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
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:

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

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  Mathematics
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 Aranguen  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 Dashiel  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
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. deChegaray, Edo de Mexico  Chemistry
BACHELOR OF SCIENCE—Continued

Alan Stuart Lederman New York, New York Mathematics
Victor Wal-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 Menkas 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 J. 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

Jose Alberto Albano do Amarante (Physics). Engineer, Instituto Tecnologico de
Aeronautica, 1966.
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 Ingenieuruschule
fur Maschinanwesen, 1964.
L. William Butterworth (Mechanical Engineering). B.S., California Institute
of Technology, 1970.
Philip Sidney Callahan (Physics). B.S., Cornell University, 1969.
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.
Theodor Sebastian Colbert (Electrical Engineering). M.S., University of
Bucharest, 1969.
John Lee Compton (Biology). B.S., Yale University, 1969.
Richard Henry Davies (Aeronautics). B.S.A.E., Northrop
Institute of Technology, 1970.
Jean Roger Delayen (Engineering Science). Engineer, Ecole Nationale Superieure
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.
Judith Louise Erb (Chemistry). B.S., University of California, Berkeley, 1968.


John Eugene Fink (Chemical Engineering). B.S. Ch.E., Newark College of Engineering, 1968.


Yaacov Goland (Mechanical Engineering). B.Sc., Israel Institute of Technology, 1969.


Leonidas John Guibas (Mathematics).


Joel Herbert Gyllenskog (Engineering Science). B.S., Utah State University, 1969.


Stephen Hernadi (Physics). B.Sc., Queens University, 1969.

Hiroshi Higuchi (Aeronautics). B.E., University of Tokyo, 1970.


James Dean Joseph (Electrical Engineering). B.S., Ohio State University, 1969; M.S., 1969.


Michael Byer Klayman (Biology). B.S., Union College, 1969.

James Joseph Kosmicki (Aeronautics). B.S., United States Naval Academy, 1968.


Fang Shyong Lai (Chemical Engineering). B.S., National Taiwan University, 1963; 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.


Dennis Y. K. Lew (Electrical Engineering). B.S.E.E., Purdue University, 1970.


Nabil I. Marzouk (Materials Science). B.Sc., American University, Cairo, 1966.


Charles C. Matthews (Mechanical Engineering). B.S.M.E., Purdue University, 1970.


Amr Mohamed Mohsen (Electrical Engineering). B. of Eng., Cairo University, Faculty of Engineering, 1968; M.S., American University, Cairo, 1970.


Wei-Tou Ni (Physics). B.Sc., National Taiwan University, 1966.


Andrew Michael Odlyzko (Mathematics).

Haluk Omer Sankur (Electrical Engineering). B.S., Robert College, 1970.
Andrew Ira Schwartz (Mechanical Engineering). B.S., Cornell University, 1970.
Frank Glenroy Smith III (Chemical Engineering). B.S., University of Louisville, 1969.
Alan Lane Sorensen (Aeronautics). B.S., Texas A & M University, 1970.
Klaus F. Stricker (Mechanical Engineering). B.S.M.E., California State Polytechnic College, Pomona, 1970.
Alan Douglas Strickland (Chemistry).


Gerald Wayne Ward (Chemical Engineering). B.S.E., University of Michigan, 1969.


Christopher George Whipple (Engineering Science). B.S., Purdue University, 1970.


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.


Jiunn-Jenq Wu (Aeronautical Engineer). B.S., National Taiwan University, 1964; M.S., California Institute of Technology, 1966.
DOCTOR OF PHILOSOPHY

  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: 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;
Barbara Joan Furman Attardi  (Biochemistry).  B.S., Cornell University, 1964.
  II. Properties of Membrane-Bound Ribosomes in Hela Cells.
  Thesis: Upper Hybrid Resonance Absorption and Scattering from a Plasma Column.
Raymond Dean Ayers  (Materials Science and Applied Mathematics).  B.S.,
  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.
Brian Thomas Barcelo  (Aeronautics).  B.S., Tulane University, 1965;
  M.S., California Institute of Technology, 1966.
  Thesis: Alfven Waves in the Interplanetary Medium.
Paula K. Bernstein  (Chemistry).  B.S., Barnard College, 1965;
  M.S., Columbia University, 1966.
DOCTOR OF PHILOSOPHY—Continued

Jacobo Bielak (Civil Engineering). Civil Engineer, National University of Mexico, 1965; M.S., Rice University, 1966.


Thesis: Hydrodynamic Shear Breakage of Native DNA.


Thesis: Elimination of Parity Doubled States from Regge Amplitudes.

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.

Thesis: Helical Movements of Flagellated-Propelling Microorganisms.


Jane Ellen Crawford (Chemistry). A.B., University of California, Santa Barbara, 1966.

Thesis: Spontaneous Breakdown of Conformal and Chiral Invariance.

DOCTOR OF PHILOSOPHY—Continued

_Thesis:_ An Experimental Investigation of the Effect of a Density Gradient on Shear Layer Instability.

