



*Seventy-Seventh  
Annual Commencement  
June 11, 1971*

CALIFORNIA INSTITUTE OF TECHNOLOGY

*Seventy-Seventh  
Annual  
Commencement*

FRIDAY MORNING AT TEN-THIRTY O'CLOCK  
JUNE ELEVENTH, NINETEEN SEVENTY-ONE

# *Academic Procession*

*Chief Marshal*, William H. Corcoran, Ph.D.

## *Assistant Marshals*

David C. Elliot, Ph.D.

Jon Mathews, Ph.D.

Hardy C. Martel, Ph.D.

James H. Sturdivant, Ph.D.

Anthonie van Harreveld, Ph.D., M.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

## CALIFORNIA INSTITUTE OF TECHNOLOGY *Seventy-Seventh Annual Commencement*

PRESIDING . . . . . Arnold O. Beckman, Ph.D., LL.D.  
*Chairman of the Board of Trustees*

PRELUDE AND PROCESSIONAL  
James H. Shearer, A.R.C.M., A.R.C.O.  
*Organist*

INVOCATION . . . . . The Reverend William W. Rankin  
*All Saints Episcopal Church, Pasadena*

COMMENCEMENT ADDRESS . . . . . "Poets and Carpenters"  
James C. Fletcher, Ph.D.  
*Administrator, National Aeronautics and Space Administration*

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 . . . Robert A. Huttenback, Ph.D.  
*Dean of Students*  
For the degree of Master of Science . . . Cornelius J. Pings, Ph.D.  
*Dean of Graduate Studies*  
For the degree of Engineer . . . . . Dean Pings  
For the degree of Doctor of Philosophy . . . . . Dean Pings

CONCLUDING REMARKS . . . . . President Brown

BENEDICTION . . . . . Reverend Rankin

RECESSIONAL . . . . . Mr. Shearer

*The audience is requested to remain standing until  
the end of the Recessional*



## 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.

# Candidates for Degrees

## BACHELOR OF SCIENCE

**Robert Mark Abarbanel** *Beverly Hills, California*  
Theagenis John Abatzoglou *Athens, Greece* Mathematics  
**Mark Joseph Abramson** *Redondo Beach, California* Mathematics  
Garold Robert Adamson *Orange, California* Chemical Engineering  
Ronald Eugene Alley *Dayton, Ohio* Chemistry  
**William Thomas Almassy** *La Canada, California* Engineering and Applied Science  
Carl Nestor Anderson *Kensington, California* Engineering and Applied Science  
**Robert R. Antaki** *Richmond, California* Engineering and Applied Science  
**Luis Aranguren** *San Salvador, El Salvador* Engineering and Applied Science  
Michael Wayne Arenton *Alhambra, California* Physics  
**Richard Arthur Ashley** *Glenview, Illinois* Biology  
Steven Carl Bankes *Columbus, Ohio* Engineering and Applied Science  
Charles Vernon Barber *Kent, Washington* Biology  
Alan Bowker Barclay *Takoma Park, Maryland* Physics  
Benjamin Joseph Barker *South Deerfield, Massachusetts* Engineering and Applied Science  
John Bernard Batchelder, Jr. *Fort Lauderdale, Florida* Chemistry  
**David Robert Bauer** *Mercer Island, Washington* Chemistry  
**Stephen Charles Beach** *Torrance, California* Economics  
James Christopher Beck *Modesto, California* Engineering and Applied Science  
J. James Belonis II *Seattle, Washington* Physics  
**Leonard Charles Berman** *Jersey City, New Jersey* Mathematics  
Thomas Malcolm Blaschko *San Gabriel, California* Astronomy  
Terry Allen Boardman *Spokane, Washington* Engineering and Applied Science  
Michael Dean Brennan *Seattle, Washington* Engineering and Applied Science  
**James Henry Cook** *Williamsville, New York* Chemistry  
Brian Tevis Cox *Madison, Indiana* Mathematics  
**James Logan Crawford** *Billings, Montana* Chemistry  
William Gill Criss *Utica, Michigan* Engineering and Applied Science  
John Edward Cronin *Paradise Valley, Arizona* Geology  
**Yoshiaki Tsuneo Daimon** *Kyoto, Japan* Engineering and Applied Science  
**Stephen Robert Dashiell** *Barstow, California* Engineering and Applied Science  
**William Kenneth Delaney** *Fort Ord, California* Mathematics  
**Dennis Leonard DiBartolomeo** *Fords, New Jersey* Astronomy  
**David Adams Dixon** *Manchester, Connecticut* Chemistry  
**Kenneth Franklin Drake, Jr.** *Evanston, Illinois* Chemistry  
William Shipley Duckwall *Kingsport, Tennessee* Biology

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

BACHELOR OF SCIENCE—Continued

Gerald S. Eisman *Philadelphia, Pennsylvania* Mathematics  
 Paul Craig Engelking *Santa Monica, California* Physics-Chemistry  
 Robert S. Fisher *Ft. Lauderdale, Florida* Biology  
 Barry K. Fitzgerald *Omaha, Nebraska* Engineering and Applied Science  
 Joshua Bennett Foreman *Scottsdale, Arizona* Economics  
 Joel Herbert Friedman *Phoenix, Arizona* Applied Physics  
 Laurence Oliver Gagliani *South San Francisco, California* Engineering and Applied Science  
 James Irwin Garrels *Danville, Iowa* Physics-Biology  
 Ralph Bremner Graham *Burlington, New Jersey* Economics  
 Martin Douglas Gray *Stoughton, Massachusetts* Engineering and Applied Science  
 David Jay Green *Pomona, California* Economics  
 Leonidas John Guibas *Athens, Greece* Mathematics  
 Donald Lee Gunter *Mount Prospect, Illinois* Physics  
 Jonathan Ingersoll Hall *Pasadena, California* Mathematics  
 Robert Earl Hall *Wyckoff, New Jersey* Physics  
 Russell Lyle Halsted *Portland, Oregon* Mathematics  
 Robert Bruce Hammond *Santa Monica, California* Physics  
 Sheridan Wilson Hammons *Anaheim, California* Engineering and Applied Science  
 Kenneth Endicott Hanson *Downey, California* Engineering and Applied Science  
 Richard Dickerson Harley *Marion, Indiana* Engineering and Applied Science  
 Andrew Mace Hautzik *Sherman Oaks, California* Mathematics  
 Thomas Randal Heinz *Denver, Colorado* Physics  
 John Monroe Heumann *Louisville, Kentucky* Physics  
 Mark Myron Hopkins *Rolling Hills Estates, California* Economics  
 William Gaong Hwang *Sacramento, California* Physics  
 Sam Frank Insana *Phoenix, Arizona* Engineering and Applied Science  
 Ronald Earl Joiner, Jr. *Portland, Oregon* Applied Physics  
 Roger Jesse Jones *Kanab, Utah* Physics  
 Thomas Reed Joseph *Riverside, California* Applied Physics  
 James Ethan Justiss *Nashville, Tennessee* Engineering and Applied Science  
 Gregory Edward Kandel *San Gabriel, California* Engineering and Applied Science  
 Milan Henry Karspeck *Loveland, Colorado* Physics  
 William Robert Kast *San Rafael, California* Engineering and Applied Science  
 Carl Paul Kaufman *Brooklyn, New York* Astronomy  
 Ian Andrew Kling *Hackettstown, New Jersey* Biology  
 Doyle Dana Knight *Culver City, California* Engineering and Applied Science  
 Gary Charles Koenig *Hyattsville, Maryland* Engineering and Applied Science  
 Andrew Koffman *South Pasadena, California* Mathematics-English  
 Arthur Edwin Kreymer *Bremerton, Washington* Physics  
 Terry Hall LaGrone *Escondido, California* Applied Physics  
 Cheong-Fay Lai *Toronto, Canada* Engineering and Applied Science  
 Clement Wing Hong Lam *Hong Kong, B.C.C.* Mathematics  
 Michael Anthony Lamanna *Albany, New York* Applied Physics  
 Michel Paul Laurent *B. deEchegaray, Edo de Mexico* Chemistry



