Eighty-Third Annual Commencement

June 10, 1977

CALIFORNIA INSTITUTE OF TECHNOLOGY

CALIFORNIA INSTITUTE OF TECHNOLOGY

Eighty-Third Annual Commencement

FRIDAY MORNING AT TEN-THIRTY O'CLOCK
JUNE TENTH, NINETEEN SEVENTY-SEVEN

Academic Procession

Chief Marshal, Robert W. Oliver, Ph.D.

Assistant Marshals

Arden L. Albee, Ph.D.

J. Kent Clark, Ph.D.

Harry B. Gray, Ph.D.

Robert V. Langmuir, Ph.D.

Jon Mathews, Ph.D.

MARCHING ORDER

CANDIDATES FOR THE DEGREE OF BACHELOR OF SCIENCE

CANDIDATES FOR THE DEGREE OF MASTER OF SCIENCE

CANDIDATE FOR THE DEGREE OF ENGINEER

CANDIDATES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

THE FACULTY

THE CHAIRMEN OF DIVISIONS

THE DEANS

THE TRUSTEES

THE COMMENCEMENT CHAPLAIN

THE ACTING PRESIDENT

THE CHAIRMAN OF THE BOARD OF TRUSTEES

Program

PRESIDING . . . . . R. Stanton Avery, LL.D.
Chairman of the Board of Trustees

ORGAN PRELUDE . . . . . Leslie J. Deutsch, M.S.

AN INTRODUCTION TO COMMENCEMENT
David C. Elliot, Ph.D.
Secretary of the Faculty

PROCESSIONAL . . The Convocation Brass Ensemble and Organ
James Rötter, M.M., Conductor

INVOCATION . . . . . George F. Regas, Rel.D.
All Saints Episcopal Church, Pasadena

COMMENCEMENT ADDRESS . "Some Dilemmas in Science"
Lee A. DuBridge, Ph.D., Sc.D., LL.D.
President Emeritus
California Institute of Technology

MUSICAL SELECTION . . . . . The Caltech Glee Club
Olaf M. Frodsham, A.M., Director

Child of God, arranged by Salli Terri
John Mosley, K. Jeffrey Erikson, Mark Bickford, soloists

CONFERRING OF DEGREES . . . Robert F. Christy, Ph.D.
Acting President
California Institute of Technology

PRESENTATION OF CANDIDATES FOR DEGREES

For the Degree of Bachelor of Science . Ray D. Owen, Ph.D., Sc.D.
Dean of Students

For the Degree of Master of Science . Stirling L. Huntley, Ph.D.
Associate Dean of Graduate Studies

For the Degree of Engineer . . . . Cornelius J. Pings, Ph.D.
Dean of Graduate Studies

For the Degree of Doctor of Philosophy . . . . . Dean Pings

Biology . . . . . Robert L. Sinsheimer, Ph.D., D.Sc.
Division Chairman

Chemistry and Chemical Engineering
John D. Baldeschwieler, Ph.D.
Division Chairman

Engineering and Applied Science . Robert H. Cannon, Jr., Sc.D.
Division Chairman

Geological and Planetary Sciences . . . Barclay Kamb, Ph.D.
Division Chairman

Physics, Mathematics and Astronomy
Maarten Schmidt, Ph.D., Sc.D.
Division Chairman

CONCLUDING REMARKS . . . Acting President Christy

BENEDICTION . . . . . Dr. Regas

RECESSIONAL . . The Convocation Brass Ensemble and Organ

ORGAN POSTLUDE . . . . . Leslie Deutsch

Academic Dress

The costume of those in the academic procession has a specific symbolism which dates back to at least the 14th century. While there have been many changes in the details, the meaning of the various parts of the costume continues to be the same. Academic institutions in the United States adopted a code of academic dress in 1895 which has been revised from time to time. The dress of institutions in other countries varies considerably, but the basic elements are present in all academic costumes.

GOWNS. The bachelor's gown has long, pointed sleeves; the master's gown has an oblong sleeve open at the wrists (or some older gowns may be open near the upper part of the arm); the doctor's gown is fuller than the others with velvet panels full length on the front and three velvet crossbars on each sleeve in black or in the color distinctive of the subject to which the owner's degree pertains. The gowns are always black except for the doctor's, which in a few instances is of a color representing the institution which conferred the degree.

HOODS. The hood, draped over the shoulders and down the back, indicates the subject to which the degree pertains and the university that conferred the degree. The level of the degree is indicated by the size of the hood. The hood for the bachelor's degree is three feet long; for the master's it is three-and-one-half feet long; and for the doctor's it is four feet long. The binding of the hood is of colored velvet designating the subject of the degree, and it is two inches, three inches, and five inches wide for the bachelor's, master's, and the doctor's degrees, respectively. The colors associated with some of the subjects are as follows:

Arts, Letters, Humanities, *White*
Commerce, Accountancy, Business, *Drab*
Economics, *Copper*
Education, *Light Blue*
Engineering, *Orange*
Fine Arts, including Architecture, *Brown*
Law, *Purple*
Medicine, *Green*
Pharmacy, *Olive Green*
Philosophy, *Dark Blue*
Public Administration, including Foreign Service, *Peacock Blue*
Public Health, *Salmon Pink*
Science, *Golden Yellow*
Theology, *Scarlet*

The lining of the hood is of the color or colors of the institution conferring the degree. When two colors are used, they are usually arranged in a single chevron. The lining of the doctor's hood is revealed more than in the master's, and much less is revealed in the bachelor's hood.

CAPS. In the United States, the black mortarboard is most commonly used. The tassel fastened to the center of the cap is normally worn in the left front quadrant of the cap and is black, although it may be of the color appropriate to the subject of the degree. The tassel for a doctor's cap may be of gold thread.

Candidates for Degrees

BACHELOR OF SCIENCE

Gul Agha *Karachi, Pakistan* Independent Studies Program
Timothy Brown Ahern *Cleveland, Ohio* Engineering and Applied Science
Charles Sem Bankert *Phoenix, Arizona* Chemistry
Budak Ziya Barkan *Istanbul, Turkey* Mathematics
John Juil Barnard *Sepulveda, California* Astronomy
John Joseph Barton *Pasadena, California* Chemistry
Richard George Graydon Beatty *La Jolla, California* Engineering and Applied Science
Thomas Allison Brown Beatty *Pittsburgh, Pennsylvania* Physics
David G. Beck *Arlington, Texas* Applied Physics
Walter Jay Beckmann *Olympia, Washington* Engineering and Applied Science
Dennis Dale Bicker *Arcadia, California* Engineering and Applied Science
Mark Samuel Bickford *Lawrence, Kansas* Mathematics
Jeffrey C. Blinn *Green Bay, Wisconsin* Chemical Engineering
David Elias Blum *Granada Hills, California* Geophysics
Duane Karl Boman *Covina, California* Biology
Douglas A. Bourne *Pasadena, California* Engineering and Applied Science
Lawrence Edward Bridges *Sunnyvale, California* Astronomy
Daniel T. Brown *Seattle, Washington* Mathematics and Engineering and Applied Science
David James Edward Callaway *Stockton, California* Physics
Douglas S. Carlson *Houston, Texas* Engineering and Applied Science
Lauretta Irene Carroll *Los Angeles, California* Engineering and Applied Science
Eric G. Carter *Fairfield, Connecticut* Astronomy
King Long Chai *Taipei, Taiwan* Physics and Engineering and Applied Science
Ngaiman Chau *Hong Kong* Engineering and Applied Science
Siu Chung Cheung *Hong Kong* Engineering and Applied Science
Raymond Maihin Chowkwanyun *Bangkok, Thailand* Mathematics
John Wen-Kiang Chu *Los Angeles, California* Biology
Talso Chung-Pang Chui *Hong Kong* Physics
Stephen Mitchell Comens *St. Louis, Missouri* Biology
Alan Elbert Comer *Kent, Washington* Physics
Reed Dennis Copsey *Sun Valley, California* Engineering and Applied Science
Louise Robin Corson *Canoga Park, California* Mathematics

Students whose names appear in bold face type are being graduated with honor in accordance with a vote of the faculty.

