



Eightieth
Annual Commencement
June 14, 1974

CALIFORNIA INSTITUTE OF TECHNOLOGY

Eightieth
Annual
Commencement

FRIDAY MORNING AT TEN-THIRTY O'CLOCK
JUNE FOURTEENTH, NINETEEN SEVENTY-FOUR

Academic Procession

Chief Marshal, William R. Cozart, Ph.D.

Assistant Marshals

Marshall Hall, Jr., Ph.D.

Jon Mathews, Ph.D.

Robert V. Langmuir, Ph.D.

Vito A. Vanoni, Ph.D.

MARCHING ORDER

CANDIDATES FOR THE DEGREE OF BACHELOR OF SCIENCE

CANDIDATES FOR THE DEGREE OF MASTER OF SCIENCE

CANDIDATES FOR THE DEGREE OF ENGINEER

CANDIDATES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

THE FACULTY

THE CHAIRMEN OF DIVISIONS

THE DEANS

THE PROVOST

THE TRUSTEES

THE COMMENCEMENT CHAPLAIN

THE PRESIDENT

THE CHAIRMAN OF THE BOARD OF TRUSTEES

Program

- PRESIDING R. Stanton Avery, LL.D.
Chairman of the Board of Trustees
- PRELUDE Caltech Convocation Brass and Percussion Choir
William Nicholls, M.M., Director
- Three pieces by Giovanni Gabrieli: 1) *Canzon Primi Toni.* 2) *Sonata pian'e forte.* 3) *Canzona per Sonare No. 1 "La Spiritata."*
- AN INTRODUCTION TO COMMENCEMENT
David C. Elliot, Ph.D.
Secretary of the Faculty
- PROCESSIONAL Leslie J. Deutsch, Class of 1976, Organ
and The Brass and Percussion Choir
- INVOCATION Rabbi Edgar F. Magnin, D.D.
Wilshire Boulevard Temple, Los Angeles
- COMMENCEMENT ADDRESS "Unscientific Evidence"
Richard P. Feynman, Ph.D., Nobel Laureate
Richard Chace Tolman Professor of Theoretical Physics, Caltech
- MUSICAL SELECTIONS The Caltech Glee Club
Olaf M. Frodsham, A.M., Director
- CONFERRING OF DEGREES Harold Brown, Ph.D., D. Eng., LL.D.
President, California Institute of Technology
- PRESENTATION OF CANDIDATES FOR DEGREES
- For the Degree of Bachelor of Science James J. Morgan, 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 Cornelius J. Pings, Ph.D.
Dean of Graduate Studies
- For the Degree of Doctor of Philosophy Dean Pings
- Biology Robert L. Sinsheimer, Ph.D.
Division Chairman
- Chemistry and Chemical Engineering. John D. Baldeschwieler, Ph.D.
Division Chairman
- Engineering and Applied Science Francis H. Clauser, Ph.D.
Division Chairman
- Geological and Planetary Sciences Bruce Murray, Ph.D.
Professor of Planetary Science
- Physics, Mathematics and Astronomy Jon Mathews, Ph.D.
Executive Officer for Physics
- CONCLUDING REMARKS President Brown
- BENEDICTION Rabbi Magnin
- RECESSIONAL The Brass and Percussion Choir and Organ

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 doctor's degrees respectively. The colors associated with some of the subjects are as follows:

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

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.

About the Music

GIOVANNI GABRIELI (c. 1557-1612)

Canzon Primi Toni appeared in the *Sacrae Symphoniae*, a collection of some forty ecclesiastical compositions for voice and/or instruments, published in Venice in 1597. "Primi Toni" refers to the first, or Dorian, church mode; the Italian instrumental canzona was based on the earlier Flemish or French *chanson*. Written for two separate choirs (*cori spezzati*; Gabrieli wrote for as many as five spatially separated vocal or instrumental choirs and organs in St. Mark's), *Primi Toni* offers a glimpse of baroque elaboration and ornamentation in the long trumpet themes. *Sonata pian'e forte*, also from *Sacrae Symphoniae*, is an instrumental Venetian motet for a high and low choir; it illustrates the typical modal polyphony—dissonance followed by resolution. *Pian'e forte* is historically significant: it is the first piece in which the composer specified the instrumentation—one choir consisting of a cornetto and three trombones, the other a viola and three trombones; it is also the first time dynamics were specified—hence the name. In 1608 Alessandro Raverij published *Canzoni per sonare con ogni sorte di stromenti*, containing 36 canzonas by a dozen Italian composers. Of the six by Gabrieli, *La Spiritata* is considered the most interesting and innovative of its time. It was probably composed long before the publication date, perhaps in the late 1580's. It is written for four instrumental voices: *canto*, *alto*, *tenore* and *basso*, and features quickly repeating themes; in this arrangement, the organ is added in the 3/2 section for contrast.

THE CALTECH CONVOCATION BRASS AND PERCUSSION CHOIR is composed of members of the Caltech Wind Ensemble and the Caltech staff, plus members of the San Marino Dads' Band. The Processional features compositions by Melchior Franck, Jeremiah Clarke, Henry Purcell, Dietrich Buxtehude, Aurelio Bonelli, and Edward Elgar. The Recessional pieces are by Sergei Prokofieff and Louis Lewandowski.

GLEE CLUB SELECTIONS

- 1) *Hodie Apparuit*Orlando di Lasso
- 2) *Miserere Mei*Antonio Lotti
- 3) *Behold Man*Ron Nelson

Candidates for Degrees

BACHELOR OF SCIENCE

- John Steele Abbott III** *Bow Mar, Colorado* Mathematics
Ervin Adler *Los Angeles, California* Engineering and Applied Science
Lisa Michelle Anderson *Manhattan Beach, California* Independent Studies Program
Phyllis Jean Anwyl *Huntington Beach, California* Biology
Phillip John Arnold *Downey, California* Engineering and Applied Science
Ronald Frederick Ayres *Los Angeles, California* Mathematics
Richard Louis Baker *Thousand Oaks, California* Engineering and Applied Science
James Francis Battey, Jr. *Los Altos, California* Independent Studies Program
Peter Wayne Beckman *Stockton, California* Economics
Thomas W. Bell *San Gabriel, California* Chemistry
Trudy Lynn Bergen *Valencia, California* Mathematics
Neil Scott Berkey *Cincinnati, Ohio* Geology
Stephen A. Bitondo *Lakeside, California* Chemistry
Kim Christian Border *Sunnymead, California* Economics
Dale Eric Bredesen *Fort Lauderdale, Florida* Biology-English
Robert Bernard Bresler *South San Francisco, California* Engineering and Applied Science
Robert Bruce Brewington *Seabrook, Texas* Chemistry
Gregory K. Brock *Chehalis, Washington* Chemistry
Clifford Lawrence Brown *Skokie, Illinois* Chemical Engineering
Mark Adrian Bruni *Salinas, California* Applied Mathematics
Leslie M. Brusseau *Phoenix, Arizona* Engineering and Applied Science
John Alden Reimer Caldwell Astronomy
John Patrick Cannady *Lakewood, California* Chemistry
Joseph A. Carlsen Biology
Donald R. Carrigan *Garland, Texas* Biology
Valerian Anthony Catanzarite *Rancho Palos Verdes, California*
Independent Studies Program
Robert Joseph Chansler, Jr. *San Jose, California* Mathematics
Wai Kong Cheng *Hong Kong* Engineering and Applied Science
Ying-Chee Chung *Hong Kong* Engineering and Applied Science-Biology
Barry Arthur Cipra *Overland Park, Kansas* Independent Studies Program
William Edward Clevenger *Rocky Ford, Colorado* Chemical Engineering
Andrew Fort Cockburn *Cave Creek, Arizona* Biology
Richard Erie Cofield IV *Livermore, California* Applied Physics
Robert Moorhouse Coleman, Jr. *Nisqually, Washington* Engineering and Applied Science
Mark Wayne Coles *Yorba Linda, California* Physics
Alan James Coltri *Granada Hills, California* Engineering and Applied Science