_Thesis:_ Part I. An Investigation of the Utility of the Claisen Rearrangement in Angular Methylation as Illustrated by the Synthesis of $\text{z}$-Valeranone. Part II. The Total Synthesis of the Pentacyclic Triterpene $\text{d}$-Germanicol.

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.

_Thesis:_ Conductance Peaks at the Cyclotron Harmonics in a Cylindric Plasma Capacitor.


Stephen Dean Ellis (Theoretical Physics). B.S.E., University of Michigan, 1965.
_Thesis:_ A Dual Quark Model with Spin.


_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.

_Thesis:_ Infrared Spectra of Late-Type Stars.

_Thesis:_ Test of the $\Delta S = \Delta Q$ rule and CP-invariance in $K_{e\mu}$ decay.
DOCTOR OF PHILOSOPHY—Continued

Thesis: Alignment of Interstellar Grains.


Thesis: Permutation Decompositions of (0,1)-Matrices and Decomposition Transversals.


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.


Thesis: Theoretical and Experimental Investigations of the Flocculation of Charged Particles in Aqueous Solution by Polyelectrolytes of Opposite Charge.

II. The Specific Heat of Solids of Geophysical Interest.


Thesis: Elimination of Parity Doublets in Regge Amplitudes.


Thesis: Simple Groups of Order $2^n q^b r^c$.

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.  

Victor K. Liang  (Physics).  S.B., Massachusetts Institute of Technology, 1964;  
Thesis: Magnetic States in Amorphous Pd$_{41}$Ni$_{41}$B$_{18}$ Alloys Containing  
Chromium and Iron.

Thesis: Experiments on Parity Non-Conservation in Nuclear Forces in $^{180}$Hf, $^{180}$Tb,  
$^{208}$Ti and $^{181}$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.  

Mario Martínez-García  (Physics).  Lic. Ciencias Físicas, Instituto Tecnologico y de  
Estudios Superiores de Monterrey, 1965; M.S., California Institute of  
Technology, 1968.  
Thesis: Experimental Transition Probabilities for Lines of Fe I.

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.

Thesis: Photoproduction of Eta Mesons from Hydrogen at 0° and 180° for Energies  
Between 0.7 and 1.1 Gev.


Robert David Nebes  (Psychobiology and Developmental Biology).  B.S., Tufts  
University, 1965.  
Thesis: Investigations on Lateralization of Function in the Disconnected  
Hemispheres of Man.
*Thesis:* A Study of \( T = 2 \) States in \( ^{12}\text{B}, ^{12}\text{C}, ^{20}\text{F} \) and \( ^{28}\text{Al} \).

*Thesis:* Some Electronic Properties of ZnO and SrTiO\(_3\).

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.

*Thesis:* Transient Heating in Bénard Convection.

*Thesis:* Conformational Study of Some Fluorine-Labeled Cyclic Compounds by Nuclear Magnetic Resonance Spectroscopy.  I. \( 1,1\)-difluoro-cyclooctane and \( 3,3\)-difluoro-trans-cyclooctene.  
II. \( \gamma,\gamma\)-difluoro-\( \varepsilon \)-caprolactone and \( \gamma,\gamma\)-difluoro-\( \varepsilon \)-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.

*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.

I. Cation-Binding Properties of Nonactin.  
II. Salt Effects on Nucleotide Conformation.


*Thesis:* An Electrical and Statistical Study of Burst Noise.
DOCTOR OF PHILOSOPHY—Continued


Thesis: Electrodynamics in a Strong Magnetic Field.

II. Kinetics of Hydrocarbon Reactions in the Positive Column of D.C. and Pulsed D.C. Discharges.

Thesis: A Relativistic Quark Model with Harmonic Dynamics.

George Robert Rossman (Chemistry). B.S., Wisconsin State University, 1966. 
II. Spectroscopic and Magnetic Studies of Monomeric and Dimeric d5 Systems. 
III. Spectroscopic and Magnetic Studies of Polymeric Oxo- and Hydroxobridged Systems.


Thesis: The Isotopic Composition of Mg and the Implied Limits on 26Al in the Early Solar System; Nucleosynthesis of 26Al; and Nucleosynthetic Chronologies for the Galaxy.

Thesis: On Bacterial and φX-174 Messenger RNA.

Thesis: Magnetism in an Amorphous Fe-Pd-P Alloy System.

DOCTOR OF PHILOSOPHY—Continued

   II. Interaction of the Face of a Cyclopropane Ring with Positively Charged Carbon.

   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 Experimental Investigation of Turbulent Boundary Layer Over a Wavy Wall.

   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.

   M.S.C.E., 1968.
   Thesis: Dynamic Analysis of Coupled Shear Walls and Sandwich Beams.


   Thesis: The $^{16}\text{O} + {^1}\text{H}$ Reaction.

   M.S., University of California, Berkeley, 1967.

   Thesis: Applications of Model Theory to Complex Analysis.

William Alvis Thomasson (Biochemistry and Chemistry). B.A., University
   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 Andrá Tökés (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


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.  

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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 "rho, 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

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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 Nicolaides, 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