BACHELOR OF SCIENCE—Continued

Alan Stuart Lederman *New York, New York* Mathematics  
Victor Wai-Dat Lee *Hong Kong, B.C.C.* Biology  
Ronald James Lipinski *Hinsdale, Illinois* Physics  
Elwyn Yuan Loh *Blacksburg, Virginia* Physics  
Joseph Michael Lyvers *Bradley, Illinois* Physics  
Louis Loewinsohn Maack *Pasadena, California* Physics  
Metin Suleyman Mangir *Kavaklidere-Ankara, Turkey* Engineering and Applied Science  
Kirk Alan Mathews *Federal Way, Washington* Physics-English  
Craig William McCluskey *Pullman, Washington* Engineering and Applied Science  
Edson Robert McCord *Rhinebeck, New York* Engineering and Applied Science  
Steven Melvin Menkus *Los Angeles, California* Chemical Engineering  
John Patrick Messmer *San Francisco, California* Engineering and Applied Science  
David Robert Mikkelsen *Albuquerque, New Mexico* Physics  
Drew Farrel Miles *Northridge, California* Physics  
Richard Bruce Moon *Pasadena, California* Chemistry  
Phil Glennon Morgan *Coos Bay, Oregon* Engineering and Applied Science  
Leonard Joseph Moss *Long Beach, California* Physics  
Wesley Elwood Munsil *Phoenix, Arizona* Mathematics  
Vasant Nanavati *Bombay, India* Engineering and Applied Science  
Mark Jeffrey Noble *Roslyn, New York* Physics  
Andrew Michael Odlyzko *Buffalo, New York* Mathematics  
Steven Charles Offen *Walnut Creek, California* Engineering and Applied Science  
Robert William Offermann *Stockton, California* Engineering and Applied Science  
Terrence Jay O'Neil *Novato, California* Biology-Chemistry  
Ahmet Ozkul *Eskisehir, Turkey* Engineering and Applied Science  
Richard I. Pelletier *Somerville, Massachusetts* Mathematics  
Bruce Hunter Penrose *Potsdam, New York* Geology  
Alan Bruce Petersen *Piedmont, California* Applied Physics  
Robert Walker Pethoud *Modesto, California* Astronomy  
Leo Bernard Pilachowski, Jr. *Hull, Massachusetts* Physics  
Raymond Pong *Oakland, California* Chemical Engineering  
Fred Prindaville *Flossmoor, Illinois* Engineering and Applied Science  
James Howard Rapp *Walnut Creek, California* Mathematics  
Paul David Reynolds *Whittier, California* Physics  
Lawrence Bryce Rhodes *Deer Lodge, Montana* Physics  
Arnold Wayne Richards *Sepulveda, California* Engineering and Applied Science  
Douglas Orange Richstone *Rockville, Maryland* Astronomy  
Jeffrey Donald Rude *Hayward, California* Biology  
Stewart Francis Sando, Jr. *St. Petersburg, Florida* Physics  
Eric Allan Schiff *Los Angeles, California* Physics-English  
Cameron J. Schlehuber *McPherson, Kansas* Biology  
Richard Joseph Schwall *Northbrook, Illinois* Chemistry  
Stanley Harold Shepherd *Fresno, California* Engineering and Applied Science  
Steven Lee Shuler *Lancaster, California* Engineering and Applied Science



BACHELOR OF SCIENCE—Continued

**Stuart Allen Sipkin** *San Rafael, California* Geophysics  
**Donald Lawrence Smith** *Annandale, Virginia* Engineering and Applied Science  
**Stephen Lawrence Smith** *Minneapolis, Minnesota* Mathematics  
**Lee Ira Sparling** *Freeport, New York* Engineering and Applied Science-Economics  
**Alan David Stein** *Los Altos, California* Physics-English  
**John Wesley Steinhauser** *Clarksville, Tennessee* Mathematics  
**Gregory Randall Stewart** *La Crescenta, California* Physics  
**Jack Arthur Stone, Jr.** *Evansville, Indiana* Physics  
**Alan Douglas Strickland** *Andrews, Texas* Chemistry  
**Pierre Sundborg** *Seattle, Washington* Geology  
**Ronald Jon Swanson** *Poulsbo, Washington* Geology  
**David Kirk Switzer** *Covina, California* Biology-Engineering and Applied Science  
**Jack Kai Pui Tam** *Hong Kong, B.C.C.* Physics  
**Armand Rene Tanguay, Jr.** *Pasadena, California* Physics  
**Timothy Jerome Tardiff** *Olympia, Washington* Mathematics  
**Duncan Paul Taylor** *Chatsworth, California* Chemistry  
**Michael David Teener** *Junction City, Kansas* Engineering and Applied Science  
**Joseph Leslie Templeton** *Knoxville, Iowa* Chemistry  
**Kenneth Paul Trabold** *Long Beach, California* Chemistry  
**Randolph Stacey Tuler** *Marina del Rey, California* Mathematics  
**David Lee Turner** *Barrington, Illinois* Physics  
**Michael Stanley Turner** *Los Angeles, California* Physics  
**Howard Clinton Tyler** *Des Plaines, Illinois* Engineering and Applied Science  
**Gregory Boreas Van Der Werff** *Burbank, California* Engineering and Applied Science-Economics  
**John G. Victor** *Northridge, California* Chemical Engineering  
**Arvind Virmani** *New Delhi, India* Engineering and Applied Science-Economics  
**William Henry Waggy** *Vacaville, California* Engineering and Applied Science  
**Larry Eugene Watkins** *Indianapolis, Indiana* Physics  
**John Coulton Waugh** *Newburgh, New York* Biology  
**Thomas Allan Weaver** *Rockville, Maryland* Physics  
**Paul Theodore Wegener** *Pasadena, California* Engineering and Applied Science  
**William Melvin Weigel** *Muskego, Wisconsin* Biology  
**Larry Alan Westerman** *Butler, Pennsylvania* Physics  
**Robert Moore Westervelt** *Schenectady, New York* Physics  
**Gregory L. Whitten** *Red Bluff, California* Engineering and Applied Science  
**Richard Reid Willis** *Palos Verdes, California* Engineering and Applied Science  
**Douglas Alan Wood** *Bellevue, Washington* Chemical Engineering  
**Bruce Richard Wright** *San Gabriel, California* Engineering and Applied Science  
**Avi Wrobel** *Pasadena, California* Engineering and Applied Science  
**Lawrence Renwick Young** *Hanover, New Hampshire* Physics