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

BACHELOR OF SCIENCE—Continued

- Dennis B. Creamer** *Tulsa, Oklahoma* Physics
Kirby Grant Dahman *Glendale, Missouri* Mathematics
Dale Brian Dalrymple *Toledo, Ohio* Engineering and Applied Science
Debra Valorie Dison *San Jose, California* Biology
Jay D. Doty *Brewster, Washington* Engineering and Applied Science
Andrew Philip Dowsett *Pacifica, California* Independent Studies Program
David Anderson Drake *Ridgewood, New Jersey* Engineering and Applied Science
Robert William Durst *Salem, Oregon* Chemistry
Charles William Eason *Redmond, Oregon* Chemical Engineering
Karen Sue Eaton *Salina, Kansas* Biology
Mary E. Eichbauer *Floral Park, New York* English
Mark W. Eltgroth *Tujunga, California* Physics
Keith Alan Ex *Sarasota, Florida* Engineering and Applied Science
Tom G. Farr *Hawthorne, California* Geology
Louis D. Fielder *Atherton, California* Engineering and Applied Science
Robert Burns Fisher III *Stockton, California* Mathematics
Gary Alan Frankel *Waco, Texas* Biology
Donald Gibson Franks *Little Rock, Arkansas* Mathematics
Howard Bradley French *Plainview, New York* Astronomy
René Charles Gandolfi *Bayside, New York* Biology
John Marland Garth *Poway, California* Applied Physics
Gene Robert Gindi *New Orleans, Louisiana* Applied Physics
David Langdon Glackin *St. Petersburg Beach, Florida* Astronomy
Christopher Allan Goldstein *Los Angeles, California* Mathematics
Mark Andrew Grunwald *St. Louis, Missouri* Biology
Eric Keith Gustafson *Sacramento, California* Physics
Bruce Scott Hantover *Engineering and Applied Science*
Christina Anne-Marie Harrington *Los Angeles, California* Biology
Jeffrey John Harrow *Houston, Texas* Engineering and Applied Science
Edward Monroe Hedgecock *Pasadena, California* Biology
John G. Helm, Jr. *New Orleans, Louisiana* Applied Physics
Thomas Herman *Torrance, California* Engineering and Applied Science
David Da-i Ho *Los Angeles, California* Biology
Frank Worden Hobbs, Jr. *Salinas, California* Chemistry
Erik Royal Horsley *La Canada, California* Engineering and Applied Science
Ron L. Hospelhorn *Glendale, Arizona* Physics
Joyce Shih-chiao Hsiao *Silver Spring, Maryland* Chemistry
James William Hugg, Jr. *Oklahoma City, Oklahoma* Physics-Social Science
Glenn Reginald Ierley *Florham Park, New Jersey* Applied Physics
Carl Frank Imparato *Stanton, California* Engineering and Applied Science
Bryan Creed Jack *Tyler, Texas* Economics
Patrick Henry Jenkins *Arlington Heights, Illinois* Chemical Engineering
John Hallock Jerman *Malibu, California* Applied Physics
Gregory Allan Jirak *Yuma, Arizona* Mathematics
Mark Richard Johnson *Potomac, Maryland* Mathematics
Nelson Daniell Johnson *Corona del Mar, California* Biology
Keith Richard Karasek *Villa Park, Illinois* Physics

BACHELOR OF SCIENCE—Continued

- John Karl Kastner *Fresno, California* Engineering and Applied Science
David Louis Kazan *Mathematics-Biology*
Ioannis Nicolaos Kessides *Prohoma, Thessaloniki, Greece* Physics
Robert Mariner Kieckhefer *Barrington, Illinois* Geophysics
Alan Willis Kleinsasser *Azusa, California* Applied Physics
Casimir C. Klimasauskas *Altadena, California* Mathematics
Hon Hong Kwai *Hong Kong* Mathematics
Betty Puifun Kwan *Los Angeles, California* Physics
David Jeffrey Larwood *Bakersfield, California* Chemistry
Kar-Shing Simon Lee *Hong Kong* Engineering and Applied Science
James Robert Leger *San Diego, California* Applied Physics
John Lehmann *Kitchener, Ontario, Canada* Biology
Raymond H. Lem *Torrance, California* Mathematics-Chemistry
Lawrence Stuart Lichtmann *Sepulveda, California* Physics-English
Anita Crafts Lighty *Fullerton, California* Biology
Gloria Won Liu *Longview, Washington* Engineering and Applied Science
Baruch Livneh *Kibbutz Hatzor, Israel* Engineering and Applied Science
Kevin Kwok-Kam Lo *Hong Kong* Engineering and Applied Science
James Matthew Loddengaard *Kabul, Afghanistan* Biology
Thanh Luu *Saigon, South Vietnam* Engineering and Applied Science
Richard Francis Lyon *El Paso, Texas* Engineering and Applied Science
Rhonda Lynne MacDonald *New Bedford, Massachusetts* Engineering and Applied Science
Daniel George Marks *South Gate, California* Mathematics
Michael John Mariani *San Jose, California* Biology
Richard B. Martin *Shawnee Mission, Kansas* Engineering and Applied Science
Steven Allen Matthews *Carmichael, California* Mathematics
Patrick John McCrea *San Leandro, California* Physics
Douglas Boyden McElroy *Palos Verdes Peninsula, California* Astronomy
John Thomas Meador *Oklahoma City, Oklahoma* Engineering and Applied Science
Donald Lee Miller *Key Biscayne, Florida* Biology
Kenneth Alan Mills *Chemistry-History*
William Richard Molzon *Vineland, New Jersey* Physics
Bruce Gilbert Montgomery *Minnetonka, Minnesota* Engineering and Applied Science
Steven Ray Moosman *Walla Walla, Washington* Chemical Engineering
John Adrian Morgan *Downey, California* Physics
John Lewis Morton, Jr. *Palo Alto, California* Engineering and Applied Science
Marion Louise Movius *Porterville, California* Mathematics
Robert Warren Murphree *Chemistry*
David L. Musgrave *Chemistry*
Stanley Kazuo Nakamoto *Los Angeles, California* Biology
Gregory Alan Nelson *Minnetonka, Minnesota* Chemistry-Biology
Mark James Nelson *Downey, California* Chemistry
Albert Tung-Yiu Ng *Hong Kong* Physics
Patrick Lee Nolan *Grass Valley, California* Physics
Carol Nottenburg *Biology*

