Eighty-Ninth Annual Commencement

June 10, 1983

CALIFORNIA INSTITUTE OF TECHNOLOGY

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Eighty-Ninth Annual Commencement

FRIDAY MORNING AT TEN O'CLOCK
JUNE TENTH, NINETEEN EIGHTY-THREE

The Commencement Ceremony

These tribal rites have a very long history. They go back to the ceremony of initiation for new university teachers in mediaeval Europe. It was then customary for students, after an appropriate apprenticeship to learning and the presentation of a thesis as their masterpiece, to be admitted to the Guild of Masters of Arts and granted the license to teach. In the ancient University of Bologna this right was granted by authority of the Pope and in the name of the Holy Trinity. We do not this day claim such high authority.

As in any other guild, whether craft or merchant, the master's status was crucial. In theory at least, it separated the men from the boys, the competent from the incompetent. On the way to his master's degree, a student might collect a bachelor's degree in recognition of the fact that he was half-trained, or partially equipped. The doctor's degree was somewhat different. Originally indistinguishable from the masters, the doctors gradually emerged by a process of escalation into a supermagisterial role—first of all in the higher faculties of theology, law, and medicine. It will come as no surprise that the lawyers had a particular and early yen for this special distinction.

These gradations and distinctions are reflected in the quaint and colorful niceties of academic dress.

Of particular interest is the cap or mortarboard. In the form of the biretta it was the peculiar sign of the master. Its use has now spread far beyond that highly select group to school boys and choir girls and even to the nursery school. *Sic transit. . . .*

The gown, of course, is the basic livery of the scholar, with its clear marks of rank and status—the pointed sleeves of the bachelor, the oblong sleeves of the master, the full sleeves and velvet trimmings of the doctor. The doctors, too, may depart from basic black and break out into many colors—Harvard crimson or Yale blue or the scarlet splash of Oxford.

Color is the very essence of the hood: color in the main body to identify the university; color perhaps in the binding to proclaim the subject of the degree—orange for engineering, gold for science, the baser copper for economics, white for arts and letters, green for medicine, purple for law, scarlet for theology, and so on. Size is a further variable, as the hoods tend to lengthen from the three feet of the bachelor to the four of the doctor. So the birds are known by their plumage.

With this color and symbolism, which is mediaeval though mutated, we stage our brief moment of pageantry, paying homage to that ancient community of scholars in whose shadow we stand, and acknowledging our debt to the university as one of the great institutional constructs of the middle ages. While looking back, however, we also celebrate the achievements of this present generation of students and look forward to the future of these our younger colleagues, whom we now welcome to our midst.

David C. Elliot
Secretary of the Faculty

Academic Procession

Chief Marshal, Christopher E. Brennen, Ph.D.

Assistant Marshals

Arden L. Albee, Ph.D.
Jenijoy La Belle, Ph.D.
J. Kent Clark, Ph.D.
Robert W. Oliver, Ph.D.
Ray D. Owen, Ph.D., Sc.D.

Faculty Officers

Fred C. Anson, Ph.D.
Donald S. Cohen, Ph.D.
David C. Elliot, 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

FACULTY OFFICERS

THE FACULTY

THE CHAIRMEN OF DIVISIONS

THE DEANS

THE PROVOST

THE TRUSTEES

THE COMMENCEMENT CHAPLAIN

THE COMMENCEMENT SPEAKER

THE 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, Ph.D.

PROCESSIONAL . . . The Caltech Wind Ensemble Brass and Organ
William Bing, M.M., Conductor

INVOCATION . . . . . The Reverend Dr. George F. Regas
Rector
All Saints Church, Pasadena

COMMENCEMENT ADDRESS . . . . . "Your Revolution"
James A. Michener
Writer

MUSICAL SELECTION . . . . . The Caltech Glee Clubs
Donald G. Caldwell, D.M.A., Conductor

Morning Trumpet
Early American Folk Hymn

CONFERRING OF DEGREES . . Marvin L. Goldberger, Ph.D., D.H.L.
President
California Institute of Technology

PRESENTATION OF CANDIDATES FOR DEGREES

For the Degree of Bachelor of Science . . . David B. Wales, Ph.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 . . . . . Francis S. Buffington, Sc.D.
Associate Dean of Graduate Studies

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

Biology . . . . . Leroy E. Hood, M.D., Ph.D.
Division Chairman

Chemistry and Chemical Engineering . . John H. Seinfeld, Ph.D.
Executive Officer for Chemical Engineering

Engineering and Applied Science . . . . Roy W. Gould, Ph.D.
Division Chairman

Geological and Planetary Sciences . . . . Arden L. Albee, Ph.D.
Professor of Geology and
Chief Scientist, Jet Propulsion Laboratory

Humanities and Social Sciences . . . . David M. Grether, Ph.D.
Division Chairman

Physics, Mathematics and Astronomy . Edward C. Stone, Jr., Ph.D.
Division Chairman

CONCLUDING REMARKS . . . . . President Goldberger

BENEDICTION . . . . . Dr. Regas

RECESSIONAL . . . The Caltech Wind Ensemble Brass and Organ

ORGAN POSTLUDE . . . . . Leslie Deutsch

Candidates for Degrees

BACHELOR OF SCIENCE

David L. Adler *Pasadena, California* Applied Physics
Lynne Kay Adler *Irvine, California* Applied Physics
Jeffrey Alan Aguilera *Santa Rosa, California* Applied Mathematics
Carla Ahlstrom *Salem, Oregon* Chemical Engineering
Philip Harold Albert Electrical Engineering
Russell George Almond *Maple Glen, Pennsylvania* Mathematics
Loren Ingrid Alving *Chevy Chase, Maryland* Biology
James Allen Anderson *Los Angeles, California* Electrical Engineering
Julie Ann Anderson *Pasadena, California* Chemistry
Lorna Lee Anderson *Sacramento, California* Chemical Engineering
Nazeeh Issa Aranki *Jerusalem, Palestine* Electrical Engineering
Justine Leslie Armantrout *Bakersfield, California* Chemistry
Gloria Ann Badilla *Pleasanton, California* Engineering and Applied Science
Michael Edward Becker *Los Angeles, California* Engineering and Applied Science
John Albert Behr *Woodlake, California* Physics
Bruce Edward Behymer *Hanover Park, Illinois* Engineering and Applied Science
Leif Bennett *Playa del Rey, California* Applied Physics and Engineering and Applied Science
Allan Ira Berger *Castro Valley, California* Electrical Engineering
Andrew Laurence Berkin *Encino, California* Physics
Jeffrey Brian Berner *Glendale, California* Electrical Engineering
Thomas Edward Berto *San Anselmo, California* Engineering and Applied Science
Robert Eric Betzig *Ann Arbor, Michigan* Physics
Robert Edward Bible, Jr. *Rancho Santa Fe, California* Engineering and Applied Science
Scott Harris Bloom *Oyster Bay Cove, New York* Physics
Arthur Paul Brazy *Milwaukee, Wisconsin* Economics
Clark Donald Brooks *Norton, Ohio* Mathematics
Ellen Susanna Bus *Mountain View, California* Geophysics
Vincenzo Cammarata *Beachwood, New Jersey* Chemistry
Bao Quoc Cao *San Diego, California* Engineering and Applied Science
Armand J. Capote *Brooklyn, New York* Chemical Engineering
Anthony Julian Capowski *Manchester, New Hampshire* Electrical Engineering

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

Mark Bernard Caruso *La Cañada, California* Electrical Engineering
Virginia M. Chan *Southington, Connecticut* Engineering and Applied Science
William Albert Chapman *Melbourne, Victoria, Australia* Engineering and Applied Science
Steven Chin *Wantagh, New York* Biology
R. Sekhar Chivukula *Lincoln, Nebraska* Physics and Applied Mathematics
Ri-Chee Chou *Sunnyvale, California* Electrical Engineering
Kenneth Shun-kei Chow *Hong Kong* Physics
Thomas Phillip Christian *Roanoke, Virginia* Engineering and Applied Science
Dale Cheng-Hsin Chu *Carson, California* Electrical Engineering
Ming-Chung Chu *Hong Kong* Physics
Karl Robert Clausing *Camarillo, California* Electrical Engineering
Jean-Pierre Deodat Clejan *New York, New York* Engineering and Applied Science
Karen Marie Close *Norwich, Connecticut* Engineering and Applied Science
Steven Lee Colwell *San Diego, California* Engineering and Applied Science
Tony M. Conneally *Lombard, Illinois* Chemical Engineering
Walter A. Coole *Bayview, Washington* Applied Physics
Mark Edward Cornell *Godfrey, Illinois* Astronomy
John Timothy Cramer *Seattle, Washington* Engineering and Applied Science
Jim Cummings *Placentia, California* Physics
Noemi Guadalupe de la Puente del Campillo *Monterey Park, California* Engineering and Applied Science
Alan Joseph Dellamore *Ogden, Utah* Engineering and Applied Science
Daniel Scott Dickerson *Pasadena, California* Engineering and Applied Science
Kaitlin Drisko *Solana Beach, California* Engineering and Applied Science
Andrew Malcolm Duncan *Napa, California* Engineering and Applied Science
Jahn-Anders Dørsdal Dyvik *New City, New York* Engineering and Applied Science
Kent Franklin Evans *Los Alamos, New Mexico* Physics
Mario Ernesto Fajardo *Miami, Florida* Chemistry
John Gregory Favor *Houston, Texas* Engineering and Applied Science
Jacqueline Fernández *Santurce, Puerto Rico* Mathematics
Lisa Lynn Flitz *Mequon, Wisconsin* Biology
Chi Hang Fong *Los Angeles, California* Chemical Engineering
Arthur J. Fortini *Bronx, New York* Chemical Engineering and Chemistry
Ronald William Francis *Bronx, New York* Applied Physics
Lloyd Paul Franklin *East Brunswick, New Jersey* Engineering and Applied Science
Joseph Franklin Garvey *Bonita, California* Electrical Engineering
Lisa C. Grenier *Brea, California* Engineering and Applied Science
John Nicholas Gross *Westbrook, Maine* Electrical Engineering