## MASTER OF SCIENCE

- Charalambos Dionisios Aliprantis (*Mathematics*). B.S., University of Athens, 1969.
- Jose Alberto Albano do Amarante (*Physics*). Engineer, Instituto Tecnológico de Aeronautica, 1966.
- Dennis Dillon Baker (*Astronomy*). B.A., University of California, 1964.
- William Fred Baron (*Physics*). A.B., Princeton University, 1969.
- Thomas Morus Bartsch (*Aeronautics*). B.S., Loyola University, 1970.
- Robert Lee Bell (*Applied Mechanics*). B.S., California Institute of Technology, 1968.
- Bruce Allan Berentsen (*Chemical Engineering*). B.S., Rutgers University, 1969.
- Rena Bizios (*Chemical Engineering*). B.S., University of Massachusetts, 1968.
- Robert Dilworth Blevins (*Mechanical Engineering*). B.S., Carnegie Mellon University, 1970.
- Ulrich Breitling (*Aeronautics*). Ingenieur, Staatliche Ingenieurschule für Maschinanwesen, 1964.
- Joseph Robert Bruckner (*Chemistry*). B.S., Loyola University, 1969.
- L. William Butterworth (*Mechanical Engineering*). B.S., California Institute of Technology, 1970.
- Philip Sidney Callahan (*Physics*). B.S., Cornell University, 1969.
- Brian Joseph Cantwell (*Aeronautics*). B.A., University of Notre Dame, 1967; B.S., 1968.
- Wilkie Yung-Kee Chen (*Physics*). B.Sc., National Taiwan University, 1968.
- Arturo Cisneros-Stoianowski (*Physics*). B.S., Instituto Politecnico Nacional de Mexico, 1967.
- Mildred Allen Clarke (*Chemistry*). B.A., Rice University, 1969.
- Gene Alan Clough (*Physics*). B.S., California Institute of Technology, 1969.
- Theodor Sebastian Colbert (*Electrical Engineering*). M.S., University of Bucharest, 1969.
- John Lee Compton (*Biology*). B.S., Yale University, 1969.
- George Edward Conway (*Applied Mechanics*). B.S., University of Illinois, 1970.
- Richard Henry Davies (*Aeronautics*). B.S.A.E., Northrop Institute of Technology, 1970.
- Stephen K. Decker (*Physics*). B.S., Auburn University, 1969.
- Jean Roger Delayen (*Engineering Science*). Engineer, Ecole Nationale Supérieure d'Arts et Metiers, 1970.
- Nathan Myron Denkin (*Physics*). B.A., Queens College, 1969; B.S., Columbia University, 1969.
- Robert James Drean (*Electrical Engineering*). B.S., California Institute of Technology, 1970.
- Leslie Leroy Durland (*Mathematics*). B.S., Miami University, 1969.
- Bruce Gardner Elgin (*Engineering Science*). B.A., Pomona College, 1968.
- Judith Louise Erb (*Chemistry*). B.S., University of California, Berkeley, 1968.
- Gary Alan Evans (*Electrical Engineering*). B.S.E.E., University of Washington, 1970.

MASTER OF SCIENCE—Continued

- Joseph Shao-Ying Feng (*Electrical Engineering*). B.S., California Institute of Technology, 1969.
- Anthony Max Fern (*Electrical Engineering*). B.S.E.E., University of Texas, 1970.
- John Eugene Fink (*Chemical Engineering*). B.S. Ch.E., Newark College of Engineering, 1968.
- Richard W. Forester (*Geology*). B.Sc., McGill University, 1965; M.Sc., 1967.
- Charles William Gabel (*Engineering Science*). B.A., University of Colorado, 1969.
- Robert James Glaser (*Aeronautics*). B.S.E., University of Michigan, 1968.
- Yaacov Goland (*Mechanical Engineering*). B.Sc., Israel Institute of Technology, 1969.
- Pierre Henri Gourgeon (*Aeronautics*). Ingenieur diplome, Ecole Polytechnique, 1967; Ingenieur diplome, Ecole Nationale Supérieur de l'Aeronautique, 1970.
- Richard David Greene (*Physics*). B.A., New York University, 1968.
- Leonidas John Guibas (*Mathematics*).
- Thomas Charles Gunderson (*Mechanical Engineering*). B.S., University of Wisconsin, 1970.
- Joel Herbert Gyllenskog (*Engineering Science*). B.S., Utah State University, 1969.
- Alfred Clyde Hartmann (*Engineering Science*). B.S., Carnegie-Mellon University, 1969.
- Steven Ludvic Heisler (*Environmental Engineering Science*). B.S., California Institute of Technology, 1970.
- Stephen Hernadi (*Physics*). B.Sc., Queens University, 1969.
- Hiroshi Higuchi (*Aeronautics*). B.E., University of Tokyo, 1970.
- James Alan Hileman (*Geophysics*). Geo. Eng., Colorado School of Mines, 1960.
- Craig Moller Hove (*Engineering Science*). B.A.Sc., University of Toronto, 1970.
- Arthur Roy Jensen (*Environmental Engineering Science*). B.S., University of California, Berkeley, 1970.
- Jerry L. Johnson (*Mathematics*). B.A., Augsburg College, 1970.
- James Dean Joseph (*Electrical Engineering*). B.S., Ohio State University, 1969; M.S., 1969.
- Bruce Leigh Ketts (*Aeronautics*). B.A.E., Georgia Institute of Technology, 1970.
- Michael Byer Klayman (*Biology*). B.S., Union College, 1969.
- James Joseph Kosmicki (*Aeronautics*). B.S., United States Naval Academy, 1968.
- Conrad John Kowalski (*Chemistry*). S.B., Massachusetts Institute of Technology, 1968.
- Paulus Arie Kroon (*Chemistry*). B.Sc., Auckland University, 1967.
- Peter Leonard Lagus (*Geophysics*). B.S., Washington University, 1965.
- Fang Shyong Lai (*Chemical Engineering*). B.S., National Taiwan University, 1965; M.S., University of Notre Dame, 1967.
- Steven Judson Lambert (*Geochemistry*). B.A., University of California, Riverside, 1970.
- Wally Po-Wah Lau (*Engineering Science*). B.Sc., Purdue University, 1969.
- Chi-Yu Gregory Lee (*Chemistry*). B.Sc., National Taiwan University, 1967.
- Edgar Frederick Lentz, Jr. (*Applied Mathematics*). A.B., Kenyon College, 1969.