BACHELOR OF SCIENCE—Continued

- John Robert Odden *Ann Arbor, Michigan* Mathematics
John Thomas O'Donnell *Lexington, Kentucky* Astronomy
Robert Bruce Olshan *Sepulveda, California* Geology
Daniel Packman *Los Angeles, California* Astronomy
David Balfour Peisner *Huntington Woods, Michigan* Engineering and Applied Science
Patrick Perkins *Redondo Beach, California* Chemistry
Darrell Lee Peterson *Chico, California* Physics
Gary Scott Peterson *Oklahoma City, Oklahoma* Chemistry
James Graham Peterson *Clarendon Hills, Illinois* Applied Physics
Robert Milton Pleva *Indianapolis, Indiana* Applied Physics
Edward Burner Pontius *Scottsdale, Arizona* Biology
Siu Joe Poon *Hong Kong* Engineering and Applied Science
Stephen R. Poon *Bacolod City, Philippines* Engineering and Applied Science
James William Posakony *Ventura, California* Biology
James Edward Price *Thousand Oaks, California* Engineering and Applied Science
Mark Keith Puryear *Denver, Colorado* Mathematics
Gary Alan Rabins *Monterey Park, California* Engineering and Applied Science
Ram Rao *Bangalore, India* Engineering and Applied Science
Celia Patricia Rivera-Zárate *Compton, California* English
D. Wilmer Rivers, Jr. *Alexandria, Virginia* Geophysics
Karen Verna Roberts *Claremont, California* Biology
Haywood James Robinson *Los Angeles, California* Biology
Charles Joseph Romeo, Jr. *Augusta, Georgia* Biology
Thomas Peter St. John *Honolulu, Hawaii* Biology
Laurie Ann Schalit *Chatsworth, California* English
Louis Kossuth Scheffer *Rochester, New York* Engineering and Applied Science
Stephen Richard Schnetzer *Lawrenceburg, Indiana* Physics
Michael Edward Schroeder *Claremont, California* Physics
Robert Alan Scranton *Huntington, New York* Applied Physics
Mei-Ling Shek *Hong Kong* Chemistry
Virgil Bernard Shields *Carson, California* Physics
Jacqueline Siegel *Detroit, Michigan* Biology
Frederick John Sigworth *Orinda, California* Applied Physics
Vanessa Roberta Skedzeleski *Bartlesville, Oklahoma* Biology
John Carl Smith *Brewster, New York* Geophysics
Hon Hing So *Hong Kong* Engineering and Applied Science
Bruce Calvin Spalding *Seattle, Washington* Chemistry
Robert Wendell Standley *Lake Forest, Illinois* Physics
Douglas Anthony Stauber *Redding, California* Geology
Paul Joseph Steinhardt *Coral Gables, Florida* Physics
Richard Leroy Stephens *Hanley Hills, Missouri* Chemistry
Gregory P. Stone *Glennville, California* Chemical Engineering
Kenneth Sanders Suslick *Glencoe, Illinois* Chemistry
Edmund Charles Sutton *Baltimore, Maryland* Physics
Paul Arthur Thomas *Miami, Florida* Biology
W. Scott Thompson *Scottsdale, Arizona* Biology

BACHELOR OF SCIENCE—Continued

- Patricia Ellen Tressel *Los Angeles, California* Physics
William Douglas Trotter *Bainbridge Island, Washington* Biology
Sheila Marie Young *Rancho Palos Verdes, California* Mathematics
James Charles Vibber *Monterey Park, California* Biology
Lee Weigle Vibber *Downey, California* English
Janet Christine Wainwright *Anaheim, California* Biology
Kenneth Lee Walker *Lakewood, Colorado* Chemical Engineering
Frederick Abbott Ware *Omaha, Nebraska* Applied Physics
Steven James Warling *Canoga Park, California* Engineering and Applied Science
Thomas Van Weaver *New Orleans, Louisiana* Mathematics
Richard Evan Weinberger *Shorewood, Wisconsin* English
David Charles Wellman *Olympia, Washington* Independent Studies Program
Robert Dean Wieting *Downey, California* Chemistry
Frederick Douglas Williams, Jr. *Los Angeles, California* Economics
Alexander Jonathan Wilson *Kansas City, Missouri* Mathematics-Engineering and Applied Science
Michael U. Wimbrow *Chappaqua, New York* Engineering and Applied Science
Durwin Wright *Compton, California* Engineering and Applied Science
Brian Stuart Yandell *Orinda, California* Mathematics
Thomas Wai Yee *Gardena, California* Biology
Michael Franz Yoder *Albuquerque, New Mexico* Mathematics
John Gregory Zima *Phoenix, Arizona* Physics

MASTER OF SCIENCE

- Pinchas Agmon (*Applied Physics*) B.Sc., Hebrew University 1972; M.Sc. 1974.
- Christopher Scott Amenson (*Biology*) B.S., Michigan State University 1971.
- James Harold Atherton (*Electrical Engineering*) B.S., University of Illinois 1972.
- Edward Lawrence Avol (*Environmental Engineering Science*) B.A., University of California, San Diego 1973.
- Gene Allan Aydinian (*Geochemistry*) B.S., University of Notre Dame 1972.
- Robert William Bachtel (*Chemical Engineering*) B.S., Syracuse University 1973.
- Timothy Miller Benjamin (*Geology*) B.S., University of California, Davis 1973.
- Meletios Spyridon Berdelis (*Aeronautics*) B.S., California Polytechnic State University, San Luis Obispo 1973.
- Larry Arthur Bergman (*Electrical Engineering*) B.S., California Polytechnic State University, San Luis Obispo 1973.
- Scott Brande (*Geology*) B.S., University of Rochester 1972.
- Robert Edward Breidenthal, Jr. (*Aeronautics*) B.S., Wichita State University 1973.
- Jean-Michel Paul Caillat (*Civil Engineering*) Baccalaureat, Lycee Enghien 1967; Engineer, Ecole Nationale Superieure d'Hydraulique 1973.
- Jean-Yves Chevalier (*Mechanical Engineering*) Diplome d'Ingenieur, Ecole Nationale Superieure des Arts et Metiers 1970.
- John Joseph Cipar (*Geophysics*) B.S., State University of New York, Binghamton 1970; M.A. 1972.
- Wayne Dale Collins, Jr. (*Social Science*) B.S., California Institute of Technology 1973.
- Robert Everett Criss (*Geology*) B.S., Case Western Reserve University 1973.
- Walter Kamiel DeLogi (*Electrical Engineering*) Electrical Engineer, Ryksuniversiteit Gent 1973.
- Anthony R. Dobrovolskis (*Planetary Science*) B.S., Illinois Institute of Technology 1973.
- Albert Elhadef (*Aeronautics*) B.Sc., Northwestern University 1973.
- Gertrude Hill Fila (*Aeronautics*) B.S., Oklahoma A & M College 1940.
- Charles Aubrey Foley (*Electrical Engineering*) B.S., University of Maryland 1972.
- James Albert Fontana (*Mathematics*) B.S., Emory University 1970.
- William Paul Fornaciari, Jr. (*Applied Physics*) B.A., Wesleyan University 1970; S.M., University of Chicago 1971.
- David Lee Fox (*Physics*) B.A., University of Colorado 1972.
- George Fox (*Applied Physics*) B.S., California Institute of Technology 1969; M.A., University of California, Los Angeles 1971.
- Gregory Gartrell, Jr. (*Environmental Engineering Science*) B.S., California Institute of Technology 1973.
- John Charles Gord (*Electrical Engineering*) B.S., California Institute of Technology 1973.
- Lawrence Jerome Grubka (*Mechanical Engineering*) B.S., Michigan State University 1972.
- Stanton Francis Gunderson (*Mechanical Engineering*) B.S., California Polytechnic State University, Pomona 1972.