Lawrence Stuart Gross *Sherman Oaks, California* Engineering and Applied Science
Wahid Suleiman Hamid *Karachi, Pakistan* Electrical Engineering
Lee Zachary Hasiuk *Philadelphia, Pennsylvania* Engineering and Applied Science
Gregory Johannes Haussmann *Torrance, California* Engineering and Applied Science
Christopher J. Hawley *Pasadena, California* Engineering and Applied Science
Mary Ellen Heinrich *Conifer, Colorado* Engineering and Applied Science
Douglas Heirich *Ann Arbor, Michigan* Engineering and Applied Science
Robert Gordon Helbing *Pasadena, California* Engineering and Applied Science
Michael Scott Hisey *Cupertino, California* Engineering and Applied Science
Pui Tong Ho *Harrisburg, Pennsylvania* Chemistry
Brian Douglas Horn *Los Angeles, California* Engineering and Applied Science
David Bland Huff *Sylacauga, Alabama* Electrical Engineering
Kevin Allen Hughes *Fair Oaks, California* Engineering and Applied Science
Johnny Nicholas Humphrey III *Savannah, Georgia* Physics
Elton Mori Inada *Honolulu, Hawaii* Engineering and Applied Science and Social Science
Tze Kin Ip *Houston, Texas* Engineering and Applied Science
Christopher Scott Jacobs *Cincinnati, Ohio* Applied Physics
Daniel K. Jew *Bell Gardens, California* Engineering and Applied Science
Hamid Johari *Tehran, Iran* Engineering and Applied Science
Howell Kenneth Johnson *Seattle, Washington* Engineering and Applied Science
Paul A. Johnson *Rock Springs, Wyoming* Electrical Engineering
Scott Russell Johnson *Lakewood, California* Mathematics
Vivek Madhusudan Joshi *Grand Forks, North Dakota* Mathematics
Arlene Patricia Keller *Arcadia, California* Chemistry
Muhammad Farrukh Khan *Lahore, Pakistan* Social Science
Paul Kevin Kienker *Palatine, Illinois* Biology
Michael Andrew Kilby *Bethesda, Maryland* Engineering and Applied Science
Sung Joon Kim *Glendale, California* Electrical Engineering
Young Shil Kim *Taegu, Korea* Physics
Steven C. Knowles *Gig Harbor, Washington* Engineering and Applied Science
Julia Ann Kornfield *Los Altos, California* Chemistry
Daniel Benjamin Kostka *Minnetonka, Minnesota* Engineering and Applied Science
Nancy Lee Krehbiel *El Cajon, California* Biology
Kenneth Ting-Yuan Kung *San Francisco, California* Electrical Engineering
Huy Minh Le *Pasadena, California* Electrical Engineering
Jeremy Leader *Princeton, New Jersey* Engineering and Applied Science
Brian Robert Leahy *El Cajon, California* Engineering and Applied Science
Young Soo Lee *Rancho Palos Verdes, California* Engineering and Applied Science

BACHELOR OF SCIENCE—*Continued*

Alexander V. Leibovich *San Jose, California* Engineering and Applied Science
Daniel Edward Lenoski *North Hollywood, California* Electrical Engineering
David John LePoire *Holland, Michigan* Physics
Lyle E. Levine *St. Louis, Missouri* Physics
Barret Lippey *San Jose, California* Applied Physics
Andrew H. Liu *Los Angeles, California* Chemisty
Donald Ching-tze Lo *West Covina, California* Biology
Sandra Tsing Loh *Malibu, California* Physics and Literature
John Charles Loveall *Covina, California* Applied Physics
Mark Warner Maier *Los Angeles, California* Engineering and Applied Science
Donald Edward Major *Seattle, Washington* Electrical Engineering
Maclen Buckminster Marvit *Swampscott, Massachusetts* Physics
Vladimir Matijasevic *Beograd, Yugoslavia* Applied Physics
Bjorn Eckart Matthias *Berlin (west), Germany* Physics
James Gerald McCuskey *Duluth, Minnesota* Engineering and Applied Science
Joseph McIntyre *Bellingham, Washington* Biology
Christopher Kevin McKinnon *Great Falls, Montana* Chemical Engineering
John Arthur Meiling *San Pedro, California* Engineering and Applied Science
Michael James Mettille *Newark, Ohio* Chemical Engineering
Frank Albert Meyer *Brentwood, New York* Electrical Engineering
Scott Michael *Novato, California* Mathematics
Richard Henry Miles *Bethesda, Maryland* Physics
Gary Craig Mockli *Lakewood, California* Biology and Chemistry
Luis A. Monsalve, Jr. *Los Angeles, California* Engineering and Applied Science
Rodney Morison, Jr. *Huntington Beach, California* Applied Mathematics
Harry George Mousmoules *Westminster, California* Engineering and Applied Science
Roman Movshovich *Los Angeles, California* Applied Physics
David James Muraki *Scarborough, Ontario, Canada* Mathematics
Lawrence Peter Muray *Los Altos, California* Applied Physics
Thomas Joseph Murphy *Dallas, Texas* Physics
Glenn Ernest Nakamura *Los Angeles, California* Biology and Chemistry
Thelma Yolanda Nunez *Tucson, Arizona* Chemical Engineering
David Arthur Oare *Wellsville, New York* Chemistry
Peter Orr *Arvada, Colorado* Engineering and Applied Science
Richard Leon Paquette *Chicopee, Massachusetts* Geophysics
Jonathan Parker *Hermosa Beach, California* Chemistry
Vipul Periwal *New Delhi, India* Physics and Mathematics
Richard William Pogge *Ridgecrest, California* Physics
William Alvo Polson *Saginaw, Michigan* Applied Physics

Leslie Anthony Poltrack *Stamford, Connecticut* Engineering and Applied Science
Vincent Martin Powers *Newport Beach, California* Chemistry
John Quackenbush *Mountaintop, Pennsylvania* Physics
Jon Tabor Quilliam *Everett, Washington* Engineering and Applied Science
Russell Warren Quong *Palos Verdes, California* Electrical Engineering
Wendy G. Rasmussen *Edina, Minnesota* Engineering and Applied Science
Zinovy Boris Reichstein *Selinsgrove, Pennsylvania* Mathematics
Ilene Miller Reinitz *Miami, Florida* Geochemistry
Brian Clark Richards *Issaquah, Washington* Electrical Engineering
Jay Bennett Rickard *Arlington, Texas* Electrical Engineering
Beverley Ann Robertson *Whitehorse, Yukon, Canada* Engineering and Applied Science
Cheryl Jean Robertson *Littleton, Colorado* Chemical Engineering
Gary Thomas Rodriguez *Kansas City, Missouri* Physics
Bruce Jones Sams III *Belvedere, California* Astronomy
Gregory Damian Sayles *El Sobrante, California* Chemical Engineering
Gregory Keith Schenter *Richland, Washington* Physics
Russell Brown Schweickart *Sacramento, California* Engineering and Applied Science
James G. Scoby *Park Ridge, Illinois* Engineering and Applied Science
Kenneth Donald Seibert *Limaville, Ohio* Electrical Engineering
Glenn Robert Seidman *Palos Verdes Estates, California* Engineering and Applied Science
Cynthia Louise Shaver *Sierra Vista, Arizona* Engineering and Applied Science
Rebecca Lynn Sheets *Wentzville, Missouri* Biology
Dean Kazuo Shibata *Westminster, California* Biology
Kenneth William Shrum *Los Angeles, California* Engineering and Applied Science
Thomas Russell Sim *Eugene, Oregon* Chemical Engineering
Evangelos Simoudis *Thessaloniki, Greece* Electrical Engineering
Eric Sinn *Pasadena, California* Biology
Risto Leo Sjogren *Los Angeles, California* Engineering and Applied Science
Don Allan Smith *Del Mar, California* Chemical Engineering
Robert James Snook *Stockton, California* Engineering and Applied Science
Christopher Martin Snyder *Evergreen, Colorado* Mathematics
Jonathan David Souder *San Diego, California* Engineering and Applied Science
Scott Edward Sperling *Tustin, California* Applied Physics
Aditya Srinivasan *Sharjah, United Arab Emirates* Electrical Engineering
Mark Joseph Stefanich *Anchorage, Alaska* Engineering and Applied Science
Michael Alan Strauser *Walla Walla, Washington* Electrical Engineering
Charlie Elliott Murton Strauss *Seattle, Washington* Electrical Engineering

