artificial insemination in the livestock industry. Many techniques developed by him for cattle have been applied to other species, including the human male.

Prof. Henry A. LARDY (born 1917 - U.S.A.) - for his pioneering research on storage and preservation of spermatozoa thus enabling artificial insemination to become a universal practice.

Professor Lardy, with the late Professor Paul H. Phillips, made the basic discovery in the early forties that a nutrient medium of egg yolk dispersed in a phosphate buffer forms an ideal environment for the storage of spermatozoa of bull, ram, stallion, and turkey. This breakthrough paved the way to the rapid expansion of the practical use of artificial insemination in livestock breeding. Further, the ability to store semen made it possible to initiate fundamental studies on the metabolism of spermatozoa. The results of this outstanding research work enabled improvements to semen storage technique leading to more efficient and widespread utilization of semen.

Prof. Glenn W. SALISBURY (born 1910 - U.S.A.) - for his outstanding achievements in basic and applied research on artificial insemination.

While working at Cornell University and the University of Illinois, Prof. Salisbury did extensive research on semen extendors, number of sperm per insemination, and insemination techniques. His contributions have been pivotal in the resolution of problems limiting successful reproduction following artificial insemination. He is known for his ability to stimulate thinking and interest in his field and for his bold scientific approach to the problems facing the animal industry.

MATHEMATICS

The Wolf Prize Committee for Mathematics has unanimously decided that the award for 1981 should be equally divided among:

Professor (Emeritus) Lars V. AHLFORS		Professor (Emeritus) Oscar ZARISKI
Harvard University	and	Harvard University
Cambridge, Mass., U. S. A.		Cambridge, Mass., U. S. A.

Lars Valerian AHLFORS (born 1907 - Finland) - for seminal discoveries and the creation of powerful new methods in geometric function theory.

For over half a century the theory of functions of a complex variable was guided by the thought and work of Lars Ahlfors. His achievements include the proof of the Denjoy conjecture, the geometric derivation of the Nevanlinna theory, an important generalization of the Schwarz lemma, the development (with Beurling) of the method of extremal length, and numerous decisive results in the theories of Riemann surfaces, quasi-conformal mappings and Teichmuller spaces. Ahlfors' celebrated finiteness theorem for Kleinian groups, and

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Ahlfors' influence was pervasive and beneficial. His methods combine deep geometric insight with subtle analytic skill; he presents them with utter clarity and simplicity. Time and again he attacked and solved the central problem in a discipline. Time and again other mathematicians were inspired by work he did many years earlier. Every complex analyst working today is, in some sense, his pupil.

Oscar ZARISKI (born 1899 - U.S.S.R.) - Creator of the modern approach to Algebraic geometry, by its fusion with Commutative algebra.

He harnessed the power of modern algebra to serve the needs of algebraic geometry. This made possible to do algebraic geometry over arbitrary fields and to apply it to deep problems in number theory. Zariski put algebraic geometry on a secure foundation, retaining the intuitive language and insight of the Italian school, in whose tradition he was trained. He showed that purely algebraic notions, like local rings, valuations, normality, etc., are intimately connected with basic properties of algebraic varieties. His wonderful algebraic intuition led him to a number of fundamental theorems and concepts, including the resolution of singularities in two and three dimensions in characteristic zero, minimal models and criterion of rationality in dimension two, the "Zariski topology", holomorphic functions in abstract algebraic geometry, the connectedness theorem and the famous "Zariski main theorem".

Zariski's papers and teachings had a tremendous impact. Algebraic geometry is one of the most active fields in modern mathematics, and perhaps half of its leading practitioners are his former students. At the age of 82 he is still the leader in studying equi-singularity, a concept he created.

CHEMISTRY

The members of the Prize Committee in Chemistry for the Wolf Prize-1981, have selected:

Professor Joseph CHATT,
University of Sussex,
Brighton - England

for pioneering and fundamental contributions to synthetic transition metal chemistry, particularly transition metal hydrides and dinitrogen complexes.

Joseph CHATT (born 1914 - England) has made outstanding pioneering contributions to modern inorganic chemistry. His work is at the basis of much of the transition metal chemistry of the last 35 years, and his name is particularly associated with the use of tertiary phosphines as ligands and the reactions of complex compounds in organic solvents. He has studied the nature of the coordinate link which led to his establishment of the Chatt-Dewar model for the binding of olefins to transition metals, and from there he developed ideas which led to the synthesis of stable transition metal alkyls and aryls, and hydrides. From these researches have grown a vast new area of organometallic and catalytic chemistry which finds direct expression in the catalytic processes exploited in the petrochemical industry.

He also has developed theories to rationalise the trans-effect and also a classification of metal ions as Class (a) or Class (b) which provided the basis for the "hard" and "soft" classification of acids and bases.

He now leads a varied team of scientists which has achieved international acclaim in the study of nitrogen fixation. His current chemical work has revealed the first reactions of complexed dinitrogen to yield well defined complexes, a large number of new dinitrogen complexes, and the first indications of a rational development of new catalytic processes for the synthesis of ammonia, hydrazine, and amines. It also offers the first real prospect of understanding the chemistry of the natural nitrogen fixation process mediated by the enzyme nitrogenase.-

PHYSICS

The Prize Committee for Physics has unanimously decided that the Wolf Prize for 1981 should be equally divided among:

Prof. Freeman J. DYSON	Prof. Gerard't HOOFT	Prof. Victor J. WEISSKOPF
Inst. for Advanced Study	Theoretical Physics Dept.	Dept. of Physics
Princeton, N.J. 08540	University of Utrecht	M. I. T.
U. S. A.	The Netherlands	Cambridge, MA 02139 -U.S.A.

for their outstanding contributions to theoretical physics, especially in the development and application of the quantum theory of fields.

Freeman J. DYSON (born 1923 - England) is noted for major contributions to many different areas of physics and technology in which he has made effective use of his deep knowledge of mathematics. In early work, he showed that the apparently different approaches of Tomonaga, Schwinger and Feynman to quantum electrodynamics were internally consistent and led to the same results. Shortly after he proved that divergences of the theory would be removed in every order of perturbation theory by incorporating them in the renormalized charge and mass of electron. In these works, Dyson developed an elegant mathematical method, based on the "U-matrix", which has become basic to more general field theories as well as to the many-body problem of the physics of condensed matter. In classic work with A. Lenard, he proved the stability of matter, that the attractive force between electrons and the positive nuclei does not cause matter to collapse. In another area, on the analyticity of scattering amplitudes, he obtained results fundamental to dispersion theory methods for scattering problems. His wide-ranging interests extend from biology to astrophysics, including such technological areas as nuclear reactors and solar energy. Through his writings, he has contributed greatly to the public understanding of science.

Gerard't HOOFT (born 1946 - The Netherlands) has made a major contribution to the revival of quantum field theory as an essential part of our understanding of elementary particle interactions. Following earlier work by his thesis advisor, M. Veltman, in 1971 t'Hooft showed that infinities could be eliminated by renormalization in theories with spontaneously broken gauge symmetries, such as the electroweak theory of Weinberg and Salam. Together with Veltman, he then systematically developed the mathematical background for calculations in such theories, including especially the method of dimensional regularization, which has been of great value in many areas, including even quantum gravity. 't Hooft also showed how dimensional regularization could serve as the basis for renormalization group calculations, by the so-called "minimum substraction" technique. He then went on to do ground-breaking work on a number of topics. He laid the foundation for systematic calculations of instanton effects, including the striking effect of baryon nonconservation. He revived interest in magnetic monopoles by showing that these particles are necessary consequences of a wide variety of gauge theories. He initiated a new approach to the calculation of physical quantities in gauge theories of strong interactions, by the "large N" approximation. Most recently, he has developed methods for deciding what sorts of massless bound states may be expected to occur in various gauge theories, providing a mathematical basis for speculations about composite-particle models of quarks and leptons. A large part of the theoretical physics of the 1970's has been based on the seminal papers of 't Hooft.

Victor F. WEISSKOPF (born 1908 - Austria) - His activity extends over a period of more than 50 years and covers two subfields of theoretical physics: quantum field theory and theoretical nuclear physics. Furthermore, he has gained a reputation as an international statesman and expositor of science. We mention some of his achievements:

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In quantum field theory his main contributions are (1) An early recognition that the incorporation of the positron in quantum electrodynamics eased to a large extent the self-energy difficulties and that infinities might be removed by re-normalization of the electron's mass and charge. (2) In collaboration with Pauli he formulated the correct quantization method for boson fields and gave the proper method for extending to bosons the concept of antiparticles. These achievements make him one of the pioneers of quantum field theory.

In nuclear physics he successfully applied thermodynamical methods to Bohrs compound nucleus model obtaining many semiquantitative results that guided the art for years. Furthermore, he analyzed with H. Feshbach and C. Porter neutron nucleus scattering introducing statistical methods, founded on quantum mechanics, that have been successfully applied in several different contexts even outside of the nuclear field.

As Director of CERN and on many other occasions he has shown considerable diplomatic ability addressed to improve international relations in science, fostering, to quote the Statute of the Wolf Foundation, "humanity and brotherly relationships amongst the peoples".

MEDICINE

The members of the Prize Committee in Medicine recommend the award of the 1981 Wolf Prize jointly to:

Dr. Barbara McCLINTOCK Carnegie Inst. of Washington Cold Spring Harbour Laboratory Long Island, N.Y. 11724 - U.S.A.	and	Prof. Stanley N. COHEN Stanford University School of Medicine Stanford, CA. 94305 - U.S.A.

Dr. Barbara McCLINTOCK (born 1902 - U.S.A.) is recognized for her imaginative and important contributions to our understanding of chromosome structure, behaviour and function. Her early work established many of the properties of chromosomes, including the cytological proof that genetic recombination involves a physical crossing over of homologous chromosomes. Her most brilliant contribution, however, has been her identification and description of transposable (mobile) genetic elements.

These are now known to exist in bacteria, lower eukaryotes, higher plants and animals. They are, in all probability, ubiquitous. Thirty years ago, McClintock had already identified and described the basic behaviour of transposable elements: that they can move from place to place in the genome, that they can disrupt expression of a gene by insertion in or near the gene, that gene expression can be restored fully or partially when the element is removed by transposition and that they are involved in the production of unidirectional deletions and a number of other types of chromosomal rearrangements. Recent studies have confirmed that the transposable elements of yeast and bacteria share all of these properties.

Prof. Stanley N. COHEN (born 1935 - U.S.A.) - Although a number of workers have contributed to the concepts underlying genetic engineering based on recombinant DNA, Dr. S. N. Cohen and his colleagues were the first to construct, in 1973, a biologically functional hybrid plasmid; and in the following year to achieve actual expression of a foreign gene implanted in E. coli by the recombinant DNA method. Dr. Cohen has exercised a central and seminal role in discovering and developing this methodology, and in demonstrating its usefulness for analysing complex genetic elements, and for obtaining expression of foreign genes in bacterial cells.

PRINCETON PACKET, 21 October 1981

Wolf physics prize to Institute's Dyson

TheWolf Foundation has awarded the 1981 Wolf Prize in Physics to Freeman J. Dyson of the Institute for Advanced Study where Professor Dyson is a member of the faculty of the School of Natural Sciences.

The $100,000 prize, which Professor Dyson shares with Professor Gerard 't Hooft of the University of Utrecht and Professor Victor Weisskopf of the Massachusetts Institute of Technology, will be presented to the recipients at the Knesset of the State of Israel in March 1982.

Professor Dyson was born in England in 1923 and joined the faculty of the institute in 1953. He is known for major contributions to many different areas of physics and technology in which he has made effective use of his deep knowledge of mathematics. His wide-ranging interests extend from biology to astrophysics, including such technological areas as nuclear reactors and solar energy.

Through his writings he has contributed greatly to the public understanding of science, a notable recent example being "disturbing the Universe" (Harper Row, 1979). The Wolf Prize citation noted in particular Professor Dyson's "outstanding contributions to theoretical physics, especially in the development and application of the quantum theory of fields."

Among Professor Dyson's other awards are the Danny Heineman Prize by the American Institute of Physics (1965), the Lorentz Medal of the Royal Netherlands Academy (1966), the Hughes Medal of the Royal Society, London (1968), the Max Planck Medal of the German Physical Society (1969), and the Harvey Prize of the Technion, Israel (1977).

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October 16, 1981

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

Dear Freeman:

I was abroad when the very good news that you had been awarded the Wolf Prize for 1981 arrived in this office.

My heartiest congratulations to you for the recognition which this brings, and I know that I speak for all our colleagues when I say that this Institute and all of us are honored by your achievement.

Sincerely yours,

Harry Woolf

THE INSTITUTE FOR ADVANCED STUDY

NEWS RELEASE

For immediate release

For additional information:

Dr Harry Woolf
Director
609-734-8203

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xc: JH

THE WOLF FOUNDATION

P. O. BOX 398
HERZLIA 46 103 (ISRAEL)
TELEPHONE 052-77723
CABLES: FOUNDATION-HERZLIYYA

September 23, 1981

Messrs.
INSTITUTE FOR ADVANCED STUDY
Olden Lane,
Princeton, New Jersey 08540
U. S. A.

Attn.: The President

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The solemn prize-awarding ceremony shall take place at the Knesset in March 1982, to coincide with the first anniversary of the passing of Dr. and Mrs. R. Wolf, the founders of The Wolf Foundation. The President of the State of Israel shall hand the prizes to their recipients, in the presence of various Ministers, national and foreign dignitaries and academic authorities.

Enclosed herewith is a copy of the material released to the media by the Minister of Education and Culture of Israel, chairman of the Council of our Foundation. Your Institute may freely publish all or any part thereof and we would appreciate receiving a copy of your publications, for our records.

Please do not hesitate to request any additional information you may require. With kindest greetings, we are pleased to remain,

Respectfully yours,
THE WOLF FOUNDATION

Y. Gruder
Director General

encls.

YG/do.-

THE WOLF FOUNDATION

P.O. BOX 398
HERZLIA BET - ISRAEL

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ת.ד. 398 - הרצליה ב'

RECIPIENTS OF THE "WOLF PRIZES - 1981"

AGRICULTURE - equally shared by:

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for his significant contributions to the application of artificial insemination to livestock improvement.

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for his concepts underlying genetic engineering; for constructing a biologically functional hybrid plasmid, and for achieving actual expression of a foreign gene implanted in E. Coli by the recombinant DNA method.

THE WOLF PRIZES.- US$ 500.000.- are distributed every year since 1978 for outstanding contributions on behalf of mankind. The Prize consists of US$ 100.000.- in each of the aforementioned 5 areas. In the event of 2 or even 3 scientists sharing one Prize, the honorarium shall be equally divided among them.

THE PRIZE COMMITTEES.- Five Prize Committees, one for every area indicated above and consisting of 3 members each, are appointed with worldwide renowned scientists in their respective fields of science and have included also this year 6 Nobel Laureates. The decisions of the Prize Committees are final and irrevocable.

The prize-awarding ceremony shall take place in March 1982, to coincide with the first anniversary of the passing of Dr. and Mrs. Ricardo Wolf, founders of The Wolf Foundation.

SPECIAL PRIZE IN ARTS.- In homage to the Founders and to mark the first anniversary of their passing, it has been decided to add this year a sixth prize in Arts. The decision of the respective Prize Committee shall be announced in the near future.

September 1981

DECISIONS OF THE 5 PRIZE COMMITTEES SET UP FOR THE AWARD OF THE 1981 "WOLF PRIZES" IN THE FOLLOWING FIELDS OF SCIENCE:

AGRICULTURE - MATHEMATICS - CHEMISTRY - PHYSICS - MEDICINE

AGRICULTURE

The Prize Committee has unanimously agreed that the Wolf Foundation Prize in Agriculture for 1981 should be awarded equally to:

Prof. John O. ALMQUIST
Pennsylvania State Univ.
University Park, U.S.A.

Prof. Henry A. LARDY
University of Wisconsin
Madison, U.S.A.

Prof. Glenn W. SALISBURY
University of Illinois
Urbana, U.S.A.

Prof. John O. ALMQUIST (born 1921 - U.S.A.) - for his significant contributions to the application of artificial insemination to livestock improvement.

Prof. Almquist's early work on the addition of antibiotics to bull semen resulted in substantial increases in breeding efficiency. This, coupled with his remarkable achievements in developing methods for processing, freezing, and thawing of frozen semen, significantly enhanced the practical utilization of artificial insemination in the livestock industry. Many techniques developed by him for cattle have been applied to other species, including the human male.

Prof. Henry A. LARDY (born 1917 - U.S.A.) - for his pioneering research on storage and preservation of spermatozoa thus enabling artificial insemination to become a universal practice.

Professor Lardy, with the late Professor Paul H. Phillips, made the basic discovery in the early forties that a nutrient medium of egg yolk dispersed in a phosphate buffer forms an ideal environment for the storage of spermatozoa of bull, ram, stallion, and turkey. This breakthrough paved the way to the rapid expansion of the practical use of artificial insemination in livestock breeding. Further, the ability to store semen made it possible to initiate fundamental studies on the metabolism of spermatozoa. The results of this outstanding research work enabled improvements to semen storage technique leading to more efficient and widespread utilization of semen.

Prof. Glenn W. SALISBURY (born 1910 - U.S.A.) - for his outstanding achievements in basic and applied research on artificial insemination.

While working at Cornell University and the University of Illinois, Prof. Salisbury did extensive research on semen extendors, number of sperm per insemination, and insemination techniques. His contributions have been pivotal in the resolution of problems limiting successful reproduction following artificial insemination. He is known for his ability to stimulate thinking and interest in his field and for his bold scientific approach to the problems facing the animal industry.

MATHEMATICS

The Wolf Prize Committee for Mathematics has unanimously decided that the award for 1981 should be equally divided among:

Professor (Emeritus) Lars V. AHLFORS
Harvard University
Cambridge, Mass., U. S. A.

and

Professor (Emeritus) Oscar ZARISKI
Harvard University
Cambridge, Mass., U. S. A.

Lars Valerian AHLFORS (born 1907 - Finland) - for seminal discoveries and the creation of powerful new methods in geometric function theory.

For over half a century the theory of functions of a complex variable was guided by the thought and work of Lars Ahlfors. His achievements include the proof of the Denjoy conjecture, the geometric derivation of the Nevanlinna theory, an important generalization of the Schwarz lemma, the development (with Beurling) of the method of extremal length, and numerous decisive results in the theories of Riemann surfaces, quasi-conformal mappings and Teichmüller spaces. Ahlfors' celebrated finiteness theorem for Kleinian groups, and

.//. his work on the limit set, revitalized an important area of research. He is now doing pioneering work on quasiconformal deformations in higher dimensions.

Ahlfors' influence was pervasive and beneficial. His methods combine deep geometric insight with subtle analytic skill; he presents them with utter clarity and simplicity. Time and again he attacked and solved the central problem in a discipline. Time and again other mathematicians were inspired by work he did many years earlier. Every complex analyst working today is, in some sense, his pupil.

Oscar ZARISKI (born 1899 - U.S.S.R.) - Creator of the modern approach to Algebraic geometry, by its fusion with Commutative algebra.

He harnessed the power of modern algebra to serve the needs of algebraic geometry. This made possible to do algebraic geometry over arbitrary fields and to apply it to deep problems in number theory. Zariski put algebraic geometry on a secure foundation, retaining the intuitive language and insight of the Italian school, in whose tradition he was trained. He showed that purely algebraic notions, like local rings, valuations, normality, etc., are intimately connected with basic properties of algebraic varieties. His wonderful algebraic intuition led him to a number of fundamental theorems and concepts, including the resolution of singularities in two and three dimensions in characteristic zero, minimal models and criterion of rationality in dimension two, the "Zariski topology", holomorphic functions in abstract algebraic geometry, the connectedness theorem and the famous "Zariski main theorem".

Zariski's papers and teachings had a tremendous impact. Algebraic geometry is one of the most active fields in modern mathematics, and perhaps half of its leading practitioners are his former students. At the age of 82 he is still the leader in studying equi-singularity, a concept he created.

CHEMISTRY

The members of the Prize Committee in Chemistry for the Wolf Prize-1981, have selected:

Professor Joseph CHATT,
University of Sussex,
Brighton - England

for pioneering and fundamental contributions to synthetic transition metal chemistry, particularly transition metal hydrides and dinitrogen complexes.

Joseph CHATT (born 1914 - England) has made outstanding pioneering contributions to modern inorganic chemistry. His work is at the basis of much of the transition metal chemistry of the last 35 years, and his name is particularly associated with the use of tertiary phosphines as ligands and the reactions of complex compounds in organic solvents. He has studied the nature of the coordinate link which led to his establishment of the Chatt-Dewar model for the binding of olefins to transition metals, and from there he developed ideas which led to the synthesis of stable transition metal alkyls and aryls, and hydrides. From these researches have grown a vast new area of organometallic and catalytic chemistry which finds direct expression in the catalytic processes exploited in the petrochemical industry.

He also has developed theories to rationalise the trans-effect and also a classification of metal ions as Class (a) or Class (b) which provided the basis for the "hard" and "soft" classification of acids and bases.

He now leads a varied team of scientists which has achieved international acclaim in the study of nitrogen fixation. His current chemical work has revealed the first reactions of complexed dinitrogen to yield well defined complexes, a large number of new dinitrogen complexes, and the first indications of a rational development of new catalytic processes for the synthesis of ammonia, hydrazine, and amines. It also offers the first real prospect of understanding the chemistry of the natural nitrogen fixation process mediated by the enzyme nitrogenase.-

PHYSICS

The Prize Committee for Physics has unanimously decided that the Wolf Prize for 1981 should be equally divided among:

Prof. Freeman J. DYSON
Inst. for Advanced Study
Princeton, N.J. 08540
U. S. A.

Prof. Gerard't HOOFT
Theoretical Physics Dept.
University of Utrecht
The Netherlands

Prof. Victor J. WEISSKOPF
Dept. of Physics
M. I. T.
Cambridge, MA 02139 -U.S.A.

for their outstanding contributions to theoretical physics, especially in the development and application of the quantum theory of fields.

Freeman J. DYSON (born 1923 - England) is noted for major contributions to many different areas of physics and technology in which he has made effective use of his deep knowledge of mathematics. In early work, he showed that the apparently different approaches of Tomonaga, Schwinger and Feynman to quantum electrodynamics were internally consistent and led to the same results. Shortly after he proved that divergences of the theory would be removed in every order of perturbation theory by incorporating them in the renormalized charge and mass of electron. In these works, Dyson developed an elegant mathematical method, based on the "U-matrix", which has become basic to more general field theories as well as to the many-body problem of the physics of condensed matter. In classic work with A. Lenard, he proved the stability of matter, that the attractive force between electrons and the positive nuclei does not cause matter to collapse. In another area, on the analyticity of scattering amplitudes, he obtained results fundamental to dispersion theory methods for scattering problems. His wide-ranging interests extend from biology to astrophysics, including such technological areas as nuclear reactors and solar energy. Through his writings, he has contributed greatly to the public understanding of science.

Gerard't HOOFT (born 1946 - The Netherlands) has made a major contribution to the revival of quantum field theory as an essential part of our understanding of elementary particle interactions. Following earlier work by his thesis advisor, M. Veltman, in 1971 t'Hooft showed that infinities could be eliminated by renormalization in theories with spontaneously broken gauge symmetries, such as the electroweak theory of Weinberg and Salam. Together with Veltman, he then systematically developed the mathematical background for calculations in such theories, including especially the method of dimensional regularization, which has been of great value in many areas, including even quantum gravity. 't Hooft also showed how dimensional regularization could serve as the basis for renormalization group calculations, by the so-called "minimum substraction" technique. He then went on to do ground-breaking work on a number of topics. He laid the foundation for systematic calculations of instanton effects, including the striking effect of baryon nonconservation. He revived interest in magnetic monopoles by showing that these particles are necessary consequences of a wide variety of gauge theories. He initiated a new approach to the calculation of physical quantities in gauge theories of strong interactions, by the "large N" approximation. Most recently, he has developed methods for deciding what sorts of massless bound states may be expected to occur in various gauge theories, providing a mathematical basis for speculations about composite-particle models of quarks and leptons. A large part of the theoretical physics of the 1970's has been based on the seminal papers of 't Hooft.

Victor F. WEISSKOPF (born 1908 - Austria) - His activity extends over a period of more than 50 years and covers two subfields of theoretical physics: quantum field theory and theoretical nuclear physics. Furthermore, he has gained a reputation as an international statesman and expositor of science. We mention some of his achievements:

./ /.

In quantum field theory his main contributions are (1) An early recognition that the incorporation of the positron in quantum electrodynamics eased to a large extent the self-energy difficulties and that infinities might be removed by renormalization of the electron's mass and charge. (2) In collaboration with Pauli he formulated the correct quantization method for boson fields and gave the proper method for extending to bosons the concept of antiparticles. These achievements make him one of the pioneers of quantum field theory.

In nuclear physics he successfully applied thermodynamical methods to Bohrs compound nucleus model obtaining many semiquantitative results that guided the art for years. Furthermore, he analyzed with H. Feshbach and C. Porter neutron nucleus scattering, introducing statistical methods, founded on quantum mechanics, that have been successfully applied in several different contexts even outside of the nuclear field.

As Director of CERN and on many other occasions he has shown considerable diplomatic ability addressed to improve international relations in science, fostering, to quote the Statute of the Wolf Foundation, "humanity and brotherly relationships amongst the peoples".

MEDICINE

The members of the Prize Committee in Medicine recommend the award of the 1981 Wolf Prize jointly to:

Dr. Barbara McCLINTOCK Carnegie Inst. of Washington Cold Spring Harbour Laboratory Long Island, N.Y. 11724 - U.S.A.	and	Prof. Stanley N. COHEN Stanford University School of Medicine Stanford, CA. 94305 - U.S.A.

Dr. Barbara McCLINTOCK (born 1902 - U.S.A.) is recognized for her imaginative and important contributions to our understanding of chromosome structure, behaviour and function. Her early work established many of the properties of chromosomes, including the cytological proof that genetic recombination involves a physical crossing over of homologous chromosomes. Her most brilliant contribution, however, has been her identification and description of transposable (mobile) genetic elements.

These are now known to exist in bacteria, lower eukaryotes, higher plants and animals. They are, in all probability, ubiquitous. Thirty years ago, McClintock had already identified and described the basic behaviour of transposable elements: that they can move from place to place in the genome, that they can disrupt expression of a gene by insertion in or near the gene, that gene expression can be restored fully or partially when the element is removed by transposition and that they are involved in the production of unidirectional deletions and a number of other types of chromosomal rearrangements. Recent studies have confirmed that the transposable elements of yeast and bacteria share all of these properties.