MASTER OF SCIENCE—Continued

- Daniel Francois Lepine (*Mechanical Engineering*). Diploma of Engineer, Institut National des Sciences Appliquees de Lyon, 1968.
- Stanley Phillip Levy (*Electrical Engineering*). B.S., California Institute of Technology, 1970.
- Dennis Y. K. Lew (*Electrical Engineering*). B.S.E.E., Purdue University, 1970.
- Chi Cheung Lo (*Physics*). S.B., Massachusetts Institute of Technology, 1970.
- Steven Jay Loer (*Physics*). B.S., University of Wisconsin, 1969.
- Eriabu Lugujjo (*Electrical Engineering*). B.Sc., Makerere University College, 1969.
- Ward Amory Lutz (*Aeronautics*). B.S., United States Military Academy, 1963.
- Isaac Majerovicz (*Electrical Engineering*). B.S., California Institute of Technology, 1970.
- James Edward Malinak (*Aeronautics*). B.S., Case Western Reserve University, 1970.
- Vincent Marrello (*Electrical Engineering*). B.A.Sc., University of Toronto, 1970.
- Nabil I. Marzouk (*Materials Science*). B.Sc., American University, Cairo, 1966.
- Harry Joseph Masoni (*Aeronautics*). B.S., California State Polytechnic College, Pomona, 1970.
- John George Mast (*Mechanical Engineering*). B.S.M.E., Illinois Institute of Technology, 1970.
- Gary Albert Matak (*Aeronautics*). B.S., California State Polytechnic College, San Luis Obispo, 1970.
- Charles C. Matthews (*Mechanical Engineering*). B.S.M.E., Purdue University, 1970.
- Stanley John McCaslin (*Physics*). B.A., Macalester College, 1969.
- Joseph Christian McGahan (*Aeronautics*). B.S., California State Polytechnic College, San Luis Obispo, 1970.
- Henry Jay Melosh IV (*Physics*). A.B., Princeton University, 1969.
- Richard Devern Samuels Melville, Jr. (*Electrical Engineering*). B.S.E.E., University of Southern California, 1960; M.S., Naval Post Graduate School, 1967.
- Norman Dean Mirsky (*Mathematics*). B.A., Johns Hopkins University, 1968.
- Thomas Lee Moeller (*Applied Mechanics*). B.S., University of California, Los Angeles, 1969.
- Amr Mohamed Mohsen (*Electrical Engineering*). B. of Eng., Cairo University, Faculty of Engineering, 1968; M.S., American University, Cairo, 1970.
- William Edwin Moore (*Physics*). B.S., University of Wisconsin, 1969.
- Terrence Marshall Morris (*Electrical Engineering*). B.S., Marietta College, 1969.
- Adrian Leigh Moys (*Mechanical Engineering*). B.A.S.C., University of British Columbia, 1970.
- Gary L. Newcomb (*Electrical Engineering*). B.S.E.E., University of Missouri, Rolla, 1970.
- Wei-Tou Ni (*Physics*). B.Sc., National Taiwan University, 1966.
- Pericles Leonidas Nicolaides (*Engineering Science*). B.S., California Institute of Technology, 1969.
- Edward Francis O'Brien (*Chemistry*). B.Sc., St. Dunstan's University, 1967.
- Andrew Michael Odlyzko (*Mathematics*).
- Jose Antonio Oliveros (*Mechanical Engineering*). M.E., Universidad Central de Venezuela, 1970.

MASTER OF SCIENCE—Continued

- Aaron J. Owens (*Physics*). B.A., Williams College, 1969.
- Benton LeRoy Parris (*Aeronautics*). B.S.A.E., Northrop Institute of Technology, 1968.
- Ronald George Patterson (*Environmental Engineering Science*). B.S.M.E., Gonzaga University, 1970.
- William Henry Press (*Physics*). A.B., Harvard College, 1969.
- Jean-Marie Quitin (*Applied Mathematics*). Diplome, Athenee de Liege I, 1964; Ingenieur-Physicien, Universite de Liege, 1969; Ingenieur en Maths. Appliquees, 1970.
- Jeffrey Lewis Ram (*Biology*). A.B., University of Pennsylvania, 1967.
- William Joseph Raymond (*Mechanical Engineering*). B.S., Northeastern University, 1970.
- Michael David Regenfuss (*Aeronautics*). B.A.E., University of Minnesota, 1970.
- Steven Lee Salem (*Engineering Science*). B.S., California Institute of Technology, 1970.
- Haluk Omer Sankur (*Electrical Engineering*). B.S., Robert College, 1970.
- Virendra Sarohia (*Aeronautics*). B.Sc., Punjab Engineering College, Chandigarh, 1970.
- Edgar Harry Satorius (*Electrical Engineering*). B.S., University of California, Los Angeles, 1970.
- Franz Karl Schenkel (*Aeronautics*). B.S., Pennsylvania State University, 1966.
- Andrew Ira Schwartz (*Mechanical Engineering*). B.S., Cornell University, 1970.
- John Thomas Shields III (*Aeronautics*). B.S.A.E., United States Naval Academy, 1970.
- Bruce Donald Sinclair (*Engineering Science*). B.S., University of Redlands, 1970.
- Frank Glenroy Smith III (*Chemical Engineering*). B.S., University of Louisville, 1969.
- Salvatore Solimeno (*Electrical Engineering*). Ing. Elettronica, University of Napoli-Lauren, 1965.
- Alan Lane Sorensen (*Aeronautics*). B.S., Texas A & M University, 1970.
- Claude Andre Sotil (*Environmental Engineering Science*). Engineer, University of Grenoble, Ecole Nationale Supérieure D'Ingenieurs, 1970.
- Emilio Andres Sovero-Temoche (*Mechanical Engineering*). B.S., California Institute of Technology, 1970.
- Sankaran Srinivas (*Electrical Engineering*). B. Tech., Indian Institute of Technology, Madras, 1970.
- Harry Paul Stough III (*Aeronautics*). B.S., Virginia Polytechnic Institute, 1970.
- Klaus F. Stricker (*Mechanical Engineering*). B.S.M.E., California State Polytechnic College, Pomona, 1970.
- Alan Douglas Strickland (*Chemistry*).
- Yen-Sheng Edmund Sun (*Electrical Engineering*). B.S., National Chiao Tung University, 1969.
- Grover Timothy Surratt (*Chemistry*). B.S., University of Delaware, 1968.
- Francesco Tamanini (*Aeronautics*). Laurea, Politecnico of Torino, 1969.

## MASTER OF SCIENCE—Continued

- Yukio Tamura (*Aeronautics*). B.D., Kyoto Institute of Technology, 1968; M.D., 1970.
- David Donald Tiffany (*Geology*). B.A., Carleton College, 1969.
- Jacques Andre Tissier dit Trarieux (*Mechanical Engineering*). Diplome d'Ingenieur, Ecole Centrale des Arts & Manufactures, 1970.
- Gordon Paul Treweek (*Engineering Science*). B.S., United States Military Academy, 1964.
- Jasenka Vuceta (*Environmental Engineering Science*). B.S., University of Zagreb, 1968.
- Alan Woodrow Walker (*Aeronautics*). B.S., California Institute of Technology, 1970.
- Run-Han Wang (*Physics*). B.S., University of California, Los Angeles, 1967.
- Gerald Wayne Ward (*Chemical Engineering*). B.S.E., University of Michigan, 1969.
- Willis George Watrous, Jr. (*Electrical Engineering*). B.S., California Institute of Technology, 1969.
- Christopher George Whipple (*Engineering Science*). B.S., Purdue University, 1970.
- Francois Wildenberg (*Mechanical Engineering*). Maitrise de Mecanique, Faculte des Sciences, 1969; Ingenieur, Ecole Nationale Superieure d'Electricite et de Mecanique, 1970.
- Robert Freeland Wiley (*Aeronautics*). S.B., Massachusetts Institute of Technology, 1966.
- Peter David Winter (*Aeronautics*). B.S., California State Polytechnic College, San Luis Obispo, 1970.
- Shu Kwong Wong (*Electrical Engineering*). B. Eng., McGill University, 1970.
- Wilson Wong (*Aeronautics*). B.M.E., City College of New York, 1969.
- Robert Howard Wyatt (*Chemistry*). B.A., Centre College of Kentucky, 1968.
- Fang-chou Yang (*Electrical Engineering*). B.S., National Taiwan University, 1969.
- Huan-Chun Yen (*Physics*). B.Sc., National Taiwan University, 1969.
- Ming Lun Yu (*Physics*). B.Sc., University of Hong Kong, 1966; M.Sc., 1969.
- William Wai Yue (*Applied Mechanics*). B.Sc., Purdue University, 1970.

## ENGINEER

- Edward Norton Evans (*Electrical Engineer*). B.S., University of California, Berkeley, 1967; M.S., California Institute of Technology, 1968.
- Jean-Francois Imbert (*Aeronautical Engineer*). Dipl. Ing., Ecole Nationale Superieure d'Arts et Metiers, 1967; Dipl. Ing. Aero., Ecole Nationale Superieure Aeronautique, 1969; A.E.A., Faculte des Sciences, 1969.
- Ting Lung Liu (*Aeronautical Engineer*). B.S., Chinese Naval College of Technology, 1965; M.S., The Institute of M.E. of Cheng Kung University, 1966; M.S., California Institute of Technology, 1969.
- Jiunn-Jenq Wu (*Aeronautical Engineer*). B.S., National Taiwan University, 1964; M.S., California Institute of Technology, 1966.