Brent Connon Stuart *Walnut Creek, California* Physics
Ichiro Sugioka *Kyoto, Japan* Engineering and Applied Science
Gary Rikio Tanigawa *Aiea, Hawaii* Biology
Arthur Christopher Thompson *Winnipeg, Manitoba, Canada* Physics
Lynmarie Kim Thompson *Manhattan Beach, California* Chemistry
Mark M. Todorovich *New York, New York* Engineering and Applied Science
Curtis Alan Trimble *Las Vegas, Nevada* Physics
Thomas Richard Tyler, Jr. *Mystic, Connecticut* Engineering and Applied Science
Carlos Valencia III *Porterville, California* Electrical Engineering
Camilla Adele Van Voorhees *Larkspur, California* Literature
Thiti Vejpas *Bangkok, Thailand* Electrical Engineering
John Szeming Wang *San Francisco, California* Electrical Engineering
John Y. Wang *Morton Grove, Illinois* Electrical Engineering
Keith Richard Warfield *Williamsport, Pennsylvania* Engineering and Applied Science
Michael Scott Weston *Los Altos, California* Engineering and Applied Science
Frederick Paul Wieland *Garden City, New York* Astronomy
Timothy Lowell Williams *Palos Verdes, California* Electrical Engineering
William Harrison Wright III *Amenia, New York* Applied Physics
Walter Ulrich Wuensch *Clinton, New York* Physics
Sung Jun Yoo *Closter, New Jersey* Biology
Jeffrey Winston Yu *Dallas, Texas* Electrical Engineering
Avideh Zakhor *Tehran, Iran* Electrical Engineering
Graham Stuart Zaretsky *Spring Valley, New York* Engineering and Applied Science

MASTER OF SCIENCE

Khaled Ahmed Sabry Abdel-Ghaffar *(Electrical Engineering)* B.Sc., Alexandria University 1980.

Marie Agnes Allard *(Civil Engineering)* Diplôme d'Ingénieur, Ecole Spéciale des Travaux Publics, du Bâtiment et de l'Industrie 1982.

Julie Ann Anderson *(Chemistry)* B.S., California Institute of Technology 1983.

Mark William Anderson *(Aeronautics)* B.S., Purdue University 1974.

A. V. Anilkumar *(Mechanical Engineering)* B.Tech., Indian Institute of Technology, Madras 1982.

Michael Charles Brewster Ashley *(Astronomy)* B.Sc., Australian National University 1981.

William C. Athas, Jr. *(Computer Science)* B.S., University of Utah 1981.

Diane Elizabeth Austin *(Environmental Engineering Science)* B.S., Texas Christian University 1981.

Haruo Awano *(Electrical Engineering)* B.S., University of Tokyo 1979.

Peter Thomas Balcewicz *(Applied Physics)* S.B., Massachusetts Institute of Technology 1981.

Christopher Louis Barrett *(Engineering Science and Bioinformation Systems)* B.S., University of New Mexico 1976.

William I. Behen *(Electrical Engineering)* B.S., California Institute of Technology 1978.

Philip Stewart Beran *(Aeronautics)* B.S., Cornell University 1982.

Janet A. Blume *(Civil Engineering)* B.S.E., Princeton University 1982.

Alice Renée Bonnefoi *(Applied Physics)* DEUG A., Université des Sciences et Techniques du Languedoc 1979; Diplôme d'Ingenieur, Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris 1983.

Alejandro Aceves Borbolla *(Applied Mathematics)* Licenciado en Fisica, Universidad Nacional Autonoma de Mexico 1981.

David Paul Brady *(Electrical Engineering)* B.S., Carnegie-Mellon University 1982.

William Michael Bruno *(Electrical Engineering)* B.S., University of California, San Diego 1981.

George Mario Buriticá *(Electrical Engineering)* B.E., Youngstown State University 1981.

Walter Yichen Chen *(Electrical Engineering)* B.S., Polytechnic Institute of New York 1982.

Yang-Tse Cheng *(Applied Physics)* B.S., California Institute of Technology 1982.

Jonathan Edward Child *(Chemical Engineering)* B.Ch.E., University of Delaware 1981.

Michael V. Chobotov *(Mechanical Engineering)* B.S., California Institute of Technology 1982.

Young-il Choo *(Computer Science)* B.S., California Institute of Technology 1978.

Christopher Vincent Chow *(Chemical Engineering)* B.S., University of Illinois at Urbana-Champaign 1980.

Eugene Yun-Ching Chu *(Electrical Engineering)* B.S., University of Detroit 1982.

Johnson Nain-Lun Chu *(Electrical Engineering)* B.S., University of California, Los Angeles 1982.

Daniel Mark Coffman *(Physics)* B.S., Yale University 1979.

Stefano Enrico Concina *(Electrical Engineering)* Diplôme d'Ingénieur, Ecole Supérieure d'Ingénieurs en Electrotechnique et Electronique 1983.

YongBum Park Cuevas *(Electrical Engineering)* B.S., University of Hawaii at Manoa 1982.

David Stewart Dandy *(Chemical Engineering)* B.S., University of California, Davis 1981.

Barry Daniel Davidson *(Aeronautics)* B.S., State University of New York at Buffalo 1981.

Teresa Melissa Davis *(Electrical Engineering)* B.S., University of Texas at Austin 1981.

Curt Gerald DeGroff *(Electrical Engineering)* B.S., State University of New York at Buffalo 1982.

Pablo de Urquijo Niembro *(Electrical Engineering)* B.S., Universidad Iberoamericana 1980.

Marc Marie de Villepin *(Electrical Engineering)* Diplôme d'Ingénieur, Ecole Nationale Supérieure des Télécommunications 1983.

Thomas Joseph DiChristina *(Environmental Engineering Science)* B.S., University of Rochester 1982.

William Patrick Donlon Jr. *(Civil Engineering)* B.S., University of Notre Dame 1982.

David Russel Dowling *(Aeronautics)* B.S., California Institute of Technology 1982.

Gregory Peter Dubois *(Physics)* B.A., University of South Florida 1981.

Bahaa Mohamed El-Aidi *(Civil Engineering)* B.Sc., Cairo University 1978.

Daniel Weiler Eustace *(Electrical Engineering)* B.S., Case Western Reserve University 1982.

Lee Samuel Finn *(Physics)* B.S., University of California, Los Angeles 1982.

James Edward Flowers *(Physics)* B.A., Rice University 1981.

Jean-Marc Henri-Noël Fournié *(Aeronautics)* Diplôme d'Ingénieur, Ecole Centrale de Lyon 1982.

Lloyd Paul Franklin *(Electrical Engineering)* B.S., California Institute of Technology 1983.

Ronald John Franz *(Mechanical Engineering)* B.S., California Institute of Technology 1982.

Stephen D. Freeland *(Electrical Engineering)* B.S., Harvey Mudd College 1982.

Clifford Eugene Frieler *(Aeronautics)* B.S., California Institute of Technology 1982.

Neil E. Gallensky *(Electrical Engineering)* B.S., The University of Wyoming 1982.

James Michael Gerard *(Social Science)* B.A., Northwestern University 1977.

Ghavam Ghavamishahidi *(Electrical Engineering)* S.B., Massachusetts Institute of Technology 1981.

Rita Gitik *(Mathematics)* B.A., Hebrew University of Jerusalem 1981.

Aaron Henry Goldberg *(Chemistry)* B.S., Yale University 1979.

Carl Scott Guernsey *(Aeronautics)* B.S., Purdue University 1976.

Armineh Hakob Nalbandian *(Civil Engineering)* B.S., California State University, Northridge 1982.

Imad Awni Hannoun *(Civil Engineering)* B.E., American University of Beirut 1982.

Debra Kay Heckendorn *(Chemistry)* B.S., University of Idaho 1980.

Joseph E. Heideman *(Electrical Engineering)* B.S., Oregon State University 1982.

Gavin Julian Hendricks *(Mechanical Engineering)* B.Sc., University of Cape Town 1981.

Maurice Alfred Hernandez *(Electrical Engineering)* B.S., University of the Pacific 1981.

Lynn Mary Hildemann *(Environmental Engineering Science)* B.S., California Institute of Technology 1980.

Eric John Holstege *(Computer Science)* B.S., California Institute of Technology 1981.

John Hyunchul Hong *(Electrical Engineering)* S.B., Massachusetts Institute of Technology 1982.