Prof. Stanley N. COHEN (born 1935 - U.S.A.) - Although a number of workers have contributed to the concepts underlying genetic engineering based on recombinant DNA, Dr. S. N. Cohen and his colleagues were the first to construct, in 1973, a biologically functional hybrid plasmid; and in the following year to achieve actual expression of a foreign gene implanted in E. coli by the recombinant DNA method. Dr. Cohen has exercised a central and seminal role in discovering and developing this methodology, and in demonstrating its usefulness for analysing complex genetic elements, and for obtaining expression of foreign genes in bacterial cells.

THE WOLF FOUNDATION

P. O. BOX 398
HERZLIA BET (ISRAEL)
TELEPHONE 052-77723
CABLES: FOUNDATION - HERZLIYYA

HERZLIA BET (ISRAEL), August 1981

SOME ADDITIONAL INFORMATION ABOUT OUR WOLF FOUNDATION

1.- The WOLF FOUNDATION started its activities on January 1st., 1976, with an initial fund of US$ 10:000.000.- donated in its entirety by the Wolf Family, whose members are at present scattered throughout the world. The main Founders: Dr. Ricardo Subirana Lobo Wolf and his wife passed away in February and March 1981, respectively.

2.- The "Wolf Foundation Law - 1975" was passed by the Knesset (Israel's Parliament) in July 1975 and thereafter the Foundation was granted legal status. Its Statutes determine the aims of the Foundation and its administration rules.

3.- The purposes of the Foundation, as set forth in Art. 2 of the Law, are as follows:

a) To promote science in all its fields and art in all its forms.

b) To award prizes to noted scientists and artists from all over the world, outstanding for their achievements in the interest of mankind and for enhancing friendly relations among peoples, without distinction of nationality, race, colour, sex or political outlook.

c) To provide scholarships to students, grants to scientists engaged in research and loans to Universities and other Institutions of higher learning in Israel, in accordance with the Rules of the Foundation.

4.- The capital of the Foundation shall be increased by approximately US$ 3:000.000.- upon receiving -as sole heir- the remaining assets bequeathed by Dr. R. Wolf in his will. It consists of investments in various countries in a permanent fund, not to be used for any other purpose whatsoever. Only its annual income may be used for the award of prizes, scholarships to needy students and eventually to support scientific research projects.

5.- In line with the aforementioned aims and resources and in accordance with the provisions of the Law, the Foundation is authorized to award every year 5 Prizes in the following fields of science:

AGRICULTURE, PHYSICS, CHEMISTRY, MEDICINE and MATHEMATICS.

The Council, with the consent of the Trustees, may award a sixth prize for achievements in the sphere of art (music, painting, sculpture, architecture) or award one of the five prizes in art rather than in one of the aforesaid fields of science.

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Out of the Foundation's income, not less than 60 % (sixty percent) shall be applied every year to the award of prizes; each annual prize to amount to US$ 100.000.- as a minimum.

6.- The Foundation is governed by the following bodies:

a) Board of Trustees -

in charge of the management of the Foundation's affairs and the supervision of all financial matters related thereto.

b) Executive Council -

of not more than 15 members, selected and appointed among Rectors of Universities, Professors, Members of Parliament and other personalities, with the Minister of Education and Culture acting as Chairman. The duties of this Council include the conduct of the Foundation's activities, the appointment of the members of the various Prize Committees and, in general, the supervision of the Foundation's compliance with the rules of the Law.

c) Prize Committees -

These are formed by world-famous scientists and experts in each field, each Committee consisting of 3 or 5 members for each scientific or artistic area in which the Foundation shall award Prizes. Every year a new Prize Committee is appointed in each scientific field. The proceedings of the Committees, their recommendations and minutes shall be kept completely secret, except for the names of the winners, which shall be publicly announced.

d) The activities of the Foundation are subject to the inspection of the State Comptroller of Israel.

7.- The outstanding features of this Foundation are its international nature and the fact that it is aimed at awarding Prizes to scientists and artists of the whole world, evaluating the candidates only on the merits of their achievements, without any discrimination whatsoever.

8.- The Minister of Education and Culture shall announce every year the names of the prizewinning candidates. The official presentation of the Prizes shall take place in the Knesset and the recipients shall be handed their awards by the President of the State, in a special prize-awarding ceremony, the first of which took place on April 10, 1978.

9.- Scholarships.-

Since 1976, more than 700 tuition fee scholarships have been granted by the Foundation to needy undergraduate students at the various Universities in Israel. The students have been selected by each Institution, according to strict criteria established by the Ministry of Education and Culture and the Universities themselves.

In 1980, the Foundation started granting scholarships towards Master degrees and we trust to be able in the near future to increase very substantially the number of scholarships in all levels.-

THE INSTITUTE FOR ADVANCED STUDY

HARRY WOOLF
Director

September 28, 1981

NOTE FOR THE FILE

Professor Freeman Dyson's secretary called this office today to inform us that he has been awarded, together with Dr. Gerardus t'Hooft of the Netherlands and Dr. Victor Weisskopf of MIT, the Wolf Prize for 1981.

The recipients will share a $100,000 prize.

AL

cc. John Hunt

October 12, 1981

Professor John Elliott
School of Historical Studies
The Institute for Advanced Study

Dear John:

This little book gave me much pleasure, for which I thank you.

Plus ça change....

John Hunt

Microcosmographia Academica
Being a Guide for the Young
Academic Politician, by F. M. Cornford

HW

THE INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY 08540

Telephone 609-734-8000

SCHOOL OF NATURAL SCIENCES

September 17, 1981

Dr. Harry Woolf
Director

Dear Harry:

According to the rules, I should let you know that I shall be away from the beginning of term until October 4. I shall be spending one week in England going to a meeting to discuss the origin of life. Manfred Eigen will be there and we shall be continuing the conversation we began here at the Humboldt meeting. The second week I shall be at a meeting on galaxies organized by the Pontifical Academy in Rome. I am sorry to be away just when the fun starts here.

Yours sincerely,

Freeman Dyson

Freeman Dyson

pb

January 9, 1981

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

Dear Freeman:

Just a quick note to tell you how much I enjoyed your talk at the AAAS, and to ask a small favor of you at the same time. Professor James Neel of the University of Michigan Medical School asked me at the AAAS meeting if I could get you to sign a copy of Disturbing the Universe to send to him. I wonder if you would do me the favor of dedicating the enclosed copy and returning it to my office.

Thank you.

Cordially yours,

Harry Woolf

P.S. He wishes to give the book to his son, so a simple autograph will do. Thanks

Ale

December 22 1980

Dr Woolf

The hundredth anniversary of Max Born's birth is December 11 1982.

So this gives us a little more time to make our preparations.

Freeman Dyson.

THE INSTITUTE FOR ADVANCED STUDY

9:00 am
Mon. 22 Dec.

HARRY WOOLF
Director

November 4, 1980

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

Dear Freeman:

Thank you for the information, in your letter of 29 October, about the series of lectures presently underway at Cornell in honor of Hans Bethe. I do hope that you will share the topics and perhaps the findings with me when you return.

Thank you too for your kind words about our inclusion of Bigelow in the anniversary dinner. A committee will be appointed to consider the question of office space, and, of course, you and other members of the Faculty, if you are not on the committee already, will certainly have ample opportunity to be heard on any decisions to be made.

Finally, thank you very much for telling me about the whole Max Born matter, which I knew nothing about. When you return from Cornell I would like to get together with you to help decide just what we do about the Max Born exhibit and symposium. It would seem to me that we have an opportunity to rectify an earlier wrong in a gracious manner if we handle it carefully. Would you be kind enough to call me when you are back and we can talk about it?

Cordially yours,

Harry

Harry Woolf

Princeton, New Jersey 08540 Telephone 609-734-8200

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

October 29, 1980

Dr. Harry Woolf
Director
Institute for Advanced Study
Princeton, NJ 08540

Dear Harry:

Our discussion at the Faculty Meeting reminded me that I had forgotten to inform you that I am intending to spend the two weeks November 3-15 at Cornell University giving a series of lectures in honor of Hans Bethe. I am sorry that I did not tell you about this earlier.

In connection with the problem of offices for long-term members after retirement, I would like to say that I was happy and grateful for your including Bigelow in the list of guests at the 50th Anniversary Dinner. I think it would be inconsistent with the humane character of the Institute if Bigelow were thrown out of his office at the age of 70. He occupies only a humble office at the old computer building. When you appoint a committee to consider this matter, I hope I will have an opportunity to express my views before any decisions are made.

I have in my files a very sad letter from Max Born complaining because we did not invite him here. We should perhaps be a little careful if we decide to hold a meeting in his honor, in case some of his family or friends may still remember the old bitterness.

Yours sincerely,

Freeman

Freeman Dyson

pb

To Pics – Sept. 10, 1980

22 Religious Groups Here to Sponsor 2-Day Conference on Nuclear Arms

"To the village square we must take the facts of atomic energy — from there will come America's voice."—Albert Einstein

In an unprecedented move, some 22 religious organizations in Princeton are taking Einstein's injunction seriously and have joined in the sponsorship of a two-day teaching conference on nuclear arms.

Freeman Dyson
Conference Participant

The conference, entitled "Can We Reverse the Nuclear Arms Race?" will be held Saturday and Sunday, September 27 and 28, with five keynote addresses by men and women prominent nationally for their views and knowledge concerning the current nuclear competition.

The talks will all be held in the sanctuary of Nassau Presbyterian Church and will be followed by discussion guided by still other experts as panelists. In addition, there will be an Interfaith Service at Princeton University Chapel for which Dr. Harvey Cox, professor of Divinity, Harvard Divinity School, will be the preacher.

The sponsoring organizations include most (13) of the churches in Princeton, from St. Paul's Roman Catholic to Mount Pisgah A.M.E. Zion; the Society of Friends; the Jewish Center; all the chaplaincies at Princeton University and the Medical Center; CROP, and Plowshare at Princeton Theological Seminary.

In deference to the Jewish Sabbath, the conference will begin on Saturday evening, September 27, at 7, with registration in the narthex of Nassau Presbyterian Church. Registrants will then see the movie "Survival or Suicide," produced by the American Committee on East-West Accord of which Princeton resident George Kennan is an active member.

It was the showing of this film to the Adult Forum at Trinity Church last February, and a follow-up talk by former Ambassador Kennan to a packed audience that was a factor in the decision to hold a conference on nuclear arms. The Rev. John Crocker Jr., rector of Trinity, asked parishioners who were interested in some sort of follow-up to indicate this on a sign-up sheet. He got 150 signatures.

In talking to his colleague, Dr. Wallace Alston, senior minister of Nassau Presbyterian Church, he learned of a similar depth of interest in that congregation, and thus the idea of a teaching conference for all of Pirnceton was born.

There will be an address by Paul Warnke, former director, U.S. Disarmament Agency, on "The Arms Race, SALT II, and the Future." Mr. Warnke, a Washington lawyer, was appointed by President

Continued on Page 23

Nuclear Arms Conference

Continued from Page 1

Carter to head the U.S. Arms Control and Disarmament Agency and was chief negotiator at the Strategic Arms Limitation Talks (SALT) from March, 1977 to November, 1978, when he resigned in the hope that the SALT treaty would, as a result, have a better chance of passage through the Senate.

The conference will continue Sunday with the Interfaith Chapel Service at 11, followed by lunch at the Nassau Presbyterian Church. The afternoon and early evening will be devoted to major addresses punctuated by refreshment breaks, discussion and the showing of films.

Richard Barnet, senior fellow of the Institute for Policy Studies which he helped to found in Washington, will speak on "The Nuclear Arms Race and the Myth of Security." Mr. Barnet served as co-director of the Institute until 1978. During the Kennedy Administration, he was an official of the State Department and the Arms Control and Disarmament Agency and a consultant to the Defense Department. He has been a fellow at Princeton's Center for International Studies and is the author of "Global Reach: The Power of Multinational Corporations" and "The Lean Years — Politics in the Age of Scarcity."

After a refreshment break, Freeman Dyson, professor of physics at the Institute for Advanced Study and author of "Disturbing the Universe," is scheduled to speak at 3:30. The topic of his talk will be "An Ethical Direction for the Arms Race: A Proposal." Prof. Dyson is expected to propose a different and more moderate concept for the balance of power between the two superpowers.

High Tea will be served at 5 in the Assembly Room of Nassau Presbyterian Church for those who are staying on through the evening program. Then at 6, Randall Forsberg, director of the new Institute for Defense and Disarmament Studies in Boston, will talk on "Nuclear Weapons and World Politics,"

Ms. Forsberg — her first name belies her femininity — worked at the Stockholm International Peace Research Institute (SIPRI) for seven years. She has written about U.S. and Soviet nuclear weapons and world military research and development and is the co-author of a book published last March entitled "The Price of Defense." She is a Ph.D. candidate in political science at M.I.T., specializing in military policy and arms control and has taught and lectured widely on this subject.

The film, "Eight Minutes to Midnight," produced by Mary Benjamin, will be shown at 7, before an address by Helen Caldicott, pediatrician with the Boston Children's Center Hospital Medical Center. Dr. Caldicott, who is president of Physicans for Social Responsibility, initiated the movement in her native Australia in 1971 against French atmospheric atomic tests in the Pacific Ocean. Author of "Nuclear Madness — What You Can Do," she will speak on "A Medical View of the Hazards of the Nuclear Arms Race," a subject on which she has lectured widely.

The conference will conclude between 8:30 and 9 p.m. with a discussion led by Cora Weiss, director of the Disarmament Program at Riverside Church, New York City, on "Where Can We Go From Here?"

Richard Falk, professor of politics and international affairs at Princeton, and Paul L. Lehman, professor emeritus, Union Theological Seminary, will be panelists guiding the discussion periods, along with David E. Lilienthal, first chairman of the Atomic Energy Commission and former chairman of the Tennessee Valley Authority.

Former Ambassador Kennan and former Undersecretary of State George Ball, both Princeton residents, had hoped to be part of this conference, but by the time the dates were pinned down, both had commitments elsewhere.

Members of the steering committee planning the conference include Dr. Alston, Henry Broad, Freda Gardner and Judy MacKenzie, all from Nassau Presbyterian Church; Rabbi Melvin Glatt, the Jewish Center; the Rev. Margot Pickett and the Rev. Mark Pickett, Christ Congregation; the Rev. Jack Johnson, Princeton United Methodist Church; Leonard Newton, Witherspoon Presbyterian Church; and from Trinity Church, Mr. Crocker, Leighton Laughlin, Joan Fleming, William Robins, John Matthews, Isabelle Sayen and Pat Roberts.

Effort to Continue. From this group, Mrs. Pickett and Ms. Gardner have formed a subcommittee to plan for ongoing education and continued involvement in the topic of nuclear arms so that the conference doesn't come off as a "one-shot deal," raising major issues but leaving the participants feeling impotent as to what they can do.

Meetings have been planned for this Thursday and Tuesday at 8 at Christ Congregation, Walnut Lane and Franklin Avenue, to which area groups, such as the Mercer SEA Alliance and the Fellowship of Reconciliation, have been invited. The idea is to bring together those already involved in anti-war projects and those who would like to know more about how they can help in this effort.

In writing to his congregation about the conference, Dr. Alston summed up the reasons for it this way: "Christians are committed to the Prince of Peace, who said 'Blessed are the Peacemakers.' How do we follow Him and work for peace in a nuclear age?

"No one I know advocates irresponsible, unilateral disarmament or a weak national defense. But many people advocate strategies that do not include the continuation of a nuclear arms race. If we are to be peacemakers in discipleship to our Lord, we must try to understand what the alternatives are. Human survival is endangered, and God's good creation threatened, not only by the existence of nuclear weapons but also by the apathy of people like us."

The fee for the conference is $2 or $1 for students and senior citizens. Pre-registration may be made by sending a check payable to Arms Conference to the United Methodist Church. Registration at the door is also possible.

—Barbara L. Johnson

June 10, 1980

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

Dear Freeman:

Just a short note to acknowledge the copy of the Kowal and Drake article on Galileo's Observations of Neptune. I am delighted to have it and look forward to going through it now that I am back here.

Cordially yours,

Harry Woolf

August 26, 1980

Professor Freeman Dyson
School of Natural Sciences
Institute for Advanced Study

Dear Freeman:

Just a short note to thank you for sending me a copy of "Quick is Beautiful." I enjoyed reading it and even more, the imagined sound and sight of your delivering it to a Monsanto audience. I think your point about quick-response technology is very important indeed.

Thanks again.

Cordially yours,

File w/ yellow

QUICK IS BEAUTIFUL

Freeman J. Dyson
Institute for Advanced Study, Princeton, NJ.

Talk to Monsanto Symposium, given at
St. Louis, October 23, 1980

I. A Tale of Two Reactors

Your chairman Jacob Schaefer asked me to talk to you about "the parallels between the human condition of the nuclear physicists some forty years ago and that of the biochemists and biologists to-day." He said that your company is just now entering a period of intensified biological research and is considering a variety of possible applications of genetic engineering. I suppose his intention was that I should supply you with some sort of practical wisdom which might enable the genetic engineering industry to avoid the mistakes which have brought the nuclear power industry into such serious trouble. I am afraid he will be disappointed. I do not have much wisdom to offer, and I am completely ignorant of the details of genetic engineering technology. I am also ignorant of chemistry, which plays, as you people well know, a more important role than physics in nuclear power technology. But I won't waste any more time apologizing for my lack of proper credentials. I mean to do the best I can with what I have. So let me come at once to the questions raised by Jacob Schaefer. What did the nuclear physicists do wrong? And what can the genetic engineers learn from our misfortunes? I will tell you a few stories about things that I have seen happen during my life as a physicist, and you can then judge for yourselves whether these stories have any relevance to the problems of genetic engineering.

The first story concerns a company called General Atomic which runs a laboratory in La Jolla, California, and manufactures nuclear reactors. The company began as a division of the General Dynamics Corporation in the year 1956. In the summer of that year the company brought together a group of consultants, some expert and some non-expert in the details of reactor engineering, and paid us to sit and think for three months. I was one of the non-expert consultants. The company was then brand new; it had no laboratories, no production facilities, and no products. The consultants could do nothing except think and talk and scribble on blackboards. We were paid what was then a princely fee of a hundred dollars a day. Allowing for overhead, the company must have spent close to half a million dollars on the three-month session. The company also promised to pay one dollar to the inventor, for the patent rights to any reactor which we might invent. I collected my dollar, and so did several other people in the group. In return for this substantial outlay, the company ended the summer with preliminary designs for three new types of reactor with some promise of commercial profitability. One of these designs was chosen for immediate development and went into production with the name TRIGA, standing for Training, Research and Isotope-production, General Atomic. The first TRIGA was built, tested, licensed and sold within less than three years from the day the consultants assembled in 1956. The company is still producing it and still selling it at a profit. The TRIGA is of course not a power-reactor; it is mostly used to produce isotopes for medical research and diagnosis, not to produce electricity.

As a follow-on to the TRIGA, General Atomic decided to develop and market a big power-reactor called HTGR, High-Temperature Gas-Cooled Reactor. The HTGR is theoretically a great reactor. Its high temperature gives it an advantage in thermodynamic efficiency over water-cooled reactors, and its big heat capacity gives it an advantage in safety. It is inherently much less vulnerable to mishandling than the light-water reactors which have monopolized nuclear power production in this country. Unfortunately the HTGR never captured a substantial share of the market. General Atomic sold one each of two versions of the HTGR. The first was a 40 megawatt (electric) version, which produced electricity for a utility company at Peach Bottom, Pennsylvania. It was turned off a few years ago because the utility decided it cost more to run it than 40 megawatts was worth. Peach Bottom was always intended to be a small-scale experiment, a harbinger of bigger and better things to come. The second HTGR sold was ten times more powerful, a 400 megawatt version which is now running at Fort St. Vrain in Colorado. The Fort St. Vrain reactor has a technical problem. When you try to run it at full power, the temperature in the core does not stay steady but wiggles a bit, probably because of some complicated coupling between the thermal expansion of graphite blocks in the core and the flow of the cooling gas through channels in the blocks. The temperature wiggles do not look dangerous, but to be on the safe side the reactor is licensed to run at only seventy percent of full power. At seventy percent power it runs smoothly. Still, you cannot call it an outstanding success of HTGR technology. You cannot expect other utility companies to come rushing with orders for more copies of the Fort St. Vrain reactor until this little problem is fixed.

Now I come to the Spring of this year 1980. In the meantime General Atomic has been bought and sold twice, sold by General Dynamics to Gulf Oil and Sold by Gulf Oil to two other oil companies, but these upheavals have left the company essentially intact. General Atomic is still in business and still has dreams of selling HTGR reactors. This last Spring Harold Agnew, newly appointed president of the company, decided to hold a Class Reunion for the Class of 1956. He invited all the surviving members of the group of consultants who had started the company going with such high hopes in 1956 to come back and have another look at it. Of course we had all in the meantime grown old and dignified, and we were all much too important and too busy to come back for three months and work out some new inventions. The most we could do was to come back for two days and have a good time remembering our lost youth. We did have a good time. And incidentally the General Atomic staff told us about their recent activities and about their plans for the future.

The main thing which the General Atomic people had to tell us was the result of two safety analyses of their full-scale HTGR power-reactor. By full-scale they mean a thousand megawatts electric, two and a half times the designed power output of Fort St. Vrain. They are not seriously interested in trying to develop a market for reactors of the Fort St. Vrain class. For many years they have concentrated their major effort on the detailed design of the full-scale thousand-megawatt HTGR, a reactor which has not yet been built. In the meantime, two independent safety-analyses of the full-scale HTGR have been done, one by a group of experts in the United States, the other by a group in Germany. Neither group of experts was connected with General Atomic; neither group had any commercial incentive to make the HTGR look good. And both groups came out with similar conclusions: in a certain well-defined sense, the HTGR is roughly a thousand times as safe as a light-water reactor of equal power. The meaning of this statement is the following. The experts analyzed billion-year accidents, caused by combinations of stupidity and back luck more extreme than anything we saw at Three Mile Island. A billion-year accident requires so much bad luck that it is supposed to happen only once in a billion years of reactor running time. As you can imagine, a billion-year accident is a hell of a lot worse than Three Mile Island. The reactor core vaporizes, the concrete containment building splits open, the atmosphere happens to have an inversion layer at the worst height and the wind is blowing in the worst direction. You do not need to believe in the accuracy of the calculation which says that this disaster happens once in a billion years. All that you need to believe is that it is possible to apply the rules of the accident-analysis game fairly, so that a billion-year accident for a light-water reactor and a billion-year accident for the HTGR are in some real sense equally unlikely. The results of the analyses are then startlingly favorable to the HTGR. The billion-year accident of a light-water reactor kills 3300 people immediately and 45000 people by delayed effects of radiation. The billion-year accident of the HTGR kills zero people immediately and seventy people by delayed effects. The numbers make no claim to accuracy, but the conclusion is qualitatively clear. It is conceivable that a mishandled HTGR may kill people, but it cannot kill them wholesale.

The next question that arises is then, if the HTGR is a thousand times as safe as a light-water reactor, and if public worries about accidents are threatening the very existence of the nuclear power industry, why is there not a crowd of utility executives standing at the door of the General Atomic sales office, waiting to trade in their light-water reactors for a shiny new HTGR? The answer to this question is simple. Even if the utility executives were in a mood to buy new and improved nuclear power-plants, General Atomic would have none ready to sell. The full-scale HTGR has never been built. The components are not in production. The final stages of its engineering development are not complete. If a customer should now come to General Atomic wanting to order a full-scale HTGR, the best that General Atomic could do would be to say: "Well, wait a moment. If you can help us raise a half-billion or so of government money to finish the engineering development, and if we don't run into any unexpected snags, with luck we could be ready to begin construction in five years, and if the licensing goes smoothly you should have your reactor on line within ten years after that." This is not the kind of answer which brings utility executives running to place orders. Nobody in his right mind wants to commit himself to a huge capital investment which will only begin to pay dividends, if all goes well, fifteen years later. Only governments can afford to make such investments, and if they are wise they do not make them very often.

So here we see in a nutshell the tragedy of nuclear power. The world crying out for safer power reactors. A company staffed by capable and dedicated people, with designs for a safer reactor, eager to go ahead with building it. And nothing can be done in less than fifteen years. That is why I chose for the title of this talk, "Quick is Beautiful."

II. False Economies of Scale

I told you this story of the two reactors, the TRIGA which was finished and ready to go in three years and the HTGR which cannot be ready in less than fifteen years, because I happen to have been personally involved with them. Similar stories could be told about many other industrial products. The nuclear industry is not the only one which has suffered from a hardening of the arteries and lost the ability to react quickly to changing conditions and changing needs. I believe the difference between a three-year and a fifteen-year reaction-time is of crucial importance. The rules of the game by which public life is governed, both in the United States and in the world outside, are liable to drastic and unpredictable change within less than ten years. By rules of the game I mean prices, interest-rates, demographic shifts and technological innovations, as well as public moods and government regulations. We have recently seen some spectacular changes in the rules of the game which the automobile industry has to play. We can expect such sudden changes to occur from time to time, but nobody is wise enough to predict when or how. Judging by the experience of the last fifty years, it seems that major changes come roughly once in a decade. In this situation it makes an enormous difference whether we are able to react to change in three years or in fifteen. An industry which is able to react in three years will find the game stimulating and enjoyable, and the people who do the work will experience the pleasant sensation of being able to cope. An industry which takes fifteen years to react will be perpetually too late, and the people running the industry will experience sensations of paralysis and demoralization. It seems that the critical time for reaction is about five years. If you can react within five years, with a bit of luck you are in good shape. If you take longer than five years, with a bit of bad luck you are in bad trouble.

Let me now go back to the example of the nuclear reactor industry. What happened between 1956 and 1980 to cause such a disastrous slowing-down of the reaction-time? Part of the loss of flexibility can be blamed on government regulations and part can be blamed on the hardening of arteries in individual heads. The people who run the industry are not as young as they were. But regulation and aging are not the whole story. There are also some identifiable errors of policy which contributed to the slowing-down. In my opinion, the two chief causes of the loss of flexibility of the industry were bandwagon-jumping and false economies of scale.