## DOCTOR OF PHILOSOPHY

Roger H. Abel (*Chemistry*). B.A., Hope College, 1965.

*Thesis:* Electrode Kinetic Studies Using a Computerized Data Acquisition and Analysis System.

Mashood Olayide Adegbola (*Electrical Engineering and Applied Mathematics*).

B.S.E.E., Purdue University, 1965; M.S., California Institute of Technology, 1966.

*Thesis:* Alias-Free Spectral Estimation of Stochastic Processes.

Randolph Ademola Adu (*Civil Engineering*). A.B., Harvard University, 1966.

*Thesis:* Response and Failure of Structures under Stationary Random Excitation.

Walter Joseph Arabasz, Jr. (*Geology and Geophysics*). B.S., Boston College, 1964;

M.S., California Institute of Technology, 1966.

*Thesis:* Geological and Geophysical Studies of the Atacama Fault Zone in Northern Chile.

David Woods Arnett (*Engineering Science*). B.S.E.E., Purdue University, 1964;

M.S.E.E., University of Pennsylvania, 1966.

*Thesis:* Information Processing by the First Optic Ganglion of Dipterans.

Barbara Joan Furman Attardi (*Biochemistry*). B.S., Cornell University, 1964.

*Thesis:* I. Characterization of the RNA from the Mitochondrial Fraction of Hela Cells.  
II. Properties of Membrane-Bound Ribosomes in Hela Cells.

Richard Harold Ault (*Physics*). B.S., University of Miami, 1964; M.S., California Institute of Technology, 1966.

*Thesis:* Upper Hybrid Resonance Absorption and Scattering from a Plasma Column.

Raymond Dean Ayers (*Materials Science and Applied Mathematics*). B.S.,

California Institute of Technology, 1963; M.S., 1964.

*Thesis:* Hall Coefficient and Resistivity of an Amorphous Palladium-Silicon Alloy.

James Henry Barbee (*Chemical Engineering*). B.S., University of Washington, 1965;

M.S., California Institute of Technology, 1967.

*Thesis:* The Flow of Human Blood Through Capillary Tubes with Inside Diameters Between 8.7 and 221 Microns.

Brian Thomas Barcelo (*Aeronautics*). B.S., Tulane University, 1965;

M.S., California Institute of Technology, 1966.

*Thesis:* Electron Beam Measurements of the Shock Wave Structure.

Part I. Determination of the Interaction Potential of the Noble Gases from Shock Wave Structure Experiments.

Part II. Feasibility of a Modified Electron Beam Densitometer Technique to Measure Diffusive Separation in Shock Waves in Helium-Argon Mixtures.

John Winston Belcher (*Physics*). B.A., Rice University, 1965.

*Thesis:* Alfvén Waves in the Interplanetary Medium.

Paula K. Bernstein (*Chemistry*). B.S., Barnard College, 1965;

M.S., Columbia University, 1966.

*Thesis:* The Electronic Structure of Complexes of the Ligand o-Phenylenebisdimethylarsine.

Jeanette Asay Betts (*Chemistry*). B.A., University of Utah, 1965.

*Thesis:* Reaction of Monoenergetic Deuterium Atoms with Hydrogen and Monoenergetic Hydrogen Atoms with per-Deutero Methane.

DOCTOR OF PHILOSOPHY—Continued

- Jacobo Bielak (*Civil Engineering*). Civil Engineer, National University of Mexico, 1963; M.S., Rice University, 1966.  
*Thesis*: Earthquake Response of Building-Foundation Systems.
- Alan B. Blumenthal (*Biochemistry*). A.B., Lafayette College, 1964.  
*Thesis*: Studies on *Drosophila* Phenol Oxidase.
- Ray Douglas Bowman (*Chemistry*). A.B., Indiana University, 1964.  
*Thesis*: Hydrodynamic Shear Breakage of Native DNA.
- Leonard William Brownlow, Jr. (*Electrical Engineering and Business Economics*). B.A., Pomona College, 1966; M.S., University of Arizona, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: Magnetoelastic Effects in Thin Ferromagnetic Films.
- Patricia Virginia Burke (*Biophysics and Physics*). B.A., Pomona College, 1964; M.S., California Institute of Technology, 1967.  
*Thesis*: Freezing *Phycomyces* Sporangioophores in Superfluid Helium for Ultrastructure Studies.
- Robert David Carlitz (*Physics*). B.S., Duke University, 1965.  
*Thesis*: Elimination of Parity Doubled States from Regge Amplitudes.
- Lee Wendel Casperson (*Electrical Engineering and Physics*). S.B., Massachusetts Institute of Technology, 1966; M.S., California Institute of Technology, 1967.  
*Thesis*: Modes and Spectra of High Gain Lasers.
- Dennis Don Chilcote (*Chemical Engineering*). B.S., University of Minnesota, 1965.  
*Thesis*: The Diffusion of Ions in Agar Gel Suspensions of Red Cells.
- Allen Tse-Yung Chwang (*Mechanical Engineering*). B.Sc., Shu Hai College, 1965; M.S., University of Saskatchewan, 1967.  
*Thesis*: Helical Movements of Flagellated-Propelling Microorganisms.
- Judith Gamora Cohen (*Astronomy*). B.A., Radcliffe College, 1967.  
*Thesis*: The Lithium Isotope Ratio in F and G Field Stars.
- Elmer William Colglazier, Jr. (*Physics*). B.S., California Institute of Technology, 1966.  
*Thesis*: Two Topics in Elementary Particle Physics: (1) Quark Graphs and Angular Distributions in the Decays of the Axial-Vector Mesons and (2) Universal Current-Current Theories and the Non-Leptonic Hyperon Decays.
- Jane Ellen Crawford (*Chemistry*). A.B., University of California, Santa Barbara, 1966.  
*Thesis*: I. Proton Magnetic Resonance of Polynucleotides and Transfer RNA.  
II. Electron Spin Relaxation Studies of Manganese (II) Complexes in Acetonitrile.
- Rodney James Crewther (*Physics*). B.Sc., University of Melbourne, 1966; M.Sc., 1968.  
*Thesis*: Spontaneous Breakdown of Conformal and Chiral Invariance.
- James Alfred John Cutts (*Planetary Science*). B.A., St. John's College, Cambridge, 1965; M.S., California Institute of Technology, 1967.  
*Thesis*: Martian Spectral Reflectivity Properties from Mariner 7 Observations.