MASTER OF SCIENCE—Continued

- Ernest Dwight Gustafson, Jr. (*Geophysics and Geology*) B.S., University of Minnesota 1972.
- Jeffrey John Hamilton (*Applied Physics*) B.S., Cornell University 1973.
- John Richard Harland (*Environmental Engineering Science*) B.Sc., Edinburgh University 1972.
- Jerry Michael Harris (*Electrical Engineering*) B.S., University of Mississippi 1973.
- Joel Norval Harrison (*Mechanical Engineering*) B.S., California Polytechnic State University, Pomona 1973.
- Eddy Walter Hartenstein (*Applied Mechanics*) B.S., California Polytechnic State University, Pomona 1972.
- Philip David Hattis (*Aeronautics*) B.S., Northwestern University 1973.
- James William Hugg, Jr. (*Physics*) B.S., California Institute of Technology 1974.
- John Neal Hurley (*Chemistry*) B.A., Williams College 1972.
- David Li-Shui Quek Hwang (*Electrical Engineering*) B.S., Rensselaer Polytechnic Institute 1973.
- Robert Murray Jaffe (*Electrical Engineering*) B.S., University of California, Berkeley 1972.
- Robert Edward Johnson (*Engineering Science*) B.S., State University of New York, Buffalo 1973.
- Terrell Harvey Johnson (*Physics*) B.S., Purdue University 1970.
- Kenneth Lee Jones (*Electrical Engineering*) B.S., Oklahoma State University 1972.
- Harold Jeffrey Katz (*Physics*) A.B., Harvard College 1973.
- James Charles Kaufeld, Jr. (*Electrical Engineering*) B.S., Michigan State University 1973.
- David Alan King (*Geology*) B.S., Wisconsin State University, River Falls 1972.
- Peter James Knox (*Chemical Engineering*) B.S., California State University, Long Beach 1973.
- Keith Koenig (*Aeronautics*) B.S., Mississippi State University 1973.
- Randall Lynn Kubena (*Applied Physics*) B.S., California Institute of Technology 1973.
- Sudarshan Kumar (*Chemical Engineering*) B. Tech., Indian Institute of Technology 1972.
- Daniel Fung Lam (*Physics*) B.S., University of Maryland 1972.
- Ignatius Po-Cheung Lam (*Civil Engineering*) B.S., Ohio State University 1973.
- Charles Adam Langston (*Geophysics*) B.S., Case Western Reserve University 1972.
- James Laurens Latimer (*Electrical Engineering*) B.S., Rice University 1973.
- Philippe Lebrun (*Materials Science*) Baccalaureat, Lycee Champollion 1968; Engineer, Ecole des Mines de Paris 1973.
- Jacques Bernard Lechat (*Chemical Engineering*) B.S. (Chem) University of Paris 1969; B.S. (Chem. Eng.) 1972.
- Vincent Wo-Sang Lee (*Mathematics*) B.S., California Institute of Technology 1973.
- David Yee-Chan Leung (*Engineering Science*) B.S., University of California, Davis 1973.

MASTER OF SCIENCE—Continued

- Kenneth MacDougall Liechti (*Aeronautics*) B.Sc., University of Glasgow 1973.
- Kevin Kwok-Kam Lo (*Applied Mechanics*) B.S., California Institute of Technology 1974.
- Kiran Ramanlal Magiawala (*Aeronautics*) B.E., Gujarat University 1971; M. Tech., Indian Institute of Technology 1973.
- Steven John Margaretic (*Applied Physics*) B.A., Occidental College 1973; B.S., California Institute of Technology 1973.
- Alain Andre Paul Martin (*Environmental Engineering Science*) Baccalaureat, College St. Joseph 1967; Certificat, Universite de Lille 1968; Diplome Ingenieur, Ecole Polytechnique Federale 1973.
- Rodney Tak Masumoto (*Electrical Engineering*) B.S., California Institute of Technology 1972.
- Douglas Colbourne Mason (*Chemistry*) B.S., California Institute of Technology 1970.
- Edward McGaffigan, Jr. (*Physics*) A.B., Harvard College 1970.
- William Francis Michael, Jr. (*Electrical Engineering*) B.S., Northeastern University 1973.
- Alan Rolf Mickelson (*Electrical Engineering*) B.S., University of Texas 1973.
- Subir Kumar Mitra (*Physics*) B.S., St. Xavier's College, Calcutta 1969; M.S. 1972.
- Lawrence Henry Mohr (*Chemistry*) B.S., University of California, Berkeley 1967.
- Galina Dmitriyevna Moller (*Biology*) M.S., University of Moscow 1968.
- Wesley Elwood Munsil (*Engineering Science*) B.S., California Institute of Technology 1971.
- Willie Wing Lau Ng (*Electrical Engineering*) B.S., Case Western Reserve University 1973.
- Roy Edward Nicholas, Jr. (*Applied Physics*) B.A., Houston Baptist College 1973.
- Johnson Olufemi Olowolafe (*Applied Physics*) B.Sc., University of Ife 1971.
- Eduardo Horacio Orces (*Mechanical Engineering*) B.S., California Institute of Technology 1973.
- Daniel B. Pearson III (*Geochemistry*) B.A., Rice University 1971; M.S. 1972.
- David Mort Pepper (*Applied Physics*) B.S., University of California, Los Angeles 1971.
- Gordon Andrew Petersen (*Mechanical Engineering*) B.S., California Institute of Technology 1973.
- Judy Hope Pollack (*Physics*) B.S., Miami University 1972.
- David Pollard (*Aeronautics*) B.A., Cambridge University 1973.
- Charles Robert Quick, Jr. (*Electrical Engineering*) B.S., University of Houston 1973.
- Gregory Joseph Rose (*Aeronautics*) B.S., United States Naval Academy 1973.
- Ernest Edward Ross (*Mechanical Engineering*) B.S., California Polytechnic State University, Pomona 1972.
- Sedigheh Salim (*Chemical Engineering*) B.S., Brigham Young University 1973.
- Eric William Schmidt (*Environmental Engineering Science*) B.S., University of Michigan 1973.