Scott Curtis Honkonen *(Mechanical Engineering)* B.S., University of Vermont 1982.

Astrid H. Howard *(Geology)* S.B., Massachusetts Institute of Technology 1979.

Joseph William Humphrey III *(Mechanical Engineering)* B.M.E., Georgia Institute of Technology 1982.

Susan Elizabeth Hunts *(Environmental Engineering Science)* B.S., California Institute of Technology 1981.

David Earl James *(Environmental Engineering Science)* A.B., University of California, Davis 1975.

Robert McNamara Kanne *(Chemistry)* B.S., Stanford University 1977.

John Kao *(Electrical Engineering)* B.S., Polytechnic Institute of New York 1982.

Gary Michael Kolbasuk *(Geology)* B.S., Northern Illinois University 1977.

Jeffrey Yau-Pak Kong *(Electrical Engineering)* B.S., University of Santa Clara 1982.

Albert Ernst Koszarek *(Mechanical Engineering)* B.S., Washington State University 1982.

Brian Charles Kravitz *(Mechanical Engineering)* B.S., Rutgers, The State University 1982.

Nehemias Lima Lacerda *(Aeronautics)* Aeronautical Engineer, Instituto Tecnológico de Aeronáutica 1978.

Jimmy Kwok-Ching Lam *(Computer Science)* B.S., California Institute of Technology 1982.

Wayne Wing Lam *(Electrical Engineering)* B.S., University of Hawaii at Manoa 1981.

Hervé Roger André Lambert *(Electrical Engineering)* Diplôme d'Ingénieur, Ecole Supérieure d'Ingénieurs en Electrotechnique et Electronique 1982.

Joseph Lebowitz *(Electrical Engineering)* B.E., Stevens Institute of Technology 1982.

Norman Tai Ming Lee *(Electrical Engineering)* B.S., California Institute of Technology 1980.

Louise Victoria LeFevre *(Geophysics)* B.A., State University of New York College at Brockport 1980.

Ping-Sang Kenneth Leung *(Environmental Engineering Science)* B.S., University of Wisconsin-Green Bay 1981.

Patrick Christian Levesque *(Aeronautics)* Diplôme d'Ingénieur, Ecole Nationale Supérieure de l'Aeronautique et de l'Espace 1982.

Liyuan Liang *(Environmental Engineering Science)* B.S., Northeastern University 1982.

Dorian Liepmann *(Chemical Engineering)* B.S., California Institute of Technology 1981; A.B., Occidental College 1981.

David Simon Sy Lim *(Aeronautics)* B.S., Rensselaer Polytechnic Institute 1982.

John Nikolai Louie *(Geophysics)* A.B., Occidental College 1982.

Jonathan Irving Lunine *(Geological and Planetary Science)* B.S., University of Rochester 1980.

Eric Etienne Majani *(Electrical Engineering)* Diplôme d'Ingénieur, Ecole Nationale Supérieure de l'Aeronautique et de l'Espace 1982.

Mary Kathleen McCann *(Aeronautics)* B.S., University of Notre Dame 1981.

Martin Conrad Miller *(Electrical Engineering)* B.A., St. John's College 1981.

Jean-Michel Missirian *(Mechanical Engineering)* Ingénieur Arts et Métiers, Ecole Nationale Supérieure d'Arts et Métiers 1982.

Michael Anthony Moser *(Mechanical Engineering)* Sc.B., Brown University 1981.

Bernhard Otto Mueller *(Mechanical Engineering)* Vordiplom, Universität Fridericiana zu Karlsruhe 1981.

David James Muraki *(Mechanical Engineering)* B.S., California Institute of Technology 1983.

Narasimhan - R. *(Applied Mechanics)* B.Tech., Indian Institute of Technology, Madras 1982.

Sotirios Natsiavas *(Mechanical Engineering)* Ptychion, Aristotelion University of Thessaloniki 1982.

Danny Neuhauser *(Physics)* B.Sc., Hebrew University of Jerusalem 1982.

Matthew Philip Newlin *(Mechanical Engineering)* B.S.M.E., University of Washington 1982.

Charles Hok-Bun Ng *(Computer Science)* B.S., California Institute of Technology 1982.

Edward Thien-Duy Nguyen *(Electrical Engineering)* B.S., California State University, Los Angeles 1982.

Jane Elizabeth Nordholt *(Physics)* B.A., Rutgers, The State University 1980.

Wendy Ann Olson *(Chemistry)* B.S., University of Illinois at Urbana-Champaign 1980.

Leonidas George Paparizos *(Civil Engineering)* Diploma, National Technical University of Athens 1982.

Hisup Park *(Mechanical Engineering)* B.S., California Institute of Technology 1982.

Peter Mirrill Partch *(Engineering Science)* B.S., University of California, San Diego 1981.

Joel Stephen Paslaski *(Electrical Engineering)* B.S., California Institute of Technology 1982.

Pascal Maurice Peguet *(Electrical Engineering)* Diplôme d'Ingénieur, Ecole Supérieure d'Ingénieurs en Electrotechnique et Electronique 1983.

Chia-Yen Peng *(Civil Engineering)* B.S., National Taiwan University 1980.

Joseph Ellsworth Pingree *(Planetary Science)* S.B., Massachusetts Institute of Technology 1981.

Alexios Pantelis Polychronakos *(Physics)* Diploma, National Technical University of Athens 1982.

Robert Francis Popoli *(Electrical Engineering)* B.E., The Cooper Union 1980.

George Anthony Rakuljic *(Electrical Engineering)* B.S., University of California, Los Angeles 1982.

Raymond Luther Rau *(Physics)* B.S., Lehigh University 1981.

Kenneth Frederick Reardon *(Chemical Engineering)* B.S., University of Pennsylvania 1981.

Gabriel Michel Rebeiz *(Electrical Engineering)* B.E., American University of Beirut 1982.

Joel Arthur Rosen *(Aeronautics)* S.B., Massachusetts Institute of Technology 1980.

Enrique Edmundo Ruiz Carballo *(Electrical Engineering)* Electrical Engineer, Universidad de San Carlos de Guatemala 1980.

John Hulett Runnels *(Chemistry)* B.S., Louisiana State University 1980.

Michael Joseph Ruth *(Applied Mechanics)* B.S.E., Duke University 1982.

Stephen Lowell Salyards *(Geophysics)* B.S., The Pennsylvania State University 1982.

David Christopher Sams *(Aeronautics)* B.S., University of Washington 1982.

Christopher O'Neill Sanders *(Geophysics)* B.S., University of Nevada, Reno 1979.

Carl Robert Schultheisz *(Aeronautics)* B.S., University of Maryland 1982.

Vera Olivia Shen *(Electrical Engineering)* B.S., Oregon State University 1982.

John J. Sidorowich *(Applied Physics)* B.S., California Institute of Technology 1981.

George Siopsis *(Physics)* B.Sc., The University of Sussex 1982.

Frank Cheung Tao So *(Electrical Engineering)* B.Sc., The University of Manchester 1982.

William Joseph Sommers Jr. *(Mechanical Engineering)* B.S.E., The University of Alabama in Huntsville 1982.

MASTER OF SCIENCE—*Continued*

Richard Jerome Stead *(Geophysics)* B.S., Lehigh University 1982.

Karl E. Steinhoff *(Applied Mathematics)* B.S., Harvey Mudd College 1981.

Kenneth Jeffrey Stern *(Electrical Engineering)* B.S., University of Pennsylvania 1979.

Stephen Yiu Ken Tam *(Electrical Engineering)* B.Sc., The University of Alberta 1982.

Chin An Tan *(Aeronautics)* B.S., University of California, Berkeley 1982.

Francis Chi Kin Ting *(Civil Engineering)* B.Sc., The University of Manchester Institute of Science and Technology 1982.

Gregory Paul Tollisen *(Mathematics)* B.S., University of Portland 1978.

David Alan Treiber *(Aeronautics)* B.S., University of Washington 1982.

Walter Shigeharu Tsuha *(Aeronautics)* B.S., University of Hawaii at Manoa 1981.

Jakob Johannes van Zyl *(Electrical Engineering)* B.Eng., University of Stellenbosch 1979.

Ramanarayanan Venkataramanan *(Electrical Engineering)* B.E., P.S.G. College of Technology 1970; M.E., Indian Institute of Science, Bangalore 1975.

David William Voorhes *(Applied Mechanics)* B.S., Yale University 1980.

Moderagé Anthony Marius Waas *(Aeronautics)* B.Sc., The Imperial College of Science and Technology 1982.

Stefan Wabnitz *(Electrical Engineering)* Laurea, Università di Roma 1982.

Korawit Wacharasindhu *(Electrical Engineering)* B.Sc., The University of Sussex 1982.

Carlos René Weissenberg Jr. *(Electrical Engineering)* B.S., University of California, Davis 1981.

Lance Nevin West *(Electrical Engineering)* B.S., Tufts University 1982.

Theresa Ann Weston *(Chemical Engineering)* S.B., Massachusetts Institute of Technology 1980.