DOCTOR OF PHILOSOPHY—Continued

- Robert Frederick Davey (*Aeronautics*). B.S., United States Air Force Academy, 1962; M.S., California Institute of Technology, 1964.  
*Thesis*: An Experimental Investigation of the Effect of a Density Gradient on Shear Layer Instability.
- Daniel Joseph Dawson (*Organic Chemistry*). B.S., University of North Carolina, 1967.  
*Thesis*: Part I. An Investigation of the Utility of the Claisen Rearrangement in Angular Methylation as Illustrated by the Synthesis of  $\alpha$ -Valeranone.  
Part II. The Total Synthesis of the Pentacyclic Triterpene  $d\alpha$ -Germanicol.
- Michael Ernest Delaney (*Applied Mathematics*). B.Sc., University of London, 1965; M.Phil., 1967.  
*Thesis*: I. Singular Perturbation Problems Involving Singular Points and Turning Points.  
II. On the Averaged Lagrangian Technique for Nonlinear Dispersive Waves.
- John David Ditmars (*Civil Engineering*). B.S.E., Princeton University, 1965; M.S., California Institute of Technology, 1966.  
*Thesis*: Mixing of Density-Stratified Impoundments with Buoyant Jets.
- James Germain Downward IV (*Plasma Physics*). S.B., Massachusetts Institute of Technology, 1965.  
*Thesis*: Conductance Peaks at the Cyclotron Harmonics in a Cylindric Plasma Capacitor.
- Charles Elachi (*Electrical Engineering and Business Economics*). Eng. of Radioelectricity, Polytechnic Institute of Grenoble, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Electromagnetic Wave Propagation and Source Radiation in Space-Time Periodic Media.
- Stephen Dean Ellis (*Theoretical Physics*). B.S.E., University of Michigan, 1965.  
*Thesis*: A Dual Quark Model with Spin.
- James Aubrey Ellison (*Applied Mathematics and Philosophy*). B.S., University of Wisconsin, 1964; M.S., 1965.  
*Thesis*: Existence, Uniqueness, and Stability of Solutions of a Class of Nonlinear Partial Differential Equations.
- William Warren Everett (*Applied Mathematics*). E.Math., Colorado School of Mines, 1965.  
*Thesis*: On the Determination of the Properties of a Medium from its Reflection Coefficient.
- Donald George Fesko (*Chemical Engineering*). B.S.ChE., Clarkson College, 1966.  
*Thesis*: Time-Temperature Superposition in Block Copolymers.
- Jay Albert Frogel (*Astronomy*). A.B., Harvard University, 1966.  
*Thesis*: Infrared Spectra of Late-Type Stars.
- John Daniel Gallivan (*Physics*). B.Sc., University College, Dublin, 1961; M.Sc., 1962.  
*Thesis*: Test of the  $\Delta S = \Delta Q$  rule and CP-invariance in  $K_{e3}$  decay.



DOCTOR OF PHILOSOPHY—Continued

- Mark Parnes Goldstein (*Physics*). B.S., Harvey Mudd College, 1965;  
M.S., California Institute of Technology, 1969.  
*Thesis*: Alignment of Interstellar Grains.
- David Barnett Hall (*Physics*). S.B., Massachusetts Institute of Technology, 1965.  
*Thesis*: Waveguiding and Electrooptic Modulation of Light with GaAs Epitaxial Thin Films.
- John Robert Henderson (*Mathematics*). B.A., University of British Columbia, 1960;  
M.S., 1963.  
*Thesis*: Permutation Decompositions of  $(0,1)$ -Matrices and Decomposition Transversals.
- David Paul Hill (*Geophysics*). B.S., San Jose State College, 1958;  
M.S., Colorado School of Mines, 1961.  
*Thesis*: High Frequency Wave Propagation in the Earth: Theory and Observation.
- J. Brent Hoerner (*Civil Engineering*). B.S., California Institute of Technology, 1967.  
*Thesis*: Modal Coupling and Earthquake Response of Tall Buildings.
- Myung Kyu Hwang (*Chemical Engineering*). B.S., Seoul National University, 1965;  
M.S., California Institute of Technology, 1968.  
*Thesis*: Estimation and Control of Stochastic Chemical Systems.
- Edwin C. James (*Engineering Science*). B.S.C.E., University of Florida, 1965;  
M.S.M.E., Catholic University, 1968.  
*Thesis*: A Small Perturbation Theory for Cycloidal Propellers.
- Robert Humphrey Francis Jeffers (*Applied Mechanics*). B.Sc., National University of Ireland, Cork, 1964; M.Sc., 1965; M.S., California Institute of Technology, 1966.  
*Thesis*: On Two-Dimensional Waves of Finite Amplitude in Elastic Materials of Harmonic Type.
- Dennis Robert Kasper (*Environmental Engineering Science*). B.S., Loyola University, Los Angeles, 1966; M.S., California Institute of Technology, 1967.  
*Thesis*: Theoretical and Experimental Investigations of the Flocculation of Charged Particles in Aqueous Solution by Polyelectrolytes of Opposite Charge.
- Susan Werner Kieffer (*Planetary Science*). B.S., Allegheny College, 1964;  
M.S., California Institute of Technology, 1967.  
*Thesis*: I. Shock Metamorphism of the Coconino Sandstone at Meteor Crater, Arizona.  
II. The Specific Heat of Solids of Geophysical Interest.
- Jong Hyun Kim (*Mechanical Engineering*). B.S., Seoul National University, 1966;  
M.S., University of Missouri, 1967.  
*Thesis*: The Unsteady Cavity in Internal Flows.
- Mark Brecher Kislinger (*Physics*). B.A., University of California, Berkeley, 1965.  
*Thesis*: Elimination of Parity Doublets in Regge Amplitudes.
- Stephen L. Kurtin (*Electrical Engineering and Physics*). S.B., Massachusetts Institute of Technology, 1966; S.M., 1966.  
*Thesis*: Current Flow in Thin Solid Films: Thermionic Emission and Tunneling.

DOCTOR OF PHILOSOPHY—Continued

- William Finlay Langford (*Applied Mathematics*). B.Sc., Queen's University, 1966.  
*Thesis*: Bifurcation Theory of Nonlinear Boundary Value Problems.
- Jeffrey Samuel Leon (*Mathematics*). B.S., California Institute of Technology, 1968.  
*Thesis*: Simple Groups of Order  $2^a q^b r^2$ .
- Jack Edward Leonard (*Chemistry and Biology*). A.B., Harvard University, 1967;  
 B.D., Southern Methodist University, 1967.  
*Thesis*: I. Studies in Isomerism: Permutations, Point Group Symmetries, and Isomer Counting.  
 II. Studies in the Photochemistry of Coumarin and Certain Coumarin Derivatives.
- Victor K. C. Liang (*Physics*). S.B., Massachusetts Institute of Technology, 1964;  
 A.M., Harvard University, 1965.  
*Thesis*: Magnetic States in Amorphous  $\text{Pd}_{41}\text{Ni}_{41}\text{B}_{18}$  Alloys Containing Chromium and Iron.
- Edward David Lipson (*Physics*). B.Sc., University of Manitoba, 1966.  
*Thesis*: Experiments on Parity Non-Conservation in Nuclear Forces in  $^{180}\text{Hf}$ ,  $^{150}\text{Tb}$ ,  $^{203}\text{Tl}$  and  $^{181}\text{Ta}$ .
- Anupam Madhukar (*Materials Science and Physics*). B.Sc., University of Lucknow, 1967; M.S., Indian Institute of Technology, 1968; M.S., California Institute of Technology, 1970.  
*Thesis*: Theory of s-d Exchange Scattering in Dilute Magnetic Alloys.
- Mario Martínez-García (*Physics*). Lic. Ciencias Físicas, Instituto Tecnológico y de Estudios Superiores de Monterrey, 1965; M.S., California Institute of Technology, 1968.  
*Thesis*: Experimental Transition Probabilities for Lines of Fe I.
- David John McConnell (*Biochemistry*). B.A., Trinity College, Dublin, 1966.  
*Thesis*: Investigations on (i) Chromosomal Ribonucleic Acid of Ascites Cells (ii) RNA Polymerase of *E. coli*.
- Harold Finley McFarlane (*Engineering Science*). B.S., University of Texas, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: Pulsed Neutron Experiments in Graphite.
- William Atwood McNeely, Jr. (*Physics*). A.B., San Diego State College, 1965.  
*Thesis*: Photoproduction of Eta Mesons from Hydrogen at  $0^\circ$  and  $180^\circ$  for Energies Between 0.7 and 1.1 Gev.
- James Wilfred Meyer (*Chemistry*). B.S., University of Wisconsin, 1966.  
*Thesis*: Photolyses of Phenyl Esters.
- David Charles Muchmore (*Chemistry*). A.B., Dartmouth College, 1966.  
*Thesis*: A Study of the Reductive Cleavage of Vinyl and Alkyl Phosphoryl Esters.
- Stephen S. Murray (*Physics*). B.S., Columbia University, 1965.  
*Thesis*: Propagation of 1-10 MeV Solar Flare Protons in Interplanetary Space.
- Robert David Nebes (*Psychobiology and Developmental Biology*). B.S., Tufts University, 1965.  
*Thesis*: Investigations on Lateralization of Function in the Disconnected Hemispheres of Man.