MASTER OF SCIENCE—Continued

- David Sheby (*Engineering Science*) B.S., Pratt Institute 1972.
Vinod Shekher (*Aeronautics*) B. Tech., Indian Institute of Technology 1970.
Stephen Avery Slutz (*Physics*) B.S., Rensselaer Polytechnic Institute 1972.
David Andrew Smith (*Engineering Science*) B.S., California Institute of Technology 1972.
Robert Schafer Smith (*Environmental Engineering Science*) B.S., Michigan State University 1973.
Polihronis-Thomas Dimitrios Spanos (*Civil Engineering*) Diploma, National Technical University, Athens 1973.
Samuel Howard Stalberg (*Environmental Engineering Science*) B.S., Columbia University 1973.
James Michael Stana (*Mechanical Engineering*) B.S., University of Pittsburgh 1973.
Arlan Duane Steinolfson (*Aeronautics*) B.S., North Dakota State University 1973.
Pieter Wilhelm Stoker (*Mechanical Engineering*) B.Sc., University of Pretoria 1972.
Gregory Paul Stone (*Chemical Engineering*) B.S., California Institute of Technology 1974.
Donald John Sullivan (*Planetary Science*) B.S., Manhattan College 1972.
Dean Dalton Taylor (*Mechanical Engineering*) B.A., University of Utah 1972; B.S. 1973.
Kee-Hau Tsang (*Environmental Engineering Science*) B.S., California Institute of Technology 1973.
Kenneth Charles Underwood (*Mathematics*) B.S., Furman University 1972.
Charl Christo Veldman (*Mechanical Engineering*) B.Sc., University of Pretoria 1972.
Pamela E. Wiedenbeck (*Planetary Science*) B.S., University of Michigan 1971.
Rick Alan Williams (*Engineering Science*) B.S., Northwestern University 1972.
Kenneth James Winston (*Mathematics*) B.S., California Institute of Technology 1973.
Jack Leroy Wise (*Aeronautics*) B.S., University of Michigan 1973.
Vincent Sydney Wong (*Electrical Engineering*) B.S., Texas A & M University 1973.
Alfred Po-hung Wu (*Geophysics*) B.S., Colorado School of Mines 1972.
Michael Franz Yoder (*Mathematics*) B.S., California Institute of Technology 1974.
Yanis Christos Yortsos (*Chemical Engineering*) Diploma, University of Athens 1973.

ENGINEER

- Hendrik Willem Marie Hoeijmakers (*Aeronautical Engineer*) M.S., Technological University of Delft 1971.
Hilary Max Irvine (*Civil Engineer*) B.E., University of Canterbury 1970; M.E. 1971.
Frank Kendall III (*Aeronautical Engineer*) B.S., U.S. Military Academy 1971; M.S., California Institute of Technology 1972.
Laurent Bernard Sidor (*Aeronautical Engineer*) B.E.S., Johns Hopkins University 1969; M.S., California Institute of Technology 1970.

DOCTOR OF PHILOSOPHY

DIVISION OF BIOLOGY

- Charles Ray Birdwell (*Biochemistry*) B.S., University of Chicago 1969.
Thesis: Studies on the Infection of Animal Cells with Sindbis Virus: Adsorption, Cell Surface Modification, and Maturation.
- Ming Ta Chong (*Biochemistry*) M.B., Medical College of National Taiwan University 1968.
Thesis: Investigation of Chromatin Bound Enzymes.
- Tommy Charles Douglas (*Immunology*) A.B., Princeton University 1969; M.S., California Institute of Technology 1970.
Thesis: The Theta Antigen of Mice and Its Analog in Rats.
- William Jack Driskell (*Biology*) B.S., University of Georgia 1967; M.S., California Institute of Technology 1968.
Thesis: The Role of Tyrosine in the Sclerotization and Tanning of the Puparium of *Drosophila Melanogaster*.
- John Edward Geltosky (*Biology*) B.S., Memphis State University 1967.
Thesis: Studies on Some of the Enzymes Involved in the Synthesis and Use of Tyrosine in *Drosophila*.
- Lily Kung-Chung Yeh Jan (*Biophysics and Physics*) B.S., National Taiwan University 1968; M.S., California Institute of Technology 1970.
Thesis: Investigations on Rhodopsin and Bacteriorhodopsin. I. Ultrastructural Localization of Rhodopsin in Vertebrate Retina. II. The Isomeric Configuration of the Bacteriorhodopsin Chromophore.
- Susan Leah Melvin (*Immunology and Cell Biology*) B.A., State University of New York, Buffalo 1968.
Thesis: Studies in Cellular Immunology.
- Ronald Leo Meyer (*Biology*) B.A., Don Bosco College 1967.
Thesis: Factors Affecting Regeneration of the Retinotectal Projection.
- William Ignatius Murphy III (*Biochemistry and Chemistry*) B.S., Fordham University 1967.
Thesis: Studies on the Mechanism and Products of Transcription of the Nuclear Genome in Animal Cells.
- Jeffrey Lewis Ram (*Biochemistry and Neurophysiology*) A.B., University of Pennsylvania 1967; M.S., California Institute of Technology 1971.
Thesis: Effects of High K^+ Media on Leucine Incorporation into *Aplysia* Nervous Tissue.
- Daniel Tawil Simmons (*Biochemistry*) B.S., Colorado College 1969.
Thesis: The Function and Replication of Sindbis Virus-Specific RNA's in Infected Cells.
- Jessica Tuchman (*Biochemistry*) B.A., Radcliffe College 1967.
Thesis: The Developmental Role of Membrane in the Cellular Slime Mold, *Dictyostelium Discoideum*.
- Anthony Joseph Zucarelli (*Biophysics and Genetics*) B.S., Cornell University 1966; M.S., Loma Linda University 1968.
Thesis: Formation of Parental Replicative Forms of $\phi X174$: Synthesis of the First Complementary Strand.

DOCTOR OF PHILOSOPHY—*Continued*

DIVISION OF CHEMISTRY AND CHEMICAL ENGINEERING

- Karl Ammon Bell (*Chemical Engineering and Environmental Engineering Science*) B.S., Lehigh University 1969; M.S., California Institute of Technology 1970.
Thesis: Aerosol Deposition in Models of a Human Lung Bifurcation.
- Theodore I. Benzer (*Chemistry and Biology*) B.A., Brandeis University 1970.
Thesis: Investigations on the Tetrodotoxin Binding Component from Electrically Excitable Tissue.
- Frank Wilhelm Bobrowicz (*Chemistry*) B.S., Seton Hall University 1969.
Thesis: 1. Generalized Valence-Bond Description for Formation of the Low-Lying States of CH, 2. The GVB TWO SCF Program, 3. Evaluation of Spin-Eigenfunction Configuration Interaction Matrices, 4. The Strongly Orthogonal Generalized Valence-Bond Wavefunction.
- Wen Hsiung Chen (*Chemical Engineering*) B.S., Tunghai University 1963; M.S., Illinois Institute of Technology 1968.
Thesis: Estimation of Parameters in Partial Differential Equations, with Applications to Petroleum Reservoir Description.
- Thomas Carl Clarke (*Chemistry*) B.A., Rice University 1969.
Thesis: I. Investigations on the Mechanism of Thermal Decomposition of α -Pyrazolines. II. The Stereochemistry of Solvolytic Displacement and Intramolecular Nucleophilic Substitution by a Double Bond at a Vinyl Center.
- Charles Dane Cowman, Jr. (*Chemistry*) B.S., Case Western Reserve University 1969.
Thesis: An Investigation of the Electronic Structures of Transition Metal Complexes by Single Crystal Polarized Spectroscopy.
- Robert Gouldman Eagar, Jr. (*Chemistry*) B.S., Virginia Polytechnic Institute 1969.
Thesis: I. Mechanism of Action of Coenzyme B₁₂. Hydrogen Transfer in the Isomerization of β -Methylaspartate to Glutamate. II. Kinetic Studies of 3-Fluoro-1,2-propanediol, a New Substance for Dioldehydrase. III. Reaction of 5'-deoxyinosylcobalamin with Propanediol Dehydrase. IV. Adenosine Deaminase.
- James Bernard Ellern (*Chemistry and Economics*) B.S., University of Illinois 1962.
Thesis: I. Synthetic Studies on Vinylogous Amides and Related Compounds. II. Cobalt (II) Chloride Complexes of Tertiary Vinylogous Amides and Related Ligands.
- Gerald W. Feigenson (*Chemistry and French*) B.S., Rensselaer Polytechnic Institute 1968; M.S. 1969.
Thesis: Nuclear Magnetic Relaxation Studies of Lecithin Bilayers.
- Steven Neil Frank (*Chemistry*) B.S., Colorado State University 1969.
Thesis: Investigations of the Binding of Some Azido-, Isocyano-, and Isothiocyanatochromium (III) and Azidocobalt (III) Complexes with Heavy Metal Ions and Mercury Electrodes.
- Gregory Lynn Geoffroy (*Chemistry*) B.S., University of Louisville 1968.
Thesis: An Investigation of the Photochemical and Excited State Properties of Selected Second and Third Row Transition Metal Complexes.
- Frank John Grunthaner (*Chemistry*) B.S., King's College 1966.
Thesis: Electronic Structure, Surface Reactivity and Site Analysis of Transition Metal Complexes and Metalloporaturs by X-Ray Photoelectron Spectroscopy.