BACHELOR OF SCIENCE—*Continued*

Lorenzo Cotton *Los Angeles, California* Engineering and Applied Science
Thomas S. Creswell *Bellflower, California* Chemical Engineering
David Charles Crocker *Topsfield, Massachusetts* Engineering and Applied Science
Arvid Peter Croonquist *Pebble Beach, California* Physics
Alan S. Danziger *Albuquerque, New Mexico* Applied Physics
Robertson Davies Davenport *Ann Arbor, Michigan* Applied Mathematics
Arthur L. Davis *Denver, Colorado* Engineering and Applied Science
Richard John Debus *Lemon Grove, California* Chemistry
Lawrence Allen DesJardin *San Andreas, California* Engineering and Applied Science
David Armstrong Dewey *Orinda, California* Engineering and Applied Science
William Vogel Dower *Palm Beach, Florida* Chemistry
Bruce Allan Dunn *Riverside, California* Engineering and Applied Science
Gregory Paul Dunn *Castro Valley, California* Mathematics
Peter Kent Edberg *La Cañada, California* Engineering and Applied Science
Robert Kim Ellis *Mount Kisco, New York* Engineering and Applied Science
John Martin Epperson *Anaheim, California* Economics
John Barnett Ernest *Santa Ana, California* Chemistry
Thomas James Estes *San Diego, California* Biology
David Faulkner *Lafayette, California* Engineering and Applied Science
Richard Karl Feldman *San Mateo, California* Engineering and Applied Science
Carl David Forgerson, II *Lakewood, Colorado* Physics and Engineering and Applied Science
Robert Steven Forgey *Seattle, Washington* Chemistry
David James Frank *Arlington, Virginia* Physics
David Lynn Gard *Portland, Oregon* Biology
Shrikant Anand Garde *Bombay, India* Engineering and Applied Science
Peter Thomas German *Houston, Texas* Geology
Gregory Steven Gibson *Los Angeles, California* Chemical Engineering
Merrill Andrew Gibson *Los Alamos, New Mexico* Engineering and Applied Science
Randal Keith Goodall *Anchorage, Alaska* Physics
Arthur Edward Gooding *Lakewood, Colorado* Chemical Engineering
Judith Sharon Greengard *Holon, Israel* Biology
Stephen Wayne Griggs *La Cañada, California* Engineering and Applied Science
Kevin Marc Gromley *Valparaiso, Indiana* Chemical Engineering
John Leroy Gustafson *Des Moines, Iowa* Applied Mathematics
Donald Hamasaki *Newcastle, California* Engineering and Applied Science
Christopher Colin Harcourt *Garden Grove, California* History
Frederick Harlan Harris *Tujunga, California* Engineering and Applied Science
Christopher Lee Henley *Baltimore, Maryland* Physics and Mathematics
Bruce Gordon Herring *Cleveland, Tennessee* Engineering and Applied Science

BACHELOR OF SCIENCE—*Continued*

Bart Dean Hibbs *Pasadena, California* Engineering and Applied Science
James Joseph Hickey *St. Louis, Missouri* Geology
Kau-Kwok Frederick Ho *Hong Kong* Biology
William David Holland *Chatsworth, California* Engineering and Applied Science
James Evan Houseworth *Pasadena, California* Engineering and Applied Science
James David Howard *Klamath Falls, Oregon* Engineering and Applied Science
Russell D. Howard *Scottsdale, Arizona* Mathematics
Melody Ann Howe *Torrance, California* Independent Studies Program
Stephen Dale Hurst *Peoria, Illinois* Chemistry
Pauline Li-Po Quek Hwang *Beltsville, Maryland* Mathematics
Mike Iwaki *Los Angeles, California* Engineering and Applied Science
Bart Jackson *Pittsford, New York* Physics
Steven Jaffe *San Mateo, California* Biology
Brian Keith Jenkins *San Juan Capistrano, California* Applied Physics
Christopher Einner Jensen *Salinas, California* Engineering and Applied Science
Allen Lewis Johnson *Everett, Washington* Chemistry
Douglas Steven Jones *Long Beach, California* Engineering and Applied Science
Kevin E. Jones *Rutland, Vermont* Physics
James J. Kelly *Selden, New York* Physics
Thomas Garrett Kennedy *Dallas, Texas* Mathematics
Taras Kiceniuk, Jr. *Altadena, California* Engineering and Applied Science
Charles Edward Kistler *Anaheim, California* Engineering and Applied Science
Robert Brix Kjelgaard *Binghamton, New York* Mathematics
Jeffrey Donald Klein *Whittier, California* Engineering and Applied Science
Edward M. Kober *Canoga Park, California* Chemistry
David Akio Kodama *Kahului, Hawaii* Physics
Kathleen Lan-Yee Kong *Huntington Beach, California* Mathematics
Ru-Chang Kung *Studio City, California* Engineering and Applied Science
Pui Kwong Lam *Oxnard, California* Applied Physics
Hon Chung Lau *Hong Kong* Chemical Engineering
Clinton Beauregard Lee *Farmville, Virginia* Engineering and Applied Science
Peter Wayne Lew *San Francisco, California* Applied Physics
Nathan Saul Lewis *Los Angeles, California* Chemistry
Kenneth Kim-Chi Li *Hong Kong* Engineering and Applied Science
Sai-Man Li *Hong Kong* Engineering and Applied Science
Robert Reed Linderman *Covina, California* Engineering and Applied Science
Thomas D. Little *Winterset, Iowa* Biology
John Hsuen Loo *Northridge, California* Chemical Engineering
Robert Alan Loveman *Rolling Hills Estates, California* Physics
Felix Wayne Loya *El Paso, Texas* Biology

BACHELOR OF SCIENCE—*Continued*

Peter Sin-Yi Lu *South Pasadena, California* Biology
Kai-Yan Michael Ma *Hong Kong* Chemistry
John Christopher Manley *East Northport, New York* Mathematics and Engineering and Applied Science
Catherine Claire Marshall *Rancho Palos Verdes, California* Literature
Jan Morris Martin *Stockton, California* Engineering and Applied Science
Paul Oakley Mason *Soldotna, Alaska* Engineering and Applied Science
William McCown *Holtville, California* Engineering and Applied Science
Merle McKenzie *Denver, Colorado* History
Eric W. McKinlay *Los Angeles, California* Engineering and Applied Science
Bruce Alan McLaughlin *Ridgecrest, California* Astronomy
Barry Bruce Megdal *Van Nuys, California* Engineering and Applied Science
Curtis Stuart Meissner *Los Alamos, New Mexico* Engineering and Applied Science
Ryn Miake *Laguna Beach, California* Biology
Steven Wylie Mitchell *Jackson, Tennessee* Mathematics
James Charles Moiseve *Salem, Oregon* Chemistry
Lee George Mundy *El Toro, California* Astronomy
Jo Ann Muramoto *Los Angeles, California* Biology
Barry Nakazono *Denver, Colorado* Engineering and Applied Science
Dennis Wayne New *Pasadena, California* Mathematics
A. P. Nikora *Stuttgart, West Germany* Engineering and Applied Science
Lynn Bruce Olson *Faulkton, South Dakota* Physics
Ann Elizabeth Orel *Clovis, New Mexico* Chemistry
Peter D. Pathe *Ashland, Massachusetts* Engineering and Applied Science
Lawrence Charles Paulson *Drexel Hill, Pennsylvania* Mathematics
Leslie E. Peterson *Everett, Washington* Biology and Engineering and Applied Science
Karen Marie Phillips *Los Angeles, California* English
Jeffrey Ross Pier *South Pasadena, California* Physics
Richard Michael Pietrasz *North Reading, Massachusetts* Applied Physics
Jon M. Portis *Berkeley, California* Chemistry
Carlton Philip Pryor *Tiburon, California* Astronomy
Donald Andy Rasmussen *Cheyenne, Wyoming* Engineering and Applied Science
Edward Charles Rea, Jr. *Seabrook, Texas* Engineering and Applied Science
Patrick T. Reardon *Richland, Washington* Engineering and Applied Science
Eileen Leslie Reeds *Thousand Oaks, California* Engineering and Applied Science
George Dennis Reyes *Pacoima, California* Engineering and Applied Science
Robert Russell Ritchey *Phoenix, Arizona* Engineering and Applied Science
Michael John Roberts *Fresno, California* Engineering and Applied Science and Economics
Enrico Alberto Rodrigo *Carson, California* Physics