Brian David Wilson *(Physics)* B.A., Rice University 1978.

Jin-Jwang Alice Wu *(Environmental Engineering Science)* B.S., National Taiwan University 1981.

Andre Julien Stuart Yakovleff *(Electrical Engineering)* Diplôme d'Ingénieur, Ecole Spéciale de Mécanique et d'Electricité 1983.

Shu Yamamoto *(Electrical Engineering)* B.E., University of Tokyo 1977; M.E., 1979.

Joanne Mulligan Yeakley *(Biology)* B.S., Purdue University 1976.

Alan Taylor Zehnder *(Mechanical Engineering)* B.S., University of California, Berkeley 1982.

ENGINEER

Anthony Magaldi *(Aeronautical Engineer)* B.S., Cornell University 1976; M.Eng., 1977.

DOCTOR OF PHILOSOPHY

DIVISION OF BIOLOGY

Steven Michael Block *(Biology)* B.A., Oxford University 1974; M.A., 1978; M.A., University of Colorado 1982.
Thesis: Chemotactic Responses of Tethered Bacteria.

Stephen Thomas Crews *(Biology)* B.A., The University of Texas at Austin 1975.
Thesis: The Structure of Mammalian Genes: I. Antibody Heavy Chain Variable Region Genes: Organization, Diversity, and Somatic Mutation. II. Structure and Transcription of the DNA Encompassing the Origin of Replication of Human Mitochondrial DNA.

Jay William Ellison *(Biology)* B.S., University of Illinois at Urbana-Champaign 1977; M.S., California Institute of Technology 1980.
Thesis: Structure and Evolution of Human Immunoglobulin $C\gamma$ Genes.

Karl Joseph Fryxell *(Biology)* B.A., B.S., The University of Texas at Austin 1975.
Thesis: Biochemical and Genetic Studies on Peripheral Myelination in Normal Development and in the Mouse Mutant Trembler.

Richard Hans Gomer *(Biology)* B.A., Pomona College 1977.
Thesis: The Role of Filamin in the Morphogenesis of the Skeletal Muscle Sarcomere.

Mitchell Kronenberg *(Molecular Biology)* B.A., Columbia University 1973.
Thesis: Gene Expression in B and T Lymphocytes: I. Evolution of Rat C_κ Alleles. II. The T-cell Receptor Problem.

Baruch Davidson Kuppermann *(Biology)* A.B., University of California, Berkeley 1977.
Thesis: Studies on the Role of Afferent Activity in the Visual Pathways of the Cat.

Greg Erwin Lemke *(Biology)* S.B., Massachusetts Institute of Technology 1978.
Thesis: Identification and Characterization of Glial Growth Factor.

James Stacy McCasland *(Neurobiology)* B.S., B.A., The University of Texas at Austin 1976.
Thesis: Neuronal Control of Bird Song Production.

Bruce John Nicholson *(Cell Biology)* B.Sc., University of Queensland 1976.
Thesis: Biochemistry and Diversity of the Gap Junction Protein: A Study of Liver, Heart and Lens.

Michael P. Snyder *(Biology)* B.A., University of Rochester 1977.
Thesis: Organization and Expression of a Cluster of Drosophila Cuticle Genes.

Chung Wang *(Biology)* B.S., National Tsing Hua University 1973; M.S., 1975.
Thesis: Induction and Methylation of Heat Shock Proteins in Cultured Vertebrate Cells.

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

DIVISION OF CHEMISTRY AND CHEMICAL ENGINEERING

David Thomas Allen *(Chemical Engineering)* B.S., Cornell University 1979; M.S., California Institute of Technology 1981.
Thesis: Modeling the Reactions of Coal Liquids.

Paul Theron Barger *(Chemistry)* B.S., University of Minnesota 1978.
Thesis: The Reactivity of Zirconium Hydrides with Transition Metal Carbonyls.

Nancy Newton Becker *(Chemistry)* B.A., University of California, San Diego 1978.
Thesis: ^{15}N Nuclear Magnetic Resonance Studies of the Liver Alcohol Dehydrogenase-NAD^+-Pyrazole Complex.

Tadhg P. Begley *(Chemistry)* B.Sc., University College, Cork 1977.
Thesis: Bispecific, Cleavable, Protein DNA Crosslinker, Psoralen-Diol-Nitroveratrole. A Probe of Bacteriophage Structure.

Robert Clark Bowman, Jr. *(Chemistry)* B.S., Miami University 1967; S.M., Massachusetts Institute of Technology 1969.
Thesis: Solid-State Proton Nuclear Magnetic Resonance Studies of Hydrogen Site Occupancies, Electronic Structure Properties, and Diffusion Behavior in Transition Metal Hydrides.

James Gleason Crump III *(Chemical Engineering and Mathematics)* S.B., Massachusetts Institute of Technology 1978.
Thesis: Aerosol Deposition, Growth, and Dynamics in the Continuous Stirred Tank Reactor.

John Powell Daub *(Chemistry)* B.A., Pomona College 1977.
Thesis: The Total Synthesis of Macrolide Antibiotics.

John Austin Dodge *(Chemistry)* B.S., University of New Orleans 1977.
Thesis: The Synthesis and Characterization of Binuclear Copper(I) Complexes as Models for Protein Active Sites.

Kenneth Martin Doxsee *(Chemistry)* B.S., Stanford University 1978; M.S., 1979.
Thesis: Homogeneous Carbon Monoxide Reduction — Catalyst Design Strategies.

Daniel C. Duan *(Chemistry)* B.S., University of Illinois at Urbana-Champaign 1976.
Thesis: Evidence for a Stereospecific 1,2-Elimination Reaction in a 1,1-Diazene. Synthesis and Decomposition of [N-Phenyl-(*Threo*-(and *Erythro*)-2-Deuterio-1-Methylpropyl)Amino]Nitrene.

Michael Dalton Ennis *(Chemistry)* B.S., University of Missouri-St. Louis 1978.
Thesis: I. Asymmetric Alkylation Reactions of Chiral Imide Enolates. II. Efforts Directed Toward the Total Synthesis of (+)-Macbecin I.

Linda F. Halle *(Chemistry)* B.S., The University of Chicago 1978.
Thesis: Studies of the Energetics and Mechanisms of Organometallic Reactions in the Gas Phase.

Eric Martin Krauss, M.D. *(Chemistry)* A.B., Harvard College 1974; M.D., Cornell University Medical College 1978.
Thesis: Conformation and Function of Gramicidin S, A Peptide Antibiotic Which Mediates Phase Transfer of Nucleotides and Nucleic Acids.

William Roger Lambert *(Chemistry)* A.B., University of California, Berkeley 1973; M.S., San Francisco State University 1977.
Thesis: Picosecond Excitation and Quantum Beats of Molecules in Supersonic Molecular Beams.

William Alan Marritt *(Chemistry)* B.A., Ohio Wesleyan University 1978.
Thesis: The Syntheses and Characterization of Binuclear Clathrochelate Complexes.

James Moers Mayer *(Chemistry)* A.B., Harvard College 1978.
Thesis: Synthesis, Characterization, and Reactivity of New Hydride Compounds of Tantalum (V).

Dennis E. McGee *(Chemistry)* B.A., University of Oregon 1978.
Thesis: Diol Dehydratase: Purification, Structural Characterization, and Mechanism of Action.

Daniel Keith McIntyre *(Chemistry)* B.A., Saint Olaf College 1976.
Thesis: Synthesis and Characterization of 1,1-Di-*Tert*-Butyldiazene.

Mark Allen Mitchell *(Chemistry)* B.S., University of Iowa 1975.
Thesis: Interhelical DNA-DNA Crosslinking of Bacteriophage Lambda: Bis(mono-azidomethidium)octaoxahexacosanediamine and Bis(psoralen)nonaethyleneoxy ether, Probes of Packaged Nucleic Acid.

David Jerry Moll *(Chemistry and Applied Physics)* B.S., Andrews University 1977.
Thesis: One- and Two-Color Laser Spectroscopy with Photoacoustic and Multiphoton Ionization Detection.

Kevin Curtis Ott *(Chemistry)* B.S., Arizona State University 1976.
Thesis: Some Mechanistic and Synthetic Aspects of the Interaction of Lewis Acids with Bis-Cyclopentadienyltitanium(IV) Alkyls and Bis-Cyclopentadienyltitana-cyclobutanes.

Mark Thomas Paffett *(Chemistry)* B.S., The University of New Mexico 1978.
Thesis: Electrochemistry of Molybdenum Aquo Ions.

Andrew John Pesthy *(Chemical Engineering)* B.Ch.E., University of Delaware 1976; M.Ch.E., 1977.
Thesis: Aerosol Formation and Growth in Laminar Flow.

Gregory Ryskin *(Chemical Engineering)* Engineer-Physicist in Fluid Mechanics, Polytechnical Institute, Leningrad, U.S.S.R. 1970; Candidate of Physical-Mathematical Sciences in Fluid Mechanics, 1976.
Thesis: A Numerical Study of Bubble Deformation in Steady Axisymmetric Flows.