DOCTOR OF PHILOSOPHY—Continued

- Amitava Gupta (*Chemistry*) B.Sc., Institute of Science 1967; M.Sc., Indian Institute of Technology 1969.
Thesis: I. The Role of Exciplexes in Singlet and Triplet Quenching Processes. II. Cage Recombination of Radical Pairs from ABN and ACC. III. Magnetic Field Effects on Cis-Trans Isomerisations of Dienes.
- Robert Alan Holwerda (*Chemistry*) B.S., Stanford University 1969.
Thesis: Kinetic Studies of the Reduction of *Rhus vernicifera* Laccase.
- Ming-Ta Hsu (*Chemistry*) B.S., National Taiwan University 1966; M.S. 1968.
Thesis: I. Electron Microscope Heteroduplex Analysis of DNA Sequences in F-prime Factors. II. Electron Microscope Studies of λ and Mu Prophages. III. An Electron Microscope Study of Sindbis Virus RNA.
- Michael W. Hunkapiller (*Chemistry*) B.S., Oklahoma Baptist University 1970.
Thesis: Nuclear Magnetic Resonance Studies of the Catalytic Mechanism of Proteolytic Enzymes.
- Joseph Francis Karnicky (*Chemistry*) B.S., Villanova University 1965.
Thesis: Determination of the Argon Intermolecular Pair Potential from Distribution Functions Measured by X-Ray Diffraction from Fluid Argon.
- Conrad John Kowalski (*Chemistry*) S.B., Massachusetts Institute of Technology 1968; M.S., California Institute of Technology 1971.
Thesis: I. Efforts Directed Towards the Total Synthesis of \bar{d} , 1-Shionone. 2. Conversion of Estrone to Androst-4-en-3-one: A New Method for Activating the 9 and 10 Positions of Estrogenic Steroids for Substitution.
- Charles Anderson Langhoff (*Chemistry*) B.S., Tulane University 1969.
Thesis: A Generalized Theory of Radiationless Transitions.
- George Benjamin Levin (*Chemistry and Physics*) B.S., University of Michigan 1963; M.S., George Washington University 1968.
Thesis: The Generalized Valence Bond Description of the Pi Electron States of Conjugated Molecules.
- David Harris Live (*Chemistry*) B.A., University of Pennsylvania 1967.
Thesis: The Interaction of Cations with Cyclic Polyethers.
- Terrance Brian McMahon (*Chemistry*) B.Sc., University of Alberta 1969.
Thesis: Trapped Ion Cyclotron Resonance Studies of Ion Molecule Reactions.
- James Gregory Nourse (*Chemistry*) B.S., Columbia University 1969.
Thesis: I. Carbon-13 Nuclear Magnetic Resonance Spectroscopy of Erythromycin Derivatives. II. Algebraic Chemistry.
- Steven Diggs Reynolds (*Chemical Engineering*) B.S., University of California, Davis 1969.
Thesis: Mathematical Modeling of Photochemical Air Pollution.
- Robert Charles Rosenberg (*Chemistry*) B.A., Columbia University 1967.
Thesis: Spectral and Magnetic Studies of Metallocoarboxypeptidase A's.
- Guston Price Russ III (*Chemistry*) B.A., University of the South 1968.
Thesis: Neutron Stratigraphy in the Lunar Regolith.
- Charles Frederick Schmidt, Jr. (*Chemistry*) B.S., Rensselaer Polytechnic Institute 1967.
Thesis: Nuclear Spin-Lattice Relaxation Studies in Liquids.

DOCTOR OF PHILOSOPHY—*Continued*

- Albert Edward Schweizer, Jr. (*Chemistry*) B.S., West Chester State College 1964; M.S., Rutgers University 1968.
Thesis: Studies of Some Inorganic Reaction Mechanisms: Part I. The Isomerization of Metal Complexes in Solution. Part II. Reaction of Nitric Oxide with Cobalt Ammine Solutions. Part III. Kinetic Studies of Nitric Oxide Decomposition over a Cobalt Oxide Catalyst.
- Charles Harrington Seiter (*Chemistry*) B.A., University of California, San Diego 1969.
Thesis: Nuclear Magnetic Resonance Linewidth Studies of Model Membranes.
- Satish Chander Sharda (*Chemical Engineering*) B.S., Panjab University 1967; M.S., Montana State University 1968.
Thesis: I. A New Elastic Potential Function for Rubbers. II. Thermoelastic Behavior of Rubbers.
- James Stanley Sherfinski (*Chemistry*) B.A., University of Wisconsin 1969.
Thesis: A Structural Analysis of Three Arabinosylpyrimidines.
- Lois Elaine Hodgson Smith (*Chemistry*) B.Sc., University of British Columbia 1968.
Thesis: Studies on the Catalytic Mechanism of Lysozyme.
- Ronald Irving Trust (*Chemistry*) B.S., Drexel Institute of Technology 1969.
Thesis: Approaches to the Synthesis of D, L-Alnusene via Non-Enzymic, Biogenetic-Like Polyolefin Cyclizations.