Bandwagon-jumping is not always bad. Only, before you jump on, you should look carefully to see whether the bandwagon is moving in the direction you want to go. If you are doubtful about the direction, it is a good idea to wait. In the case of the American nuclear power industry, the bandwagon was started by Admiral Rickover, who developed with admirable speed and efficiency a reactor to drive nuclear submarines. Rickover's reactor went into mass production and gave a flying start to the industry. It was a pressurized light-water reactor. So the light-water bandwagon started to roll. When the time came to build power-reactors for the civilian utility market, everybody except General Atomic jumped onto Rickover's bandwagon. Unfortunately they overlooked a well-known fact about submarines. There is not much room to spare in a submarine. Therefore the most important requirement for a submarine reactor is to be compact, to have a lot of power in a small volume. But when you build reactors for civilian utilities, the most important requirement should be safety. Other things being equal, the more compact a reactor is, the more power it generates in a given volume, the more quickly it will melt or vaporize in case of an accident with a loss of coolant. The shorter the time that is available before the reactor melts, the more difficult it is to keep an accident from turning into a catastrophe. So compactness and safety are not running in the same direction. The main reason why the HTGR is safer than a light-water reactor is that it is less compact. What is good for submarines is not necessarily good for civilians. But once almost everybody had jumped onto Rickover's bandwagon, it became very difficult for anybody to jump off. By jumping on too soon, the nuclear industry deprived itself of alternative technologies which were leading in different directions. When the public rather suddenly became aware of the deficiencies of light-water reactors, the Rickover bandwagon finally ground to a halt, but the passengers were then left stuck in the mud with nowhere else to go.

The effect of the bandwagon in immobilizing the nuclear industry was bad enough, but the effect was made much worse by a second factor, the pursuit of false economies of scale. I am not denying the reality of economies of scale. I am not recommending "Small is Beautiful" as a suitable motto for the chemical industry. Up to a point, big plants are usually more economical than small ones. Big nuclear reactors, up to a point, generate cheaper electricity than small ones. But I am saying that the economy of scale is lost or even reversed when the big plant takes too long to build. If a plant takes ten years to build, it is almost certainly too big. The economy of scale is likely to be canceled out by interest charges and by loss of flexibility, and it will often happen that changes in the rules of the game make the big plant obsolete before it even comes on line. So I am saying that you should pursue economies of scale up to the point where each unit takes five years to bring on line, but no further. Further than that, it is a false economy.

The light-water reactor industry probably made a fundamental mistake in going to thousand-megawatt units. The expected economy of scale seems to have been illusory. Unfortunately, General Atomic felt compelled to make the same mistake with the HTGR. Just to keep up with the Joneses, General Atomic concentrated its efforts on the thousand-megawatt monster which cannot be ready when it is needed.

The market for nuclear power reactors is at the moment non-existent. Nobody knows whether the market will revive in the future. The hopes of the industry rest on the possibility that there will be some new oil crisis or some unpredictable change of political mood which will create a massive new demand for nuclear power. When this happens, the demand will be for reactors which are safe, and flexible, and quick to build. The thousand-megawatt HTGR is safe but not quick. Perhaps General Atomic might finally achieve its rightful share of the market, if it could be ready when the time comes with a HTGR reactor of modest size, thoroughly tested and debugged, and capable of being mass-produced in a hurry.

One of the most beautiful pieces of technology I have ever seen is the factory in Everett north of Seattle where they build Boeing 747's. The Boeing 747 is not small and neither is the factory. But the factory is wondrous quick. At the time I visited, they were turning out 747's at the rate of one a week. That is the sort of operation which I have in mind when I say, Quick is Beautiful.

People of my generation who lived through World War 2 have vivid memories of monumental confusion and incompetence--after all, the word Snafu is of World War 2 vintage--and in spite of all that, we remember that in the end things got done. When Winston Churchill became Prime Minister in 1940, England was desperately short of ships, airplanes, tanks, guns, everything that we needed to fight a war. I saw how bad things were when the little old 22-calibre rifles that my high-school ROTC used for target practice were taken away from us and given to the army.

Those rifles probably last saw active service in the Crimea in 1857. In 1940 Winston Churchill spoke on the radio and said, "I am sorry I cannot do anything for you in less than three years. I give an order to build a factory to-day, and in two years you have nothing, in three years you have a little, in four years you have a lot, in five years you have all you want." He was right. In five years we had all we wanted and in five years the war was over.

These experiences of World War 2 made an indelible impression on people of my generation. At the bottom of our hearts we still believe you can have anything you want in five years if you need it badly enough and if you are prepared to slog your way through the barriers of confusion and incompetence to get it. Some of us even believe that if tomorrow the oil-exporting countries would do us the favor of imposing a total and permanent embargo on all shipment of oil to this country, the shock to our system would be sufficient to push us into a serious synthetic-fuel program, and we would end up within five years producing so much fuel that we could undersell OPEC in the world market. Such ideas are totally contrary to the accepted wisdom of our economists and politicians. The accepted wisdom says that, no matter what we decide to do about the energy problem, we cannot expect to see any substantial results before the year 2000. The accepted wisdom is no doubt correct, if we continue to play the game by the rules of to-day. But anybody who lived through World War 2 knows that the rules can be changed very fast when the necessity arises.

Why is it that our whole economic and political system has tended recently to become so sluggish and inflexible? Why have we become resigned to the idea that nothing substantial can ever be done in less than ten years? Obviously there are many reasons. But I believe the principal reason for this sluggishness is that our whole society has fallen into the same trap as our nuclear industry. Not only in the nuclear industry but in many other industries and public institutions, we have pursued economies of scale which turned out to be false. One of the most fundamental false economies of scale is the overgrowth of cities. At one time it looked economically attractive to cram millions of people together into huge agglomerations. The budgetary problems of New York City have now made clear to everybody that this was a false economy.

When we turn from sociology to biology, we see the same historical processes at work. So long as no sudden changes in the rules of the game occurred, all through the soft swampy sluggish hundred-million-year summer of the mesozoic era, the dinosaurs pursued their economies of scale, growing big and fat and prosperous, specializing their bodily structures more and more precisely to their chosen ecological niches. Then one day, as we recently learned from the brilliant observations of Luis Alvarez and his colleagues at Berkeley, an asteroid fell from the sky and covered the earth with its debris. The rules of the ecological game were changed overnight, and our ancestors, the small, the quick, the unspecialized, inherited the earth.

III. Ice-Ponds and Heat-engines

Let me now tell you a more cheerful story. In Princeton there are two projects in progress, each of them in its own way trying to contribute to a solution of the energy problem. The two efforts stand side by side on the Forrestal Campus of Princeton University. One of them is the TFTR, the Tokamak Fusion Test Reactor, the white hope of the magnetic confinement fusion program, a magnificent piece of engineering, lavishly funded by the Department of Energy. If all goes well, it will cost only $300 million and will be ready to go into operation in 1986. It will then explore the technology for commercial fusion reactors which will possibly begin producing electricity ten or fifteen years later.

The other project, the one with which I have the honor to be associated, is the Princeton Ice Pond. This is a square hole in the ground with a dirt berm around it and a sheet of griffolin plastic lining its bottom. Two men with a mechanical digger dug the hole last January. We rented a commercial snow machine and squirted snow over the hole during the cold days and nights of February, until we had something that looked like the Disneyland Matterhorn. Halfway through the snowmaking, we found out that we didn't need that fancy ski-resort snow-machine. We didn't need skiing-quality snow for our pond. We found out that for our purposes a fireman's fog-nozzle which you can buy for $450 does the job just as well. Our Matterhorn stood high and proud for a few weeks. Then the March sun shrank it down a bit, and the April rains reduced it to a pool of slush, filled up to the top of the berm. We covered it over with an insulating layer of plastic and straw, and on top of that we put an air-supported mylar dome to keep the straw dry. In June a hefty hail-storm wrecked the mylar and so we are making do with wet straw for the insulation. I say "we," but you must understand that I am not claiming credit for any of this. The project is run by Bob Socolow and Don Kirkpatrick and Ted Taylor and their students at Princeton University. I am only an unskilled laborer who goes out to help them occasionally. In June we measured the contents of the pond and found that we had about 450 tons of ice in a thousand tons of slush.

The ice-pond project is not supported by the Department of Energy. We applied to DOE for funds several times, but the most DOE could do for us was to tell us to apply to Housing and Urban Development, and when we applied to HUD they told us, not unexpectedly, to go back to DOE. The project finally got started last January because the Prudential Insurance Company decided we might be a good investment. The Prudential is prepared to spend $300 thousand (not million) to find out whether we are as crazy as we look. The Prudential does not require us to spend three quarters of the money on paper-work.

Now why should the Prudential Insurance Company be interested in supporting a technologically primitive and low-grade project like ours? It happens that the Prudential is investing its surplus cash in the construction of several office buildings in an industrial park near the Forrestal Campus. The possible pay-off for the Prudential is a solar heating and cooling system for one of their office buildings. If our wildest dreams come true, we will be able to supply solar heating and cooling to the building at a capital cost equal to the cost of fuel and electricity used by an equivalent conventional system in about two years. In other words, the Prudential would write off the cost of the solar system in two years and would enjoy free heating and cooling thereafter as long as the system lasted. The Prudential is prepared to gamble $300 thousand on the remote chance that something like that might happen. The government, of course, does not like to gamble.

The key to cheap and reliable solar energy is to have a cheap and massive storage of heat and cold, massive enough so that it can ride over the annual weather-cycle, heat being collected in summer and used in winter, cold being collected in winter and used in summer. The system which we have in mind for the Prudential building would use two ponds for storage, a hot pond containing 100000 tons of hot water, and a cold pond containing 10000 tons of ice. We started first with the ice-pond experiment because the money came through in January just in time for the snow-making. It is much easier to make snow in a hurry in winter than to make hot water in a hurry in summer. We hope to have an experimental hot pond running next summer with a large area of cheap plastic air-mattress collecting solar heat. Then in the winter of 1981-82 we shall find out whether the hot pond stays hot.

The beauty of solar-pond technology, to my eyes, lies in the fact that your mistakes do not stay hidden for long. We made a mistake with the mylar dome; in two months the hail ripped it apart and we are ready to try something else. We made another mistake with our heat-engine. An important part of our original plan was to generate home-made electricity with a heat-engine, using the hot and cold ponds as heat-source and heat-sink. The ideal Carnot efficiency of an engine working between 140 degrees Fahrenheit and ice-temperature is twenty per cent, so we thought we could expect to run a real engine making electricity at ten per cent efficiency. We found a supplier in Florida who claimed he could sell us an engine for $12 thousand, putting out ten kilowatts of electricity. 1200 dollars capital cost per kilowatt, and zero cost for fuel, would compete quite well with central-station power. The Department of Energy people told us, in their lordly fashion, that the Florida engine was a pile of junk, but that only made us more determined to prove the Department of Energy wrong. We arranged with the designer in Florida that he would rent us one of his engines for three months. He drove it himself all the way from Florida to Princeton and proudly handed it over. The machine looked good, not like a pile of junk at all. The designer told us how he had run it in Florida using muddy swamp-water full of frogs for the cold end, and the machine handled the frogs smoothly without ever getting choked up. The whole deal looked very good, and so we paid our three months' rent with the option to purchase, and handed the machine over to one of our undergraduates to measure its performance carefully. A few weeks later the undergraduate reported his results. Unfortunately it turned out that the designer of the machine did not understand three-phase circuitry. All his numbers for electric power were too high by a factor of the square root of three. He was better at handling frogs than at handling complex numbers. The actual efficiency of the machine was six per cent and not ten. So we sadly shipped it back to Florida. Round two went to the Department of Energy.

The Prudential Insurance Company has never been enthusiastic about heat-engines. They are happy to buy their electricity from Public Service Electric and Gas, and have no wish to get into the utility business themselves. So it was easy to agree with them to go ahead with the solar heating and cooling experiments and drop the heat-engine for the time being. If all goes well with the heating and cooling, we can come back to heat-engines later.

That is the story of the Princeton Ice-Pond. I told you the story because it illustrates what I have in mind when I ask for a technology with a quick response. I am not claiming that solar ponds by themselves will solve the energy problem. Still less am I claiming that the little game we are playing in Princeton has demonstrated the existence of an economically viable solar pond technology. What I do claim is that solar ponds are an example of a technology free from the rigidities and the decade-long delays which have made both fission and fusion power unable to respond to urgent need. Solar ponds may or may not turn out to be cheap and effective. If they fail, they will fail quickly and we shall not have spent half a life-time proving them useless. If they succeed, there is a chance that they could be deployed rapidly on a very large scale. Sites could be surveyed, holes in the ground dug, and plumbing fixtures installed by thousands of local contractors responding to local demand. Plastic liners and pipes and solar collectors could be mass-produced in factories. A whole new industry could grow up in a few years like the industries of World War 2. All this is only a dream, or at best a remote possibility. But there is no reason why a new technology has to develop like fission and fusion on a thirty-year time-scale. All it needs in order to go fast is small size of units, simple design, mass production, and a big market. When I go out to the Forrestal Campus and see those two machines, the $300 million TFTR and our little ice-pond, what I see in my mind's eye is a dinosaur and an early primate. I wonder how long it will be before the next asteroid falls.

IV. Genetic Engineering

Finally I have to say something about genetic engineering. I left only a short time for this because I know so little about it. I will speak only in generalities because I am ignorant of details.

When I compare the biological world with the world of mechanical industry, I am impressed by the enormous superiority of biological processes in speed, economy and flexibility. A skunk dies in a forest; within a few days an army of ants and beetles and bacteria goes to work, and after a few weeks barely a bone remains. An automobile dies and is taken to a junk-yard; after ten years it is still there. Consider anything that our industrial machines can do, whether it is mining, chemical refining, material processing, building or scavenging; biological processes in the natural world do the same thing more efficiently, more quietly and usually more quickly. That, it seems to me, is the fundamental reason why genetic engineering must in the long run be beneficial and also profitable. It offers us the chance to imitate nature's speed and flexibility in our industrial operations.

It is difficult to speak of specific examples of things genetic engineering may do for us in the long run. Specific examples always sound too much like stories out of Astounding Science Fiction magazine. Fully aware of this danger, I mention three long-range possibilities which I take seriously. First, the energy tree, programmed to convert the products of photosynthesis into conveniently harvested liquid fuels instead of into cellulose. Second, the mining worm, a creature like an earthworm, programmed to dig into any kind of clay or metalliferous ore and bring to the surface the desired chemical constituent in purified form. Third, the scavenger turtle with diamond-tipped teeth, a creature programmed to deal in a similar fashion with human refuse and derelict automobiles. None of these creatures performs a task essentially more difficult than the task of the honey-bee with which we are all familiar. But it is a sound instinct which leads us to be distrustful of such grand ideas. If we pursue long-range objectives of this kind, we are likely to find ourselves involved in a twenty-year development program with all the inertia and inflexibility of a nuclear power program. The whole advantage of biological technology will be lost if we let it become rigid and slow.

So I would advise you to make your entry into genetic engineering in a thoroughly progmatic and opportunistic fashion, choosing projects which lead quickly to short-range objectives, choosing processes which fit conveniently into the framework of existing chemical and pharmaceutical industries. That is the way we went into nuclear engineering with the TRIGA reactor in 1956. And that is the way we should have continued in nuclear engineering if we had been a little wiser.

Above all, you should try to exploit the small scale and fine tuning of biological processes to achieve production facilities which are rapidly responsive to changing needs. Never sacrifice economies of speed to achieve economies of scale. And never let yourselves get stuck with facilities which take ten years to turn on or off. If you follow these simple rules, I believe there is a good chance you will help genetic engineering fulfil the promise of a cleaner and more liveable world for mankind, the promise which nuclear energy once made but was never able to fulfil.

A last brief word about bombs and genetic dangers. In my discussion of nuclear energy, I spoke only about reactors and not at all about bombs. In my opinion, the biggest mistake by far of the nuclear scientists was their enthusiastic pursuit of bombs. I cannot consider Three Mile Island to be an event in any way comparable with Hiroshima. The question then has to be faced, whether the pursuit of genetic engineering might expose us to dangers comparable with the dangers of nuclear weapons and nuclear war. I have thought a lot about this question and I believe the answer is no, with one essential proviso. The proviso is that the existing laws restricting experimentation on human subjects continue to be strictly enforced. In other words, genetic engineering must stop short of monkeying around with the species Homo Sapiens. So long as Homo Sapiens is left out of it, I do not see how genetic engineering can lead to military abuses significantly worse than the old-fashioned chemical and biological weapons with which we are unhappily familiar. And I do not see how genetic engineering can lead to accidental disasters in any way comparable with nuclear explosions. But do not take my word for it. Expect the unexpected. Keep a careful look-out for dangers ahead, and when something on the horizon looks bad, call a halt, blow the whistle, and try to find a different way to go. If the worst comes to the worst, there are other ways to make a living.

I do not think that any of the theoretically possible dangers of genetic engineering will turn out to be real. I think that the benefits of it will be large and important. So I wish you luck and joy in your share of the enterprise. The best luck that I can wish you is to have as much fun with genetic engineering as we had with the TRIGA reactor and with the Princeton Ice-Pond. Developing a new technology is a lot of hard work, but it is also a lot of fun. If it is not fun, then it is not likely to be either useful or profitable, and you had better stop and try something else.

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THE THIRD
ALBERT EINSTEIN LECTURE

will be presented by

FREEMAN J. DYSON, Ph.D.

Professor of Physics

Institute for Advanced Study

on

Wednesday, March 5, 1980, 8:00 P.M.

at

Caspary Auditorium

The Rockefeller University

York Avenue and 66th Street

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THE THIRD ALBERT EINSTEIN LECTURE

Wednesday, March 5, 1980

8:00 P.M.

Introduction

Heinz Pagels, Ph.D.
Professor
The Rockefeller University

"LIFE IN THE UNIVERSE"

Freeman J. Dyson, Ph.D.
Professor of Physics
Institute for Advanced Study
Princeton, New Jersey

In the historical development of ideas about the shape and size of the universe, astronomical observations and physical theories were freely mixed with speculations about the suitability of the cosmos as an abode of life. Only in recent times have cosmology and biology become separated. The separation occurred for reasons which were valid in the past but may no longer be compelling in the future.

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Dr. Joel Lebowitz (Rutgers University)
Dr. Heinz Pagels
(Chairman, Rockefeller University)

Tel. to wake F.D.

THE NEW YORK ACADEMY OF SCIENCES

The Albert Einstein Lecture Committee

Cordially Invites You To Attend

A Reception And Dinner

On

Wednesday, March 5, 6:00 p.m. Africa

At

Alfred E. Cohn Library

Abby Aldrich Rockefeller Hall

The Rockefeller University

York Avenue At 66th Street

To Honor

Freeman J. Dyson, Ph.D.

Prior To His Presentation Of

The Third Albert Einstein Lecture

At 8:00 p.m.

In Caspary Auditorium

The Rockefeller University

R.S.V.P.
Public Relations Department
The New York Academy of Sciences
(212) 838-0230

regretted
13 Feb 1980

Please Post

THE NEW YORK ACADEMY OF SCIENCES

THE THIRD ALBERT EINSTEIN LECTURE

MARCH 5, 1980 WEDNESDAY 8:00 P.M.

"LIFE IN THE UNIVERSE"

presented by

FREEMAN J. DYSON, PH.D.
PROFESSOR OF PHYSICS
INSTITUTE FOR ADVANCED STUDY

at

CASPARY AUDITORIUM
THE ROCKEFELLER UNIVERSITY
YORK AVENUE AND 66TH STREET
NEW YORK CITY

In the historical development of ideas about the shape and size of the universe, astronomical observations and physical theories were freely mixed with speculations about the suitability of the cosmos as an abode of life. Only in recent times have cosmology and biology become separated. The separation occurred for reasons which were valid in the past but may no longer be compelling in the future.

* * *

ADMISSION to the lecture is free of charge, however, a reservation should be made in advance by calling or writing to the Public Relations Department, The New York Academy of Sciences, 2 East 63rd Street, New York, New York 10021, (212) 838-0230.

* * *

These lectures are made possible through the generosity of the Joseph H. Hazen Foundation and are sponsored by The New York Academy of Sciences.

Hw

February 1, 1980

Professor Y. Gruder
Director General
The Wolf Foundation
P.O. Box 398
Herzlia Bet, Israel

Dear Professor Gruder:

Thank you for your letter of January 13, 1980 announcing the nomination of Professor Freeman J. Dyson for the 1980 Wolf Prize in physics.

Enclosed are the requested vitae, bibliography and description of scientific contribution.

I have asked Professors Elliot Lieb of Princeton University and Hans Bethe of Cornell to write supporting letters for Professor Dyson.

If I can be of any further help, please do not hesitate to contact me.

Sincerely yours,

VN

Valerie Nowak
Administrative Officer
School of Natural Sciences

Encls.
cc: Dr. H. Woolf, Director

FREEMAN J. DYSON

Description of Scientific Contribution

Freeman Dyson began research with a brief and successful career as a mathematician, before turning his interests in 1947-48 to the exciting new developments in physics involving the theory of quantized fields. (One still hears anecdotes about Dyson, the young physicist, being asked by young mathematicians who had seen his mathematical papers, whether he was related to the well-known mathematician Dyson.) Almost immediately upon his entry into theoretical physics, Dyson wrote two papers[1,2] on the foundations of quantum electrodynamics which have had a profound and lasting influence on many branches of modern theoretical physics. In his paper[1] on "The Radiation Theories of Tomonaga, Schwinger and Feynman," Dyson proved the equivalence of the equations-of-motion approach to field theory of Schwinger and Tomonaga with the diagrammatic rules of Feynman. In doing so, he introduced the interaction representation perturbation theory based on the U-matrix and its series expansion in terms of time-ordered products, which has remained the standard method for deriving the Feynman rules for a given physical system, both in the contexts of relativistic quantum field theories[3] and nonrelativistic many particle systems.[4] In the second paper[2] on "The S-Matrix in Quantum Electrodynamics," Dyson used the U-matrix approach to derive the Feynman rules for the general S-matrix element in electrodynamics, and then systematically analyzed the occurrence, and removal by renormalization, of divergences in the S-matrix. He introduced the criterion for the divergence of a given diagram in terms of external line counting, the various definitions ("vertex part," "self-energy part," "primitive divergent," etc.) which are essential in all analyses of Feynman graphs, and sketched how the divergences in electrodynamics can be absorbed order by order in perturbation theory in the unobservable electron bare charge and bare mass. Dyson's analysis of the renormalizability of electrodynamics has become a classic of modern theoretical physics, both appearing in the standard textbook treatments[5] and providing the motivation and model for much further work on renormalizable field theories, such as the unified renormalizable theories of electromagnetic and weak interactions formulated recently by Salam and Weinberg. A further important innovation in Dyson's "...S-Matrix..." paper is his formulation of integral equations (now called Dyson's equations) which give a nonperturbative meaning to the Feynman-Dyson perturbation series. These equations play an important role in the theory of many particle systems,[6] and find a particularly significant application in modern formulations of the theory of superconductivity,[7] where a nonperturbative treatment is essential.

In the years subsequent to his work in electrodynamics, Dyson has done important research on a large variety of problems in theoretical physics. One of his significant interests has been in the area of analyticity properties of scattering amplitudes. In collaboration with Castillejo and Dalitz, he analyzed[8] the properties of Low's scattering equation and showed that its solution contains an infinite number of adjustable parameters; these so-called Castillejo-Dalitz-Dyson poles play an important role in the application of dispersion theory methods to scattering problems, in particular in the formulation of Levinson's theorem[9] relating the change in the phase shift between zero and infinite energy with the number of bound state poles. A second important contribution by Dyson to the analyticity program was his ingenious paper[10] extending the Jost-Lehmann representation for causal commutators to the unequal mass case, by using Huygen's principle for the six-dimensional wave equation. The extended result, called the Jost-Lehmann-Dyson representation, is a starting point for deriving such analyticity properties of scattering amplitudes as fixed momentum transfer dispersion relations.[11] Another important paper by Dyson in this area was his theorem on the connection between analyticity of the Wightman functions (vacuum expectation values of products of field operators) of a field theory and the so-called weak local commutativity property.[12]

Another of Dyson's major interests, extending over a period of many years, has been statistical physics. One facet of this work has involved the study of the excitation spectra of disordered systems. In a beautiful and important paper, Dyson studied the dynamics of a disordered linear chain[13] and brought into tractable form the problem of evaluating, in the limit of infinite chain length, the distribution function of normal mode frequencies. In a long series of papers Dyson, and Dyson and Mehta worked out a theory of the statistical behavior of energy levels in complex quantum mechanical systems,[14,15] and applied the theory to cases of interest in nuclear physics. A second facet of Dyson's statistical work has involved the study of magnetic systems and phase transitions. In two early papers[16] he developed a systematic theory of spin wave interactions and applied it to the study of the low temperature thermodynamic behavior of an ideal ferromagnet. He proved conditions for phase transitions in a class of one-dimensional Ising models,[17] and in his most recent paper[18] (in collaboration with E. Lieb and B. Simon) proves the existence of a phase transition in the three-dimensional nearest-neighbor Heisenberg model. A final and major facet of Dyson's statistical work has been his work with Lenard giving a rigorous proof of the stability of matter,[19] starting from the general N-body Schrödinger equation for a system of charged particles. This work has stimulated important further developments by other workers in rigorous statistical mechanics, and constitutes a basic link in the chain of reasoning that leads from the microscopic laws of atomic physics to the laws of behavior of matter in bulk.

The above survey of Dyson's research accomplishments only touches on some of the highlights of a long and varied research career. In addition to the research detailed above, Dyson has made contributions[20] in such diverse areas as particle physics, astrophysics and relativity, optics, biophysics and combinatorics. He has written excellent reviews (see, for example, his survey on "The Fundamental Constants and Their Time Variation"[21]), has helped popularize science through articles in the Scientific American and the New Yorker, has contributed to the public debate on scientific-political questions (see, in particular, his provocative and still-timely article[22] on "The Hidden Costs of Saying No"), and has contributed to the national defense. As the senior member of the physics Faculty at The Institute for Advanced Study, Dyson has played an important role in maintaining a strong physics group at the Institute during the last nineteen years.

References

[Note: Wherever possible, I have given textbook or monograph references to Dyson's work, as well as the references to the original articles. Many of the articles cited below have been included in reprint collections, as noted in the full bibliography.]