BACHELOR OF SCIENCE—*Continued*

David Andrew Rolfe *Los Angeles, California* Engineering and Applied Science
Christopher Boyd Russell *Pullman, Washington* Chemistry
Michael John Saari *Anchorage, Alaska* Engineering and Applied Science
Dean Lawrence Sanzo *Bellevue, Nebraska* Engineering and Applied Science
Stewart Scherer *Yonkers, New York* Biology
Jon Russell Schmidt *Northridge, California* Chemistry
James Philip Seidel *Park Ridge, Illinois* Applied Mathematics
Marc Alexander Sengstacke *Chicago, Illinois* Physics
Alfred Steven Sepulveda *San Antonio, Texas* Mathematics
Audrey Lee Seymour *Valley Forge, Pennsylvania* Mathematics
Madeline Adele Shea *Rockville, Maryland* Chemistry
Phillip J. Short *Burnsville, Minnesota* Engineering and Applied Science
Alan Jeff Silverstein Engineering and Applied Science
Jeffrey Alan Simmen *Tonawanda, New York* Applied Mathematics
Joseph Michael Smyth *Pasadena, California* Engineering and Applied Science
Thomas Deane Snyder *Fargo, North Dakota* Biology
Frederich William Solomon *Anaheim, California* Applied Mathematics
Claudia Alison Spiro *Altadena, California* Mathematics
Richard Alan Stall *Metairie, Lousiana* Engineering and Applied Science
M. Carol Stevens *Orlando, Florida* Applied Physics
Mark Alan Sturza *Northridge, California* Applied Mathematics
Mark Nathanael Swanson *Kingston, Jamaica* Chemistry
Randall Philip Tagg *Dallas, Texas* Physics
Robert Lawrence Thornton *Washington, District of Columbia* Engineering and Applied Science
Stephen Mathias Trimberger *Sacramento, California* Engineering and Applied Science
Paul William Tuinenga *Boulder, Wyoming* Engineering and Applied Science
Douglas Blaine Tyler *Fullerton, California* Mathematics
Michael K. Ullner *Monterey Park, California* Engineering and Applied Science
Jean Uwate *Whittier, California* Biology
Richard Paul Vasquez *Des Moines, Iowa* Chemistry
Alfonso Vazquez Cuervo *Elkins, West Virginia* Engineering and Applied Science
Stephen Roy Walton *Jackson, New Jersey* Astronomy
Sally Allyn Weaks *St. Louis, Missouri* Chemistry
Douglas G. Weber *Fairborn, Ohio* Physics
Donna Mae Wegemer *San Diego, California* Applied Mathematics
Richard Mark Weinapple *Valley Stream, New York* Biology
Lawrence Camest West *Brea, California* Applied Physics
Gregory Thomas White *Los Angeles, California* Mathematics

BACHELOR OF SCIENCE—*Continued*

Paul Michael Whitmore *St. Louis, Missouri* Chemistry
Deborah Ann Wilson *Stockton, California* Chemical Engineering
J. Michael Wilson *San Luis Obispo, California* Mathematics
Rebecca Jane Winter *South Pasadena, California* History
Erna Wei Wong *Irvine, California* Biology
Jim Lung-Gim Wong *Norwalk, California* Chemical Engineering
Glenn Douglas Wood *Paradise, California* Engineering and Applied Science
W. Hugh Woodin *Tucson, Arizona* Mathematics
Nicholas Wei-Hsiung Yang *Jersey City, New Jersey* Engineering and Applied Science and Applied Mathematics
William Chor Chun Yeung *Hong Kong* Engineering and Applied Science
Maurice Saul Zwass *Sherman Oaks, California* Biology

MASTER OF SCIENCE

Mustafa A. G. Abushagur *(Electrical Engineering)* B.Sc.E.E., University of Tripoli 1974.

Adi Rahman Adiwoso *(Aeronautics)* B.S.Ae., Purdue University 1975.

James Carl Althoff, Jr. *(Engineering Science)* B.S., Florida State University 1976.

Arthur Thomas Andrews III *(Chemical Engineering)* B.E., Manhattan College 1976.

Mark Edward Ankrom *(Mechanical Engineering)* B.S.M.E., Northrop Institute of Technology 1973.

Kwok-Shing Kenneth Auyeung *(Civil Engineering)* B.Sc., Ohio University 1975.

Philippe René Bardey *(Civil Engineering)* Diplôme d'Ingénieur, École Nationale Supérieure d'Electrotechnique, d'Electronique d'Informatique et d'Hydraulique 1976.

Jeffrey Richard Barnes *(Planetary Science)* B.S., Iowa State University 1975.

Anthony Francis Barton *(Engineering Science)* B.Sc., St. Andrews University 1976.

Eugene Patrick Berek *(Civil Engineering)* B.S., State University of New York, Buffalo 1976.

Andrew Bewsher *(Civil Engineering)* B.E., University of Tasmania 1976.

Russell Leslie Bone *(Chemical Engineering)* B.S., Kansas State University 1975.

Alexander Nelson Brooks *(Civil Engineering)* B.S., University of California, Berkeley 1976.

Arthur Raymond Brown *(Electrical Engineering)* B.S., Stanford University 1976.

Sally Anne Browning *(Engineering Science)* B.S., University of Oregon 1974.

Scott Charles Burkhart *(Applied Physics)* B.A., B.S., Western Washington State College 1975.

Richard George Campbell *(Chemical Engineering)* B.S., University of California, Davis 1975.

Thomas Richard Card *(Civil Engineering)* B.S., University of Washington 1976.

Christopher Ralph Carroll *(Electrical Engineering)* B.S., Georgia Institute of Technology 1975.

Chi Ming Chan *(Chemical Engineering)* B.Chem.Eng., University of Minnesota 1975.

Philemon Chi-Ting Chan *(Mechanical Engineering)* B.S., Virginia Polytechnic Institute and State University 1976.

Pei-Chuang Chen *(Physics)* B.S., State University of New York, Stony Brook 1975.

Nancy Maressa Childs *(Social Science)* B.A., Duke University 1972.

Pierre Choubert *(Electrical Engineering)* Diplôme d'Ingénieur, Institut Supérieur d'Electronique de Paris 1974; Diplôme de Specialisation, École Nationale Supérieure de l'Aeronautique et de l'Espace 1975.

Eric Roland Christensen *(Aeronautics)* B.S., University of Maryland 1976.

Susan Ellen Conrad *(Biology)* B.S., Tufts University 1974.

Stanton Jonathan Cowen *(Environmental Engineering Science)* B.S., Columbia University 1976.

MASTER OF SCIENCE—*Continued*

Michael James Kenneth Craig *(Civil Engineering)* B.Sc., University of Southampton 1974.

Robert Buck Crombie *(Aeronautics)* B.S., United States Air Force Academy 1976.

Bernard André Jean-Marie Cuny *(Civil Engineering)* Diplôme d'Ingénieur, École Nationale Supérieure d'Arts et Métiers de Paris 1976.

Vaughn Omer Davidson *(Physics)* B.S., Indiana University 1971.

Leslie Joseph Deutsch *(Mathematics)* B.S., California Institute of Technology 1976.

David Joseph Diner *(Planetary Science)* B.S., State University of New York, Stony Brook 1973.

Michael Thomas Duncan *(Chemical Engineering)* B.S.E., University of Michigan 1975.

Raymond Joseph Durkan *(Geology)* B.S., University of Massachusetts 1971.

Theodore Edwin Farrington, Jr. *(Chemical Engineering)* B.S.Math., B.S.Physics, M.S.Math., Clarkson College of Technology 1975.

Bradley Arnold Flanders *(Physics)* B.S., Rensselaer Polytechnic Institute 1974.

Leslie Ann Froisland *(Engineering Science)* A.B., University of California, Berkeley 1976.

Gerald Gendall Fuller *(Chemical Engineering)* B.Sc., University of Calgary 1975.

Timothy Joseph Gallagher *(Applied Physics)* B.S., Rose-Hulman Institute of Technology 1975.

Gregory Steven Gibson *(Chemical Engineering)* B.S., California Institute of Technology 1977.

Alan Reed Gillespie *(Geology)* B.S., Stanford University 1969.

Glenn Joel Greene *(Applied Physics)* B.A., University of California, San Diego 1975.

Eberhard Erwin Grötsch *(Engineering Science)* Diplom, Universität Erlangen-Nürnberg 1976.