DIVISION OF ENGINEERING AND APPLIED SCIENCE

- Robert Dilworth Blevins (*Applied Mechanics and Economics*) B.S., Carnegie-Mellon University 1970; M.S., California Institute of Technology 1971.
Thesis: Flow Induced Vibration of Bluff Structures.
- Norval Lagier Broome (*Electrical Engineering*) B.S., M.S., Purdue University 1966.
Thesis: Transient Radiation from Coaxial Waveguide and Cylindrical Monopole Antennas.
- Charles Brian Crouse (*Civil Engineering*) B.S., Case Institute of Technology 1968; M.S., California Institute of Technology 1969.
Thesis: Engineering Studies of the San Fernando Earthquake.
- Robert Alexander Dukelow (*Electrical Engineering*) B.S., California Institute of Technology 1969; M.S. 1970.
Thesis: An Experimental Investigation of Very Low Frequency Semiconductor Noise.
- Donnie Carlton Fletcher (*Engineering Science*) B.Sc., Massachusetts Institute of Technology 1965.
Thesis: The Conservation Laws of Linearized Elasticity Theory.
- Blair Allen Folsom (*Mechanical Engineering and Business Economics*) B.S., California State College, Long Beach 1967; M.S., California Institute of Technology 1968.
Thesis: I. Two Phase Flow in Vertical and Annular Fluidized Beds. II. Unsteady Disturbances in Axial Compressors.

DOCTOR OF PHILOSOPHY—Continued

- Jerry Howard Griffin (*Applied Mechanics*) B.S., M.S., University of South Florida 1969.
Thesis: Wave Front Analysis in the Scattering of a Plane Compressional Pulse by a Cylindrical Elastic Inclusion.
- Atul Jain (*Electrical Engineering*) B.S., California Institute of Technology 1969; M.S. 1970.
Thesis: A Wavelength Diversity Technique for Smoothing of Speckle.
- Doyle Dana Knight (*Aeronautics and Applied Mathematics*) B.A., Occidental College 1971; B.S., California Institute of Technology 1971; M.S. 1972.
Thesis: "An Analytical Investigation of Turbulent Flow Over a Wavy Boundary.
- Eriabu Lugujo (*Electrical Engineering*) B.Sc., Makarere University College 1969; M.S., California Institute of Technology 1971.
Thesis: I. Backscattering and Channeling Effect Studies on Semiconductor-Metal Systems; II. Low Temperature Migration of Silicon Through Metal Films.
- Montaz Nosshi Mansour (*Engineering Science*) B.Ae.E., Cairo University 1962; M.S., California Institute of Technology 1965.
Thesis: On the Inverse Problem in Electrocardiography.
- Horacio Augusto Méndez (*Electrical Engineering*) Ensign, Argentine Naval Academy 1953; M.S., California Institute of Technology 1964; Engineer, Stanford University 1969.
Thesis: Shielding Theory of Enclosures with Apertures.
- Thomas Lee Moeller (*Applied Mechanics and Engineering Science*) B.S., University of California, Los Angeles 1969; M.S., California Institute of Technology 1971.
Thesis: The Dynamics of a Spinning Elastic Disk with Massive Load.
- Edward Payson Myers (*Environmental Engineering Science*) B.S., Oregon State University 1965; M.S., California Institute of Technology 1969.
Thesis: The Concentration and Isotopic Composition of Carbon in Marine Sediments Affected by a Sewage Discharge.
- Richard Dana Pashley (*Electrical Engineering*) B.A., University of Colorado 1969; M.S., California Institute of Technology 1970.
Thesis: Electrical Properties of Ion Implanted Layers in Silicon and Gallium Arsenide.
- Lee Louis Peterson (*Environmental Engineering Science*) B.S., California Institute of Technology 1964; M.S. 1966.
Thesis: The Propagation of Sunlight and the Size Distribution of Suspended Particles in a Municipally Polluted Ocean Water.
- Andrea Prosperetti (*Engineering Science*) Laurea in Fisica, University of Milano 1968; M.S., California Institute of Technology 1972.
Thesis: Viscous and Nonlinear Effects in the Oscillations of Drops and Bubbles.
- Magdi Hanna Rizk (*Aeronautics and Applied Mathematics*) B.S., Columbia University 1969; M.S., California Institute of Technology 1970.
Thesis: Nonsteady Fluid Mechanics of Vehicles in Tubes.
- Sasson Roger Somekh (*Electrical Engineering*) B.S., University of Tel-Aviv 1969; M.S., California Institute of Technology 1970.
Thesis: Theory, Fabrication and Performance of Some Integrated Optical Devices.

DOCTOR OF PHILOSOPHY—*Continued*

Harold McDowell Stoll (*Electrical Engineering*) B.S., Stanford University 1968; M.S., California Institute of Technology 1969.

Thesis: Proton-Implanted Optical Waveguides and Integrated Optical Detectors in Gallium Arsenide.

Sachio Uehara (*Aeronautics*) B.S., University of Tokyo 1956; M.S., California Institute of Technology 1965.

Thesis: Theoretical Investigation of Minimum Time Loop Maneuvers of Jet Aircraft.

Christopher George Whipple (*Engineering Science*) B.S., Purdue University 1970; M.S., California Institute of Technology 1971.

Thesis: Extension of Rayleigh-Taylor Instability Theory with Applications.

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES

Ralph Wilson Alewine III (*Geophysics*) B.S., Mississippi State University 1968; Sc.M., Brown University 1970.

Thesis: Application of Linear Inversion Theory Toward the Estimation of Seismic Source Parameters.

Gary Stephen Fuis (*Geology and Geophysics*) B.A., Cornell University 1966.

Thesis: The Geology and Mechanics of Formation of the Fort Rock Dome, Yavapai County, Arizona.

Rex Vincent Gibbons (*Geology*) B.A., Memorial University of Newfoundland 1967; M.Sc. 1969.

Thesis: Experimental Effects of High Shock Pressure on Materials of Geological and Geophysical Interest.

Raymond Leonard Joesten (*Geology*) B.S., San Jose State College 1966.

Thesis: Metasomatism and Magmatic Assimilation at a Gabbro-Limestone Contact, Christmas Mountains, Big Bend Region, Texas.

Peter Leonard Lagus (*Geophysics and Planetary Science*) B.S., Washington University 1965; M.S., California Institute of Technology 1971.

Thesis: The Equations of State of Hydrogen and Argon; Applications to the Jovian Interior.

Hsi-ping Liu (*Geophysics and Applied Physics*) B.Sc., Tunghai University 1964; M.A., Dartmouth College 1968.

Thesis: I. Temperature Dependence of Single Crystal Spinel ($MgAl_2O_4$) Elastic Constants from 293K to 423K Measured by Light-Sound Scattering in the Raman-Nath Region, II. Effect of Anelasticity on Periods of Earth's Free Oscillation (Toroidal Modes).

Kenneth Raymond Ludwig (*Geology and Geochemistry*) B.S., California Institute of Technology 1965; M.S. 1967.

Thesis: I. Precambrian Geology of the Central Mazatzal Mountains, Arizona; II. Lead Isotope Heterogeneity in Precambrian Igneous Feldspars.

Jean-Bernard Minster (*Geophysics*) Ingenieur Civil, Ecole des Mines de Paris 1969; Diplome, Institut Francais du Petrole, 1969.

Thesis: Elastodynamics of Failure in a Continuum.

DOCTOR OF PHILOSOPHY—Continued

DIVISION OF PHYSICS, MATHEMATICS AND ASTRONOMY

John Harold Biegging (*Astronomy*) A.B., Dartmouth College 1966; M.S., California Institute of Technology 1969.

Thesis: Aperture Synthesis Observations of OH Absorption in the Galactic Center.