DOCTOR OF PHILOSOPHY—Continued

- Patrick Henly Nettles, Jr. (*Physics*). B.S., Georgia Institute of Technology, 1964.  
*Thesis*: A Study of T=2 States in  $^{12}\text{B}$ ,  $^{12}\text{C}$ ,  $^{20}\text{F}$  and  $^{28}\text{Al}$ .
- Richard Coulston Neville (*Electrical Engineering*). B.S., California Institute of Technology, 1958; M.S., 1959.  
*Thesis*: Some Electronic Properties of Zn O and  $\text{SrTiO}_3$ .
- Howard White Nicholson, Jr. (*Physics*). B.A., Hamilton College, 1966;  
S.B., Massachusetts Institute of Technology, 1966.  
*Thesis*: A Study of the Reactions  $\bar{p}p \rightarrow \pi^+\pi^-$  and  $\bar{p}p \rightarrow K^+K^-$  from 0.7 to 2.4 GEV/C.
- Richard Carl Nielsen (*Mechanical Engineering*). B.S., California Institute of Technology, 1966; M.S., 1967.  
*Thesis*: Transient Heating in Bénard Convection.
- Eric Arden Noe (*Chemistry*). B.S., University of Cincinnati, 1965.  
*Thesis*: Conformational Study of Some Fluorine-Labeled Cyclic Compounds by Nuclear Magnetic Resonance Spectroscopy. I. 1,1-Difluoro-cyclodecane and 3,3-Difluoro-trans-cyclodecene.  
II.  $\gamma,\gamma$ -Difluoro- $\epsilon$ -caprolactone and  $\gamma,\gamma$ -Difluoro- $\epsilon$ -caprolactam.
- Patricia Marie O'Keefe (*Chemistry*). B.S., University of Delaware, 1965.  
*Thesis*: Application of the GI Method to Incorporation of Many-Body Effects in Metals; The Band Structure and Resolution of Several Anomalous Properties of Lithium Metal.
- Josephat Kanayo Okoye (*Environmental Engineering Science*). B.S., Purdue University, 1965; M.S., California Institute of Technology, 1966.  
*Thesis*: Characteristics of Transverse Mixing in Open-Channel Flows.
- David Keith Ottesen (*Chemistry*). B.S., New Mexico State University, 1966.  
*Thesis*: The Vibrational and Electronic Spectrum, and the Potential Field of Various Manganese Carbonyl Complexes.
- Stanley Monroe Parsons (*Chemistry*). B.S., California Institute of Technology, 1965.  
*Thesis*: The Catalytic Site of Lysozyme.
- Navin B. Patel (*Physics*). B.Sc., University of Bombay, 1963; M.Sc., 1965;  
M.S., California Institute of Technology, 1967.  
*Thesis*: Electrical and Optical Characteristics of Indium Arsenide Junction Lasers.
- James Harold Prestegard (*Chemistry*). B.Chem., University of Minnesota, 1966.  
*Thesis*: Proton Magnetic Resonance Studies of Biologically Significant Molecules.  
I. Cation-Binding Properties of Nonactin.  
II. Salt Effects on Nucleotide Conformation.
- Richard Henry Price (*Physics*). B.E.Ph., Cornell University, 1965.  
*Thesis*: Nonspherical Perturbation of Relativistic Gravitational Collapse.
- Jason Niles Puckett, Jr. (*Electrical Engineering*). B.S., California Institute of Technology, 1965; M.S., 1966.  
*Thesis*: An Electrical and Statistical Study of Burst Noise.



DOCTOR OF PHILOSOPHY—Continued

- Mathagondapally A. Ramaswamy (*Aeronautics*). B.E., College of Engineering, 1956; M.E., Indian Institute of Science, 1958.  
*Thesis*: Experimental Investigation of the Effect of Cooling on Near Wake of Circular Cylinder at Mach Number Six.
- Michael Eric Rassbach (*Physics and Engineering Science*). B.A., Rice University, 1965; M.A., 1966.  
*Thesis*: Electrodynamics in a Strong Magnetic Field.
- Arakali L. Ravimohan (*Chemical Engineering and Business Economics*). B.Tech., Indian Institute of Technology, 1967.  
*Thesis*: I. Experimental Tests on the Positive Column of Pure Rare Gases and Their Binary Mixtures.  
II. Kinetics of Hydrocarbon Reactions in the Positive Column of D.C. and Pulsed D.C. Discharges.
- Finn Ravndal (*Physics*). Siv.ing., Norwegian Institute of Technology, 1966; Lic.techn., 1968.  
*Thesis*: A Relativistic Quark Model with Harmonic Dynamics.
- George Robert Rossman (*Chemistry*). B.S., Wisconsin State University, 1966.  
*Thesis*: I. The Heptacyanomolybdate (III) Ion: Spectroscopic and Magnetic Properties and Chemical Reactivity.  
II. Spectroscopic and Magnetic Studies of Monomeric and Dimeric  $d^5$  Systems.  
III. Spectroscopic and Magnetic Studies of Polymeric Oxo- and Hydroxobridged Systems.
- Paul Klenett Salzman (*Chemical Engineering*). B.S., New York University, 1955; M.Ch.E., Rensselaer Polytechnic Institute, 1959.  
*Thesis*: A Theory for the Hugoniot of Condensed Media.
- Charles George Sammis (*Geophysics*). Sc.B., Brown University, 1965; M.S., California Institute of Technology, 1968.  
*Thesis*: Seismological Applications of Lattice Theory.
- David Norman Schramm (*Physics*). S.B., Massachusetts Institute of Technology, 1967.  
*Thesis*: The Isotopic Composition of Mg and the Implied Limits on  $^{26}\text{Al}$  in the Early Solar System; Nucleosynthesis of  $^{26}\text{Al}$ ; and Nucleosynthetic Chronologies for the Galaxy.
- John W. Sedat (*Biology and Chemistry*). B.A., Pasadena College, 1963.  
*Thesis*: On Bacterial and  $\phi\text{X-174}$  Messenger RNA.
- Thomas Edward Sharon (*Engineering Science and Physics*). S.B., Massachusetts Institute of Technology, 1967; M.S., California Institute of Technology, 1969.  
*Thesis*: Magnetism in an Amorphous Fe-Pd-P Alloy System.
- Richard David Sherman (*Physics*). S.B., Massachusetts Institute of Technology, 1965; M.S., California Institute of Technology, 1966.  
*Thesis*: Surface Impedance Theory of Superconductors in Large Static Magnetic Fields.