1. Freeman J. Dyson, "The Radiation Theories of Tomonaga, Schwinger and Feynman". Phys. Rev. 75, 486 (1949).
2. Freeman J. Dyson, "The S-Matrix in Quantum Electrodynamics", Phys. Rev. 75, 1736 (1949).
3. See, for example, J. D. Bjorken and S. D. Drell, Relativistic Quantum Fields (McGraw-Hill, New York, 1965), Chapter 17.
4. See A. L. Fetter and J. D. Walecka, Quantum Theory of Many-Particle Systems (McGraw-Hill, New York, 1971), Section 6 and 20.
5. J. D. Bjorken and S. D. Drell, Ref. 3, Chapter 19.
6. A. L. Fetter and J. D. Walecka, Ref. 4, pp. 105-111, 211-214; A. A. Abrikosov, L. P. Gorkov and I. E. Dzyaloshinski, Methods of Quantum Field Theory in Statistical Physics (Prentice-Hall, New Jersey, 1963) Secs. 10 and 16.
7. J. R. Schrieffer, Theory of Superconductivity (W. A. Benjamin, New York), Sec. 7-2.
8. L. Castillejo, R. H. Dalitz and F. J. Dyson, "Low's Scattering Equation for the Charged and Neutral Scalar Theories", Phys. Rev. 101, 453 (1956).
9. See R. J. Eden, High Energy Collisions of Elementary Particles. (Cambridge University Press, 1967), Sec. 3.5.
10. Freeman J. Dyson, "Integral Representations of the Causal Commutators", Phys. Rev. 110, 1460 (1958).
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14. Freeman J. Dyson, "Statistical Theory of the Energy Levels of Complex Systems, I, II, III", J. Math. Phys. 3, 140, 157, 166 (1962); Freeman J. Dyson and Madan Lal Mehta, "Statistical Theory of the Energy Levels of Complex Systems IV, V", J. Math. Phys. 4, 701, 713 (1953).

15. An expository account of the work of Ref. 14 can be found in M. L. Mehta, Random Matrices and the Statistical Theory of Energy Levels (Academic Press, New York, 1967).

16. Freeman J. Dyson, "General Theory of Spin-Wave Interactions", Phys. Rev. 102, 1217 (1956); "Thermodynamic Behavior of an Ideal Ferromagnet", Phys. Rev. 102, 1230 (1956).

17. Freeman J. Dyson, "Existence of a Phase-Transition in a One-Dimensional Ising Ferromagnet", Comm. Math. Phys. 12, 91 (1969); "Non-Existence of Spontaneous Magnetization in a One-Dimensional Ising Ferromagnet", Comm. Math. Phys. 12, 212 (1969).

18. Freeman J. Dyson, Elliott H. Lieb and Barry Simon, "Phase Transitions in the Quantum Heisenberg Model", submitted to Phys. Rev. Letters in May, 1976.

19. Freeman J. Dyson and A. Lenard, "Stability of Matter I; II", J. Math. Phys. 8, 423 (1967); 9, 698 (1968).

20. See the full bibliography, Part 5.

21. Freeman J. Dyson, "The Fundamental Constants and Their Time Variation", in Aspects of Quantum Theory, A. Salam and E. P. Wigner, eds. (Cambridge University Press, 1972).

22. Freeman J. Dyson, "The Hidden Costs of Saying No", Bull. Atomic Scientists 31, 23 (1975).

November 12, 1979

Dear Freeman:

Have a happy trip and a safe return.

As always, we are all enhanced by your accomplishments.

Cordially yours,

Harry Woolf

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

HW

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

November 9, 1979

Dr. Harry Woolf
Director

Dear Harry:

I think I ought to let you know that I am making a trip to England for the week of November 19-24 to celebrate the British publication of my book. This will mean a radio interview and a few meetings with scientific colleagues. I shall try not to bring our Institute into disrepute.

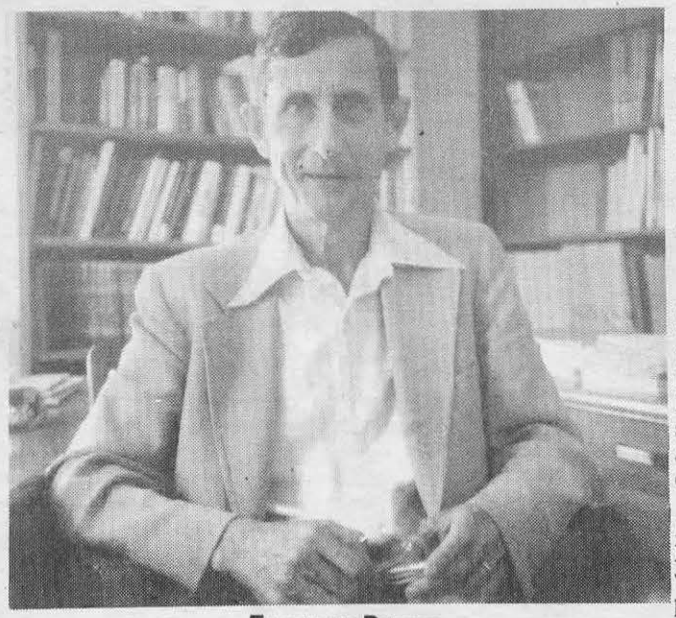
Yours sincerely,

Freeman

Freeman Dyson

pb

Freeman Dyson: a Firm Believer in Mankind's Need to Achieve Creative, Not Destructive, Goals for Science and Technology



Freeman Dyson

"A Resonant Book Can Move the World"

"When a book hits a really deep resonance, it moves the world."

Having said that, Freeman Dyson recalls the impact of Rachel Carson's anti-insecticide book, "Silent Spring." He believes there is "a fighting chance" that his autobiography, "Disturbing the Universe," may have that resonance. The book has just been published, following serialization of about half of it in The New Yorker.

"The first thing is to get the attention of the public to what I've always believed in: making a moral distinction between defensive and offensive weapons. The world should be ready for that.

"This doctrine of mutually assured destruction that all my friends seem to believe in! Everyone in government, even professors here at the Institute, believe the one thing you must do is keep the offensive weapons overwhelmingly effective.

"I think there is a chance people have had enough of that."

Here for 25 Years. Sinewy and silent, with fine inner tensions, Freeman Dyson is a man with a deep resonance of his own. A mathematician and astrophysicist of world renown, he has been at the Institute for Advanced Study for 25 years. He is, quite clearly, a person who is interested in and excited about everything that goes on, or has gone on, or will perhaps one day go on, in the universe.

He has even been a member of Princeton's Parent-Teacher Organization.

"Of course! I've had six kids in the Princeton public schools." (One was graduated from Princeton High in June, one is there now, one is in the Middle School.)

In Princeton, outside the Institute, he is remembered for his work on the 11-member citizens committee that pondered the problem during most of 1977, of controlling recombinant DNA research.

Early in "Disturbing the Universe," Dr. Dyson makes it clear that he is talking to "unscientific people, who ultimately have the responsibility for guiding the growth of science and technology in creative rather than destructive directions."

The Princeton Community Committee on Research with Biohazardous Material had just that responsibility: to decide whether research on recombinant DNA should be allowed in Princeton or if so, at what level of hazard. Some of its members were hardly "unscientific people" — witness Dr. Dyson — but it was a group selected from a cross-section of the community.

"The first thing is to get the attention of the public to what I've always believed in: making a moral distinction between defensive and offensive weapons. The world should be ready for that."

A Fascinating Experience. "I wasn't expert at all in biology — I learned the science, on that committee, and found it fascinating.

"It was absorbing, getting to understand in depth that the others were feeling, and seeing those issues through 11 pairs of eyes. I had a great time: as a human event, it was one of the most rewarding I've ever been involved in.

"Then, of course, there was disillusionment, when Borough Council disregarded our advice and nothing happened for eight months. However, when they finally got around to studying and acting, then it became clear that it had all been worthwhile."

Council passed an ordinance in March, 1978, allowing recombinant DNA research at the so-called P-3 level of security, with strict guidelines, as recommended by the citizens' committee.

An Object Lesson. "Democratic processes do tend to be a bit slow, but it was a fine object lesson in how public participation can actually work — provided you don't have to act quite fast."

The two DNA chapters in "Disturbing the Universe" were not in The New Yorker. One chapter describes the events in Cambridge, where the institution involved was Harvard; another tells about the Princeton community and Princeton University.

"I believe the one glaring omission in our Princeton DNA committee was industry, and I very much regretted this. It is sad that people regard those who work for industry as second-class persons. There is academic snobbery in Princeton, you know, and a general feeling that people in industry aren't to be trusted.

"On our DNA committee, discussions of possible commercial or industrial DNA research were most uninformed, because there were no representatives."

An Early Start. Now in his mid-50s, Dr. Dyson said he surprised himself by writing his autobiography at this point in life.

"I'd always thought I'd do it when I was 70."

New Yorker readers suspected he might have written his autobiography in reply to "The Starship and the Canoe," Kenneth Brower's 1978 book about the relationship between Dr. Dyson and his son, George, who builds canoes in British Columbia.

Not at all, Dr. Dyson explains. He was well into his own book when Brower's came out, and feels only some embarassment that they have been published so close together.

The decision to write "Disturbing the Universe" came after a Phi Beta Kappa lecture tour to eight small colleges.

"I visited such places as Moscow, Idaho and Greenville, South Carolina, and the more remote the campus, the warmer they were, of course." The "of course" says that there is an obvious corollary between remoteness and hospitality.

Anecdotes Appeal. "I found out that what these kids were turned on by was not so much the substance of science, as the anecdotes. They wanted to know what it felt like to be a scientist, and I felt it would be a good idea to write it all down."

By coincidence, unaware of his decision, the Sloan Foundation invited him to write for its science book program. He accepted and they gave him an advance,

Continued on Page 12B

Freeman Dyson

Continued from Page 1B

"so I could sit quietly for six months and work." He completed the book over the 1978 summer.

This summer, before visiting son George in British Columbia, he spent two months in California studying carbon dioxide, "a politically hot subject, since the synthetic fuel proposals."

To an offhand remark about the deleterious effects of carbon dioxide, he has indignant response:

"That's the trouble! Everyone talks about deleterious effects! The media have this one-way filter that only accepts gloomy information."

No Use Guessing. "Is it deleterious or beneficial? The fact is, we know only a few things and they are evenly split. It may be good, or there may be bad effects so it's absurd to try and guess how it will come out. Mostly, we need measurements."

He adds that the problem is now being studied "in massive fashion" by the group he worked with in California. Dr. Dyson would like to see programs for the development of all forms of energy "because one can't possibly tell in advance which are going to be the good ones."

Although he had spoken of disillusionment with Borough Council's delay in implementing the recommendations of the DNA committee, he believes it's a "terrible mistake" to make choices too soon.

"Politicians always want something right now!"

Carbon dioxide is only part-time for Dr. Dyson. With the academic year about to begin, he's about to return to what he calls "real science" — mathematics or physics — but he does not yet know what particular aspect of "real science."

Another Book Planned. The next Dyson book may well deal with military doctrines.

"I was a very strong pacifist at the start of World War II, although that feeling was driven out by events. I disagree so strongly with the military doctrines we're living by at the moment, and I certainly have something to say."

Dr. Dyson was involved in negotiations for the original 1963 test ban treaty — "an exciting time, a great piece of luck to be there at the center of things during that period.

"SALT II? It's a wonderful example of how offensive strategies have run into a complete dead end. I'm all in favor of the treaty, but it's such a feeble thing! And if we continue with our present strategy, we'll never get anything significantly better. If there could be a fundamental change in mood, SALT III might be quite different.

"An optimist? Of course, I'm an optimist! That's what the book is about."

It is also, of course, about Freeman Dyson, a scientist whose imagination vaults the stars, whose son builds canoes in British Columbia and whose life has clearly been infused with poetry.

A Welcome Discovery. Not so much poetry as he'd like, these days.

"I'm terribly illiterate about modern poetry — I just discovered Robinson Jeffers! Dorothy Commins put me onto him in her book about her husband, who had been Jeffers's editor." (Mrs. Commins, another Princeton resident, recently published a book about her husband, the editor Saxe Commins.)

"Jeffers is an anti-humanist, and puts the case most marvellously against the optimistic view. I like to understand both sides."

Freeman Dyson's autobiography begins with a sentence about a small boy — himself — high in a tree reading a book. Freeman's son, George, lives in a tree-house 95 feet up in a Pacific Northwest Douglas fir.

Did the father start his autobiography with that sentence because the son now lives in a tree? Only the breath of a pause, a smile.

"Yes."

—Katharine H. Bretnall

TOWN TOPICS is delivered without charge to every home in Princeton Borough and Township and to part or all of West Windsor, Lawrence, Hopewell, Montgomery, South Brunswick and Franklin Townships and Griggstown. At all newsstands, including **TOWN TOPICS'** office, it costs 20 cents.

Weddings

Continued from Page 7B

Grochala, son of Mrs. Stella Grochala of Trenton and the late Peter Grochala; August 18 in St. Paul's Roman Catholic Church.

The bride, a graduate of Notre Dame High School and Rider College, is a computer programmer for Petrodata in Princeton. Her husband, a superviser for data processing at Worthington Biochemical in Freehold, graduated from Mercer County Community College and attended Rider College.

The couple will live in Hamilton Township.

Neale-D'Alesio. Maria D. D'Alesio, daughter of Mr. and Mrs. Dominick D'Alesio of Hopewell Township, to David L. Neale, son of Mr. and Mrs. Robert Neale of Caledonia, N.Y.; July 7 in St. James Church in Pennington. The couple now lives in Caledonia.

Mrs. Neale, a graduate of Hopewell Valley Central High School and the Eastman School of Music, teaches music in Caledonia. Mr. Neale attended Monroe Community College and is employed by the Caledonia Lines.

Brodeur-Quick. Carol G. Quick, daughter of the Rev. and Mrs. Bernard E. Quick of Lawrenceville, to Gregg G. Brodeur, son of Mr. and Mrs. Rene H. Brodeur of Wilmette, Ill.; June 23 in the Lawrenceville Presbyterian Church, with the bride's father officiating.

Miss Quick graduated from the University of Wisconsin with a B.S. degree in education. Mr. Brodeur received a B.A. degree in geography and urban planning, also from Wisconsin. The couple live in Trenton.

Punia-Berger. Sheryl D. Berger, daughter of Dr. and Mrs. Harold Berger of Lawrenceville, to Joseph D. Punia, son of Mr. and Mrs. Leonard Punia of Princeton; August 12 at the home of the bride's parents.

Mrs. Punia, a graduate of Lawrence High School and the University of Maryland, teaches language arts at the Hightstown Intermediate School. Mr. Punia graduated from Princeton Day School, Carnegie Mellon University, and Wharton Graduate School of Business. He is employed by Punia Company, a mortgage-brokerage firm.

The couple live in Lawrenceville.

Edmondson-Moore. Lisa C. Moore, daughter of Mr. and Mrs. Neil E. Moore of Lawrenceville, to David J. Edmondson, son of Mr. and Mrs. John H. Edmondson of Maryville, Tenn.; August 11 in Maryville. The couple live in Knoxville, Tenn.

A graduate of Lawrence High School, the bride attends the University of Tennessee. Her husband graduated from the University of Tennessee at Chattanooga and is a contractor with the Tennessee Valley Insulation Company in Knoxville.

Scivoletti-Petruska. Florence M. Petruska of Plainsboro, daughter of Mr. and Mrs. Stephen Petruska of South River, to Dr. Peter D. Scivoletti, son of Mr. and Mrs. Peter Scivoletti of Jersey City; August 11 in South River. The couple will live in North Brunswick.

The bride, a respiratory therapist at Princeton Medical Center, received a B.S. degree in health services administration from Quinnipiac College in Hamden, Conn. Dr. Scivoletti, a graduate of St. Peter's College in Jersey City and Hahnemann Medical College in Philadelphia, is a board certified internist and an instructor in medicine at Rutgers Medical School.

Barbati-Melchiondo. Christine M. Melchiondo, daughter of Mrs. Madeline Melchiondo of Yardley, Pa., and the late Louis F. Melchiondo, to Donald C. Barbati, son of Orlando Barbati of Old Bridge and the late Mrs. Barbati; August 5 in the Princeton University Chapel.

The bride, who is employed by Dr. George Isaacson of Princeton, graduated from Pennsbury High School and attended Trenton State College. Her husband, deli manager at Davidson's market on Nassau Street, graduated from Perth Amboy High School and attended Middlesex County College.

The couple live in Hamilton Square.

Correction

In the announcement last week of the engagement of Elizabeth Partridge of 529 Prospect Avenue to F. Douglas Raymond III, a senior at Harvard, Mr. Raymond should have been identified as a member of the Fly Club at Harvard.

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

Dr Woolf
Director's Office

June 5 1979

Dear Harry

I send you this because you have a right to be informed about any political activity of your faculty. If you feel like adding your name to our statement, I will be surprised and pleased.

Yours

Freeman Dyson.

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
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SCHOOL OF NATURAL SCIENCES

June 4, 1979

Bir Zeit University

Attached is a letter to Menachem Begin, a statement for newspaper publication, and a translation of the Ha'aretz statement of 60 Israeli academics. Please add your signatures to the first two documents. We intend to send the newspaper statement to both Israeli and American papers.

I visited Bir Zeit University in 1977 and can certify that it is a serious academic institution doing a remarkable job of education under difficult circumstances. I have met with an American eye-witness (Ann Lesch of the Ford Foundation) who was at Bir Zeit on May 2. Her report makes clear that there is no legal or moral justification for keeping the university closed. A lengthy closure may well do irreparable damage to the university and to its students.

Freeman Dyson

Enclosures

Princeton, New Jersey
June 4, 1979

The Honorable Menachem Begin
Office of the Prime Minister
Jerusalem, Israel

Your Excellency:

The undersigned residents of the Princeton area respectfully request you to order the necessary steps to reopen Bir Zeit University. Like the many Israeli academics who published their statement in Ha'aretz on May 21, we feel that "the order (to close the University) serves to obscure the distinction between criminal acts and the free expression of political views," by "imposing collective punishment on the students."

Sincerely yours,

(titles listed for identification purposes only)

Princeton, New Jersey
June 4, 1979

Statement for newspaper publication.

Bir Zeit University

The undersigned residents of the Princeton area support the call of the 60 Israeli academics for the reopening of Bir Zeit University, which we reprint here.

We hope that after the University is reopened, a clear distinction will be made between individual actions punishable under the criminal codes in force on the West Bank and the educational functions of a University, which must include the free expression and discussion of opinions, including political opinions however much one may agree or disagree with them.

CALL TO OPEN WEST BANK COLLEGES

We view with concern the decision of May 2, 1979 by the Military Governor of the Ramallah District to close Bir Zeit University for an indefinite period. The closure order was issued without a full investigation of the disturbances attendant upon the Independence Day procession of Gush Emunim supporters through the village of Bir Zeit. In contravention of the spirit of due legal process, it arbitrarily places responsibility for the disturbances upon Bir Zeit University by imposing collective punishment on the students--deprivation of the right to pursue an education.

In the name of security, the order serves to obscure the distinction between criminal acts and the free expression of political views. At a time when our government is shaping policy concerning autonomy, freedom of discussion is more, not less, imperative. In such circumstances, the closure of Bir Zeit University and other West Bank institutions of higher education will be construed as an attempt to suppress opinions contrary to those of the Israeli authorities.

The closing down of the University denies the tenet of democracy, free speech, and free thought. As Israeli educators, we are under special obligation to assure that Palestinian Arabs are secure in the same rights we demand for ourselves, including the right to higher education.

Advertisement in Ha'aretz, May 21, 1979, signed by 60 Israeli university professors and lecturers. Among them are:

Micah Ardon, Physical Chemistry, Hebrew University
Peter Hillman, Neurobiology, Hebrew University
Solly Cohen, Physics, Hebrew University
Zvi Lam, Law, Tel Aviv
Tuvia Shlonsky, Literature, Hebrew University
Shlomo Alexander, Physics, Hebrew University
Galia Golan, International Relations, Hebrew University
Moshe Greenberg, Professor of Bible, Hebrew University
Ernst Simon, Education, Hebrew University (retired)
Saul Foguel, Mathematics, Hebrew University
Matitiyahu Peled, Political Science, Hebrew University
Hagit Shlonsky, Sociology, Hebrew University
A. B. Yehoshua, author
Aharon Antonovsky, Medical Sociology, Beersheva

February 6, 1979

Dear Freeman:

Thank you very much for yours of 31 January 1979, informing me of your forthcoming Australian trip. Of course, there is no objection to your undertaking it.

I would take it as a great kindness, however, if you would share with me the program descriptions or any lecture titles, as well as a list of the institutions you are to visit for it would enable me to add such attractive information to my efforts, financial and otherwise, on behalf of the Institute.

Sincerely yours,

Harry Woolf

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

January 31, 1979

Dr. Harry Woolf
Director

Dear Harry,

I have accepted an invitation from the Australian Academy of Sciences to give one of the main speeches at their 25th Anniversary celebration at the end of March. This will also involve two weeks of travelling around and lecturing at various Australian universities. I hope you will have no objection to my doing this. It means that I shall be away from March 20 to April 15. I shall be back here from April 15 to June 15. I think the trip is worthwhile as it enables me to keep in touch with a lot of interesting things that are going on in Australia.

Yours sincerely,

Freeman Dyson

Freeman Dyson

January 24, 1979

Dear Freeman:

Thank you very much for your help in the preparation of the Institute brochure. I am grateful for your criticisms and corrections, and have incorporated the changes you suggested.

Sincereely,

John Hunt
Associate Director

Professor Freeman J. Dyson
School of Natural Sceiences
Institute for Advanced Study

July 21, 1978

Dr. Philip Handler
President, National Academy of Sciences
2101 Constitution Avenue NW
Washington, DC 20418

Dear Dr. Handler:

I am enclosing a copy of a letter which came to me from Jerusalem a few days ago without any signature. In case you do not know what Birzeit University is, I should explain that it is a bona fide university operating on the West Bank about 50 kilometers north of Jerusalem. I visited the university briefly a year ago and was favorably impressed with what they are doing. The head of the physics department happened to have been in my quantum mechanics class at Columbia 20 years ago. So far as I could tell, the university is doing a creditable job in providing higher education for the inhabitants of the West Bank, and is doing its best to remain non-political under very difficult circumstances.

I have no independent verification of the facts alleged in the enclosed letter, but I have no reason to doubt that the statements in it are largely true. The fact that the letter is unsigned is unfortunate but understandable in the circumstances. I am now requesting you to bring this matter on an official level to the attention of the public and of the Israeli government. If the facts are not as reported in this letter I will be happy to admit that I misjudged the situation. Thanking you for your help, I am,

Yours sincerely,

Freeman Dyson

FD:pb

Encl.

July 21, 1978

Professor George S. Hammond
Foreign Secretary, National Academy of Sciences
Dept. of Chemistry
University of California
Santa Cruz, CA 95064

Dear Professor Hammond:

I am enclosing a copy of a letter which came to me from Jerusalem a few days ago without any signature. In case you do not know what Birzeit University is, I should explain that it is a bona fide university operating on the West Bank about 50 kilometers north of Jerusalem. I visited the university briefly a year ago and was favorably impressed with what they are doing. The head of the physics department happened to have been in my quantum mechanics class at Columbia 20 years ago. So far as I could tell, the university is doing a creditable job in providing higher education for the inhabitants of the West Bank, and is doing its best to remain non-political under very difficult circumstances.

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Yours sincerely,

Freeman Dyson

Encl.

July 21, 1978

The Editor
"Science" Magazine
1515 Massachusetts Ave. NW
Washington, DC 20005

Dear Sir:

I am enclosing a copy of a letter which came to me from Jerusalem a few days ago without any signature. In case you do not know what Birzeit University is, I should explain that it is a bona fide university operating on the West Bank about 50 kilometers north of Jerusalem. I visited the university briefly a year ago and was favorably impressed with what they are doing. The head of the physics department happened to have been in my quantum mechanics class at Columbia 20 years ago. So far as I could tell, the university is doing a creditable job in providing higher education for the inhabitants of the West Bank, and is doing its best to remain non-political under very difficult circumstances.

I have no independent verification of the facts alleged in the enclosed letter, but I have no reason to doubt that the statements in it are largely true. The fact that the letter is unsigned is unfortunate but understandable in the circumstances.

I am now requesting that you make this letter public, either as a letter to the Editor under my name, or as an item in one of your news columns, with an explanation of the circumstances. I have considered carefully whether making it public is likely to do more harm than good to the people named in it, and I have concluded that this is a risk I am willing to accept. The fact that they sent the letter out presumably means that they wish to have it made public. If the letter is too long for you to publish in full, you may publish excerpts from it at your discretion, but I hope you will not find it necessary to do this.

Yours sincerely,

Freeman Dyson

Encl.

جامعة بيرزيت

BIRZEIT UNIVERSITY

P. O. BOX 14 BIRZEIT . PHONE (95) 2428

July 1, 1978

TO WHOM IT MAY CONCERN

Birzeit University protests the serious and unprecedented interference with its normal and legitimate academic operation by the Israeli military occupation authorities. This interference has latterly taken the form of denying work permits and imposing other restrictions on sixteen Birzeit University faculty members.

I. Since 1974, the University has been required by the Israeli Military Governor of the Ramallah District to file requests for work permits for its foreign faculty members and employees. Only after securing a work permit was a foreign faculty member eligible to apply for a temporary residence permit. The University has acceded to what was presumably a routine process and has duly submitted work permit requests in writing well in advance of the beginning of each academic year, with all the information required by the military authorities. The requests for the past academic year, October 1, 1977 to July 7, , 1978, were filed between February and August, 1977.

The response of the Ramallah Military Governor to these requests is usually communicated to the University verbally by telephone, never in writing. The Military Governor often delays his response to these work permit requests for up to one year (in one case three years). This delaying tactic tends to demoralize both the University and the individual faculty members, to undermine contractual agreements, and to disrupt academic planning for the future.

By January, 1978, 16 of the 19 current requests for work permits (some of which had been filed almost a year previously) had still not been approved. For the next few months the University was in constant touch with the office of the Military Governor. The latter and his assistants gave inconclusive and sometimes contradictory responses.

In April, the Military Governor informed the University that seven of the pending applications of foreign passport holders had been rejected. He declared that these seven must cease working at Birzeit University and leave the country immediately. He later relented and allowed the seven to remain until the end of the academic year, July 7, 1978.

The Military Governor and his assistants repeatedly refused to give any reasons for the decisions. He further refused even to meet with the seven faculty members on the grounds that he was "too busy".

Early in June another Palestinian professor, Wasif Abboushi who holds an American passport, was summoned to the Ramallah headquarters of the Military Governor and told by an officer that he would not be issued the work permit he had previously been promised and that he was forbidden to work at Birzeit University. In response to all of his questions about the reasons behind the decision and its implications, Prof. Abboushi was told by the officer, "No questions!"