Jon Stuart Hanson *(Aeronautics)* B.S., University of Illinois, Urbana 1975.

David John Debenham Harper *(Civil Engineering)* B.A., Downing College 1972; M.A., University of Cambridge 1972.

David Harry Hawke *(Chemistry)* S.B., Massachusetts Institute of Technology 1974.

Alan D. Hebb *(Aeronautics)* B.S., United States Air Force Academy 1976.

Gideon Hess *(Engineering Science)* B.Sc., Technion, Israel Institute of Technology 1968; M.Sc., 1975.

Luc Jozef Heymans *(Aeronautics)* Master of Eng., Katholieke Universiteit Leuven 1976.

John William Hicks *(Aeronautics)* B.S., University of Texas, Austin 1969.

Franklin Sai Wai Ho *(Electrical Engineering)* B.S., Cornell University 1976.

Sue Carol Hocker *(Biology)* B.S., Purdue University 1974.

Mark Joachim Holum *(Civil Engineering)* B.A., Reed College 1973; B.S., University of Alaska 1975.

Joyce Shih-chiao Hsiao *(Environmental Engineering Science)* B.S., California Institute of Technology 1974.

Shi-Ping Hsu *(Electrical Engineering)* B.S., National Taiwan University 1973.

Michael David Huffman *(Mathematics)* B.S., University of New Mexico 1975.

Beatriz Valdes Infante *(Engineering Science)* B.S.E.E., Princeton University 1976.

Frances Ellen Janssen *(Environmental Engineering Science)* B.S., California Institute of Technology 1975.

Frederick Grove Johnson *(Aeronautics)* B.S., United States Naval Academy 1976.

Stephen Kadysiewski *(Civil Engineering)* B.E., State University of New York, Stony Brook 1976.

Rosemary Gillian Kennett *(Physics)* B.Sc., University of Nottingham 1972.

Paul Kikuchi *(Chemical Engineering)* B.S., University of Utah 1976.

Scott Stephen Kimbrough *(Mechanical Engineering)* B.S.M.E., University of Nevada 1975.

Annie Ming Chi Ko *(Chemical Engineering)* B.S., Stanford University 1976.

Vijaya Narayan Korwar *(Electrical Engineering)* P.D.Sc., Fergusson College, Poona 1971; B.Tech., Indian Institute of Technology, Bombay 1976.

James Gregory Kralik *(Chemical Engineering)* B.S.Chem.Eng., B.S.Ch., University of California, Davis 1976.

Mark Jay Kushner *(Applied Physics)* B.S., University of California, Los Angeles 1976.

Daniel Bernard Lang *(Applied Physics)* B.S., California Institute of Technology 1976.

Richard Laura *(Chemistry)* S.B., Massachusetts Institute of Technology 1974.

Philippe François Le Guludec *(Civil Engineering)* Baccalauréat, Naval College 1971; Diplôme d'Ingénieur, École Nationale Supérieure d'Electrotechnique, d'Electronique d'Informatique et d'Hydraulique 1976.

Nathan Saul Lewis *(Chemistry)* B.S., California Institute of Technology 1977.

Richard Edwin Lewis *(Geology)* B.S., University of California, Los Angeles 1976.

Wing Kam Liu *(Civil Engineering)* B.Sc., University of Illinois, Chicago Circle 1976.

Bartholomew Nicholas Locanthi III *(Engineering Science)* B.S., California Institute of Technology 1975; M.S., Cornell University 1976.

Gregory Allen Lyzenga *(Applied Physics)* B.S., Harvey Mudd College 1975.

Bruce Edward MacNeal *(Applied Physics)* B.A., Pomona College 1974.

John Douglas Marshall *(Electrical Engineering)* B.S., University of Rochester 1976.

Paul Oakley Mason *(Mechanical Engineering)* B.S., California Institute of Technology 1977.

Olivier Maumy *(Aeronautics)* Diplôme d'Ingénieur, Institut Industriel du Nord 1976.

Jewell Clinton Maxwell, Jr. *(Applied Mechanics)* B.M.E., Auburn University 1975.

Philip Burtis McLaughlin *(Chemical Engineering)* B.S., University of Arizona 1975.

Lyle Dean Meier *(Geophysics)* B.S., Michigan State University 1972.

Charles Kenneth Meins, Jr. *(Physics)* S.B., Massachusetts Institute of Technology 1975.

Richard Barron Mintz *(Aeronautics)* B.S., United States Air Force Academy 1976.

Gordon S. Mitchard *(Applied Physics)* B.Sc., University of Waterloo 1976.

Alan Henry Moskowitz *(Chemistry)* B.S., State University of New York, Stony Brook 1975.

Mark Godfrey Mungal *(Aeronautics)* B.A.Sc., University of Toronto 1975.

Brian Mitsuo Murata *(Civil Engineering)* B.S.C.E., Purdue University 1975.

Marco Antonio Chaer Nascimento *(Chemistry)* B.Sc., Escola de Quimica, Universidade Federal do Rio de Janeiro 1968; M.Sc., Instituto de Quimica 1973.

Philip Malcolm Neches *(Engineering Science)* B.S., California Institute of Technology 1973.

Stephen Lee Nesbitt *(Chemistry)* B.S., University of Illinois, Urbana 1974.

Buu Dinh Nguyen *(Mechanical Engineering)* B.S.M.E., California State University, Long Beach 1976.

Darwin C. Niekerk *(Social Science)* B.S., Colorado State University 1972; M.A., University of Denver 1974.

Daniel Mark Nosenchuck *(Aeronautics)* B.S., Syracuse University 1976.

Obiefuna Timothy Nwasike *(Environmental Engineering Science)* B.Sc., University College of Swansea 1976.

James Richard Ouimette *(Environmental Engineering Science)* B.S., University of California, Riverside 1970.

Madeline Paciorek *(Chemical Engineering)* B.S., St. Louis University 1975.

David Paul Palmer *(Chemical Engineering)* B.S., Kansas State University 1975.

James Frederick Pankow *(Environmental Engineering Science)* B.A., State University of New York, Binghamton 1973.

Charles Wilcox Pinney *(Aeronautics)* B.S., United States Air Force Academy 1976.

Joseph Charles Prinster Jr. *(Civil Engineering)* B.S.C.E., University of Notre Dame 1976.

Ioannis Nikolaou Psycharis *(Civil Engineering)* Diploma, National Technical University, Athens 1976.

Ajay Kumar Puri *(Electrical Engineering)* B.S., University of Minnesota 1976.

Ibrahim Muhammed Rashed *(Aeronautics)* B.S., University of Manchester 1972.

K. Ravi Chandar *(Aeronautics)* B.S., St. Joseph's College 1973.

Michael John Roberts *(Electrical Engineering)* B.S., California Institute of Technology 1977.

James Allely Rowson *(Engineering Science)* B.S., California Institute of Technology 1976.

Larry John Ruff *(Geophysics)* B.S., University of California, Riverside 1975.

Jeffrey Ducloux Sanders *(Geophysics)* B.S., California Institute of Technology 1976.

Michael John Savage *(Biology)* B.S., Ft. Lewis College 1975.

Mei-Ling Shek *(Applied Physics)* B.S., California Institute of Technology 1974.

Phillip A. Sher *(Social Science)* B.A., California State College, Sonoma 1974.

Choon-foo Shih *(Aeronautics)* B.S., National Taiwan University 1974.

David Frank Sholle *(Astronomy)* B.S., Case Western Reserve University 1974.

MASTER OF SCIENCE—*Continued*

Claudia Alison Spiro *(Mathematics)* B.S., California Institute of Technology 1977.

Frank A. Stackhouse *(Chemistry)* B.S., University of Notre Dame 1973.

Seth Avram Stein *(Geophysics)* S.B., Massachusetts Institute of Technology 1975.

Michael Allen Surkes *(Biology)* B.Sc., McGill University 1974.

Anne Marie Suteau (Geophysics) Maîtrise, Université Paris VI 1973; D.E.A., 1974.

Stephen Taylor *(Aeronautics)* A.A., St. Petersburg Junior College 1974; B.S., University of Florida 1976.

Daniel Paul Teichman *(Chemical Engineering)* B.S., Cornell University 1976.

James Victor Tierney III *(Electrical Engineering)* B.S.E.E., Marquette University 1976.