DOCTOR OF PHILOSOPHY—Continued

- Shelby Allen Sherrod (*Chemistry*). B.S., University of Kentucky, 1967.  
*Thesis*: I. Structure and Reactions of the 1-Cyclopropylvinyl Cation.  
II. Interaction of the Face of a Cyclopropane Ring with Positively Charged Carbon.
- Henry Longfellow Shipman (*Astronomy*). B.A., Harvard College, 1969;  
M.S., California Institute of Technology, 1970.  
*Thesis*: White Dwarfs.
- Carl Alvin Shollenberger (*Aeronautics and Economics*). B.S., Pennsylvania State University, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: An Investigation of a Two-Dimensional Propulsive Lifting System.
- Asher Sigal (*Aeronautics*). B.Sc., Israel Institute of Technology, 1960; M.Sc., 1966.  
*Thesis*: An Experimental Investigation of Turbulent Boundary Layer Over a Wavy Wall.
- Richard Neil Silver (*Physics*). B.S., California Institute of Technology, 1966.  
*Thesis*: I. Tests for Helicity Conservation and Spin-Parity Selection Rules in Diffraction Dissociation.  
II. Independent Production of Pions.
- Nagendra Singh (*Electrical Engineering*). B.Tech., Indian Institute of Technology, 1966; M.S., California Institute of Technology, 1967.  
*Thesis*: Radiation from a Short Electric Dipole Antenna in a Hot Uniaxial Plasma.
- Knut Sverre Skattum (*Applied Mechanics*). B.S.C.E., University of Colorado, 1967; M.S.C.E., 1968.  
*Thesis*: Dynamic Analysis of Coupled Shear Walls and Sandwich Beams.
- Youn Soo Sohn (*Chemistry*). B.S., Seoul National University, 1963; M.S., 1965.  
*Thesis*: Electronic Structures of Metallocene Complexes.
- Harold Spinka (*Physics and Astronomy*). B.A., Northwestern University, 1966.  
*Thesis*: The  $^{18}\text{O} + ^{16}\text{O}$  Reaction.
- Karl John Stahl (*Applied Mechanics*). B.S., University of Colorado, 1966; M.S., University of California, Berkeley, 1967.  
*Thesis*: Dynamic Response of Circular Plates Subjected to Moving Massive Loads.
- Keith Duncan Stroyan (*Mathematics*). B.S., Drexel Institute of Technology, 1967.  
*Thesis*: Applications of Model Theory to Complex Analysis.
- William Alvis Thomasson (*Biochemistry and Chemistry*). B.A., University of Chicago, 1955; M.A., California State College, Long Beach, 1965.  
*Thesis*: Hormonal Control of Protein Granule Accumulation in Fat Bodies of *Drosophila melanogaster* Larvae.
- Donald Dean Titus (*Chemistry*). B.S., University of Wyoming, 1966.  
*Thesis*: Structural Studies of Diethylphenylphosphonite—Transition Metal Complexes.
- Zoltán Andr   T  k  s (*Biochemistry and Chemistry*). B.S., University of Southern California, 1964.  
*Thesis*: Cell Surface Changes in Development: The I Blood Group Antigen in Humans.

DOCTOR OF PHILOSOPHY—*Continued*

- Irving Marvin Treitel (*Chemistry*). B.A., Yeshiva University, 1964;  
M.S., Yale University, 1966.  
*Thesis*: The Electronic Structures of Ligand Bridged Ruthenium and Cobalt Binuclear Complexes.
- William Boyce Upholt (*Chemistry*). B.A., Pomona College, 1965.  
*Thesis*: Properties of Closed Circular DNA.
- A. Vijayaraghavan (*Mechanical Engineering*). B.E., Madras University, 1959;  
M.S., Syracuse University, 1966.  
*Thesis*: Free and Forced Oscillations in a Class of Piecewise-Linear Dynamic Systems.
- John Longstreet Wallace (*Physics*). A.B., Temple University, 1964;  
M.S., California Institute of Technology, 1966.  
*Thesis*: Equilibrium Properties of Submonolayer He<sup>4</sup> Films.
- Samuel Ward (*Biochemistry and Neurophysiology*). A.B., Princeton University, 1965.  
*Thesis*: Structure and Assembly of Bacteriophage T4 Tail Fibers.
- Donna E. Weistrop (*Astronomy*). B.A., Wellesley College, 1965.  
*Thesis*: Characteristics of Disk and Halo Populations Derived from Photographic Photometry.
- David Bruce Wenner (*Geochemistry and Geology*). B.S., University of Cincinnati, 1963; M.S., California Institute of Technology, 1966.  
*Thesis*: Hydrogen and Oxygen Isotopic Studies of Serpentinization of Ultramafic Rocks.
- James Edward Westmoreland III (*Physics*). B.S., Georgia Institute of Technology, 1966; M.S., California Institute of Technology, 1968.  
*Thesis*: Channeling Effect Analysis of Lattice Disorder in Boron Implanted Silicon.
- Clifford Martin Will (*Physics*). B.Sc., McMaster University, 1968.  
*Thesis*: Theoretical Frameworks for Testing Relativistic Gravity; The Parametrized Post-Newtonian Formalism.
- Charles Arthur Willus (*Mechanical Engineering and Physics*). B.M.E., Cornell University, 1965.  
*Thesis*: An Experimental Investigation of Particle Motion in Liquid Fluidized Beds.
- Michael Barron Wilson (*Applied Mechanics*). B.S.E., University of Michigan, 1963; M.S., 1964.  
*Thesis*: A Michell Oseen-Flow Theory for Thin Ships.
- Sandra Winicur (*Biochemistry*). B.A., Hunter College, 1960;  
M.S., University of Connecticut, 1963.  
*Thesis*: I. Studies on the Motility and Biochemistry of Cilia.  
II. Chitinase Activity During *Drosophila* Development.
- Steven Joseph Yellin (*Physics*). B.S., California Institute of Technology, 1963.  
*Thesis*: Photoproduction of Eta Mesons from Deuterium at 0° and 180° with Photon Energy from 725 MeV to 1225 MeV.



# 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 the field of creative scholarship.

*David Dixon, chemistry*

*Thomas A. Weaver, physics*

## FREDERICK W. HINRICHS, JR., MEMORIAL AWARD

Awarded to the senior who, in the opinion of the Undergraduate Deans, has throughout his years at the Institute made the greatest 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 upperclassmen, the basic costs of whose education have already been met but who would find it difficult, without additional help, to engage in extracurricular activities and in the cultural opportunities afforded by the community. The recipients are selected on the basis of their capacity to take advantage of and to profit from these opportunities rather than on the basis of their scholastic standing.

*Masayuki Ono, sophomore*

*Carroll Boswell, junior*

*Michael Muskin, junior*

*Bruce Spalding, freshman*

*Paul Re, junior*

## DAVID JOSEPH MACPHERSON PRIZE IN ENGINEERING

Awarded annually to the graduating senior in engineering who best exemplifies excellence in scholarship. The winning student is selected by a faculty committee of three, appointed annually by the chairman of the Division of Engineering and Applied Science.

*William T. Almassy*

## PRIZES AND AWARDS—*continued*

### DONALD S. CLARK ALUMNI AWARDS

May be awarded annually 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.

*George Nicolaidis, junior, chemical engineering*

*Stephen S. Watkins, sophomore, engineering*

### HAREN LEE FISHER MEMORIAL AWARD IN JUNIOR PHYSICS

Awarded annually to a junior physics major, to be selected by a physics faculty committee as demonstrating the greatest promise of future contributions to physics.

*Craig Sarazin*

### SIGMA XI AWARD

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

*Robert S. Fisher, biology*

### THE MORGAN WARD AWARD

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

*Bruce Reznick, sophomore*