These eight (7 + 1) faculty members are:

Name	Citizenship	Age	Degree & Field	Rank & Dept.
Wasif Abboushi	U.S.A. (Palestinian)	47	Ph.D. (Cincinnati) International Law/Pol.Sc.	Professor Middle East Studies Dept.
E. Robert Adkins	U.S.A.	61	Ph.D. (Columbia) Education	Professor Education and Psychology Dept.
Said Atamneh	U.S.A. and Israeli (Palestinian)	41	Ph.D. (Missouri) Accounting	Asst.Professor Business Admin. Dept.
Hugh Harcourt	U.S.A.	48	Ph.D. (Edinburgh) Philosophy	Associate Prof. Cultural Studies
Donald Holroyd	U.S.A.	51	M.A. English (Clairmont)	Lecturer Dept.of English

Name	Citizenship	Age	Degree & Field	Rank & Dept.
Walter Lehn	Canadian	52	Ph.D. (Cornell) Linguistics	Professor Dept.of English
Richard Lorch	British	36	Ph.D. (Manchester) History of Science	Asst. Professor Mathematics Dept.
Nafez Nazzal	U.S.A. and Jordanian (Palestinian)	37	Ph.D. (Georgetown) Political Science	Associate Prof. Middle East Studies Dept.

II. In the summer of 1977, the Ramallah Military Governor informed the University by telephone that it would have to start filing applications for work permits for its Israeli Arab faculty members, something which had never previously been required. However, the University also acceded to this demand. In December 1977, the Military Governor informed the University that all these applications had been rejected. Again, no explanation was given for the decisions. Furthermore, two of these faculty members received restraining orders that forbade them even to enter the West Bank. These Israeli Arab faculty members are:

Bakr Abu-Kishek	Israeli	51	Ph.D. (Iowa Tech.) Agricultural Economics	Asst. Prof. Dept. of Economics
Suleiman Basheer	Israeli	31	Ph.D. (London) Political Science	Asst. Prof. Middle East Studies Dept.
Mahmoud Miari	Israeli	35	M.A.(Hebrew U.) Sociology	Instructor Sociology and Anthropology
Riyad Miflih (restraining order)	Israeli	30	M.Sc. Biochemistry	Lecturer Chemistry Dept.
Munther Nijm (restraining order)	Israeli	28	M.A.(No. Texas st.) Economics	Instructor Business Admin. Dept.
Edward Sader	Israeli	27	M.Sc. (Hebrew U.) Physics	Lecturer Physics Dept.
Ghassan Yaseen	Israeli	27	M.Sc. Physics (Hebrew U.)	Instructor Physics Dept.

III. The case of Mr. Fawwaz Zaidan (a Palestinian with a Jordanian passport , age 31, M.A. in Arabic, Instructor in the Department of Arabic).

Mr. Zaidan was employed by the University in October 1974. He had requested a family reunion permit which would grant him residence in the West Bank. He qualified for the permit since he was born in the West Bank, is unmarried, and his widowed mother has resided continuously in the West Bank. However, his application was rejected. Mr. Zaidan spent a whole year here on temporary visitor's permit. He was then granted a one-year residence permit for the academic year 1975/76. In November 1976, his application for renewal was rejected. Since the academic year had already started, he continued teaching.

In March 1977, the Authorities demanded that the University fire him. The demand was rejected by the University and in April 1977 the Authorities permitted him to continue for three more months until the end of the semester. In the meantime, Mr. Zaidan obtained a stay of execution against his deportation from the Israeli Supreme Court.

In March 1978 he was jailed for eighteen days although he was not charged with any offense. Upon his release, the military authorities confiscated his Jordanian passport and have recently (June 21) informed the University that the passport had been "lost". In effect, the same authorities who have attempted to deny Mr. Zaidan an opportunity for employment on the West Bank have now made it impossible for him to leave to seek employment or professional advancement elsewhere. Without a passport or any other kind of official identity certificate, Mr. Zaidan dare not even travel outside of the small town of Birzeit for fear of being stopped at a check point. If picked up by the Israeli army without identity papers he would immediately be jailed for violating the military security regulations. He can perhaps comfort himself in this peculiar situation by reading works of Franz Kafka.

In summary, these sixteen members of the faculty of the University, out of a total of 84, are being forced to leave the West Bank and their professional responsibilities at Birzeit University. They include seven Israeli citizens, six Americans, one Britisher, one Canadian, and one Jordanian passport holder. Eleven academic departments of the University are affected by this series of arbitrary and unexplained measures. If these decisions of the military authorities are allowed to remain unchallenged, the program of the University will be seriously impeded. Furthermore, they would establish an extremely dangerous precedent for the infringement by the military authorities of the independence and integrity of the University. Such an attack on the academic freedom of the institution, namely, the hiring of faculty through an open and competitive process based on academic competence, cannot be accepted. This attack not only violates the fundamental academic integrity of the University, but also makes it incapable of fulfilling its commitments to its faculty and students and the community in which it exists.

These actions of the military authorities must be viewed in the context of other attempts by the authorities to inhibit the work of the University. These include the imposition of extremely heavy custom duties on its imports of educational equipment, closing the university for two weeks in December 1973, deporting its president, Dr. Hanna Nasir, in November 1974, forcible intrusions of military units onto the campus (especially in March 1976), and numerous arrests, interrogations, and other harrassments of its students, usually without any charge or legal proceedings.

We are anxious for the military authorities to turn their energies to other matters and allow Birzeit University to resume its proper and legal work.

July 12, 1978

Dear Freeman:

I was away when you sent over the two recent offprints from the proceedings of the American Philosophical Society and the other from "Science." Thank you so much. I look forward to reading the review and to reexamining, having already heard from you directly, the issue of Pilgrim Fathers and Space Colonists.

Thank you again.

Cordially yours,

Harry Woolf

Professor Freeman Dyson
School of Natural Sciences

Reprint Series
12 May 1978, volume 200, pages 677-678

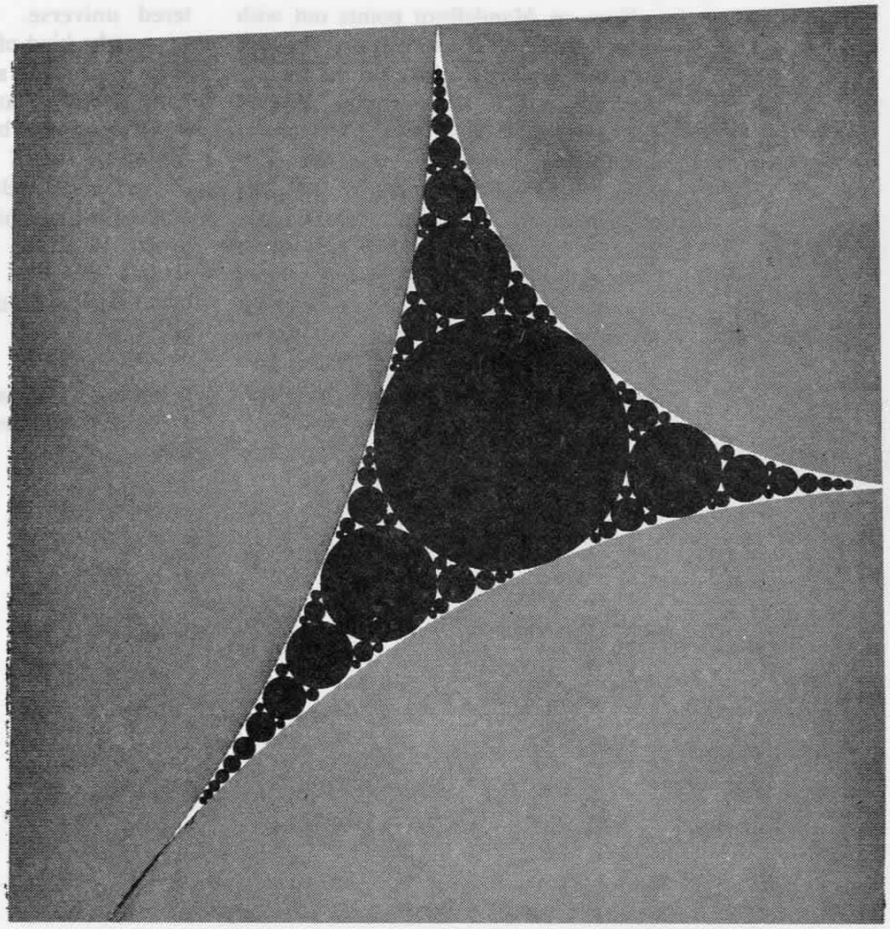
SCIENCE

Characterizing Irregularity

Fractals. Form, Chance, and Dimension. BENOIT B. MANDELBROT. Translation and revision of French edition (Paris, 1975). Freeman, San Francisco, 1977. xviii, 366 pp., illus. $14.95.

"Fractal" is a word invented by Mandelbrot to bring together under one heading a large class of objects that have certain structural features in common although they appear in diverse contexts in astronomy, geography, biology, fluid dynamics, probability theory, and pure mathematics. The essential feature of a fractal is a fine-grained lumpiness or wiggliness that remains inherent in its texture no matter how thin you slice it. In an article in *Science* 11 years ago, "How long is the coast of Britain?," Mandelbrot pointed out that the concept of length is inappropriate to the description of a natural coastline. If you measure the length by following all the wiggles around the boundary of a map of Britain, the answer will depend on the scale of the map. The finer the scale, the more wiggly the boundary and the greater the measured length. To characterize the texture of the coastline in a manner independent of scale, you can say that it has a geometric dimension $D = 1.25$, intermediate between the dimension of a smooth curve ($D = 1$) and the dimension of a smooth surface ($D = 2$). The coastline is here showing the typical behavior of a fractal. In his book, Mandelbrot collects a great variety of examples from various domains of science and shows that they can all be described in the same way as the coastline of Britain by being assigned suitable "fractal dimensions." Important examples from human anatomy are our vascular system (veins and arteries) and the bronchiole structure of our lungs. In the vegetable world we have trees, in the world of geography we have river networks and archipelagoes, in astronomy we have the hierarchical clustering of stars and galaxies.

The cataloging of natural objects with fractal structure is only half of Mandelbrot's theme. The other half is the historical role that fractals played in the development of pure mathematics. A great revolution of ideas separates the classical mathematics of the 19th century from the modern mathematics of the 20th. Classical mathematics had its roots in the regular geometric structures of Euclid and the continuously evolving dy-



Apollonian gasket, dimension about 1.306951. "To construct a circle tangent to three given circles constitutes one of the geometric problems that tradition attributes to Apollonius of Perga. Begin with three gray circles tangent two by two, forming a circular triangle, and let the above construction be iterated to infinity. The black Apollonian circles (less their circumferences) will 'pack' our triangle, in the sense that almost every point of it will eventually be covered. The remainder will be called [an] *Apollonian gasket*. Its surface measure vanishes, while its linear measure, defined as the sum of the circumferences of the packing circles, is infinite. Thus the shape of the Apollonian gasket lies somewhere between a line and a surface. It enters in the theory of Smectic A liquid crystals." [From *Fractals*] namics of Newton. Modern mathematics began with Cantor's set theory and Peano's space-filling curve. Historically, the revolution was forced by the discovery of mathematical structures that did not fit the patterns of Euclid and Newton. These new structures were regarded by contemporary mathematicians as "pathological." They were described as a "gallery of monsters," kin to the cubist painting and atonal music that were upsetting established standards of taste in the arts at about the same time. The mathematicians who created the monsters regarded them as important in showing that the world of pure mathematics contains a richness of possibilities going far beyond the simple structures that they saw in nature. Twentieth-century mathematics flowered in the belief that it had transcended completely the limitations imposed by its natural origins.

Now, as Mandelbrot points out with one example after another, we see that nature has played a joke on the mathematicians. The 19th-century mathematicians may have been lacking in imagination, but nature was not. The same pathological structures that the mathematicians invented to break loose from 19th-century naturalism turn out to be inherent in familiar objects all around us in nature. We do not have to look far to find them. Human tissue, as Mandelbrot notes, "is a bona fide fractal surface. . . . *Lebesgue-Osgood monsters are the very substance of our flesh!*"

Unfortunately Mandelbrot's book is fractally written. The main theme is clear and important; some of the digressions are unimportant and unclear. There are many illustrations, all of them computer-generated mathematical structures rather than pictures of natural objects. Some of these computer print-outs are beautiful, some are illuminating, some are obscure and poorly explained. There is a factual error in the caption to plate 167. The dimension of the Sierpiński carpet shown in the picture is 1.8927, not 1.2618.

The reviewer particularly enjoyed chapter 11, a dense cluster of historical anecdotes. Mandelbrot has an affinity for eccentric characters, and his historical scholarship is meticulously exact. One of his finest discoveries is a book called *Two New Worlds*, published in 1907 by Edmund Fournier D'Albe and containing the first description of a fractally clustered universe. "It is," Mandelbrot says, "the kind of work in which one is surprised to find anything sensible. One fears attracting attention to it, lest the more disputable bulk of the material be taken seriously." Mandelbrot the scientific maverick finds in Fournier D'Albe a kindred spirit, while Mandelbrot the historian, in a fine display of irony, describes D'Albe's book in words that could also be used to describe his own.

FREEMAN DYSON
Institute for Advanced Study, Princeton, New Jersey 08540

PILGRIM FATHERS, MORMON PIONEERS, AND SPACE COLONISTS: AN ECONOMIC COMPARISON

FREEMAN J. DYSON

Professor, Institute for Advanced Study

(*Read November 10, 1977*)

GOVERNOR WILLIAM BRADFORD of the Plymouth Colony, President Brigham Young of the Church of Jesus Christ of Latter-Day Saints, and my friend Professor Gerard O'Neill of the Princeton University physics department, have much in common. Each of the three is a man of vision. Each believes passionately in the ability of ordinary men and women to go out into the wilderness and build there a society better than the one they left behind. Each has written a book[1] to record for posterity his vision and his struggles. Each has his feet firmly on the ground in the real world of politics and finance. Each is acutely aware of the importance of dollars and cents, or pounds and shillings, in making his dreams come true.

In this article I am saying that the human and economic problems which the space colonists of tomorrow will face are not essentially different from the problems faced by Bradford in 1620 and by Young in 1847. Unfortunately, the extravagant style and exorbitant costs of the Apollo expeditions to the Moon have created in the minds of the public the impression that any human activities in space must necessarily cost tens of billions of dollars. I believe this impression to be fundamentally mistaken. I shall argue that, if we reject the style of Apollo and follow the style of the *Mayflower* and the Mormons, we shall find the costs of space-colonization coming down to a reasonable level. By a reasonable level of costs I mean a sum of money comparable to the sums which the Pilgrims and the Mormons successfully raised. To give this argument substance, I must begin by establishing the true costs of the *Mayflower* and Mormon expeditions and the proper rates of exchange for converting these costs into 1977 dollars.

Bradford and Young provide abundant documentation of the difficulties they faced in raising funds. Bradford emphasizes in his book that the toughest problem in the whole venture of colonization was to define a set of objectives upon which the brethren could agree.[2]

> But as in all businesses the acting part is most difficult, especially where the work of many agents must concur, so was it found in this. For some of those that should have gone in England fell off and would not go; other merchants and friends that had offered to adventure their moneys withdrew and pretended many excuses; some disliking they went not to Guiana; others again would adventure nothing except they went to Virginia. Some again (and those that were most relied on) fell in utter dislike of Virginia and would do nothing if they went thither.

Without agreement upon objectives, the task of fund-raising becomes impossible. This is a fact of life which remains as true in 1977 as it was in 1620. Bradford and Young devote more pages of their histories to the preliminary battles over objectives and finance than they devote to the description of their voyages. For both of them, it came as a blessed relief when the miseries of indecision were over, the expeditions were ready to go, and they were finally able to turn their attention away from political and financial matters to the simpler problems of physical survival. Here is Young[3] writing from his winter quarters in February, 1847, six weeks before starting his journey across the plains:

> I feel like a father with a great family of children around me, in a winter storm, and I am looking with calmness, confidence and patience, for the clouds to break and the sun to shine, so that I can run out and plant and sow and gather in the corn and wheat and say, children, come home, winter is approaching again and I have homes and wood and flour and meal and meat and potatoes and squashes and onions and cabbages and all things in abundance, and I am ready to kill the fatted calf and make a joyful feast to all who will come and partake. We have done all we could here and are satisfied it will be all right in the end.

---

[1] William Bradford, *Of Plymouth Plantation, 1620–1647*, ed. Samuel E. Morison (New York, Alfred A. Knopf, 1952). Brigham Young, *History of the Church of Jesus Christ of Latter-Day Saints, Period II, from the Manuscript History of Brigham Young and other Original Documents* 7, ed. B. H. Roberts (Salt Lake City, Deseret News, 1960). Gerard K. O'Neill, *The High Frontier, Human Colonies in Space* (New York, W. Morrow and Co. Inc., 1977).

[2] Bradford, *loc. cit.*, p. 39.

[3] *Messages of the First Presidency of the Church of Jesus Christ of Latter-Day Saints, 1833–1964*, ed. James R. Clark, 1: p. 318 (Salt Lake City, Bookcraft, Inc., 1965). Young crossed the plains to Utah twice, in 1847 with an advance party to choose the site for the colony, and in 1848 with the main body of colonists. The numbers that I have collected here refer to the 1848 crossing, but I used 1847 prices since most of the purchasing and provisioning must have been completed in 1847.

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But I must come back from these idyllic sentiments to questions of dollars and cents. Two years earlier, Young reported:[4]

> For an outfit that every family of five persons would require: one good wagon, three yoke of cattle, two cows, two beef cattle, three sheep, one thousand pounds of flour, twenty pounds of sugar, one rifle and ammunition, a tent and tent-poles—the cost would be about $250 provided the family had nothing to begin with, only bedding and cooking utensils, and the weight would be about twenty-seven hundred [pounds] including the family.

The arts were also included in Young's budget. On November 1, 1845, he paid[5] $150 to purchase instruments for the brass band. This was a wise investment, for the band[6]

> Was sometimes invited to give concerts at villages near to the line of march, which did much to change the feelings of hostility which occasionally was manifested in such places. Thus this band proved a very great benefit to the marching column, besides cheering the spirit of the pilgrims.

The actual numbers that crossed the plains with Young were[7] 1,891 souls, 623 wagons, 131 horses, 44 mules, 2012 oxen, 983 cows, 334 loose cattle, 654 sheep, 237 pigs, 904 chickens.

So we can estimate the total payload of Young's expedition to be 3,500 tons, mainly consisting of animals on the hoof, and the total cost to be $150,000 in 1847 dollars.

Bradford unfortunately does not provide such an exact accounting for the *Mayflower*. He quotes a letter[8] from Robert Cushman, dated June 10, 1620, in London, two months before the sailing. Cushman was one of the people in charge of provisioning for the voyage:

> Loving Friend, I have received from you some letters, full of affection and complaints, and what it is you would have of me I know not; for your crying out, "Negligence, negligence, negligence," I marvel why so negligent a man was used in the business. —Counting upon 150 persons, there cannot be found above £1,200 and odd moneys of all the ventures you can reckon, besides some cloth, stockings and shoes which are not counted, so we shall come short at least £300 or £400. I would have had something shortened at first of beer and other provisions, in hope of other adventures; and now we could, both in Amsterdam and Kent, have beer enough to serve our turn, but now we cannot accept it without prejudice—£500 you say will serve; for the rest which here and in Holland is to be used, we may go scratch for it. —Think the best of all and bear with patience what is wanting, and the Lord guide us all.
>
> Your loving friend, Robert Cushman.

This letter shows that Cushman was personally responsible for meeting expenses to the tune of £1,500. It does not say whether all the expenses, and in particular the rental fee for the *Mayflower*, were included in this figure.

Three weeks later, on July 1, 1620, an agreement[9] was signed between the Planters and the Adventurers. The Planters were the colonists. The Adventurers were the shareholders who invested money in the enterprise and stayed at home. The agreement stipulated "that at the end of the seven years, the capital and profits, viz. the houses, lands, goods and chattels, be divided equally betwixt the Adventurers and Planters." The word "equally" is here ambiguous. It probably meant that the assets would be divided among Adventurers and Planters alike in proportion to the numbers of shares that they held. Alternatively, it may have meant that half of the assets would be divided among the Planters and half among the Adventurers. Another clause of the agreement gave one share to each of the Planters as a bonus for their seven years of hard labor: "Every person that goeth being aged 16 years and upward be rated at £10, and £10 to be accounted a single share." Any cash that the Planters contributed would entitle them to additional shares.

The 1620 agreement proved unsatisfactory to both sides and caused constant friction. In 1626, a year before the planned division of assets, the whole matter was renegotiated and a new agreement was signed,[10] "drawn by the best counsel of law they could get, to make it firm." The 1626 agreement stipulated that the Adventurers sell to the Planters, "in consideration of the sum of one thousand and eight hundred pounds sterling to be paid in manner and form following—all and every the stocks, shares, lands, merchandise and chattels—any way accruing or belonging to the generality of the said Adventurers aforesaid." Having bought out the Adventurers' shares, the Planters were left with a debt of £1,800 which they finally succeeded in paying off twenty-two years later.

I do not know how much profit or loss the Adventurers took in the 1626 settlement. I also do not know how large a fraction of the original cost of the expedition was paid by the Planters. As to the first point, it is unlikely that the Adventurers took a loss, for the colony was not bankrupt in 1626 and the Adventurers were not in the habit of lending their money for nothing. As to the second point, it is unlikely that the Planters paid as much as half of the original costs. If they had been in a position to pay half, they would probably have managed to squeeze the expenses down to such a point that they could do without the Adventurers altogether and avoid the innumerable headaches that the partnership brought with it. I therefore conclude from the evidence of the 1626 settlement that £3,600 is a safe upper limit to the original cost of renting and provisioning the *Mayflower*. The evidence of the Cushman letter implies a lower limit of £1,500. I shall arbitrarily adopt £2,500 as my estimate of the cost of the expedition in 1620 pounds. This figure can hardly be wrong by a factor of two either way. The payload of the *Mayflower* is stated explicitly by Bradford.[11] It was 180 tons.

My next problem is to convert the 1620 and 1847 cost figures into their modern equivalents. A good source of information about the history of wages and prices in England is the work of Ernest Phelps Brown and Sheila Hopkins,[12] published in two articles in the journal *Economica* and reprinted in a series called *Essays in Economic History* put out by the Economic History Society.[13] The first article deals with wages, the second with prices. It is a question of taste whether one prefers to use wages or prices as the basis for comparing costs between different centuries. If we use wages, we are saying that an hour of a working man's time in 1620 is equivalent to an hour in 1977. If we use prices, we are saying that a pound of butter in 1620 is equivalent to a pound of butter today. With wages, we compare costs by the magnitude of the human effort needed to get a job done. With prices, we compare costs by the quantity of goods needed. My personal opinion is that wages give a truer standard of comparison than prices. My purpose in making the comparison is to try to define in a roughly quantitative fashion the size of the human efforts that the *Mayflower* and the Mormon expeditions demanded. But since economists are accustomed to deflate costs using price indices rather than wage indices, I will do the calculation both ways and you can choose whichever set of numbers you prefer.

First let us look at wages. According to Phelps Brown and Hopkins,[12] the wages of workers in the building trade in 1620 were in the range from 8 to 12 pence per day. In 1847 the range was from 33 to 49 pence. These numbers refer to England. Wages in America were usually higher, but I did not find any comparable figures[14] for American wages during this period. I take for American wages in 1847 the range 65 cents to 1 dollar per day, obtained by converting the English rates at 5 dollars per pound. For the modern equivalent of these numbers I take the minimum rate of $9.63 per hour[15] imposed by building trade-union contracts in New York in 1975. The exchange rates on the basis of wages are then:

£1 (1620) equals $2,500 (1975),
$1 (1847) equals $100 (1975).

These are very approximate numbers. A rough check on the numbers for 1620 is provided by the fact already mentioned that each Planter received a credit of £10 for going to Plymouth and working for the community for seven years without wages. If £10 were really the equivalent of seven years of work in the building trade, the exchange rate would be

£1 (1620) equals $14,000 (1975).

Obviously the Planters were badly paid, even by the standards of 1620. But this check shows that my figure of $2,500 for one 1620 pound is more likely to be too low than too high.

Next I examine the evidence concerning prices. Phelps Brown and Hopkins[12] define a consumer price index normalized to 100 for the third quarter of the fifteenth century. This index is 485 in 1620, 1257 in 1847, and 3,825 in 1954, the last year included in their table. All these numbers refer to England. The American price index published by the Bureau of the Census[16] is normalized to 100 in 1967. This index is 28 in 1847, 80 in 1954, and 169 in 1976. Taking these numbers at face value, we find on the basis of prices

£1 (1620) equals $67 (1976),
$1 (1847) equals $6 (1976).

The exchange rate for 1847 can be checked against the first-hand testimony of Brigham Young.[17] Writing on January 6, 1847, Young reports:

> In the fall, wheat in Upper Missouri was worth 18¾ to 25 cents per bushel, corn from 10 to 12 cents. By our stopping at this point, they have taken occasion to raise wheat from 40 to 50 and corn from 20 to 25, and the clerk says "Woe unto you, ye Missourians," but we are independent of them and can live without them, for we have thousands of cattle left yet. A few brethren have gone to Missouri and paid high prices because the people have asked it. Pork has been worth at this point from 3½ to 5 by the hog, but we have now engaged to supply the market at 2½.—Good corn and meal are tolerable plenty at 40 and 50, and if the Missourians don't sell us cheaper than that, pretty soon they will not sell us at all, for we have means to support ourselves.