Albert Chia Ting *(Applied Mechanics)* B.A., University of California, Los Angeles 1973; M.S., California State University, Los Angeles 1975.

Carel A. T. Veenhuyzen *(Planetary Science)* B.A., Pomona College 1974.

Larry Kevin Warne *(Electrical Engineering)* B.S., Fairleigh Dickinson University 1976.

Gerald Allen Wedekind *(Engineering Science)* B.S., California Institute of Technology 1976.

Lawrence Camest West *(Applied Physics)* B.S., California Institute of Technology 1977.

William Lee Wheatley *(Biology)* S.B., Massachusetts Institute of Technology 1974.

Gregory Mark Wilkinson *(Physics)* B.S., University of Maryland 1975.

Yau-Ching James Wu *(Mechanical Engineering)* B.S., University of California, Los Angeles 1976.

Gong Ping Yeh *(Physics)* S.B., Massachusetts Institute of Technology 1975.

Ronald Willard Zimmerman *(Aeronautics)* B.S., United States Air Force Academy 1976.

ENGINEER

Tadashi Shiraishi *(Mechanical Engineer)* B.Eng., Meiji University 1970; M.Eng., University of Tokyo 1972.

DOCTOR OF PHILOSOPHY

DIVISION OF BIOLOGY

Michael Joseph DeNiro *(Biochemistry and Geobiology)* B.S., University of Notre Dame 1970.
Thesis: I. Carbon Isotope Distribution in Food Chains. II. Mechanism of Carbon Isotope Fractionation Associated with Lipid Synthesis.

Ernst-Peter Fischer *(Biophysics)* Diplom, University of Cologne 1972.
Thesis: I. Serine Proteases, Their Inhibitors and Chitin Synthetase in *Phycomyces.*

David Howard Hall *(Biochemistry)* S.B., Massachusetts Institute of Technology 1970.
Thesis: The Posterior Nervous System of the Nematode *Caenorhabditis elegans.*

David Saul Isenberg *(Experimental Psychology)* B.A., University of Oregon 1971.
Thesis: Attention Demands of Processing Phonetic Information in the Perception of Dichotic Speech.

Carl Douglas Johnson *(Biology)* B.S., University of Chicago 1970.
Thesis: Multiple Molecular Forms of Cholinesterase from Elongated Animals.

William Raymond Pearson *(Biochemistry)* B.S., University of Illinois, Urbana 1971.
Thesis: Studies on the Arrangement of Repeated Sequences in DNA.

Donald Furner Ready *(Neurobiology)* B.A., Columbia College 1971.
Thesis: Development of the *Drosophila* Retina.

Margaret Yoshiko Iwaki Scott *(Biology)* B.A., California State College, Los Angeles 1971.
Thesis: Studies on Selective Neuroregeneration in Lower Vertebrates.

Mahlon McGregor Wilkes *(Biochemistry)* B.A., University of South Florida 1972.
Thesis: DNA Sequence Organization by Electron Microscopy.

DIVISION OF CHEMISTRY AND CHEMICAL ENGINEERING

Paul Adrian Aristoff *(Chemistry)* B.A., M.S., Northwestern University 1973.
Thesis: An Approach to the Total Synthesis of Aphidicolin.

Amir Attar *(Chemical Engineering and Environmental Engineering Science)* B.Sc., Technion, Israel Institute of Technology 1970; M.Sc., 1972.
Thesis: The Chemistry of Selective Oxidation of Sulfur Compounds and Its Relation to Fuel Desulfurization.

William Walter Bachovchin *(Chemistry)* B.S., Wake Forest University 1970; M.A., 1972.
Thesis: The Mechanism of Action of Adenosylcobalamin (Coenzyme B_{12}).

When more than one field of study is indicated, the first is the major and the second and others are minors.

Jacqueline O. Berg *(Chemistry)* B.S., University of California, Los Angeles 1972.
Thesis: Theory of Radiationless Transitions, Light Scattering and Fluorescence.

Jonathan Arno Burke *(Chemistry)* B.S., Valparaiso University 1970.
Thesis: Investigations of the Photochemistry of Mixtures of Methane, Nitrogen, and Ammonia with Lyman-Alpha Radiation.

John L. Chambers *(Chemistry)* B.A., College of Wooster 1972.
Thesis: Inhibited Bovine Trypsin, and Bovine Trypsinogen: The Refined Structure and Mechanism of a Not-Too-Serene Protease.

Paul How-kei Cheong *(Chemical Engineering)* B.Chem.E., B.Math., University of Minnesota, Minneapolis 1971.
Thesis: A Modeling Study of Coal Pyrolysis.

Reed Roeder Corderman *(Chemistry)* B.A., Case Western Reserve University 1973.
Thesis: Ion Cyclotron Resonance Studies of Inorganic Molecules in the Gas Phase. I. Organotransition Metal Complexes. II. Chain Reactions Involving Ionic Intermediates.

James Hubbard Davis *(Chemistry)* B.S., M.S., Yale University 1973.
Thesis: Theoretical Studies of Organic Diradicals and the Thermal Rearrangement of Bicyclopropenyls.

Kilian Dill *(Chemistry)* A.B., Hunter College of the City University of New York 1971.
Thesis: ^{13}C Nuclear Magnetic Resonance Studies of Hemoglobin and Myoglobin.

Ben Sherman Freiser *(Chemistry)* B.S., University of California, Los Angeles 1971.
Thesis: Photochemical Investigations of Ions in the Gas Phase Utilizing Ion Cyclotron Resonance Spectroscopy.

Theodore Tsan-tsung Lee *(Chemistry)* B.S., National Taiwan University 1971.
Thesis: (I) A Comparison of the Functional Properties of Human Hemoglobin A and Its (β-93)-Trifluoroacetonylated Derivative. (II) Studies of the Ligand-binding Properties of Acetylcholine Receptor from *Torpedo californica.*

Kent Robert Mann *(Chemistry)* B.A., University of Illinois, Urbana 1973.
Thesis: An Investigation of the Photochemical and Spectroscopic Properties of Chromium, Molybdenum, Tungsten, and Rhodium Isocyanide Complexes.

Juan Manuel Manriquez *(Chemistry)* Licenciado, Catholic University of Chile 1968; B.S., University of Chile 1971.
Thesis: I. The Reduction of Molecular Nitrogen in Binuclear Dinitrogen Complexes of Titanium and Zirconium. II. Hydrogen Reduction of Carbon Monoxide Promoted by Mononuclear Carbonyl and Hydride Complexes of Bis(Pentamethylcyclopentadienyl) Zirconium.

Thomas Joe McMillen *(Chemical Engineering)* B.S., Kansas State University 1971.
Thesis: The Thermal Constitutive Behavior of Suspensions.

DOCTOR OF PHILOSOPHY—*Continued*

Milton Keith Murphy *(Chemistry)* B.S., University of Houston 1972.
Thesis: Gas Phase Investigations of the Lewis Acid Properties of Electron Deficient Compounds of Boron, Carbon and Silicon.

Robert Henry Reiner *(Chemistry)* B.A., DePauw University 1970; M.S., California Institute of Technology 1976.
Thesis: I. Calculation of Vibrational Transition Moments. II. Photochemistry of Vibrationally Excited Hydrogen Iodide. III. Photochemistry of Iodine Monochloride in Hydrogen.

Michael Jay Ross *(Chemistry)* A.B., Dartmouth College 1971.
Thesis: I. Purification and Partial Characterization of Chromatin Subunits. II. Structural Studies of a Membrane-Bound Acetylcholine Receptor.

Vega Dibag Sankur *(Chemical Engineering)* B.S., Robert College 1971.
Thesis: I. Study of Macromolecular Brownian Motion by Laser Light Scattering. II. Light Scattering Investigation of Amorphous Polymethylmethacrylate.

Michael Edward Stoll *(Applied Physics)* B.S., University of Illinois, Urbana 1972; M.S., California Institute of Technology 1973.
Thesis: Spin Dynamics of Pulsed Nuclear Magnetic Double Resonance in Solids.

Stephen Perry Walch *(Chemistry)* B.S., University of Maine 1967.
Thesis: Theoretical Studies of Chemisorption.

Gerald Wayne Ward *(Chemical Engineering)* B.S.E., University of Michigan 1969; M.S., California Institute of Technology 1971.
Thesis: Strain Induced Changes in the Permeability of Water Swollen Segmented Polyurethane Elastomers.