Paul David Siders *(Chemistry)* B.S., University of Wisconsin-Whitewater 1978.
Thesis: Theory of Outer-Sphere Electron-Transfer Reactions.

David John Strader *(Chemistry)* B.S.Eng., University of Virginia 1975.
Thesis: Studies on the Mechanism of Complement Activation by Murine Immunoglobulin G.

Daniel Albert Straus *(Chemistry)* B.S., University of California, Santa Barbara 1977.
Thesis: Synthesis and Reactivity of Bis(cyclopentadienyl)titanacyclobutanes and Ketene Complexes of Bis(cyclopentadienyl)titanium and Bis(cyclopentadienyl)-zirconium.

David Walter Suobank *(Chemical Engineering)* B.S., University of Arkansas 1976.
Thesis: A Quantitative, Comparative Study of Sound Produced *In Vitro* by Pulsatile Flow in and Around Prosthetic, Aortic Heart-Valves.

Arthur Ford Voter *(Chemistry)* B.S., Pennsylvania State University 1977.
Thesis: The Resonating Valence Bond Model of Molecules and Reactions.

Brian Christopher Willett *(Chemistry)* B.S., Indiana University 1978.
Thesis: Electron Transfer Rates and Adsorption in the Electrochemistry of Cobalt-2,2′-Bipyridine, Ruthenium Ammine Thiocyanate Complexes and cis-$[(C_5H_5)Fe(CO)P(C_6H_5)_2]_2$.

DIVISION OF ENGINEERING AND APPLIED SCIENCE

Yaser Said Abu-Mostafa *(Electrical Engineering and Computer Science)* B.Sc., Cairo University 1979; M.S.E.E., Georgia Institute of Technology 1981.
Thesis: Complexity of Information Extraction.

Elias A. Awad *(Mechanical Engineering)* Diplôme d'Ingénieur, Ecole Centrale des Arts et Manufactures 1979; M.S., California Institute of Technology 1980.
Thesis: Nonlinear Instabilities in Combustion Chambers.

Farhad Barzegar *(Electrical Engineering)* B.S., Arya-Mehr University of Technology 1977; M.S., California Institute of Technology 1978.
Thesis: Problems in Switched-Mode DC and AC Power Conversion.

Henry A. Blauvelt *(Applied Physics)* B.S., Cornell University 1978.
Thesis: New Structures for AlGaAs Lasers and Avalanche Photodetectors.

Dirceu Luiz Rodrigues Botelho *(Civil Engineering)* Engenheiro, Escola Politécnica da Universidade de Sao Paulo 1975; Mestre em Engenharia, 1978; M.S., California Institute of Technology 1979.
Thesis: An Empirical Model for Vortex-Induced Vibrations.

Dimitri S. Chamieh *(Mechanical Engineering)* B.S., Northwestern University 1977; M.S., California Institute of Technology 1978.
Thesis: Forces on a Whirling Centrifugal Pump-Impeller.

Marina Chien-mei Chen *(Computer Science)* B.S., National Taiwan University 1978; M.S., California Institute of Technology 1980.
Thesis: Space-Time Algorithms: Semantics and Methodology.

Arthur Er-Terg Chiou *(Applied Physics)* B.S., Rangoon Arts and Science University 1969; M.S., National Taiwan University 1972.
Thesis: I. Parametric Study of Optically Pumped Far-Infrared Waveguide Lasers. II. Theory and Experiment of Folded Fabry-Perot Quasi-Optical Ring Resonator Diplexer.

Liew-Chuang Chiu *(Applied Physics)* B.S., California Institute of Technology 1979; M.S., 1980.
Thesis: III-V Semiconductor Lasers and Detectors.

Bruce Montgomery Clemens *(Applied Physics)* B.S., Colorado School of Mines 1978; M.S., California Institute of Technology 1979.
Thesis: Superconductivity as a Structural Characterization Tool in Amorphous Materials.

Jeremiah F. Connolly *(Applied Mechanics)* B.Sc., University College, Cork 1975; M.Sc., 1976.
Thesis: Two Problems in Plane Finite Elastostatics.

Erik Penn DeBenedictis *(Computer Science)* B.S., California Institute of Technology 1978; M.S., Carnegie-Mellon University 1979.
Thesis: Techniques for Testing Integrated Circuits.

Mark Barry Dolson *(Electrical Engineering)* B.S., Carnegie-Mellon University 1976; M.S., California Institute of Technology 1978.
Thesis: A Tracking Phase Vocoder and Its Use in the Analysis of Ensemble Sounds.

Robert Warren Erickson, Jr. *(Electrical Engineering)* B.S., California Institute of Technology 1978; M.S., 1980.
Thesis: Large Signals in Switching Converters.

Morteza Gharib *(Aeronautics)* B.S., Tehran University 1976; M.S., Syracuse University 1977.
Thesis: The Effect of Flow Oscillations on Cavity Drag and a Technique for Their Control.

Chuen Jin Goh *(Applied Mechanics)* B.Math., The University of Newcastle 1979; B.E., 1980.
Thesis: Analysis and Control of Quasi Distributed Parameter Systems.

Christoph S. Harder *(Electrical Engineering)* Diploma, Swiss Federal Institute of Technology, Zurich 1978; M.S., California Institute of Technology 1980.
Thesis: Bistability, High Speed Modulation, Noise and Pulsations in GaAlAs Semiconductor Lasers.

Luc J. Heymans *(Aeronautics)* Master of Engineering, Katholieke Universiteit te Leuven 1976; M.S., California Institute of Technology 1977.
Thesis: An Engineering Analysis of Polymer Film Adhesion to Rigid Substrates.

Stuart Thomas Hopkins *(Applied Physics)* B.Sc., Queen's University at Kingston 1977; M.S., California Institute of Technology 1978.
Thesis: Low Temperature Specific Heat Studies of Molybdenum-Ruthenium Based Superconducting Metallic Glasses.

Sudhir Kumar Jain *(Civil Engineering)* B.E., University of Roorkee 1979; M.S., California Institute of Technology 1980.
Thesis: Analytical Models for the Dynamics of Buildings.

Itzhak Levit *(Mechanical Engineering)* B.Sc., Tel-Aviv University 1977; M.Sc., 1979.
Thesis: A General Solution Strategy for Large Scale Static and Dynamic Nonlinear Finite Element Problems Employing the Element-by-Element Factorization Concept.

Barry Bruce Megdal *(Computer Science)* B.S., California Institute of Technology 1977; M.S., 1978.
Thesis: VLSI Computational Structures Applied to Fingerprint Image Analysis.

Douglas Marion Moody, Jr. *(Applied Physics)* B.S., University of Oklahoma 1972; M.S., California Institute of Technology 1973.
Thesis: I. Numerical Solution of the Superfluid Helium Shock Jump Conditions. II. Experimental Investigation of the Liquid Helium II — Vapor Interface.

Mark Godfrey Mungal *(Aeronautics)* B.A.Sc., University of Toronto 1975; M.S., California Institute of Technology 1977.
Thesis: Experiments on Mixing and Combustion with Low Heat Release in a Turbulent Shear Flow.

Philip Malcolm Neches *(Computer Science)* B.S., California Institute of Technology 1973; M.S., 1977.
Thesis: Hardware Support for Advanced Data Management Systems.

Olin Perry Norton *(Mechanical Engineering)* B.S., Mississippi State University 1975; M.S., Rensselaer Polytechnic Institute 1976.
Thesis: The Effects of a Vortex Field on Flames with Finite Reaction Rates.

Timothy Christopher O'Sullivan *(Applied Mechanics)* B.Sc., University College, Cork 1976; M.Sc., 1977.
Thesis: The Propagation and Arrest of an Edge Crack in an Elastic Half-Space Under Conditions of Anti-Plane Shear: Analytical and Numerical Results.

Thomas James Pence *(Applied Mechanics)* B.S., Michigan State University 1979; M.S., California Institute of Technology 1980.
Thesis: The Emergence and Propagation of a Phase Boundary in an Elastic Bar.

Ahmed Atef Rashed *(Civil Engineering)* B.Sc., Cairo University 1975; M.S., California Institute of Technology 1979.
Thesis: Dynamic Analyses of Fluid-Structure Systems.

William Stapf Sargent *(Aeronautics)* A.B., Princeton University 1974; M.S., California Institute of Technology 1975.
Thesis: Natural Convection Flows and Associated Heat Transfer Processes in Room Fires.

Virgil Simon Speriosu *(Applied Physics)* B.S., Case Western Reserve University 1976; M.S., California Institute of Technology 1978.
Thesis: X-Ray Rocking Curve and Ferromagnetic Resonance Investigations of Ion-Implanted Crystals.

Alan Thomas Stone *(Environmental Engineering Science and Chemistry)* B.S., University of Maryland 1978; M.S., California Institute of Technology 1981.
Thesis: The Reduction and Dissolution of Manganese(III) and (IV) Oxides by Organics.