[4] Young, ref. 1, p. 447.
[5] Young, *ibid.*, p. 510.
[6] Young, *ibid.*, p. 606.
[7] Young, *ibid.*, p. 627.
[8] Bradford, *loc. cit.*, p. 45.
[9] Bradford, *ibid.*, p. 41.
[10] Bradford, *ibid.*, p. 184.
[11] Bradford, *ibid.*, p. 47.
[12] E. H. Phelps Brown and Sheila V. Hopkins, "Seven Centuries of Building Wages," *Economica* 22 (1955): p. 195; "Seven Centuries of the Prices of Consumables, compared with Builders' Wage-Rates," *Economica* 23 (1956): p. 296.
[13] *Essays in Economic History* 2, ed. E. M. Carus-Wilson (London, Edward Arnold, Ltd., 1962).
[14] In *Historical Statistics of the United States, Colonial Times to 1970* (Washington, D. C., U. S. Bureau of the Census, Govt. Printing Office, 1975), p. 163, it is reported that average wages of farm laborers in 1850 were $10.85 per month with board. This is equivalent to 45 cents or 22 pence per working day, below the range quoted for 1847 by Phelps Brown and Hopkins. But farm laborers were no doubt paid less than building workers in England too.
[15] *Statistical Abstract of the United States, 1976* (Washington, D. C., U. S. Bureau of the Census, Govt. Printing Office, 1976), p. 383.
[16] *Loc. cit.*, ref. 14, p. 211 and ref. 15, p. 439.
[17] Young, ref. 3, p. 310.

TABLE 1

COMPARISON OF FOUR EXPEDITIONS

(Cost exchange rates based on building trade wages).
(K means thousands, M means millions).

Expedition	*Mayflower*	Mormons	Island One L5 Colony	Homesteading the Asteroids
Date	1620	1847	1990+	2000+
Number of people	103	1891	10,000	23
Payload (tons)	180	3500	3.6 M	50
Cost (old money)	£2,500	$150 K	—	—
Cost (1975 dollars)	$6 M	$15 M	$96,000 M	$1 M
Payload (tons per person)	1.8	2	360	2
Cost per pound (1975 dollars)	$15	$2	$13	$10
Cost per person (1975 dollars)	$60 K	$8 K	$9.6 M	$40 K
Cost in Man-years per person	3	0.5	500	2
Cost in Man-years per family	7.5	2.5	1,500	6

Young's numbers can be compared with the prices [18] of wholesale farm commodities in 1977, which are $2.36 per bushel for wheat, $1.92 per bushel for corn, and 49 cents a pound for pig bellies. So far as these particular commodities are concerned, we find

$1 (1847) equals $5 to $20 (1977).

But Young's narrative shows how the vagaries of real life make nonsense of any single price index.

To summarize the results of these calculations, I will merely say that in my opinion the exchange rates based upon prices enormously underestimate the real human costs of the *Mayflower* and Mormon colonies. The rates based upon wages are not free from uncertainties and ambiguities, but I believe they come much closer to the truth. I shall therefore adopt without further discussion for the remainder of this article the rates based upon wages, namely £1 = $2,500 for the *Mayflower* and $1 = $100 for the Mormons. The estimated total costs in 1975 dollars are then 6 million for the *Mayflower* and 15 million for the Mormons. On this basis I have drawn up the first two columns of table 1. The point I am trying to emphasize with these numbers is that both the *Mayflower* and Mormon expeditions were extremely expensive operations. In their time, each of them stretched the limits of what a group of private people without governmental support could accomplish.

Let me call your attention especially to the numbers in the bottom row of table 1. These numbers give an estimate of the number of years an average wage-earner would have had to save his entire income to pay the passage for his family. The average size of family on the *Mayflower* was $2\frac{1}{2}$ (41 heads of families signed the *Mayflower* Compact at Cape Cod on behalf of the 102 surviving passengers), and I have assumed that the average Mormon family size was 5, the number that Young [4] used in planning the expedition. You see that there is a difference of a factor of three between the two figures, $7\frac{1}{2}$ man-years per family for the *Mayflower* and $2\frac{1}{2}$ for the Mormons. This difference had a decisive effect on the financing of the colonies. An average person, with single-minded dedication to a cause and with a little help from his friends, can save two or three times his annual income. An average person with a family to feed, no matter how dedicated he may be, cannot save seven times his income. So the Mormons were able to pay their way, while the Planters on the *Mayflower* were forced to borrow heavily from the Adventurers and to run up debts which took twenty-eight years to pay off. Somewhere between 2 and 7 man-years per family comes the breaking-point, beyond which simple do-it-yourself financing by ordinary people becomes impossible.

You will probably have noticed that I said nothing yet about the last two columns in my table of costs. These represent two contrasting styles of space-colonization, both taken from O'Neill's book,[1] "The High Frontier," with some changes for which I am responsible.[19] Column 3 comes from O'Neill's Chapter 8, which he entitles "The First New World," describing space-colonization organized by the American government in the official National Aeronautics and Space Administration (NASA) style. Column 4 comes from O'Neill's Chapter 11, with the title "Homesteading the Asteroids," in which he describes space-colonization done in the *Mayflower* style by a bunch of enthusiastic amateurs.

The first thing you will notice about the "Island One" project is that the cost is 96 billion dollars. When you see this number you may well say, "This is preposterous." I happen to agree with you. It is preposterous. But still we have to take this number seriously. It was arrived at by a group of competent engineers and accountants familiar with the ways of the government and the aerospace industry. It is probably the most accurate of all the cost estimates that I have included in table 1. For this 96 billion dollars you can buy a great deal of hardware.

[18] *New York Times*, September 14, 1977.

[19] The main change I have made is to reduce drastically the weight estimate of the asteroid expedition. O'Neill's estimate of 2,500 tons consists mainly of a layer of sand enclosing the ships and shielding the crews from radiation. I have cut the weight to 50 tons since I wish to leave open the possibility of a take-off from Earth. O'Neill (ref. 1, chap. 7) gives a detailed account of the pros and cons of radiation shielding. There is a good chance that colonists could travel to the asteroid belt without shielding and without noticeable adverse effects.

You can buy a complete floating city to house and support 10,000 people with all modern conveniences at the magic point L5 which is just as far from the earth and from the moon as these bodies are from each other. You can buy enough synthetic farmland to make a closed ecological system which supplies the colonists with food and water and air. You can buy a space-borne factory in which the colonists manufacture solar power-stations to transmit huge amounts of energy in the form of microwave beams to receivers on the earth. All these things may one day come to pass. It may well be true, as O'Neill [20] claims, that the investment of 96 billion dollars will be repaid in twenty-four years out of the profits accruing from the sale of electricity. If the debt could be paid off in twenty-four years, that would be four years quicker than the *Mayflower* Planters could do it. But there is one inescapable difference between Island One and the *Mayflower*. In the bottom row of table 1 you see that the Island One colonist would have to work for 1,500 years to pay his family's share of the costs. This means that Island One cannot by any stretch of the imagination be considered as a private adventure. It must inevitably be a government project, with bureaucratic management, with national prestige at stake, and with occupational health and safety regulations rigidly enforced. As soon as our government takes responsibility for such a project, any serious risk of failure or of loss of life becomes politically unacceptable. The costs of Island One become high for the same reason that the costs of the Apollo expeditions were high. The government can afford to waste money but it cannot afford to be responsible for a disaster.

After this brief visit to the super-hygienic welfare state at Island One, let us go to the last column of table 1. The last column describes O'Neill's vision of a group of young pioneers who save enough money to move out on their own from the L5 colony into the wilderness of the Asteroid Belt. They are going on a one-way trip at their own risk. The cost estimates here describe hopes rather than facts. Nobody can possibly know today whether it will be feasible for a group of twenty-three private people to equip such an expedition at a total cost of a million dollars. Anybody who is professionally qualified to estimate costs will say that this figure is absurdly low. I do not believe that it is absurdly low. All I can say for sure is that a cost in the range of $40,000 per head must be achieved if space-colonization is to become an important liberating force in human affairs. It is no accident that the per capita cost estimates for the asteroid colony turn out to be similar to those of the *Mayflower*. This is the maximum level of costs at which the space beyond the earth will give back to mankind the open frontier that we no longer possess on this planet.

If you compare the third and fourth columns of table 1, you will see that the cost per pound of the Asteroid expedition is not significantly less than that of Island One. The big differences between the two expeditions lie in the number of people and in the weight carried per person. The feasibility of cheap space-colonization in the style of the Asteroid expedition depends upon one crucial question. Can a family, bringing a total weight of only two tons per person, arrive at an asteroid, build themselves a home and a greenhouse, plant seeds and raise crops in the soil as they find it, and survive? This is what the *Mayflower* and Mormon colonists did, and it is what the space-colonists must do if they are to be truly free and independent.

I cannot here embark upon a technical discussion of the mechanics of space-colonization. I will only indicate with some brief remarks why I consider it may not be absurd to imagine a reduction in costs by a factor of 100,000 from the 96 billion dollars of Island One to the 1 million dollars of the asteroid colony. First we save a factor of 400 by reducing the number of people from 10,000 to 23. That leaves a factor of 250 still to be found. I claim that we can save a factor of 10 by accepting risks and hardships that no government would impose upon its employees, and another factor of 5 by eliminating trade-union rules and bureaucratic management. The last factor of 5 will be harder to find. It might come from new technology, or more probably from salvaging and reusing equipment left over from earlier government projects. There are already today several hundred derelict space-craft in orbit around the earth, besides a number on the moon, waiting for our asteroid pioneers to collect and refurbish them.

O'Neill sees Island One as a necessary first step in the colonization of space. He has his pioneers starting out for the asteroids from L5, their transportation from earth to L5 already paid for. His cost estimates assume the asteroid expedition to be equipped and launched at L5. I am a little more ambitious, or a little more hopeful. I imagine that an asteroid expedition with *Mayflower* style and *Mayflower* costs may take off directly from Earth.

The Island One and the asteroid homesteading expeditions are extreme cases. I chose them to illustrate high and low estimates of the costs of colonization. The true costs, if and when colonization begins, will probably lie somewhere in between. In so difficult and long-range a venture, there is room for a mixture of styles. Governmental, industrial, and private operations must all go forward, learning and borrowing from one another, before we shall find

[20] O'Neill, ref. 1, p. 268.

out how to establish colonies safely and cheaply. The private adventurers will need all the help they can get from governmental and commercial experience. In this connection, it is worth remembering that 128 years passed between the voyages of Columbus and the *Mayflower*. In those 128 years, the kings and queens and princes of Spain and Portugal, England and Holland, were building the ships and establishing the commercial infrastructure that would make the *Mayflower* possible. Columbus did not sail across the ocean on private money.[21]

O'Neill and I have a dream, that one day there will be a free expansion of small groups of private citizens all over the Solar System and beyond. Perhaps it is an idle dream. It is a question of dollars and cents, as Bradford and Young well knew. We shall never find out what is possible, until we try it.

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[21] The funding for Columbus's first voyage was partly private and partly public. For details see F. M. Padrón, *Manual de Historia Universal, Historia de América* **6** (Madrid, 1975): p. 154. For this reference I am indebted to Professor John Elliott.

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SCHOOL OF NATURAL SCIENCES

May 15, 1978

Dr. H. Woolf
Director's Office

Dear Harry,

If it is not too late, you might perhaps wish to include in your Director's letter the text of this scroll which was presented by the faculty to Mike Morgan at a little ceremony on May 12.

I would like also to let you know, in case you did not know it already, that I sense in the faculty a strong concern that in choosing Mike's successor you should look for these same human qualities rather than merely for administrative competence. In saying this, I am not speaking officially for the faculty, but I think I know how most of us feel.

Yours sincerely,

Freeman

Freeman Dyson

Director's Letter
Director's Report

May 9, 1978

Dear Freeman:

Just a short note to thank you very much for the copy of your Florida State University talk on Variation of Constants.

I shall look into it at the first opportunity and do my best to grasp what you say.

Sincerely yours,

Harry Woolf

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

D. L.

May 1978

VARIATION OF CONSTANTS

Freeman J. Dyson
Institute for Advanced Study, Princeton, NJ, 08540

Talk given at Florida State University in Tallahasee, April 7, 1978, to the Conference in honor of Paul A. M. Dirac, "Fifty Years of the Dirac Equation."

Supported by National Science Foundation Grant No. NSF PHY77-20612.

VARIATION OF CONSTANTS

Freeman J. Dyson
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ABSTRACT

A summary of recent observational evidence bearing on the question of the possible variation of the natural constants with time. No conclusive evidence of variation is found.

1. INTRODUCTION

Six years ago I wrote a review article[1] summarizing the evidence for and against Dirac's hypothesis[2] that the large dimensionless numbers appearing in the laws of physics are increasing with time. I described five alternative hypotheses defining the way the constants might be varying, and ended my review with the words: "It is quite possible that all five will fail, and then it will be up to the speculative cosmologists, and up to Dirac in particular, to think of something new." Now, six years later, although two of the five hypotheses are still viable, Dirac has thought of something new.[3] I am sorry that I have not had time to study Dirac's new theory[3] in detail, nor the very interesting papers of Canuto and his collaborators[4] in which Dirac's cosmology is analyzed in depth. I am sorry that Canuto is not here to comment on the new ideas of Dirac that we shall hear this morning.[5] All that I shall do in this talk is to bring my 1972 review[1] up-to-date by describing the new observational evidence that has appeared in the last six years concerning the possible variation of the constants. The only strong conclusion that my 1972 article contained was the upper limit

$$\left| \frac{1}{\alpha}\frac{d\alpha}{dt} \right| < 5.10^{-15}\ \text{year}^{-1}\ , \qquad (1)$$

on the variation of the fine-structure constant α, obtained from an analysis of the abundance ratios of rhenium and osmium isotopes in iron meteorites and molybdenite ores. The reason why these isotope-ratios are a sensitive indicator of variation of α is[6] that the decay of Rhenium 187 to Osmium 187 has a long half-life and the exceptionally small decay-energy of 2.5 Kev. The effect of a change in α on the decay is amplified by the ratio of the Coulomb energy of a proton in the nucleus to the decay-energy, in this case by a factor of about 20000.

2. SHLYAKHTER

A spectacular improvement on the upper limit (1) for variation of α was obtained by Shlyakhter[7] from an analysis of isotope ratios in the natural fission reactor[8] that operated about 2.10^9 years ago in the ore body of the Oklo uranium mine in Gabon, West Africa.

The crucial quantity is the ratio (Sm 149/Sm 147) between the abundances of two light isotopes of samarium which are not fission products. In normal samarium this ratio is 0.9, in the Oklo reactor it is about 0.02. Evidently the Samarium 149 has been heavily depleted by the dose of thermal neutrons to which it was exposed during the operation of the reactor. The fluence (integrated dose) of neutrons can be calculated from the measured ratios of (U 235/U 238) and (Nd 143/Nd 142) in the same ore samples, and is found to be about $1.5 \cdot 10^{21}$ neutrons cm^{-2}. A detailed analysis of the data gives the result

$$\sigma = 55 \pm 8 \text{ Kilobarn} \qquad (2)$$

for the capture cross-section of thermal neutrons by Samarium 149 two billion years ago. This agrees with the modern value. Now the cross-section (2) is dominated by a capture resonance at a neutron energy of 0.1 ev. If the energy difference between the ground-state of Sm 149 and the compound nucleus Sm 150 had varied by as much as 0.02 ev between Oklo time and the present, the cross-section (2) would be more than two standard deviations away from its present value. This neutron resonance provides a far more sensitive test for variation of constants than the Re 187 decay. Roughly speaking, the effect of a variation of α will be amplified in the neutron cross-section by a factor 10^8, the ratio of the neutron binding energy to the neutron resonance energy in Sm 150. Shlyakhter, using some detailed assumptions about the nuclear physics which I will not discuss here, deduces from (2) the upper limit

$$\left| \frac{1}{\alpha} \frac{d\alpha}{dt} \right| < 5.10^{-18} \text{ year}^{-1} . \qquad (3)$$

I have checked his numbers and find that (3) is a conservative estimate. Anyone with access to the original Oklo data could probably push the upper limit down even further.

Another important by-product of Shlyakhter's analysis is an upper limit

$$\left| \frac{1}{\beta} \frac{d\beta}{dt} \right| < 10^{-12} \text{ year}^{-1} \qquad (4)$$

on the time-variation of the dimensionless ratio

$$\beta = (gm^2 c/\hbar^3) = 9.10^{-6} \qquad (5)$$

which measures the strength of the weak-interaction coupling constant g. The estimate (4) is obtained from the same data as (3), assuming that weak interactions contribute a fraction of the order of 10^{-7} to nuclear binding. From (4) we can already exclude with some degree of certainty the hypothesis that β might be varying with cosmic time t with some small negative exponent such as $t^{-(1/8)}$.

3. WOLFE, BROWN AND ROBERTS

Wolfe, Brown and Roberts[9] measured the red-shift

$$Z_H = 0.52385 \pm 0.00001 \qquad (6)$$

in the absorption by neutral hydrogen of radio waves from the BL-Lac object AO 0235+164. They pointed out that the optical red-shift of the same object,

$$Z_{Mg} = 0.52392 \pm 0.0001 , \qquad (7)$$

deduced from the absorption of light by magnesium ions, agrees with (6) within the accuracy of the measurements. The frequency of the radio-absorption depends on the proton magnetic moment, whereas the optical frequency depends only on the properties of the electron. The ratio of the two frequencies is therefore proportional to the quantity

$$P = \alpha^2 g_P (m_e/m_P) , \qquad (8)$$

and the equality of the red-shifts implies an upper bound

$$\left| \frac{1}{P}\frac{dP}{dt} \right| < 2.10^{-14} \text{ year}^{-1} . \qquad (9)$$

Here g_P is the proton gyromagnetic ratio, m_e and m_P the electron and proton masses. The bound (9) thus implies an equally strong bound on possible variation with time of the electron-proton mass-ratio.

4. REASENBERG AND SHAPIRO

We now come to the question of the variation of the gravitational constant G, or of the dimensionless ratio

$$\gamma = Gm^2/\hbar c = 5.10^{-39} , \qquad (10)$$

where m is the proton mass. The central feature of Dirac's cosmology is that G and γ should vary as t^{-1}. Reasenberg and Shapiro[10] have observed the planets Mercury, Venus and Mars with radar. If G were decreasing, there should be a secular increase in the radii and in the periods of the planetary orbits. Unfortunately the effects of varying G can only be disentangled from the effects of mutual planetary perturbations by a very precise and elaborate integration of the equations of motion of the entire solar system extending over many years of data. The data from the period 1966 to 1975 lead to the conclusion

$$-0.5.10^{-10} \text{ year}^{-1} < \frac{1}{G}\frac{dG}{dt} < 1.5.10^{-10} \text{ year}^{-1} . \qquad (11)$$

This result is consistent with G varying like t^{-1} or with G staying constant. There are no other astronomical data comparable in accuracy and reliability with these radar observations.

Looking to the future, Reasenberg and Shapiro remark that the statistical uncertainty in (dG/dt) resulting from observations extending over T years is proportional to $T^{-5/2}$ if the precision of individual measurements remains constant. If the techniques of measurement improve, the uncertainty in (dG/dt) decreases with T even faster. Reasenberg and Shapiro are therefore confident that, if they are fortunate enough to continue their observations until 1985, they will then be able to determine (G^{-1} dG/dt) to a precision of one part in 10^{11} years. It will then be possible to distinguish clearly between the Dirac cosmology and the orthodox constant-G cosmology.

There is unfortunately an additional theoretical ambiguity in the analysis of the Reasenberg-Shapiro data. Reasenberg and Shapiro assumed in their analysis that the radius R and period P of each orbit vary with G according to the adiabatic law

$$R \sim G^{-1}, \quad P \sim G^{-2} . \qquad (12)$$

But Dirac's 1978 theory[3] breaks the adiabatic invariance and gives a different rule of evolution of the orbits,

$$R \sim G^{-1/3}, \quad P \sim G^{-1} . \qquad (13)$$

If the radar observations are to be used to test the Dirac cosmology, the entire analysis of the data must be carried through consistently, with the orbits varying according to (13). It is not possible in any simple way to correct the result (11), which Reasenberg and Shapiro calculated using the assumption (12), to find the limit on variation of G which would follow from the assumption (13). It is to be hoped that when Reasenberg and Shapiro analyze their data in 1985 they will consider both possibilities (12) and (13) and clear up this ambiguity once and for all.

5. VAN FLANDERN

Van Flandern[11] claims to have found positive evidence for a variation of G by analyzing observations of the motion of the moon. He discusses a quantity called the "lunar acceleration" which means the second derivative of the observed deviation of the moon from its calculated orbit. He looks at two series of observations, modern and old.

a) Modern measurements, made by timing with atomic clocks the occultation of stars by the edge of the moon. These extend over the time-base 1955-1974 and give for the acceleration the value

$$A = -65 \pm 18 \text{ arc sec/century}^2 . \qquad (14)$$

b) Old measurements, made by observing the moon's position with clocks keeping "ephemeris time," i.e. with time defined by the motion of the earth around the sun. These measurements are less accurate but extend over a longer time-base, 1750-1970. They give the acceleration

$$A = -38 \pm 4 \text{ arc sec/century}^2 . \qquad (15)$$

Now Van Flandern observes that the acceleration (14) should include the deviation of ephemeris time from atomic time produced by a variation of G, whereas the acceleration (15) refers only to ephemeris time and should be independent of any variation of G. So he claims that the difference between (14) and (15) gives a direct measurement of the variation of G, namely

$$\frac{1}{G}\frac{dG}{dt} = -7.5 \pm 2.7.10^{-11} \text{ year}^{-1} . \qquad (16)$$

This rate of variation has the right sign and the right order of magnitude to agree with Dirac's cosmology.

Unfortunately the moon itself is not a good enough clock to make the difference between (14) and (15) significant. The acceleration (15) is averaged over 200 years while (14) is averaged over 20. There is no reason to believe that A remains constant to the required accuracy over 200 years. The tidal interactions of the moon with the earth can neither be measured nor calculated accurately enough to allow the effect on A of varying G to be isolated.

So I conclude that Van Flandern's case for a variation of G with time remains unproven.

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cc: Mr. Hurst
Dyson

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SCHOOL OF NATURAL SCIENCES

April 11, 1978

Dr. Woolf
Director's Office

Dear Harry,

This is in reply to your request for material for your Director's letter. The summary of our School activities for the Trustees will follow later.

I have been intermittently involved with two activities of the U.S. National Academy of Sciences. As a member of the Committee on Science and Public Policy I have been reviewing various Academy Studies, in particular a study of the Peer Review system used by the federal government in funding research, and a study of the hazards of nuclear power. As a member of the Advisory Committee for the Academy Forum, I am involved in organizing public meetings of the Academy to discuss science-related issues of major public concern. Last year we organized a well-attended meeting on Recombinant DNA. Next year we are planning a meeting on Solar Energy with myself and Michael Kasha (a physical chemist) as co-chairmen.

I am continuing to keep in touch with the solar energy program at the Center for Environmental Studies of Princeton University. This program, under the leadership of Theodore Taylor, has the long-range goal of developing solar energy systems radically cheaper than anything now available. As a step in this direction they have made a proposal to the Department of Energy for the development of a solar energy system to supply heating, air-conditioning and electricity to our Institute Housing Project. The proposal has been rejected by DOE but we are not giving up. The basic ideas of the proposal are good and will sooner or later come to fruition. I shall continue to be involved in the program in two ways, as an intellectual participant and as a representative of the interest of the Institute in pioneering a new energy-saving technology.

This week I was at Florida State University, the home of Professor Dirac since his retirement from Cambridge, taking part in a conference to celebrate the fiftieth birthday of the Dirac Equation. The Dirac Equation, the relativistic wave equation of the electron, was the last major cornerstone that completed the foundations of atomic physics fifty years ago. I spoke at the meeting, summarizing recent evidence for and against Dirac's idea that some of the "constants" in the laws of physics should change with time. The evidence for change is suggestive but not conclusive. Dirac, still intellectually vigorous at age 75, gave a talk outlining a new cosmological theory in which the variation of the constants fits naturally and harmoniously. The same aesthetic sense that led him to the relativistic wave equation in 1928 still guides him today.

Freeman Dyson

Freeman Dyson

From
F. DYSON

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540

SCHOOL OF NATURAL SCIENCES

March 15 1978

Dear Dr Woolf

To avoid any appearance of going behind your back, I send you a copy of this exchange of letters with Nigel Calder.

Note especially the last paragraph of his letter.

I am not intending to take an active part in the relativity show. In any case I will let you know if any questions concerning the Institute come up.

Yours
Freeman.

March 14, 1978

Mr. Nigel Calder
8 The Chase, Furnace Green
Crawley, Sussex RH10 6HW, ENGLAND

Dear Nigel:

Thanks for your letter of March 7. I will be very glad to meet you for lunch on April 27. We can then discuss in detail the answers to your various questions. For the moment I will merely say that it is not true that John Bahcall is active in relativity. He is an astrophysicist who is interested in all kinds of things, but not specifically in relativity. The keeper of the Einstein archives is Miss Helen Dukas, and I will be happy to introduce you to her but I cannot promise you her cooperation. That is something that she will have to decide for herself. I am interested in what you say about Adrian Malone. I have not been involved in his project, and I don't know how far the plans have advanced.

Sincerely yours,

Freeman J. Dyson

FJD/b

from Nigel Calder

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Professor Freeman J. Dyson FRS
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7 March 1978

Dear Freeman,

Our BBC series Spaceships of the Mind is finished and you have a starring role. Regrettably, BBC-TV is not broadcasting it for another three months.

I am now working on a production on relativity (special and general). It would be nice if we could meet again, to chat about this new theme. As you know, I always find your insights into fundamental principles immensely helpful.

Martin Freeth, the producer, and I will be in Princeton on 26-27 April. Can I suggest we meet for lunch on the 27th, say at noon? You have been so generous with lunches at the Institute that I think Martin and I should insist on taking you out to a restaurant.

We shall be visiting some of the obvious people at Princeton University, but I do not know who ought to be on our list at the Institute. Is it correct, for instance, that John Bahcall now has Einstein's old chair? And is he active in relativity? Although our approach is not primarily historical, we should also like to see something of the Einsteiniana at Princeton, e.g. his home, and any archives of photographs, films and papers that might be useful for the occasional biographical reference. Does any one person have charge of such things?

We understand that the Institute, with our former colleague Adrian Malone, is planning its own TV production on Einstein. We do not regard our project as being in competition with Adrian's but we can imagine that others might do so. We are therefore treading a little warily, and certainly avoiding any prying into Adrian's plans. And that is why I am approaching you informally, to take the temperature of the water, as it were. I should be grateful for any comments or advice you can give.

With best personal regards,

Yours sincerely,

Nigel

file

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

January 24, 1978

Dr. H. Woolf
Director's Office

Dear Dr. Woolf,

When I came to you with Illarionov, you spoke rather emphatically of your desire to be informed about our traveling away from Princeton. Perhaps I have been remiss. For the record, let me tell you of my movements for this Academic Year. In October, I spent ten days at Harvard lecturing by invitation of the Physics Department. In December, I spent two weeks in Europe, attending a Royal Society meeting in London (with a side-trip to visit my family in England) and a meeting organized by the European Southern Observatory in Geneva. In February, I shall be away for ten days attending a meeting of COSPUP (National Academy) in Berkeley and visiting the University of British Columbia in Vancouver. This is more traveling than I usually do, but I think it is all an appropriate part of my functioning as a scientist. To make up for it, I shall be staying in Princeton most of next summer.