Scot Edward Wherland *(Chemistry)* B.S., University of Chicago 1973.
Thesis: Metalloprotein Electron Transfer Mechanisms.

DIVISION OF ENGINEERING AND APPLIED SCIENCE

Gregory Richard Baker *(Applied Mathematics)* B.Sc., University of Natal 1968; B.Sc., (Honors) 1969; M.S., 1972.
Thesis: Studies in Vortex Motion.

Dale Evan Berg *(Aeronautics)* B.S., Michigan State University 1967; M.S., University of New Mexico 1969.
Thesis: Surface Roughness Effects on the Hypersonic Turbulent Boundary Layer.

Fernando Cadena Cepeda *(Environmental Engineering Science and Social Science)* B.S., Instituto Technológico y de Estudios Superiores 1970; M.S., New Mexico State University 1973.
Thesis: Temperature Effects on the Activity Coefficient of the Bicarbonate Ion.

Craig Cheetham *(Electrical Engineering and Mathematics)* B.E.E., Ohio State University 1970; M.S., 1971.
Thesis: Perception of Pitch in Pulse Waveforms Whose Spectra Are Flat.

DOCTOR OF PHILOSOPHY—*Continued*

Martin Yu-Wen Chen *(Applied Physics)* B.S., California Institute of Technology 1972; M.S., 1973.
Thesis: Luminescence Properties of Electron-Hole-Droplets in Pure and Doped Germanium.

James Eldon Craig *(Aeronautics)* B.S., California State Polytechnic College, Pomona 1972; M.S., California Institute of Technology 1973.
Thesis: Weak Shocks in Open-Ended Ducts with Complex Geometry.

Slobodan M. Cuk *(Electrical Engineering)* B.S., University of Belgrade 1970; M.S., University of Santa Clara 1973.
Thesis: Modelling, Analysis, and Design of Switching Converters.

Cliff Ian Davidson *(Environmental Engineering Science and Electrical Engineering)* B.S., Carnegie-Mellon University 1972; M.S., California Institute of Technology 1973.
Thesis: Deposition of Trace Metal-Containing Aerosols on Smooth, Flat Surfaces and on Wild Oat Grass *(Avena fatua)*

Dean Barton Edwards *(Mechanical Engineering)* B.S., Illinois Institute of Technology 1972; M.S., California Institute of Technology 1973.
Thesis: Time Domain Analysis of Switching Regulators.

Douglas Allen Foutch *(Civil Engineering)* B.S., University of Illinois, Urbana 1970; M.S., University of Hawaii 1973.
Thesis: A Study of the Vibrational Characteristics of Two Multistory Buildings.

W. Riley Garrott *(Applied Mechanics and Physics)* B.S., Tufts University 1972.
Thesis: Transient Response of Two-Dimensional Cantilevered Semi-Infinite and Finite Elastic Plates, Subjected to Base Motions.

Edward Maurice Gates *(Mechanical Engineering)* B.Sc., University of Alberta 1971; M.S., California Institute of Technology 1972.
Thesis: The Influence of Freestream Turbulence, Freestream Nuclei Populations and a Drag-Reducing Polymer on Cavitation Inception on Two Axisymmetric Bodies.

Nathan Craig Gates *(Applied Mechanics)* B.A., Occidental College 1972; B.S., California Institute of Technology 1972; M.S., 1973.
Thesis: The Earthquake Response of Deteriorating Systems.

Lambertus Hesselink *(Applied Mechanics)* B.S.Mechanics, Twente University of Technology 1970; B.S.Physics, 1971; M.S., California Institute of Technology 1972; Eng., Twente University of Technology 1974.
Thesis: An Experimental Investigation on Propagation of Weak Shock Waves in a Random Medium.

Hiroshi Higuchi *(Aeronautics and German)* B.E., University of Tokyo 1970; M.S., California Institute of Technology 1971.
Thesis: Experimental Investigation on Axisymmetric Turbulent Wakes with Zero Momentum Defect.

DOCTOR OF PHILOSOPHY—*Continued*

Dwight L. Jaggard *(Electrical Engineering and Applied Physics)* B.S., University of Wisconsin, Madison 1971; M.S., 1972.
Thesis: Bragg Interactions in Periodic Media.

Robert Edward Johnson *(Engineering Science)* B.S., State University of New York, Buffalo 1973; M.S., California Institute of Technology 1974.
Thesis: Slender-Body Theory for Stokes Flow and Flagellar Hydrodynamics.

Arthur Joseph Koblasz *(Engineering Science)* B.S., University of Florida, Gainesville 1970; M.S., California Institute of Technology 1973.
Thesis: Nonlinear Analysis of the Human Electroretinogram.

John Harrison Konrad *(Aeronautics)* B.S., Oklahoma State University 1971; M.S., California Institute of Technology 1972.
Thesis: An Experimental Investigation of Mixing in Two-Dimensional Turbulent Shear Flows with Applications to Diffusion-Limited Chemical Reactions.

Peter Howard McMurry *(Environmental Engineering Science and Physics)* B.A., University of Pennsylvania 1969; M.S., California Institute of Technology 1973.
Thesis: On the Relationship Between Aerosol Dynamics and the Rate of Gas-to-Particle Conversion.

Johnson Olufemi Olowolafe *(Applied Physics)* B.Sc., University of Ife 1971; M.S., California Institute of Technology 1974.
Thesis: Silicide Formation and the Interaction of Metals with Polycrystalline Si.

Antonio Redondo-Muiño *(Applied Physics and Chemistry)* B.S., Utah State University 1971; M.S., California Institute of Technology 1972.
Thesis: Theoretical Studies of Silicon Surfaces Using Finite Clusters.

Philip Joseph William Roberts *(Environmental Engineering Science)* B.Sc., Imperial College 1968; S.M., Massachusetts Institute of Technology 1970; M.S., California Institute of Technology 1972.
Thesis: Dispersion of Buoyant Wastewater Discharged from Outfall Diffusers of Finite Length.

Thomas Peter Santoro *(Engineering Science)* B.S., University of Rhode Island 1967; M.S., California Institute of Technology 1968.
Thesis: An Investigation of Pattern Vision in the Human by Psychophysics and Evoked Potentials.

Piyush Chimanlal Shah *(Aeronautics)* B.Tech., Indian Institute of Technology, Bombay 1971; M.S., California Institute of Technology 1972.
Thesis: Estimation of Properties in Petroleum Reservoirs.

Emilio Andres Sovero-Temoche *(Applied Physics and Information Science)* B.S., California Institute of Technology 1970; M.S., 1971.
Thesis: Application of Microwave Diagnostics to Copper Chloride and Carbon Dioxide Lasers.

DOCTOR OF PHILOSOPHY—*Continued*

Polihronis-Thomas Dimitrios Spanos *(Applied Mechanics and Applied Mathematics and Business Economics and Management)* Diploma, National Technical University, Athens 1973; M.S., California Institute of Technology 1974.
Thesis: Linearization Techniques for Non-Linear Dynamical Systems.

Sankaran Srinivas *(Engineering Science and Mathematics)* B.Tech., Indian Institute of Technology, Madras 1970; M.S., California Institute of Technology 1971.
Thesis: Error Recovery in Robot Systems.

Shriram Mahabal Udupa *(Enginering Science and Mathematics)* B.Tech., Indian Institute of Technology, Bombay 1971; M.S., California Institute of Technology 1972.
Thesis: Collision Detection and Avoidance in Computer Controlled Manipulators.

Hans van der Kogel *(Civil Engineering)* B.Sc., Delft University of Technology 1972; Eng., 1973.
Thesis: Wavepropagation in Saturated Porous Media.

Gregory Lynn Wojcik *(Aeronautics)* B.S.Ae., B.S.Math., California Polytechnic University, San Luis Obispo 1971; M.S., California Institute of Technology 1972.
Thesis: Self-Similar Elastodynamic Solutions for the Plane Wedge.

Steven J. Wright *(Civil Engineering)* B.S., Washington State University 1971; M.S., 1973.
Thesis: Effects of Ambient Crossflows and Density Stratification on the Characteristic Behavior of Round, Turbulent Buoyant Jets.