James Andrew Boa (*Applied Mathematics*) B.Sc., University of Toronto 1970.

Thesis: A Model Biochemical Reaction.

Donald Campbell Brabston, Jr. (*Applied Mathematics and Engineering Science*) B.S., Georgia Institute of Technology 1967; M.S., California Institute of Technology 1968.

Thesis: I. Numerical Solutions of Steady Viscous Flow Past Spheres and Gas Bubbles.

II. Numerical Solution of Singular Endpoint Boundary Value Problems.

James William Brown (*Physics*) B.S., Villanova University 1968.

Thesis: A Satellite Measurement of Cosmic-Ray Abundances and Spectra in the Charge Range $2 \leq Z \leq 10$.

Keith Howard Burrell (*Physics, Applied Mathematics, and History*) B.S., Stanford University 1968; M.S., California Institute of Technology 1970.

Thesis: An Investigation of the Resonance Cone Structure in a Warm Anisotropic Plasma.

Philip Sidney Callahan (*Physics and Astronomy*) B.S., Cornell University 1969; M.S., California Institute of Technology 1971.

Thesis: Observation of the Solar-Wind Turbulence Near the Sun.

Paul Charles Clapham (*Mathematics*) B.Sc., University of British Columbia 1970.

Thesis: Steiner Triple Systems with Block-Transitive Automorphism Groups.

Jack Clifton Comly, Jr. (*Physics*) B.S., California Institute of Technology 1966.

Thesis: Optical Pulse Propagation in Media Exhibiting a Third Order Nonlinear Polarization.

Daniel Edwin Erickson (*Mathematics and Economics*) B.S., California Institute of Technology 1967; M.S., Stanford University 1968.

Thesis: Counting Zeros of Polynomials Over Finite Fields.

Lawrence Charles Ford (*Mathematics*) B.S., Portland State University 1968; M.S. 1970.

Thesis: Generalized Multipliers on Locally Compact Abelian Groups.

Paul Michael Harvey (*Physics*) B.A., Wesleyan University 1968.

Thesis: Infrared and Microwave Variability of OH/IR Stars, and a One Millimeter Wavelength Detecting System for the 200-Inch Telescope.

William Cary Huffman (*Mathematics*) B.S., University of New Mexico 1970.

Thesis: Eigenvalue Structure in Primitive Linear Groups.

Robert Vernon Kline (*Physics*) S.B., Massachusetts Institute of Technology 1967.

Thesis: A Measurement of the Process $p+d \rightarrow \text{He}^3 + \text{Photon}$ at Intermediate Energies.

Clement Wing Hong Lam (*Mathematics and Engineering Science*) B.S., California Institute of Technology 1971.

Thesis: Rational g-Circulants Satisfying the Matrix Equation $A^2 = dI + \lambda J$.

DOCTOR OF PHILOSOPHY—*Continued*

- David Li Lee (*Physics and Economics*) B.Sc., McGill University 1970.
Thesis: Frameworks for Analyzing and Testing Theories of Gravity.
- Douglas Albert Leich (*Physics*) B.A., Colgate University 1968.
Thesis: Applications of a Nuclear Technique for Depth-Sensitive Hydrogen Analysis: Trapped H in Lunar Samples and the Hydration of Terrestrial Obsidian.
- William Norman Lennard (*Physics*) B.A.Sc., University of Toronto 1969.
Thesis: Absolute Transition Probabilities for Ni I and the Solar Nickel Abundance.
- Alan Paige Lightman (*Physics*) A.B., Princeton University 1970; M.S., California Institute of Technology 1973.
Thesis: I. Time-Dependent Accretion Disks Around Compact Objects; II. Theoretical Frameworks for Analyzing and Testing Gravitation Theories.
- Paul Kim Mazaika (*Applied Mathematics*) B.S., New York University 1970.
Thesis: On the Settling Speed of Dilute Arrays of Spheres.
- Jonathan David Melvin (*Physics and Biology*) B.A., M.A., Yale University 1968.
Thesis: Energy Loss of Light Ions Channeling in Silicon.
- William James Metcalf (*Physics*) B.S., University of California, Los Angeles 1967.
Thesis: The Recoil Proton Polarization in π - Photoproduction From Deuterium Between 450 and 950 MeV and a Partial Wave Analysis of $\gamma n \rightarrow \pi$ -p in the Resonance Region.
- Howard Cary Morris (*Mathematics*) B.S., Louisiana Polytechnic Institute 1969.
Thesis: Two Pigeon Hole Principles and Unions of Convexly Disjoint Sets.
- Augustus Oemler, Jr. (*Astronomy*) A.B., Princeton University 1969; M.S., California Institute of Technology 1970.
Thesis: The Systematic Properties of Clusters of Galaxies.
- Bruce Kent Richard (*Mathematics*) B.S., Georgia Institute of Technology 1969.
Thesis: Numerical Ranges and Commutation Properties of Hilbert Space Operators.
- David Bruce Shaffer (*Astronomy*) B.S., Carnegie-Mellon University 1968.
Thesis: The Structure of Compact Radio Sources at 10.7 GHz.
- Stephen Alan Sheckman (*Astronomy*) B.S., Yale University 1969.
Thesis: Clusters of Galaxies and the Cosmic Light.
- Rafael Sorkin (*Physics*) A.B., Harvard University 1966.
Thesis: Development of Symplectic Methods for the Metrical and Electromagnetic Fields.
- Saul Arno Teukolsky (*Physics*) B.S., University of Witwatersrand, Johannesburg 1970.
Thesis: Perturbations of a Rotating Black Hole.
- Glenn John Veeder, Jr. (*Astronomy*) S.B., Massachusetts Institute of Technology 1968.
Thesis: Temperatures and Luminosities of M Type Dwarfs from Infrared Photometry.
- Andrew Benjamin White, Jr. (*Applied Mathematics*) B.A., University of Texas 1969.
Thesis: Numerical Solution of Two-Point Boundary Value Problems.
- Ming Lun Yu (*Physics*) B.Sc., University of Hong Kong 1966; M.Sc. 1969; M.S., California Institute of Technology 1971.
Thesis: An Experimental Study of Nonequilibrium Superconductivity.

Prizes and Awards

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.

Kenneth Stephen Jancaitis

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.*

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.

Claude Anderson

José Cabezon

Margaret Evans

Kathleen Kong

Gary Wakai

DAVID JOSEPH MacPHERSON PRIZE IN ENGINEERING

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

Siu Joe Poon

DONALD S. CLARK 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.

Jonathan Marc Teich, sophomore

Richard Steven Gruner, junior

HAREN LEE FISHER MEMORIAL AWARD IN JUNIOR PHYSICS

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

Joseph G. Polchinski

PRIZES AND AWARDS—*Continued*

SIGMA XI AWARD

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

David Langdon Glackin

THE MORGAN WARD AWARD

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

Christopher Henley, freshman

MARY A. EARLE 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.

Dale Eric Bredesen

Barry Arthur Cipra

JACK E. FROELICH MEMORIAL AWARD

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

Roland Robert Lee

ERIC TEMPLE BELL UNDERGRADUATE MATHEMATICS RESEARCH PRIZE

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

David Dummit, junior

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: *Kenneth Sanders Suslick*