Yours sincerely,

Freeman Dyson

Freeman Dyson

FD:pb

אגף קשרי ציבור
Department of Public Relations

Technion - Israel Institute of Technology הטכניון - מכון טכנולוגי לישראל

TECHNION CITY, HAIFA, TEL: 235193 :טל' 32000 קרית הטכניון, חיפה

Director
Department of Public Relations
Institute for Advanced Studies
Princeton
New Jersey
U. S. A.

5th May 1977

Dear Sir,

Your Professor John Freeman Dyson has been awarded the Harvey Prize for 1977 and will be attending the award ceremony, here at Technion in June. We would much appreciate a film clipping of Professor Dyson at work in his laboratory for our media coverage of the event. The material is needed by June 10th, so that your prompt attention will be greatly appreciated. ?

Yours sincerely,

Yardenna Caplan

Yardenna Caplan
Overseas Press Officer

New York Times
5/13/77

Freeman John Dyson of the Institute for Applied Science at Princeton University and **Seymour Benzer** of the California Institute of Technology were named yesterday as winners of the $35,000 Harvey Prizes, awarded annually by Technion, Israel's Institute of Technology. Dr. Dyson, winner of the science and technology prize, was honored for his work at Princeton in applying mathematical analysis to theoretical physics. Dr. Benzer won the human health prize for his research in molecular genetics, the Technion announcement said.

Dyson

לשכת הנשיא
Office of the President

Technion - Israel Institute of Technology הטכניון - מכון טכנולוגי לישראל

TECHNION CITY, HAIFA. TEL : 227111 : טל 32000 קרית הטכניון, חיפה

COPY FOR Prof Ne'eman

March 1, 1977

Professor Freeman J. Dyson
Institute for Advanced Study
Princeton, N.J. 08540
U . S . A .

Dear Professor Dyson,

It is my great pleasure to inform you that you have been chosen to receive this year's Harvey Prize in Science and Technology. The prize will be awarded in recognition of your contribution to science and technology, through your work in the fields of quantum electrodynamics, ferromagnetism, field theory, statistical mechanics, and the stability of matter. It is our earnest hope that you will honour Israel and the Technion by accepting the prize.

Two equal prizes in different areas are being awarded this year. The other prize is in Human Health, and the recipient will be Professor Seymour Benzer, a distinguished biologist at the California Institute of Technology, Pasadena.

The Harvey Prize will be presented at Technion City on or about Wednesday, June 22nd, 1977. It is one of the conditions of the Prize that you receive it in person and that you spend a period of time in Israel lecturing and touring the country. In addition to the $35,000 prize itself, the Harvey Prize Fund covers your journey to and from Israel, and the expenses of your stay.

The American Technion Society will be glad to assist you in any necessary travel arrangements you may want to make. Mrs. Rachel Loewenthal of our office in Haifa will also be in contact with you to facilitate arrangements from this end.

I would like to close with my personal congratulations, and we look forward to receiving you soon at the Technion.

Sincerely yours,

A. Horev

Gen. (Res.) A. Horev
President.

פרס
הארווי

THE HARVEY PRIZE FUND

TECHNION ISRAEL INSTITUTE OF TECHNOLOGY

SENATE HOUSE, TECHNION CITY, HAIFA, 32000 ISRAEL.
PHONE : 227111
TELEX : 650
CABLES : HARVEY, TECHNION, HAIFA.

AMERICAN SOCIETY FOR TECHNION,
271 MADISON AVE., NEW-YORK, N.Y. 10016, U.S.A.

LIST OF HARVEY PRIZE WINNERS

1972 Willem J. Kolf, U.S.A., in recognition of his contribution to human health through his invention of the artificial kidney.

Claude E. Shannon, U.S.A., in recognition of his contribution to science and technology through his mathematical theory of communication now known as the science of Information Theory.

1974 Alan Howard Cottrell, United Kingdom, in recognition of his contribution to science and technology through his comprehensive theories concerning the mechanical properties of materials.

Gershom Scholem, Israel, in recognition of his contribution to literature of profound insight into the life of the peoples of the Middle East through his illuminating studies in Jewish mysticism.

1975 George Klein, Sweden, in recognition of his contribution to human health through his discoveries in cancer immunology.

Edward Teller, U.S.A., in recognition of his contribution to science and technology through his discoveries in atomic, nuclear and solid state physics and their practical application for the production of energy.

1976 Saul Lieberman, U.S.A., in recognition of his investigations into the civilizations of the peoples of the Middle East in the Hellenistic and Roman periods, and for his great and profound commentaries on the sources of Talmudic literature.

Herman F. Mark, U.S.A., in recognition of his contribution to science and technology through his pioneering research, continuing studies and educational efforts in the field of polymers and plastics.

1977 Seymour Benzer, U.S.A., in recognition of his contribution to human health through his discoveries in molecular genetics and behavior, which inspired the work and thoughts of a whole generation of modern experimental biologists.

Freeman John Dyson, U.S.A., in recognition of his contribution to science and technology, through his work in the fields of quantum electrodynamics, ferromagnetism, field theory, statistical mechanics, and the stability of matter.

THE HARVEY PRIZE

The Harvey Prize is derived from a donation made by the Lena P. Harvey Foundation to the American Technion Society in September 1971. At the first presentation of the Harvey Prize two awards of $ 35,000 each were made. The prizewinners received their awards in Israel where, for a period of one month, they were guests of the Technion.

The following is excerpted from :
The Procedures for the Selection of Candidates for the Harvey Prize (as approved by the Senate of the Technion, Israel Institute of Technology, on 29 March, 1973).

1. The prizes will be awarded each year in perpetuity in two of the following fields of human endeavour :
   (1) Science and Technology
   (2) Human Health
   (3) Advancement of Peace in the Mid East
   (4) Literature of Profound Insight about the Mores and Life of the Mid East People.

2. The Harvey Prize will be awarded without regard to race, religion, nationality, or sex.

3. Each Harvey Prize winner will be invited to appear in person at the Technion to receive the Prize and spend time at the Institute in teaching on his subject.

4. The Harvey Prize awards shall be given international publicity so that the work of the Harvey Prizewinners shall benefit the largest number of people possible and therefore do the greatest public good, and encourage others to support and engage in the same type of public endeavour.

5. Prospective candidates for the Harvey Prize should be outstanding personalities in one of the four fields of human endeavour outlined above. They should be persons whose achievements have served as a source of inspiration to many others.

6. All nominations will be tendered in writing, accompanied by material to facilitate the evaluation of candidates.

7. Persons associated with the following categories are eligible to make one or more nominations :
   (1) Members of the Board of Governors of the Technion, and of the Technion Senate.
   (2) Harvey Prize Laureates.
   (3) Members of the Israel Committee for the Harvey Prize.
   (4) Members of the Israel Academy of Sciences and Humanities.
   (5) Presidents, Vice Presidents, and Deans of recognised institutions of higher learning and research in Israel.
   (6) Other persons associated with institutions and groups, as well as individuals, as the Harvey Prize Selection Committee may decide from year to year.

8. No one may nominate himself.

9. Those making nominations are requested not to inform the proposed candidates.

10. Nominations will be made in the name of individuals, and not of institutions or organizations.

c/o AMERICAN TECHNION SOCIETY
Tel. 212-889-2050

CARL ALPERT

EXECUTIVE VICE CHAIRMAN, BOARD OF GOVERNORS

TECHNION
ISRAEL INSTITUTE OF TECHNOLOGY

HAIFA
ISRAEL

AMERICAN SOCIETY FOR
TECHNION-
ISRAEL INSTITUTE OF TECHNOLOGY, INC.

March 9, 1977

Dear Prof. Ne'eman:

Upon my arrival in New York from Haifa I had hoped to speak to you, but since you are not due back here until the 14th I anticipate our conversation in this way.

I assume you are familiar with the Technion Harvey Prize. It has been decided to award the prizes this year to Prof Seymour Benzer of Cal Tech, and to Prof Freeman Dyson of the Institute for Advanced Study. Since we should like to have the recipient properly informed, we are asking you to place in Prof Dyson's hands the enclosed letter from General Horev. We hope that he will accept, and reply accordingly to General Horev.

However, it is important that I be informed at once that he does indeed accept, and I would appreciate your telephoning me at this office (212-889-2050) to that effect. Should you require any further information with respect to the prize and its award, please do not hesitate to get in touch with me.

✓ all done on the 12th

Yours sincerely,

Carl Alpert

Carl Alpert
Executive Vice Chairman
Technion Board of Governors

Harry

This is the documentation relating to the award of the Harvey Prize to Freeman Dyson. For your information and utilisation if and when the need occurs. I have the impression that the Technion are completely unaware of the publicity and public aspects abroad, and concentrate on the ceremony and letters in Israel. I have written to Gen. Horev, the President, to tell him that the Prize would gain in importance if an announcement would be made earlier, while the recipients are still under the "charm" of their own institutions. Regards

Yuval N.

April 21, 1977

Dear Freeman:

So that the event does not excape me, I am merely putting into writing what I requested of you earlier, to wit: that you inform me when it may be permissible for us to announce the award of the Harvey Prize to you.

Thank you.

Cordially yours,

Harry Woolf

Professor Freeman Dyson
School of Natural Sciences
Institute for Advanced Study

March 21, 1977

Dear Freeman:

In reply to yours of 11 March 1977, let me assure you of my empathy for the intriguing volume to be "disturbing the Universe". Out of the immediate context on which it is to bear, it sounds like an underground statement from the Weathermen. I see no difficulty with your doing the colume in the manner you describe, and I am grateful for your informing me of your intentions.

Cordially yours,

Harry Woolf

Professor Freeman Dyson
School of Natural Sciences
Institute for Advanced Study

March 11, 1977

Dr. H. Woolf
Director's Office

Dear Dr. Woolf:

I am sorry I had to miss the Space Telescope meeting yesterday. John Bahcall tells me you did quite well without my help.

To avoid any misunderstandings or possible conflicts of interest I think I should tell you officially what I was doing yesterday. I was meeting with a committee of distinguished consultants to the Sloane Foundation, who are commissioning a series of books to be written for the general public presenting personal views of scientific subjects. They have agreed to commission a book by me with the title "Disturbing the Universe," to be published by Harper and Row. The agreement provides that I shall be paid a substantial advance on royalties for any periods when I am working full-time on the book. I told them that I will not accept any payment for any writing I may do during times that the Institute is officially in session. I plan to claim payment from them for two months during summer 1977, and probably for another two months in summer 1978. With luck the job will be done in two summers, but perhaps I am being over-optimistic.

Please let me know if you consider this arrangement in any way inappropriate or unethical. I will be glad to discuss it with you further if you have doubts about it. There is of course a serious question whether a professor can write popular books on the side and still maintain his position as a scholar. Some critics unkindly suggested that George Kennan should have been given the title Professor of Autobiography rather than of history. But I shall be happy if I can do as well as he did in combining popularization with scholarship.

I look forward to hearing Pat on Gordon Conferences next Wednesday.

Yours sincerely,

Freeman

Freeman Dyson

FD:pb

November 22, 1976

Dear Freeman:

To some extent my reply to your letter of 17 November 1976, is already contained in the general comments we exchanged at the Faculty meeting a few days ago. We are in deficit, things are tight, so that I would suggest, and I do wish to emphasize that word, that you attempt to obtain the travel allowance from the Pugwash Committee itself, but that if funds prove to be unavailable to you then it would not be inappropriate to utilize your Institute travel allowance. As with other aspects of life, not all Pugwash conferences are equal, and it must be within the field of your judgment to weigh the importance, need, and other purposes for which your modest travel allowance is available.

Yours sincerely,

Harry Woolf

Professor Freeman J. Dyson
School of Natural Sciences
Institute for Advanced Study

Dr. Harry Woolf
Director's Office

November 17, 1976

Dear Dr. Woolf,

I come to you for an administrative ruling. I am invited to a Pugwash meeting in Munich next August and I want to know whether this counts as a professional trip chargeable to my Institute travel allowance. The American Pugwash Committee can pay traveling expenses in case of necessity, but their funds are limited and they urge us to find other sources of travel money if possible.

Yours sincerely,

Freeman Dyson

Freeman Dyson

FD:pb

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

September 30 1976

Dear Dr Woolf

Thankyou for the declaration of amnesty for Institute children. We have waited for this a long time.

When I came here as a visitor in 1947 the first people I met were two small daughters of Dirac enjoying themselves in the common-room. This was typical of the open and friendly atmosphere which used to prevail here, and which with your help we may now hope to restore.

Yours sincerely

Freeman Dyson.

April 14, 1976

Dear Freeman:

Attached are pictures of some of your family and friends, which I couldn't resist stopping them to take when I saw them yesterday.

Let's have lunch one day. Would Thursday or Monday next be good for you?

Cordially,

Carl Kaysen

Enclosure

Professor Freeman Dyson
School of Natural Sciences

January 8, 1976

Dear Marshall:

In response to the usual annual invitation to nominate candidates for the National Medal of Science I am going to make my last try at pushing Freeman. I have done so twice, in 1967 and 1970, with no visible effect. The main things I sent before were the attached brief statement, a bibliography, and the names of Wigner, Bethe, and Strömgren as people who know his work. I think I will continue with Wigner and Bethe, but look for somebody other than Strömgren, perhaps Johnny Wheeler, who is anyhow now in favor.

I have an updated bibliography, can I ask you to take the trouble to see what if anything ought to be added to the description reflecting some of the things Freeman has been doing recently; also I need a one sentence capsule summary of why Freeman is a great man.

Cordially,

Enclosure

Carl Kaysen

Professor Marshall Rosenbluth
School of Natural Sciences

1976

Prof. Dyson

Awards

1965	Dannie Heineman Prize for Mathematical Physics - American Institute of Physics
1966	Lorentz Medal of the Royal Netherlands Academy of Science
1968	Hughes Medal - Royal Society of London
1969	Max Planck Medal - German Physical Society
1970	J. Robert Oppenheimer Memorial Prize, Center for Theoretical Studies, Miami

Fellow: Royal Society

Member: National Academy of Science;
American Physical Society

November 18, 1975

Dr. Kaysen:

For information. A copy of Professor Dyson's bibliography was sent to Prof. Breit last Friday.

Aida

State University of New York at Buffalo

73 Allenhurst Road
Buffalo, New York 14214

DEPARTMENT OF PHYSICS AND ASTRONOMY

FACULTY OF NATURAL SCIENCES AND MATHEMATICS

15 November 1975

Mrs. Aida La Brutte
Secretary to the Director
Institute for Advanced Studay
Princeton, New Jersey 08540

Dear Mrs. La Brutte:

This is to confirm our telephone conversation of 13 November 1975 in which you told me you would send to the above address to my husband, Gregory Breit, Distinguished Service Professor Emeritus of the State University of New York at Buffalo, a list of the papers published by Professor Freeman John Dyson through 1974.

Mr. Breit wants to recommend Professor Dyson for a distinguished award. Although he knows that for some recommendations it is best to have the actual order of authors, in this particular case he is convinced that the order will not matter because the incumbent's best papers are by himself alone. Therefore my husband says that he will accept any order and asks that the material be sent will all reasonable speed especially because other matters will have to be arranged in this connection. Your cooperation will be much appreciated.

Sincerely yours,
Marjorie MacDill Breit
Mrs. Gregory Breit

[redacted] BUFFALO, NEW YORK 14214 TEL.(716)[redacted] 836-7110

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

August 20

Dear Carl

Here is the Ramo thing.

Also a journal of my recent holiday, which I wrote for my family in England. Parts of it you and Annette may find interesting.

Yours
Freeman.

MEMORANDUM

To: Those Listed on the Attached

From: Simon Ramo

Subject: Meeting with Vice President Rockefeller

As already discussed with you by telephone, we are all invited to meet with the Vice President in his offices on September 4, from 9:30 a.m. to 4:00 p.m. We will also be luncheon guests of the Vice President. You will shortly receive a letter from Mr. Richard Allison of the Vice President's staff providing information about entry arrangements, transportation expense re-imbursement, consultant fees, etc.

This meeting is part of an effort by the Vice President, in anticipation of the creation of the President's proposed Office of Science and Technology Policy, to seek the counsel of leading scientists and technologists regarding issues meriting early attention by the Office. More specifically, this meeting will consider a number of areas of such nature and importance that they might warrant the immediate appointment of task forces by the President to commence study of the matters without waiting for the inauguration of the new Office.

A preliminary meeting was held a few weeks ago to discuss a wide variety of problems or potential opportunities in which science and technology were seen to be either dominant, or of high significance in conjunction with non-technological factors (social, economic, or political). Also, the meeting's discussion aided in clarifying the criteria that should be used for the selection of those issues fully deserving priority attention by the proposed Office.

The September 4 meeting is expected to focus on three areas which emerged from the preliminary meeting as appearing both to meet the criterion of exceptional importance and to lend themselves to constructive progress through the activities of a Presidentially appointed task force, more particularly a task force that might be brought into operation even before the Office is established. However, the agenda will include time for the attendees to speak their minds as they might desire on other issues they deem worth consideration, since the "first sorting" of the preliminary meeting was intended only to be helpful and not limiting.

Attached are brief descriptions of the three areas, written to aid in the launching of discussion rather than as drafts of charters for task forces that might be set up. Thus, the descriptions are purposely broad and many aspects are included. In contrast, a work statement for a task force doubtless would have to be more specific and limited. We shall look to the meeting's discussion to suggest how best to concentrate the subject matter. Also, it is hoped we will deliberate on the challenging question of how to structure any task force that might be proposed - as to area, objectives, results, and mechanism of co-ordination and reporting - so its recommendations will be implementable (and implemented).

Task Force Area No. 1 "Comparative Evaluation of U.S. vs U.S.S.R. Effort in Military Research and Development" will undoubtedly require that if a task force is set up, it can deal with classified information. However, it is not contemplated that the meeting discussion of this example will require the taking up of classified data.

Task Force Area No. 2 "Anticipation of Major Advances in Science and Technology" is one where many new science and advanced technology topics will deserve consideration. Here a task force might be charged with selecting which topics to attack first from a long list provided. Or, instead, the task force's charter might call out only a few of the most urgent or most promising specific examples. The invitees to the meeting are encouraged to be ready to suggest topics they consider especially important to incorporate into the task force considerations.

Task Force Area No. 3 "Technology Policy and Economic Growth" is the most general and most in need of additional clarity, refinement and focus. The meeting attendees are urged to give thought to this important area and come prepared to suggest specific aspects which can be adequately articulated and defined to the point of leading to a useful attack by a task force.

Simon Ramo

Simon Ramo

SR/pd
8/18/75

TASK FORCE AREA NO. 1

COMPARATIVE EVALUATION OF U.S. VS U.S.S.R. EFFORT IN MILITARY RESEARCH AND DEVELOPMENT

Specific Questions for the Task Force

1. Is the Soviet Union now employing more scientists and engineers than the U.S. in its efforts to advance the science and technology basic to the development of military weapons systems and to the creating of options for use, or threat of use, of military force?

2. What is judged to be the relative quality of these efforts - for instance: capability of individual scientists and engineers assigned; nature and degree of backup of required resources; methods of, and judgment used in, selection of programs and objectives?

3. What does the imbalance in the U.S.S.R.'s favor, if it is deemed to exist, mean to the U.S. as regards security and military and political options?

4. What steps should be taken to minimize the probability of occurrence of penalizing "surprises" and other negative consequences that an inferior position for the U.S. in the science and technology underlying our military capability might portend?

5. How serious and urgent does the situation appear to be, and hence, how rapidly is it essential that these steps be taken?

TASK FORCE AREA NO. 2

ANTICIPATION OF MAJOR ADVANCES IN SCIENCE & TECHNOLOGY

At any given time interested scientists and engineers are able to discern certain trends and potentials which suggest the emergence of major advances in science or technology in the future. Of course, many important possibilities cannot be envisaged because no hint of them has yet surfaced or because they depend upon factors not yet suspectible to evaluation. Important changes, however, are not always unpredictable. Many are merely unpredicted. Moreover, some advances can be speeded up by adequate early appreciation and action.

High quality and deliberate effort, both creative and analytical, should make possible the calling out ahead of a useful fraction of coming advances on the science and technology front. Such anticipations should provide us often with options for action to enhance the potential benefits and to minimize conceivable adverse consequences.

The proposed panel should consider a number of frontier areas of science and technology, sorting them as to inherent possiblities and as to their seeming susceptibility to influence (either to accentuate the positive or eliminate the negative). The panel should then recommend courses of action.

Examples of topics (in arbitrary order) that appear to deserve attention are : weather prediction and control; ocean farming; minerals from the ocean floor; electronic information systems to improve productivity; genetic engineering; technological aids for improved or more economical health care; substitutes for material resources in short supply; new communications technology; new applications of space technology; new transportation technology (air, sea, land); disaster prediction and control technology (earthquake, forest fires, tornados, etc.); water supply technology; environmental science; waste-disposal technology.

(NOTE: Bio-medical and energy areas have not been listed because large-scale advisory committee activities, recently launched in these fields at Departmental levels, lower the priority for further attention now at the level of the proposed new Office.)

TASK FORCE AREA NO. 3

TECHNOLOGY POLICY AND ECONOMIC GROWTH

The Issue Stated as a Series of Questions

1. Are science and technology being used to the fullest on behalf of the society? If not, why not, and what can be done to remedy this situation?

2. To what extent is U.S. international economic competitiveness dependent on advancing science and technology? What altered policies and new government actions affecting science and technology might enhance the U.S. competitive position?

3. What added steps might the U.S. government take to advance private-sector technology in support of the domestic economy and international competitiveness?

4. What science and technology efforts necessary to the nation's economic health can only be caused to advance satisfactorily under government sponsorship and what further action should be taken for appropriate support of such activities?

Some Specific Examples of Issues to be Considered by the Task Force

1. Productivity Improvement

The U.S. is recognized as suffering from a low relative rate of increase of productivity as compared with other nations. This is despite the fact that a number of areas of technology in which the U.S. leads are seen to offer the possibility of high productivity gains. * The panel should pinpoint the potentials for productivity improvement and for economic return on investment through the developing and installing of technological systems. The panel should also identify the impediments to such gains and recommend government actions to remove them where possible.

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* For example: a large fraction of the increasing costs for the production of goods and services lies in the handling of information. Application of advanced technological apparatus and systems - computers, intelligent terminals, data communications systems, etc.- can lower the cost of information accumulation, sorting, storage, interpretation, transmittal and use.

2. Energy and Economic Growth vs Environment and Safety

Further economic growth, with the accompanying requirements for an increasing energy supply, involves trade-offs with environmental protection and safety standards. Moreover, economic and standard of living growth, and the technological advance to sustain them, will soon be constrained by shortages of various resources. Unfortunately, needed government policies dealing with these interactions too often have had to be formed in an atmosphere of confused, emotional, and politically inspired pressures. It is necessary to press for more adequate studies of the environmental and safety aspects of individual technological developments. It is also essential to provide a broader base of citizen understanding of the balances between opposing demands and constraints. Such understandings cannot come without a constant flow of objective, scientifically based data and well articulated analyses and conclusions.* The panel should attempt to describe a program to place these overall confrontations on a rational plane and thus reduce a major impediment to the fullest use of science and technology on behalf of the citizenry.

3. Technology Subsidy Systems/Foreign Governments vs the U.S.

In certain important areas of technological advance, U.S. economic competitiveness rests on a sometimes vague and shaky hybrid of private enterprise and government aid and control (through sponsorship, regulation, patent policy, anti-trust and various other legal constraints). Our approach often competes against totally government financed activities abroad and foreign-based monopolies.** The panel should examine the competitive situation and study the potential position of the U.S. versus the

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* Example: The public accepts high hazards for old technology yet often seemingly wants no hazards at all for new technological systems. Thus, 50,000 are killed each year through automobile accidents, while nuclear reactors are regarded as unacceptable unless the accident rate potential is nil.

** Example: The science and technology of aeronautics, and the air transportation and airplane manufacturing industries.

foreign based activities and ask whether possible deterioration in the U.S. relative position can be prevented by altering policies, organization, or goals or taking other government actions.

4. Technology Transfer to Other Nations

The transfer of technology to and from the United States is affected by, and has a tremendous effect upon, foreign trade, balance of payments, foreign investment and the general economic competitiveness of the United States. Influenced as well by technology transfer is the U.S. role in ensuring world economic development, cooperation and stability. Technology transfer can provide both handicaps and benefits. The panel should not be concerned with the question of political advantages or disadvantages of technology transfer, but should study primarily the technological-economic interactions with the objective of defining options and pinpointing problems and potential benefits.

The United Chapters of Phi Beta Kappa
1811 Q Street, N. W., Washington 9, D. C.

Kathy Navascues
(202) 265-3808

FOR RELEASE - FREEMAN J. DYSON, professor of physics at the Institute for Advanced Study in Princeton, has been appointed a Phi Beta Kappa Visiting Scholar for 1975-76. Visiting Professor at the Max-Planck-Institute during 1974-75, he is currently engaged in a study of astronomical telescopes, their fundamental limitations and possible improvements.

As a participant in the Visiting Scholar Program, Mr. Dyson will travel to eight institutions: Reed and Smith Colleges; the Universities of Idaho and California at Riverside; San Diego State, Furman, Emory, and Florida State Universities. During his two-day stay at each institution he will meet with students and faculty in a variety of formal and informal encounters, which usually include classroom discussions, seminars, and one public lecture. His lectures will cover such topics as: the search for extraterrestrial intelligence and the next industrial revolution.

The Phi Beta Kappa Visiting Scholar Program was begun in 1956 to enable undergraduates to meet and talk with established scholars in diverse disciplines. Other Visiting Scholars for 1975-76 are: Wayne Andrews, Archives of American Art Professor, Wayne State University; Houston A. Baker, Jr., director of Afro-American Studies and professor of English, University of Pennsylvania; L. H. Butterfield, editor in chief emeritus, The Adams Papers; Marshall Cohen, professor of philosophy, Richmond College and The Graduate School, City University of New York; James S. Coleman, representative in Zaire, The Rockefeller Foundation; John Fischer, associate editor, Harper's Magazine; David A. Hamburg, Reed-Hodgson Professor of Human Biology, Stanford University; Juanita M. Kreps, vice-president and James B. Duke Professor of Economics, Duke University; Howard Nemerov, professor of English, Washington University; Helen North, William R. Kenan Professor of Classics, Swarthmore College; Francis T. P. Plimpton, lawyer and diplomat, New York City; Cyril Ponnamperuma, professor of chemistry and director of the Laboratory of Chemical Evolution, University of Maryland; William B. Willcox, professor of history and editor of The Papers of Benjamin Franklin, Yale University. These men and women, invited by local Phi Beta Kappa chapters, will travel to 95 colleges and universities during the academic year.