James Zareh Tatoian *(Applied Mathematics and Electrical Engineering)* B.S.E.E., Yerevan Polytechnic Institute 1974; M.S., University of Pennsylvania 1978.
Thesis: An Analytical Study of Electromagnetic Vector Field Propagation in a Nonlinear Electron Plasma.

John Robert Torczynski *(Applied Physics and Applied Mathematics)* B.A., Rice University 1979; M.S., California Institute of Technology 1981.
Thesis: Second Sound Shock Waves in Rotating Superfluid Helium.

DOCTOR OF PHILOSOPHY—*Continued*

David James Trawick *(Computer Science)* B.S., M.S., California Institute of Technology 1979.
Thesis: Robust Sentence Analysis and Habitability.

Stephen Mathias Trimberger *(Computer Science)* B.S., California Institute of Technology 1977; M.S., University of California, Irvine 1978.
Thesis: Automated Performance Optimization of Custom Integrated Circuits.

Michael K. Ullner *(Computer Science)* B.S., California Institute of Technology 1977.
Thesis: Parallel Machines for Computer Graphics.

Iraklis Anestis Valioulis *(Environmental Engineering Science)* B.S., Aristotle University of Thessaloniki 1978; M.S., Cornell University 1980.
Thesis: Particle Collisions and Coalescence in Fluids.

Layne Zee *(Applied Mechanics)* B.S., State University of New York at Buffalo 1978.
Thesis: Ordinary and Strong Ellipticity in the Equilibrium Theory of Incompressible Hyperelastic Solids.

Keith P. Zondervan *(Applied Mechanics)* B.S., Calvin College 1975; B.S.E., University of Michigan, Ann Arbor 1975; M.S.E., 1977.
Thesis: Optimal Low Thrust, Three Burn Orbit Transfers with Large Plane Changes.

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES

Eric Paul Chael *(Geophysics)* B.S., Purdue University 1977; M.S., California Institute of Technology 1979.
Thesis: Constraints on the Earth's Anelastic and Aspherical Structure from Antipodal Surface Waves.

Robert Todd Clancy *(Planetary Science and Astronomy)* B.A., University of North Carolina at Chapel Hill 1975; M.S., Cornell University 1977.
Thesis: Carbon Monoxide in the Atmospheres of the Terrestrial Planets.

Stephen Norfleet Cohn *(Geophysics)* A.B., Harvard College 1975; M.S., California Institute of Technology 1978.
Thesis: Holographic In-Situ Stress Measurement in Geophysics.

Keith Alan Echelmeyer *(Geophysics)* B.A., University of Colorado 1976.
Thesis: Response of Blue Glacier to a Perturbation in Ice Thickness: Theory and Observation.

George Randall Gladstone *(Planetary Science and Astronomy)* B.Sc., University of British Columbia 1978; M.S., California Institute of Technology 1980.
Thesis: Radiative Transfer and Photochemistry in the Upper Atmosphere of Jupiter.

Bruce Martin Jakosky *(Planetary Science and Geophysics)* B.S., University of California, Los Angeles 1977; M.S., California Institute of Technology 1980.
Thesis: The Seasonal Behavior of Water Vapor in the Mars Atmosphere.

David Clifford Jewitt *(Planetary Science and Astronomy)* B.Sc., University College London 1979; M.S., California Institute of Technology 1980.
Thesis: I. Physical Studies of Distant Comets. II. Morphologies of Planetary Nebulae.

DOCTOR OF PHILOSOPHY—*Continued*

Thorne Lay *(Geophysics)* B.S., University of Rochester 1978; M.S., California Institute of Technology 1980.
Thesis: Analysis of Upper and Lower Mantle Structure Using Shear Waves.

Richard Edwin Lewis *(Geology)* B.S., University of California, Los Angeles 1976; M.S., California Institute of Technology 1977.
Thesis: Geology of the Hackberry Mountain Volcanic Center, Yavapai County, Arizona.

Hsui-Lin Liu *(Geophysics)* B.S., National Central University 1973; M.S., 1975.
Thesis: Interpretation of Near-Source Ground Motion and Implications.

James Christopher Pechmann *(Geophysics)* A.B., Hamilton College 1976; M.S., California Institute of Technology 1979.
Thesis: The Relationship of Small Earthquakes to Strain Accumulation Along Major Faults in Southern California.

Judith Burt Pechmann *(Planetary Science and Astronomy)* B.A., Cornell University 1976.
Thesis: Thermal Tides in the Atmosphere of Venus.

Carolyn C. Porco *(Planetary Science and Astronomy)* B.S., State University of New York at Stony Brook 1974; M.S., California Institute of Technology 1979.
Thesis: Voyager Observations of Saturn's Rings: I. The Eccentric Rings at 1.29, 1.45, 1.95, and 2.27 R_S. II. The Periodic Variation of Spokes.

Marios Simou Vassiliou *(Geophysics and Electrical Engineering)* A.B., Harvard College 1978; M.S., California Institute of Technology 1979.
Thesis: The Energy Release in Earthquakes, and Subduction Zone Seismicity and Stress in Slabs.

Terry Charles Wallace, Jr. *(Geophysics)* B.S., New Mexico Institute of Mining and Technology 1978; M.S., California Institute of Technology 1980.
Thesis: Long Period Regional Body Waves.

DIVISION OF THE HUMANITIES AND SOCIAL SCIENCES

Gary Walter Cox *(Social Science)* B.S., California Institute of Technology 1978.
Thesis: Party and Constituency in Victorian Britain.

Mathew Daniel McCubbins *(Social Science)* B.A., University of California, Irvine 1978; M.S., California Institute of Technology 1980.
Thesis: Rational Individual Behavior and Collective Irrationality: The Legislative Choice of Regulatory Form.

Venkatraman Sadanand *(Social Science)* B.Tech., Indian Institute of Technology, Madras 1978; M.S., California Institute of Technology 1980.
Thesis: Imperfect Information and Oligopoly with Endogeneous Market Power.

DIVISION OF PHYSICS, MATHEMATICS AND ASTRONOMY

Graham Berriman *(Astronomy)* B.Sc., St. Andrews University 1977.
Thesis: Visible and Infrared Studies of Cataclysmic Variable Stars.

Norman Bobroff *(Physics)* B.S., University of Chicago 1977; M.S., California Institute of Technology 1980.
Thesis: Sounding Rocket XUV Observations of Capella.

Kirk Daniel Borne *(Astronomy)* B.S., Louisiana State University 1975; M.S., California Institute of Technology 1980.
Thesis: The Structure and Evolution of Interacting Binary Galaxies.

Mark John Bowick *(Physics)* B.Sc., University of Canterbury 1976; M.S., California Institute of Technology 1979.
Thesis: Radiative Mass Structure in Unified Models and Fermions in the Desert.

Mark Cronin-Golomb *(Physics)* B.Sc., University of Sydney 1979.
Thesis: Large Nonlinearities in Four-Wave Mixing in Photorefractive Crystals and Applications in Passive Optical Phase Conjugation.

John Alan Fawcett *(Applied Mathematics)* B.Sc., University of Victoria 1979.
Thesis: I. Three Dimensional Ray-Tracing and Ray-Inversion in Layered Media. II. Inverse Scattering and Curved Ray Tomography with Applications to Seismology.

Halis Yekta Gürsel *(Physics)* B.S., Middle East Technical University 1975.
Thesis: Stability of Spherically Symmetric, Charged Black Holes and Multipole Moments for Stationary Systems.

Thomas Michael Hagstrom *(Applied Mathematics)* B.A., Dartmouth College 1979.
Thesis: Reduction of Unbounded Domains to Bounded Domains for Partial Differential Equation Problems.

Jeffrey John Hamilton *(Physics)* B.S., Cornell University 1973; M.S., (Applied Physics) California Institute of Technology 1974; M.S., (Physics) 1979.
Thesis: A Thermodynamic Study of Methane Multilayers Adsorbed on Graphite.

Dean Robert Hart *(Mathematics)* B.S., University of Chicago 1978.
Thesis: Disjointness Preserving Operators.

Keith Douglas Horne *(Astronomy)* B.A., Pomona College 1977.
Thesis: Eclipse Mapping of Accretion Disks in Cataclysmic Binaries.

Kenneth A. Jensen *(Physics)* B.S., State University of New York at Stony Brook 1976.
Thesis: X-Ray Observations of Cataclysmic Variables.

Sarbmeet Singh Kanwal *(Physics)* M.Sc., Indian Institute of Technology, Kanpur 1976.
Thesis: A Leading Order QCD Computation of $\pi\pi$ Elastic Scattering.

Keith E. Krombel *(Physics)* B.S., Wilkes College 1976; M.S., California Institute of Technology 1979.
Thesis: The Relative Abundances of Sn, Te, Xe, Ba, and Ce in the Cosmic Radiation.

Nai-Hang Kwong *(Physics)* B.A., Hamilton College 1977.
Thesis: Realistic Calculations of Excitations in Nuclear Matter.