George Thomas Yates *(Engineering Science)* B.S., Purdue University 1971; M.S., California Institute of Technology 1972.
Thesis: Finite Amplitude Unsteady Slender Body Theory and Experiments.

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES

James Rodney Anderson *(Geology)* B.A., Williams College 1968.
Thesis: The Polymetamorphic Sequence in the Paleozoic Rocks of Northern Vermont: A New Approach Using Metamorphic Veins as Petrologic and Structural Markers.

Lawrence James Burdick *(Geophysics)* B.S., Arizona State University 1971; M.S., California Institute of Technology 1973.
Thesis: Broad-Band Seismic Studies of Body Waves.

Robert F. Dymek *(Geology)* A.B., Princeton University 1971; M.S., Stanford University 1972.
Thesis: Mineralogic and Petrologic Studies of Archaean Metamorphic Rocks from West Greenland, Lunar Samples, and the Meteorite Kapoeta.

Daniel Dzurisin *(Planetary Science ond Geology)* B.S., University of Notre Dame 1973; M.S., California Institute of Technology 1975.
Thesis: Part 1: Scarps, Ridges, Troughs, and Other Lineaments on Mercury. Part 2: Geologic Significance of Photometric Variations on Mercury.

Dwight L. Jaggard *(Electrical Engineering and Applied Physics)* B.S., University of Wisconsin, Madison 1971; M.S., 1972.
Thesis: Bragg Interactions in Periodic Media.

Robert Edward Johnson *(Engineering Science)* B.S., State University of New York, Buffalo 1973; M.S., California Institute of Technology 1974.
Thesis: Slender-Body Theory for Stokes Flow and Flagellar Hydrodynamics.

Arthur Joseph Koblasz *(Engineering Science)* B.S., University of Florida, Gainesville 1970; M.S., California Institute of Technology 1973.
Thesis: Nonlinear Analysis of the Human Electroretinogram.

John Harrison Konrad *(Aeronautics)* B.S., Oklahoma State University 1971; M.S., California Institute of Technology 1972.
Thesis: An Experimental Investigation of Mixing in Two-Dimensional Turbulent Shear Flows with Applications to Diffusion-Limited Chemical Reactions.

Peter Howard McMurry *(Environmental Engineering Science and Physics)* B.A., University of Pennsylvania 1969; M.S., California Institute of Technology 1973.
Thesis: On the Relationship Between Aerosol Dynamics and the Rate of Gas-to-Particle Conversion.

Johnson Olufemi Olowolafe *(Applied Physics)* B.Sc., University of Ife 1971; M.S., California Institute of Technology 1974.
Thesis: Silicide Formation and the Interaction of Metals with Polycrystalline Si.

Antonio Redondo-Muiño *(Applied Physics and Chemistry)* B.S., Utah State University 1971; M.S., California Institute of Technology 1972.
Thesis: Theoretical Studies of Silicon Surfaces Using Finite Clusters.

Philip Joseph William Roberts *(Environmental Engineering Science)* B.Sc., Imperial College 1968; S.M., Massachusetts Institute of Technology 1970; M.S., California Institute of Technology 1972.
Thesis: Dispersion of Buoyant Wastewater Discharged from Outfall Diffusers of Finite Length.

Thomas Peter Santoro *(Engineering Science)* B.S., University of Rhode Island 1967; M.S., California Institute of Technology 1968.
Thesis: An Investigation of Pattern Vision in the Human by Psychophysics and Evoked Potentials.

Piyush Chimanlal Shah *(Aeronautics)* B.Tech., Indian Institute of Technology, Bombay 1971; M.S., California Institute of Technology 1972.
Thesis: Estimation of Properties in Petroleum Reservoirs.

Emilio Andres Sovero-Temoche *(Applied Physics and Information Science)* B.S., California Institute of Technology 1970; M.S., 1971.
Thesis: Application of Microwave Diagnostics to Copper Chloride and Carbon Dioxide Lasers.

DOCTOR OF PHILOSOPHY—*Continued*

Polihronis-Thomas Dimitrios Spanos *(Applied Mechanics and Applied Mathematics and Business Economics and Management)* Diploma, National Technical University, Athens 1973; M.S., California Institute of Technology 1974.
Thesis: Linearization Techniques for Non-Linear Dynamical Systems.

Sankaran Srinivas *(Engineering Science and Mathematics)* B.Tech., Indian Institute of Technology, Madras 1970; M.S., California Institute of Technology 1971.
Thesis: Error Recovery in Robot Systems.

Shriram Mahabal Udupa *(Enginering Science and Mathematics)* B.Tech., Indian Institute of Technology, Bombay 1971; M.S., California Institute of Technology 1972.
Thesis: Collision Detection and Avoidance in Computer Controlled Manipulators.

Hans van der Kogel *(Civil Engineering)* B.Sc., Delft University of Technology 1972; Eng., 1973.
Thesis: Wavepropagation in Saturated Porous Media.

Gregory Lynn Wojcik *(Aeronautics)* B.S.Ae., B.S.Math., California Polytechnic University, San Luis Obispo 1971; M.S., California Institute of Technology 1972.
Thesis: Self-Similar Elastodynamic Solutions for the Plane Wedge.

Steven J. Wright *(Civil Engineering)* B.S., Washington State University 1971; M.S., 1973.
Thesis: Effects of Ambient Crossflows and Density Stratification on the Characteristic Behavior of Round, Turbulent Buoyant Jets.

George Thomas Yates *(Engineering Science)* B.S., Purdue University 1971; M.S., California Institute of Technology 1972.
Thesis: Finite Amplitude Unsteady Slender Body Theory and Experiments.

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES

James Rodney Anderson *(Geology)* B.A., Williams College 1968.
Thesis: The Polymetamorphic Sequence in the Paleozoic Rocks of Northern Vermont: A New Approach Using Metamorphic Veins as Petrologic and Structural Markers.

Lawrence James Burdick *(Geophysics)* B.S., Arizona State University 1971; M.S., California Institute of Technology 1973.
Thesis: Broad-Band Seismic Studies of Body Waves.

Robert F. Dymek *(Geology)* A.B., Princeton University 1971; M.S., Stanford University 1972.
Thesis: Mineralogic and Petrologic Studies of Archaean Metamorphic Rocks from West Greenland, Lunar Samples, and the Meteorite Kapoeta.

Daniel Dzurisin *(Planetary Science ond Geology)* B.S., University of Notre Dame 1973; M.S., California Institute of Technology 1975.
Thesis: Part 1: Scarps, Ridges, Troughs, and Other Lineaments on Mercury. Part 2: Geologic Significance of Photometric Variations on Mercury.

Robert James Geller *(Geophysics)* B.S., California Institute of Technology 1973; M.S., 1975.
Thesis: Part I. Earthquake Source Models, Magnitudes and Scaling Relations. Part II. Amplitudes of Rotationally Split Normal Modes for the 1960 Chilean and 1964 Alaskan Earthquakes.

Don Steven Goldman *(Geochemistry and Chemistry)* B.S., University of Washington 1972.
Thesis: Crystal-Field and Mössbauer Applications to the Study of Site Distribution and Electronic Properties of Ferrous Iron in Minerals with Emphasis on Calcic Amphiboles, Orthopyroxene and Cordierite.

Robert Stuart Hart *(Geophysics)* S.B., Massachusetts Institute of Technology 1972; M.S., California Institute of Technology 1976.
Thesis: The Distribution of Seismic Velocities and Attenuation in the Earth.

Jo Laird *(Geology and Geochemistry)* B.A., University of California, San Diego 1969.
Thesis: Phase Equilibria in Mafic Schist and the Polymetamorphic History of Vermont.

Stephen Weiner *(Geobiology)* B.Sc., University of Cape Town 1969; M.Sc., Hebrew University 1972.
Thesis: Aspects of the Biochemistry of the Organic Matrix of Extant and Fossil Mollusks.

DIVISION OF PHYSICS, MATHEMATICS AND ASTRONOMY

Frank Edward Barnes *(Physics)* B.S.E., University of Michigan, Ann Arbor 1970; M.S., California Institute of Technology 1973.
Thesis: Quarks, Gluons, Bags, and Hadrons.

Gary Bedrosian *(Physics)* B.S., Rensselaer Polytechnic Institute 1973; M.S., California Institute of Technology 1976.
Thesis: The Invariant Imbedding Solution for Electromagnetic Wave Propagation in Periodic, Almost Homogeneous, and Almost Periodic Media.