September 5, 1975

Dear Freeman:

Thank you for your note of September 2. Subject to my continued feeling that any absence on your part is to be deplored, I am glad to grant the formal permission requested.

Who knows, you might even miss a Faculty meeting.

As ever,

Professor Freeman Dyson
School of Natural

MEMO

Dr. Carl Kaysen
Director's Office

September 2, 1975

Dear Carl:

I must ask you formally for permission to be away twice during the coming term. I tried without success to move the dates of these trips outside term-time.

(1) September 22 - October 3, 1975. A lecture tour of small colleges, under the auspices of Phi Beta Kappa, bringing them the good word about recent developments in science.

(2) November 12-30, 1975. Visiting the Space Research Institute of the USSR Academy of Sciences, including a trip to the new Zelenchukskaya observatory in the Caucasus.

Yours sincerely,

Freeman

Freeman Dyson

FD:pb

December 2, 1974

Dear Freeman:

Thanks very much for sending me the copies of your talk in Madrid, The Hidden Costs of Saying No. You are, as usual, eloquent and persuasive, but perhaps not quite convincing. Maybe its because I'm a bureaucrat at heart, but I don't see an escape from the dilemma. Perhaps I misread you, but my question at the end of your piece is, would we be able to practice intellectual infanticide more effectively than you think we can practice birth control? In other words, if we had less stringent controls over development and followed every possible new path, could we have effective controls over which of the many developments we in fact put into use. Years ago, when I tried to understand the economics of military research and development, I came away with the conclusion we spent relatively too little money on research and early stages of development, and that therefore we had a narrower choice of possible weapons for final procurement than we should have had. Further, that if we had changed the balance, the whole process, including the procurement, need not have been more expensive. The argument on the other side, of course, was that once a development was complete, it was very hard to resist the pressure and buy what was developed, and perhaps this was the argument that ultimately prevailed.

I trust that you are all enjoying Munich, and Annette joins me in regards to all the Dysons.

Warmly,

Professor Freeman J. Dyson
Max-Planck Institut für Physik und
Astro-Physik
8 München 40
Föhringer Ring 6
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October 1974

Dyson

The Hidden Costs of Saying No

Talk to the International Meeting on Scientific Research and Energy Problems, Madrid, October 16, 1974

by

Freeman J. Dyson

Max-Planck-Institut für Physik und Astrophysik,
München, Germany

(on leave of absence from the Institute for Advanced Study,
Princeton, New Jersey, U. S. A.)

"One Law for the Lion and Ox is Oppression."
"You never know what is enough unless you know
what is more than enough."

William Blake,

"The Marriage of Heaven and Hell" (1790)

During the last ten years, in every industrialized country, the general public and the political authorities have become acutely aware of the existence of hidden costs. The economists have taught us that every industrial or social innovation carries hidden costs that do not appear in the immediate profit-and-loss accounts of any individual enterprise. For example, flood-control dams in California cause rivers to carry less sand to the ocean, with the consequence that the width of certain swimming beaches is diminishing. High-intensity street lights, installed by our highway authorities to reduce the frequency of accidents, destroy the quality of the sky over an astronomical observatory fifty kilometers away. A hundred and eighty years ago, William Blake could write:

"Though born on the cheating banks of Thames,
Though his waters bathed my infant limbs,
The Ohio shall wash his stains from me."

If Blake were living now, he would find that after a swim in the Ohio he would still need a wash. Many other examples of hidden costs have become so notorious that I do not need to describe them in detail. The list of these horrors is a long one: the sinking of the city of Venice, the smog of Los Angeles, the poisoning of the American eagle by insecticides, and many more. The public has been awakened to the importance of hidden costs, mainly through the influence of a small number of books. Let nobody say that books have lost their power to persuade in the modern world of computers and television. A few writers gifted with common sense and eloquence, Rachel Carson with her "Silent Spring," Harrison Brown with his "Plundered Planet," Barry Commoner with his "Closing Circle," persuaded the people and Congress of the United States of America to count the hidden costs of industrial development. A similarly small and gifted group of writers has done the same for Northern Europe. As a result, we now have laws which prescribe a careful public accounting of the hidden costs before any large public enterprise is undertaken.

Several proposed enterprises have come spectacularly to grief during the process of public accounting, and have as a consequence been discredited and abandoned. The most famous of these projects killed by the public examination of hidden costs was the American supersonic airliner (SST). But the most important effect of the new public attitude toward technological innovation does not lie in the small number of big projects that have been exposed to public scrutiny and then stopped. Far more important is the larger number of projects that never come to the notice of the public but die unseen, their proponents discouraged by the expense, delay and uncertainty which the procedures of public examination impose. For every one power-station or oil-refinery that is publicly killed, ten others are privately discouraged. The doctrine of deterrence, whether or not it is valid in the strategic sphere, certainly applies in the sphere of technological innovation. After a government kills one thorium-breeding reactor project, nobody has the heart to try to begin another. After one nuclear-rocket program has been officially abandoned, young men with brains and imagination

turn their attention elsewhere.

I am not saying that the counting of hidden costs is a mistake, or that the public indignation aroused by dead birds and dead fish was unjustified. We shall not turn the clock back to the time when everyone was free to dump soot upon his neighbour's garden. Rachel Carson's cry of anguish has made this planet a pleasanter place, not only for birds but also for people. The good that she has done shall not be undone. But I am saying that it is not enough to count the hidden costs of saying yes to new enterprises. We must also learn to count the hidden costs of saying no. The costs of saying no may be extremely high, although they are often uncertain and intangible. Our existing political processes introduce a strong bias into the consideration of new enterprises. The costs of saying yes can be calculated and demonstrated in a style that is familiar and congenial to lawyers, whereas the costs of saying no are a matter of conjecture and have no established legal standing. We must learn that costs may be tragically real even when they are legally unprovable. We must try to establish processes of decision-making that give the costs of yes and no an equal voice. We need to know more accurately what are the costs of saying no in cases where this can be known. We need more knowledge, and we need procedures that allow a more realistic weighing of uncertainties when knowledge is lacking.

One case study, in which the costs of saying no were demonstrated in convincing fashion, was published by Carl Djerassi in two articles[1)] in "Science." Djerassi took the trouble to document his facts carefully, and his conclusions have not, so far as I know, been seriously challenged. His study is concerned with the process of development of chemical birth-control agents. I do not need to explain to this audience the importance of birth-control agents to the future of mankind. Another fact which I do not need to emphasize is that the presently existing birth-control agents are in various ways unsatisfactory, unsafe, or inadequate to the purposes for which they were intended. Djerassi analyses in detail the costs in money and time which are imposed by government regulation upon anybody who wishes to develop a new variety of agent. The costs apply equally, whether the project is undertaken by an industrial company, a governmental agency, or a private philanthropic organisation. The cost in time turns out to be 17 years, the cost in money 18 million dollars of 1970 vintage. These are minimum figures, based on the assumption that the various steps in the prescribed procedure follow one another smoothly and that no unforeseen difficulties arise. The figures are presented in detail for work performed under United States regulations, but the conclusions would not be substantially different in other industrialised countries. The large expenditures of time and money are required in order to carry out long-term studies involving large numbers of animals and, in the later stages, human volunteers, to ensure that the product is safe and effective before it is made available for

public use.

Djerassi was not arguing, and I am not here arguing, that these strict regulations governing the introduction of new drugs should be abandoned. The regulations came into existence as a result of the public reaction to the Thalidomide tragedy, in which thousands of babies were crippled by a supposedly harmless sleeping-pill. Nobody with responsibility for developing new drugs would wish to have another such tragedy on his conscience, and nobody with responsibility for formulating regulations would wish to leave open a chance that it might happen again. In this case the costs of saying yes are so high and so abominable that the regulations must be accepted as a permanent necessity. What Djerassi is saying is simply that the practical consequence of these regulations must also be accepted. The regulations mean in practice that no substantially new chemical birth-control agents will become available during the foreseeable future. No companies, and few individuals, will devote themselves to an expensive and elaborate project which will take at least 17 years to complete and may at any stage be halted and come to nothing. Djerassi argues that it should still be possible to develop new agents under the existing regulations, if the government would give such projects long-term financial and administrative support. Needless to say, the government has done nothing in the meantime to bring such hopes to reality. So from this study of Djerassi's I draw the following conclusion. The price of safety in the development of new drugs is that large public expenditures are required to do a job that in the past could be done by private industry, and in the future may not be done at all. This is one of the rare cases in which the costs of saying no are not hidden but are almost calculable, as a result of one man's careful work in collecting the relevant facts.

Let me now return briefly to the example of the supersonic airliner. I do not wish to argue that the killing of the SST project was a mistake. There were indeed some good reasons for killing it. Nevertheless the decision was actually influenced by calculations of costs and benefits which bore little relation to reality. For example, it was argued that the SST would have a large adverse effect on the balance of payments of the United States, because it would stimulate a massive flow of American tourists to Europe, unbalanced by any comparable flow of Europeans to America. This argument may have had some merit, but the calculations that were used to support it have already been made completely obsolete by the world economic crisis. As often happens in such cases, a cost that could be calculated in dollars and cents was taken seriously by the politicians, even though the precision of the calculation was entirely illusory. I would venture to say that almost all numerical estimates of the long-range costs of technological innovations are illusory. In the case of the SST, I believe that the most important cost of saying no was the discouragement of future enterprises in aeronautical engineering, many of which have not yet been conceived. This

is a cost which may in the long run heavily outweigh the costs which we should have incurred by saying yes. As always, the weighing of intangible costs is a matter of taste and of judgment.

Whenever I travel by air, I am always amazed by the efficiency and reliability of the modern commercial airliner. Theodore Taylor once collected some facts concerning the history of commercial airplanes. He found that the number of different types of airplane that have been developed and flown, not counting minor modifications, is considerably larger than one hundred thousand. It took a hundred thousand attempts, most of which ended in failure, to produce the few types of airplane that are now flying. The evolution of airplanes was a strictly Darwinian process of the survival of the fittest. And that is why the modern airliner is efficient and reliable.

I find it instructive to contrast this history of the airplane with the history of commercial nuclear reactors. In the world-wide effort to develop an economical nuclear power-station, less than a hundred different types of reactor have been operated. The number of different types under development grows constantly smaller, as the political authorities in various countries eliminate the less promising candidates for reasons of economy. The growth of extremely strict and complicated safety regulations also discourages any attempt at radical innovation. The consequence of this history is that there now exist only about ten types of nuclear power-station that have any hopes of survival, and it is improbable that any new type differing radically from these will ever receive a fair trial. Perhaps this is the fundamental reason why nuclear power-plants are not as successful as airplanes. We did not have the patience to try out a hundred thousand different designs, and so the really good reactors were never found. Perhaps it is true in technology as it is in biological evolution, that wastage is the key to efficiency.

So far I have talked about the past, and it is now time to turn to the future. I shall discuss two problems of the future which I consider to be of central importance, namely, climate modification and genetic engineering. It is obvious that any further large expansion of the industrial activities of mankind will cause noticeable changes in the climate of the earth. This fact is often used by advocates of "Limits to Growth" as an argument for halting further expansion. I wish to argue the contrary view. I see no reason at all to believe that the present climate of this planet is in any sense optimal. The concept of an "optimal climate" is in fact meaningless, since different people with different ways of life will always have different preferences in matters of climate. I do not claim that it is either possible or desirable to choose one particular climate, such as that of Mallorca or Hawaii, and impose it uniformly upon the whole world. I claim only that there are many large areas of this planet, for example the Sahara desert and the Siberian tundra, where some mitigation of the climate would produce obvious benefits. A warmer Siberia and a wetter Sahara would allow a richer life not only for

human beings but also for wild animals and plants.

The idea that an artificially created ecology can be richer and aesthetically more pleasing than a natural one is at present highly unpopular. The fashionable belief is expressed by the writer Barry Commoner when he states as a basic law of ecology: "Nature Knows Best." Commoner is able to present an impressive collection of horror stories to support his opinion that human alteration of a natural ecology leads inevitably to deterioration and ultimate disaster. Nevertheless I know of equally impressive examples to the contrary. I spent my childhood years in rural England, and I frequently return there for a few days of rest and spiritual renewal. At any season of the year you may find in rural England an ecological harmony of extraordinary richness, with a tremendous variety of species of plants, birds and animals. This ecology is also unusually robust, surviving without obvious damage the assaults inflicted by a high density of human population and industry. It is a community of species in which ecologists and poets can equally rejoice. But nothing in this ecology of rural England is natural. The natural state of England was incomparably poorer, being a rather uniform expanse of forest and swamp. Almost everything that now exists there is artificial, created by men who were not afraid to turn wilderness into village, crop-land and pasture. I do not believe that there exist any laws of nature that forbid us to create an artificial ecology as varied and as beautiful as that of rural England, either in the central Sahara or on the shores of the Arctic Ocean. To do this will require a long time, great quantities of energy, and knowledge which we do not yet possess of the long-range consequences of our actions. When we have acquired the knowledge and power to modify climates according to our taste, we shall be exposed to great dangers at the same time as we reap great rewards. There is no reason why a prudent fear of the dangers should cause us to deny the possibility of the rewards.

A look at the past history of the earth's natural climate gives additional grounds for optimism concerning the feasibility of producing desired changes without disastrous side-effects. It is known that about 5000 years ago the climate of Northern Europe and Asia was considerably milder than it is now, and the variety of indigenous plants and animals was considerably greater. Mixed forests grew far to the north, where now only conifers can survive. At roughly the same period, the rock paintings of the central Sahara show herds of giraffes, which are vivid evidence of a climate wet enough to support trees and grass over a wide area. We have absolutely no idea how and why the climate in these two widely separated areas deteriorated, or whether the changes in the two areas were causally linked. It seems improbable that changes on this scale and at so early a date were strongly influenced by human activities. But our ignorance of the mechanisms of climatic change is so profound that all theories of causation are pure speculation. What we can say with some degree of certainty is that 5000 years ago a climatic regime existed which was in many parts of the Earth more hospitable to living creatures than the present regime. It is at least possible that some

comparatively modest human intervention, applied with adequate understanding of the consequences, would result in the reestablishment of the regime which existed naturally in the past. This is a possibility which should be a source of hope to mankind. A wetter Sahara and a warmer Arctic could mean a doubling of the area of this planet suitable for productive agriculture. A hungry world should count the cost before saying no to such possibilities.

The second problem of the future which I want to consider is genetic engineering. I am not a biologist, but it seems to me certain that the really important technological advances of the next fifty years will come from biology and not from the physical sciences. Within less than fifty years I expect that we shall have achieved a mastery of the fundamental processes of living organisms, as complete as the mastery we now possess of the processes of physics and chemistry. A mastery of biological processes will imply, among other things, the ability to produce micro-organisms with enzymatic machinery tailored to suit our needs. Chemical processes carried out by systems of enzymes generally proceed with much higher efficiency, higher specificity, and lower wastage of material, than processes carried out by conventional industrial methods. In particular, we can expect that the development of microbiological technology will revolutionize the production of food, the conversion of coal and crude oil into clean fuel, the concentration and reduction of ores, and the handling and recycling of waste materials. Each one of these revolutions will have profound effects on the conditions of human life. All of them together will change the world in ways that we can hardly imagine. When I use the phrase "genetic engineering," I am referring to this future industrial revolution based on artificially produced micro-organisms. I am not speaking about genetic engineering applied to human beings, since that is a separate problem with unique dangers and more dubious rewards.

I am suggesting to you that the human rewards resulting from a massive development of microbiological genetic engineering may be very great indeed. We can expect that almost any organic material, from sawdust to sewage, may be converted quantitatively into clean fuel and other useful chemicals. We can expect to evolve techniques of "indoor farming" which will allow abundant production of food in all parts of the globe. We can expect the overall style and appearance of industry to change in an aesthetically desirable direction. Oil refineries need not stink, mine-dumps need not despoil the earth, and men who work in factories need not drive to homes twenty kilometers away to find clean air. A second industrial revolution, based on biological technology, may largely undo the evil effects of the first industrial revolution based upon steam and coal. These are some of the rewards that genetic engineering appears to offer to us.

These are the possible rewards. But of course there are also dangers. And in recent years my biologist colleagues seem to have been thinking much more about the dangers than about the rewards. In particular, a group of

leading microbiologists under the chairmanship of Paul Berg recently issued a statement[2)] calling attention to the dangers involved in the use of newly discovered techniques of manipulating DNA molecules. Berg's group not only called attention to the dangers but called upon all biologists to abstain from certain types of experiment which were judged particularly hazardous. The particularly hazardous experiments involve the grafting of alien genes into the genetic apparatus of bacteria which might afterwards escape from control and infect human populations. I am not expert in biology, and I have no competence to assess the magnitude of the danger involved in these experiments. I am quite willing to accept the view of the experts that the danger is real and serious. Once again, we must respect the caution of scientists who do not wish to take any risk that they might inflict a new Thalidomide tragedy upon babies yet unborn. And yet, the tone of the Berg statement leaves me with a feeling of deep dissatisfaction. The statement is written as if the only factors to be considered were, on the one hand, the danger to society involved in certain experiments, and on the other hand, the professional interest of a few biologists in doing the experiments. The cost of saying yes to these experiments is a risk of a disastrous epidemic disease, the cost of saying no is a minor setback in the professional careers of a few scientists. When the balance of costs is presented in these terms, the inevitable conclusion is a negative one. Any biologist performing such experiments is automatically judged to be selfish and irresponsible.

Unfortunately, the experiments now judged dangerous lie extremely close in technique and concept to the experiments which would be required for the development of a genetic industrial technology. The prohibition of the dangerous experiments may well imply the postponement of an industrial technology that is of crucial importance to mankind. This is the hidden cost of saying no, a cost which the Berg statement totally ignores. The Berg statement includes a proposal for an international meeting to be held next year to "further discuss appropriate ways to deal with the potential bio-hazards of recombinant DNA molecules." It is to be hoped that the international meeting will consider, not only the hazards of these molecules but also their promise for human welfare. Not only the costs of saying yes but the costs of saying no. The most useful outcome of the international meeting would be the definition of two clearly separated classes of experiments, one class carrying danger to human populations, the other class carrying no visible danger but still promising to unravel the complexities of structure that must be understood before genetic engineering will become a reality. It is as important to encourage the second class of experiment as to discourage the first.

I have now passed in review four problems of the regulation of technological development, two from the past and two from the future. From the past came Djerassi's study of the regulation of chemical birth-control agents, and the downfall of the American supersonic airliner. From the future came

climate modification and genetic engineering. I will now try to sum up what general conclusions one can derive from the consideration of these four examples.

In each case, there are two stubborn facts of life which make it extraordinarily difficult for political authorities to reach wise decisions. These two facts are the unpredictability of technology and the inflexibility of bureaucratic institutions. Technology has always been, and always will be, unpredictable. Whenever things seem to be moving smoothly along a predictable path, there is always some unexpected twist which changes the rules of the game and makes the old predictions irrelevant. Quantitative factors, which are more or less predictable, are always outweighed by qualitative factors which are unpredictable. To take an example from the past which I owe to Leon Cooper[3)], a mid-nineteenth-century development program aimed at the mechanical reproduction of music might have produced a superbly engineered music-box or pianola, but it would never have imagined a transistor radio or subsidized the work of Maxwell on the physics of the electromagnetic field which made the transistor radio possible. As to the future, it is clear that the development of genetic engineering will have a major impact on agriculture and industry all over the world, but the impact will come in unexpected ways and will almost certainly not follow the path which I have predicted for it. And yet, human legislators are always tempted to act as if the future were predictable. They attempt to legislate solutions to technological problems, and they make choices between technological alternatives before the evidence upon which a rational choice might be based is available. A glaring example of premature choice was the American decision to give absolute priority to the Liquid Metal Fast Breeder Reactor in the nuclear power program. The LMFBR is an excellent concept and should by all means be developed, but we have no reason to believe that other alternative concepts might not work better. It often happens in technological development that one design turns out to be not merely better, but enormously better, than its competitors, for reasons that could not have been predicted in advance. There is no way to find the best design except to try out as many designs as possible and discard the failures. The governmental authorities in all countries have to learn the lesson which Blake etched on a plate of copper 180 years ago: "You never know what is enough unless you know what is more than enough."

The other lesson which we have to learn is that bureaucratic regulation has a killing effect on all creative endeavor. No matter how wisely framed and well intentioned, legal formalities tend to become inflexible. Procedures designed to fit one situation are applied indiscriminately to others. Regulations, whose purpose was to count the cost of saying yes to an unsound project, have the unintended effect of saying no to all projects which do not fit snugly into the bureaucratic machine. Inventive spirits

rebel against such rules and leave the leadership of technology to the uninventive. These are the hidden costs of saying no. To mitigate such costs, every lawyer and every legislator should carry in his heart the other lesson which Blake has taught us:

"One law for the Lion and Ox is Oppression."

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1. Carl Djerassi, "Prognosis for the Development of New Chemical Birth-Control Agents." Science, 166, 468 (1969); "Birth Control After 1984," Science, 169, 941 (1970).
2. Paul Berg et al. "Potential Biohazards of Recombinant DNA Molecules," Science, 185, 303 (1974).
3. Leon Cooper, Lecture at the Naval Research Laboratory Fiftieth Anniversary Celebration, Alexandria, Va., (October 1973).

DYSON ADDRESS: 1974-75

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Astro-Physik
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Föhringer Ring 6
Postfach 401212
Germany

April 18, 1974

Dear Freeman:

I received a farewell call this morning from Dieter Ohly, a classical archaeologist who is Director of the Glyptothek in Munich. Apparently, you and he have not encountered each other during the course of his visit. In any event, he and his wife are both very lively, so I found occasion to mention that you would be in Munich next year. If you feel like meeting some archaeological classicists, etc., I am sure that they would be very pleased if you looked them up, and the Glyptothek is a lovely museum.

If you are free, shall we have lunch on Monday and talk about nuclear power?

Cordially,

Carl Kaysen

Professor Freeman Dyson
School of Natural Science
Institute for Advanced Study

April 1, 1974

Dear Freeman:

Thanks for your note. I guess what I got out of the paper was invariant to the details of the mistake.

The essay I mentioned appears in a book called "Imperialism and Social Classes", published by Augustus M. Kelley in 1951, translator Heinz Norden. The original essay appeared in the Archiv für Sozialwissenschaft und Socialpolitik (Vol. 57 (1927) pp. 1-67, title: "Die sozialen Klassen im ethnisch homogenen Milieu".

Yours,

Carl Kaysen

Professor Freeman Dyson
School of Natural Sciences

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540

SCHOOL OF NATURAL SCIENCES

Dr Carl Kaysen

March 29 1974

Dear Carl

Since you took the trouble to read my evolution paper, I am obliged to send ~~to~~ you this too. It is not the first time that I goofed. Anyhow the next step which Orgel and I hope to take is to construct a more-or-less realistic model — which will certainly be so complicated that one has to run it on a computer rather than looking for an elegant analytical solution.

I would be interested to read the Schumpeter article if you have an exact reference to it.

Thanks

Freeman.

~~5 Year plan~~

March 27, 1974

Dr. Leslie Orgel
Salk Institute for Biological Studies
P. O. Box 1809
La Jolla, California 92112

Dear Leslie:

A funny thing happened after I talked to you on the telephone yesterday. Having decided to publish this little piece I sat down and carefully checked the details for the first time. It turns out the approximation of going from Eq. (10) to (11) is quite bad since when U is large k is also large. Everything from that point on is quantitatively wrong, although the qualitative behavior remains correct. You showed great wisdom in declining to have your name put on the thing as joint author. Anyhow I shall not publish it. It will be amusing to see if any of the people I sent it to will find the mistake.

The basic idea of course remains valid. It is still true if one does the calculation right that the number of unessential sites U comes into the exponent only with a square-root. However the details get complicated. And I think the main point of such an abstract model is lost if it cannot be solved elegantly and exactly.

The model to which my analysis does apply exactly is a continuum model. Each molecule is a continuous string of length (E + U), which can have defects at any set of points along its length. One defect in the part of length E and the molecule is dead. The rule of inheritance is the same as before, i. e. if a parent has k unessential defects, the offspring has defects distributed at random along its length with average spacing (U/k). The zero-generation has defects distributed at random with average spacing L. The theory then gives (I hope correctly this time)

$$p_n(0) = N \exp[-(\frac{1}{3}E + (2EU)^{\frac{1}{2}})/L]$$

instead of the old Eq. (18). But I feel this continuum model is so far from reality that not many biologists would find it of interest.

Looking forward to seeing you here in April.

Yours sincerely,

Freeman Dyson

FD:pb

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540
Telephone-609-924-4400

SCHOOL OF NATURAL SCIENCES

March 1, 1974

Memorandum to: Executive Officers of School of Historical Studies,
School of Mathematics, School of Social Science
From: E. S. Gorman

The School of Natural Sciences committee assignments for next year are as follows:

Social Science Committee: Tullio Regge (John Bahcall - alternate)
Governance Committee: Stephen Adler (Roger Dashen - alternate)

The SNS Executive Officer for next year is Marshall Rosenbluth.

Freeman Dyson will be on sabbatical next year.

Copies to: Profs. Cherniss, Harish-Chandra, Kaysen, SNS Faculty.

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SCHOOL OF NATURAL SCIENCES

February 8 1974

Carl Kaysen
Director's Office

Dear Carl

I am sorry I forgot to ask earlier for your permission to leave for the two weeks Feb 17 – March 2. I am to give the "Pauli Memorial Lectures" in Zürich during the first week, and I shall spend the second in England visiting Cambridge and also my family.

Thankyou very much.

Yours

Freeman.

OK per phone

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY 08540

SCHOOL OF NATURAL SCIENCES

March 20 1973

Dear Carl

Quotation from letter of Nietzsche to Burckhardt:

In the end I would much rather be a Basel professor than God; but I have not dared push my private egoism so far as to desist for its sake from the creation of the world.

Yours
Freeman