DOCTOR OF PHILOSOPHY—*Continued*

Matthew Arnold Malkan *(Astronomy)* A.B., Harvard College 1977; A.M., Harvard University 1977.
Thesis: The Physical Nature of the Continuum in Active Galaxies.

Olivier Martin *(Physics)* DEUG, Lycée Janson de Sailly 1978; M.S., California Institute of Technology 1982.
Thesis: Large N Gauge Theory at Strong Coupling with Chiral Fermions.

Marcus Holden Mendenhall *(Physics)* B.A., Washington University 1979; M.S., California Institute of Technology 1981.
Thesis: High Energy Heavy Ion Induced Enhanced Adhesion.

John Joseph Nugent Jr. *(Physics)* S.B., Massachusetts Institute of Technology 1977.
Thesis: Non-Equilibrium X-Ray Emission from Young Supernova Remnants.

John Lawrence Osborne *(Physics)* B.S., University of Washington 1977.
Thesis: The $^{3}He(\alpha,\gamma)^{7}Be$ Reaction at Low Energies.

Steve William Otto *(Physics)* B.S., University of California, Berkeley 1978.
Thesis: Monte Carlo Methods in Lattice Gauge Theories.

Jeffrey Ross Pier *(Astronomy)* B.A., University of Minnesota 1968; B.S., California Institute of Technology 1977; M.S., 1979.
Thesis: A Study of A- and B-Type Stars in the Southern Galactic Halo.

Michael David Prendergast *(Applied Mathematics)* B.S., Harvey Mudd College 1979.
Thesis: Linear Programming Methods for the Numerical Solution of Parabolic Equations Backwards in Time.

Luis Guillermo Maria Reyna *(Applied Mathematics)* Licenciado, Universidad Nacional de Cordoba 1978.
Thesis: I. Stability of Tchebyshev Collocation. II. Interpolation for Surfaces with 1-D Discontinuities. III. On Composite Meshes.

Augusto Sagnotti *(Physics)* Laurea, Universita di Roma 1978; M.S., California Institute of Technology 1979.
Thesis: Topics in Supersymmetry Theory: I. A Superspace Action for Ten-Dimensional Supersymmetric Yang-Mills Theory in Terms of Four-Dimensional Superfields. II. Gauge Groups for Type-I Superstrings.

Balachandran Sathiapalan *(Physics)* B.Tech., Indian Institute of Technology, New Delhi 1979.
Thesis: Topics in Grand Unified Theories: I. The Naturalness Problem. II. Monopoles and Fermion Number Violation.

Kristen Sellgren *(Physics)* B.A., University of California, San Diego 1976.
Thesis: Near Infrared Studies of Reflection Nebulae.

Richard Stanley Simon *(Astronomy)* B.A., University of California, Santa Barbara 1977; M.S., California Institute of Technology 1979.
Thesis: Nuclear Structure of Quasars at 329 Megahertz.

John David Spalding *(Physics)* B.S., Carnegie-Mellon University 1976.
Thesis: The Isotopic Composition of Energetic Particles Emitted from a Large Solar Flare.

Srinivas Sridhar *(Physics)* B.Sc., University of Calcutta 1972; M.Sc., Madurai University 1974; M.S., The Ohio State University 1976.
Thesis: Microwave Dynamics of Quasiparticles and Critical Fields in Superconducting Films.

Stephen Trentalange *(Physics)* B.S., Rensselaer Polytechnic Institute 1976.
Thesis: Carbon Isotope Fusion.

Jeffrey Eugene Ungar *(Applied Physics)* B.A., Yeshiva University 1978.
Thesis: Double Charge Exchange of Pions on Helium-4.

John Reinhold Valainis *(Physics)* B.S., Butler University 1973; M.S., California Institute of Technology 1975.
Thesis: Second Order Corrections to the Variational Approximation to Frolich's Polaron Model.

Roy David Williams *(Physics)* B.A., Cambridge University 1979.
Thesis: Semiclassical Quantization in Many Dimensions.

Barton Zwiebach *(Physics)* Ingeniero, Universidad Nacional de Ingeniería 1977; M.S., California Institute of Technology 1978.
Thesis: Use of Superspace Geometry to Find All Supergravity Theories: Case of $N=4$ and $SO(4)$ Symmetry.

Daniel Ian Zwillinger *(Applied Mathematics)* S.B., Massachusetts Institute of Technology 1978.
Thesis: Long Distance Energy Correlations in Random Media.

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.

THE MILTON AND FRANCIS CLAUSER DOCTORAL PRIZE

Awarded to the Ph.D. candidate whose research is judged to exhibit the greatest degree of originality as evidenced by its potential for opening up new avenues of human thought and endeavor as well as by the ingenuity with which it has been carried out.

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.

Vipul Periwal, senior; Mark R. Purtill, junior

CALTECH PRIZE SCHOLARSHIPS AND CARNATION SCHOLARSHIPS

Each year Caltech awards these prizes for academic excellence. They are based solely on merit (selection is made on the basis of grades, faculty recommendations, and demonstrated research productivity) with no consideration given to need or any other nonacademic criteria. Listed below are graduating seniors who have been recipients of these prizes.

David L. Adler
Jeffrey A. Aguilera
Loren I. Alving
Julie A. Anderson
Robert E. Betzig
Arthur P. Brazy
Armand J. Capote
William A. Chapman
R. Sekhar Chivukula
Kenneth S. Chow
John G. Favor
Lisa L. Flitz
Scott R. Johnson
Steven C. Knowles
Young S. Lee
David J. LePoire
Andrew H. Liu
Donald C. Lo
Maclen B. Marvit
Vladimir Matijasevic
Richard H. Miles
Gary C. Mockli
Roman Movshovich
Glenn E. Nakamura
Richard W. Pogge
Zinovy B. Reichstein
Beverley A. Robertson
Gregory K. Schenter
Russell B. Schweickart
Aditya Srinivasan
Arthur C. Thompson
John S. Wang

THE W. P. CAREY & CO., INC. PRIZE IN APPLIED MATHEMATICS

Awarded to the student receiving a Doctor of Philosophy degree for an outstanding doctoral dissertation in applied mathematics.

Luis Guillermo M. Reyna

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.

1983 Richard E. Honrath, Jr., junior;
Donald Laurence Meixner, junior

*1982 Russell B. Schweickart**

HAREN LEE FISHER MEMORIAL AWARD IN JUNIOR PHYSICS

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

1983 Kenneth Hui

*1982 Arthur C. Thompson**

HENRY FORD II SCHOLAR AWARD

Awarded either to the engineering student with the best academic record at the end of the third year of undergraduate study, or to the engineering student with the best first-year record in the graduate program.

1983 Avideh Zakhor, senior

*1982 Kenneth Ting-Yuan Kung**

JACK E. FROEHLICH MEMORIAL AWARD

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

1983 Ned S. Wingreen

1982 Kenneth Shun-Kei Chow, Roman Movshovich**

**The names of students who have received prizes or awards in previous years, but who are graduating in 1983, are also listed.*

GEORGE W. GREEN MEMORIAL PRIZE

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

1983 Ming-Chung Chu, senior; Arthur C. Thompson, senior

*1982 David J. LePoire**

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.

1983 Candice McCoy, junior; Eliza L. Sutton, junior

*1982 Julia A. Kornfield**

INSTITUTE FOR THE ADVANCEMENT OF ENGINEERING AWARD

Awarded to a student who exhibits a professional attitude toward engineering by a leadership role in the student chapter of a professional organization, such as the IEEE, ASCE, ASME.

Beverley A. Robertson, senior

DAVID JOSEPH MACPHERSON PRIZE IN ENGINEERING

Awarded to the graduating senior in engineering who best exemplifies excellence in scholarship.

John G. Favor

MARY A. EARL McKINNEY PRIZE IN LITERATURE

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

Glen D. Crawford, sophomore; Dean K. Shibata, senior

ROBERT L. NOLAND LEADERSHIP SCHOLARSHIP

Awarded to students who exhibit qualities of outstanding leadership, which is most often expressed as personal actions that have helped other people and that have inspired others to fulfill their capabilities.

1983 Arthur P. Brazy, senior; Richard H. Miles, senior

*1982 R. Sekhar Chivukula**

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.

Kenneth S. Chow

THE ERNEST E. SECHLER MEMORIAL AWARD IN AERONAUTICS

Awarded to an aeronautics student who has made the most significant contribution to the teaching and research efforts of GALCIT (Graduate Aeronautical Laboratories of the California Institute of Technology). Preference is given to students working in structural mechanics.

Thomas Roesgen

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.

1983 Barbara J. Turpin, junior; Sven Andreas Wolf, sophomore; Frederic Y. Wong, sophomore

1982 Paul K. Kienker, Sandra T. Loh**

*1981 Avideh Zakhor**

SIGMA XI AWARD

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

Kent Franklin Evans, Donald C. Lo

THE MORGAN WARD PRIZE

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

1983 Tad P. White, sophomore

*1980 Scott Michael**