John Roll Bloom *(Mathematics)* A.B., Princeton University 1973.
Thesis: On the Invariants of Some $\mathbf{Z}_l$-extensions.

Thomas Lynn Curtright *(Physics)* B.S., M.S., University of Missouri 1970.
Thesis: Stability and Supersymmetry.

Nathan Myron Denkin *(Physics)* B.A., Queens College 1969; B.S., Columbia University 1969; M.S., California Institute of Technology 1971.
Thesis: Stopping Power of Gases for Heavy Ions.

DOCTOR OF PHILOSOPHY—*Continued*

Elliot Fischer *(Applied Mathematics)* B.S., Cooper Union 1973.
Thesis: Exact Solutions and Transformation Properties of Nonlinear Partial Differential Equations from General Relativity.

James Dean Franson *(Physics)* B.S., Purdue University 1970.
Thesis: I. Microwave Impedance of Superconducting Weak Links. II. Effects of Nonequilibrium Quasi-Particle Distributions in Superconducting Weak Links.

Richard Frederick Green *(Astronomy)* A.B., Harvard College 1971.
Thesis: A Complete Sample of White Dwarfs, Hot Subdwarfs, and Quasars.

Ron Gregg *(Applied Physics)* B.S., California Institute of Technology 1969.
Thesis: Sputtering of Uranium.

Christopher Thaddeus Hill *(Physics)* B.S., M.S., Massachusetts Institute of Technology 1972.
Thesis: Higgs Scalars and the Nonleptonic Weak Interactions.

John Peter Huchra *(Astronomy)* S.B., Massachusetts Institute of Technology 1970.
Thesis: The Nature of Markarian Galaxies and Studies of Star Formation in Blue Galaxies.

Darrell Richard Jackson *(Physics)* B.S.E.E., University of Washington, Seattle 1960; M.S.E.E., 1963; Ph.D.E.E., 1966.
Thesis: Light-Cone Behavior of Hadronic Wavefunctions in QCD and Experimental Consequences.

Donald Eugene Keenan *(Mathematics)* B.S., California Institute of Technology 1973.
Thesis: Subsets of a Finite Set that Intersect Each Other in at Most One Element.

Sándor János Kovács Jr. *(Physics)* B.S., Cornell University 1969; M.S., California Institute of Technology 1972.
Thesis: The Generation of Gravitational Waves.

Francis E. Marshall *(Physics)* B.S., University of Miami 1970.
Thesis: The Streaming of 1.3 - 2.3 MeV Cosmic-Ray Protons During Periods Between Prompt Solar Particle Events.

Jorge Melnick *(Astronomy)* Licenciado, University of Chile 1972.
Thesis: The Structure of Giant Extragalactic H II Regions.

Frank Smith Merritt *(Physics)* B.A., Columbia College 1970; M.S., California Institute of Technology 1972.
Thesis: The Structure of the Neutral Current Coupling in High Energy Neutrino-Nucleon Interactions.

James Marshal Mosher *(Physics)* B.S., California Institute of Technology 1969.
Thesis: The Magnetic History of Solar Active Regions.

Daniel Edward Novoseller *(Physics)* B.A., M.S., University of Pennsylvania 1969.
Thesis: π-Exchange in a Partial Wave Analysis of $\pi N \to N\pi\pi$. I. Partial Wave Analysis Including π-Exchange for $\pi N \to N\pi\pi$ in the Center of Mass Energy Range 1.65 - 1.97 GeV. II. Resonance Parameter Analyses of $\pi N \to \Delta\pi + \rho N + \epsilon N$.

Rodolfo Rubén Rosales *(Applied Mathematics)* Licenciado, University of Cordoba 1973.
Thesis: I. Exact Solution of Some Nonlinear Evolution Equations. II. The Similarity Solution for the Korteweg-De Vries Equation and the Related Painlevé Transcendent.

Leo C. Rosenfeld *(Physics)* S.B., Massachusetts Institute of Technology 1966.
Thesis: The Diffractive Dissociation Process $\pi^- p \to \pi^-(\pi^-\pi^+ p)$ at 14 GeV/c.

Huan-chun Yen *(Applied Physics)* B.Sc., National Taiwan University 1969; M.S., California Institute of Technology 1971.
Thesis: A Study of a New Electromechanical Energy Conversion Process Using Superconducting Frequency Modulated Resonators.

Tadashi Yogi *(Applied Physics)* B.S., University of Hawaii 1970; M.S., California Institute of Technology 1973.
Thesis: Radio Frequency Studies of Surface Resistance and Critical Magnetic Field of Type I and Type II Superconductors.

Prizes and Awards

FREDERIC W. HINRICHS, JR., MEMORIAL AWARD

Awarded to the senior who, in the opinion of the undergraduate Deans, has made the greatest undergraduate contribution to the welfare of the student body and whose qualities of leadership, character, and responsibility have been outstanding. *Recipient to be announced at Commencement.*

ERIC TEMPLE BELL UNDERGRADUATE MATHEMATICS RESEARCH PRIZE

Awarded to one or more juniors or seniors for outstanding original research in mathematics.

1977 *Thomas Garrett Kennedy*
1976 *W. Hugh Woodin, John Leroy Gustafson**

DONALD S. CLARK MEMORIAL AWARDS

May be awarded to a sophomore and a junior in recognition of service to the campus community and good academic performance. Preference is given to students in the Division of Engineering and Applied Science and to those in Chemical Engineering.

1977 *Eric W. Kaler*
1976 *Kevin Marc Gromley**
1975 *Richard Karl Feldman**

HAREN LEE FISHER MEMORIAL AWARD IN JUNIOR PHYSICS

Awarded to a junior physics major who demonstrates the greatest promise of future contributions in physics.

1977 *Izabella B. Kierkowska*
1976 *Christopher Lee Henley**

JACK E. FROEHLICH MEMORIAL AWARD

Awarded to a junior in the upper five percent of his class who shows outstanding promise for a creative professional career.

1977 *Kam Y. Lau*
1976 *Christopher Lee Henley**

GEORGE W. GREEN MEMORIAL AWARD

Awarded to the undergraduate student who, in the opinion of the division chairmen, has shown outstanding ability and achievement in creative scholarship.

W. Hugh Woodin

**The names of students who have received prizes or awards in previous years, but who are graduating in 1977, are also listed.*

ARIE J. HAAGEN-SMIT MEMORIAL AWARD

Awarded to a sophomore or junior in biology or chemistry who has shown academic promise and who has made recognized contributions to Caltech.

Thomas J. McDonnell

DAVID JOSEPH MACPHERSON PRIZE IN ENGINEERING

Awarded to the graduating senior in engineering who best exemplifies excellence in scholarship. Limited to U.S. citizens.

Jan Morris Martin

MARY A. EARL McKINNEY PRIZE IN ENGLISH

The purpose of this prize is to cultivate proficiency in writing. It may be awarded for essays submitted in connection with regular English classes or awarded on the basis of a special essay contest.

1977 *Dennis P. Ferrill, Rex D. Golding*
1976 *J. Michael Wilson**
1975 *J. Michael Wilson**

THE ROYAL SOCIETY FOR THE ENCOURAGEMENT OF ARTS MANUFACTURES AND COMMERCE SILVER MEDAL

Awarded to students who are receiving their first degrees from the most important institutions of learning in the United States. Winners are selected on the basis of outstanding academic records and significant participation in student activities.

Designee: Kathleen Lan-Yee Kong

DON SHEPARD AWARD

Awarded to students who would find it difficult, without additional financial help, to engage in extracurricular and cultural activities. The recipients are selected on the basis of their capacity to take advantage of and to profit from these activities rather than on the basis of their scholastic standing.

1977 *Bruce Baker, John Reinitz, Kenneth Rousseau*
1976 *Allen Lewis Johnson**
1975 *David James Edward Callaway, Brian Keith Jenkins, Christopher Boyd Russell**
1974 *Kathleen Lan-Yee Kong**

SIGMA XI AWARD

Awarded to a senior selected for an outstanding piece of original scientific research.

Nathan Saul Lewis

THE MORGAN WARD AWARD

Awarded for the best problems and solutions in mathematics submitted by a freshman or sophomore.

1974 *Christopher Lee Henley**