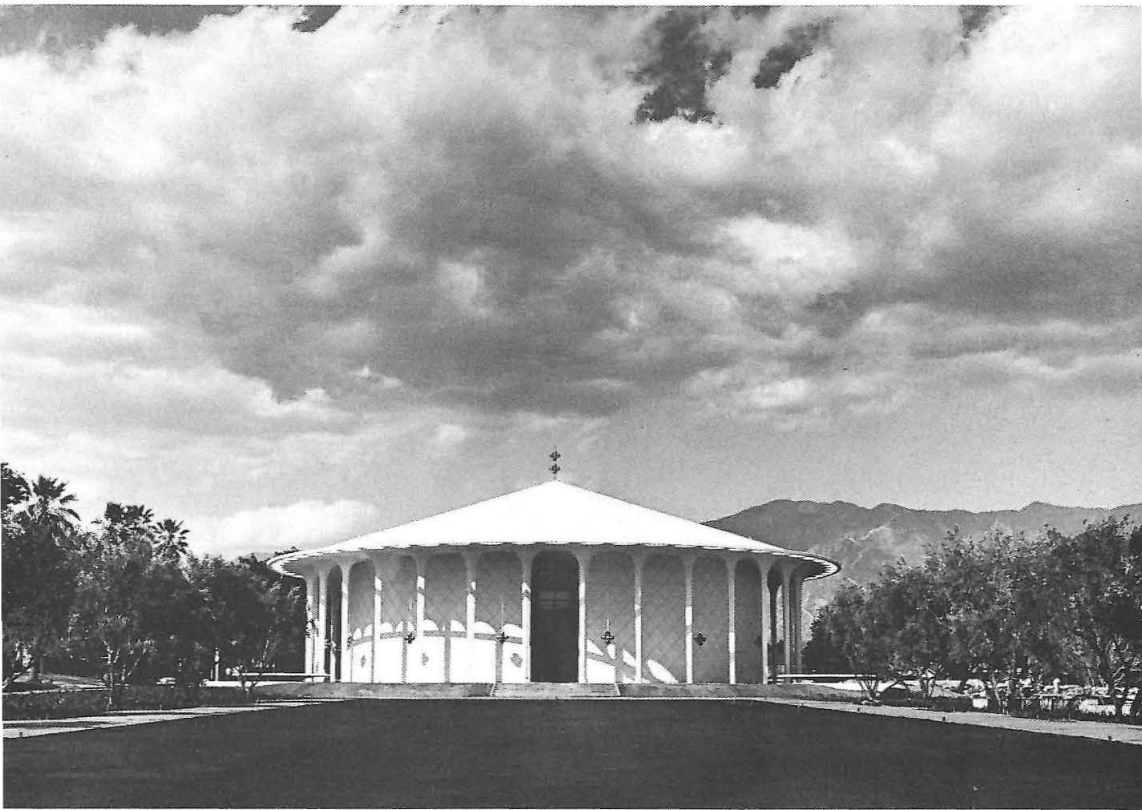


CALIFORNIA
INSTITUTE OF
TECHNOLOGY

Seventieth Annual Commencement



June 12, 1964

CALIFORNIA INSTITUTE OF TECHNOLOGY

*Seventieth
Annual
Commencement*

FRIDAY AFTERNOON AT FOUR-THIRTY O'CLOCK
JUNE TWELFTH, NINETEEN SIXTY-FOUR

Academic Procession

Chief Marshal, David S. Wood, Ph.D.

Assistant Marshals

Donald S. Clark, Ph.D. William H. Corcoran, Ph.D.

Rodman W. Paul, Ph.D.

MARCHING ORDER

Division I

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

Division II

THE FACULTY

THE CHAIRMEN OF DIVISIONS

THE DEANS

THE PROVOST

THE TRUSTEES

THE COMMENCEMENT CHAPLAIN

THE PRESIDENT

THE COMMENCEMENT SPEAKER

THE CHAIRMAN OF THE BOARD OF TRUSTEES

Program

CALIFORNIA INSTITUTE OF TECHNOLOGY

SEVENTIETH

ANNUAL COMMENCEMENT

PRESIDING: ARNOLD O. BECKMAN, Ph.D.

Chairman of the Board of Trustees

PRELUDE AND PROCESSIONAL The Caltech Band

INVOCATION . . . The Reverend David M. Held, B.A., B.D.

First Congregational Church, Pasadena

COMMENCEMENT ADDRESS

"The Arts in a Scientific Culture" . Henry T. Heald, D.Sc., LL.D.

President of The Ford Foundation

Program — continued

CONFERRING OF DEGREES . . . Lee A. DuBridge, Ph.D., Sc.D.

President of the California Institute of Technology

PRESENTATION OF CANDIDATES FOR DEGREES

For the degree of Bachelor of Science . . . Paul C. Eaton, A.M.

Dean of Students

For the degree of Master of Science . . . Milton S. Plesset, Ph.D.

Chairman of the Curriculum Committee

For the degree of Engineer . . . Frederic Bohnenblust, Ph.D.

Dean of Graduate Studies

For the degree of Doctor of Philosophy . . . Dean Bohnenblust

CONCLUDING REMARKS President DuBridge

BENEDICTION The Reverend Mr. Held

RECESSIONAL . *Organist:* James H. Shearer, A.R.C.M., A.R.C.O.

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

Candidates for Degrees

BACHELOR OF SCIENCE

Edward Stanley Angel, *Brooklyn, New York.* Engineering.
Curtis Lyman Atkin, *Cedar City, Utah.* Chemistry.
Jesse Lee Beauchamp, *Needles, California.* Chemistry.
Bruce Richard Beeghly, *Youngstown, Ohio.* Engineering.
Philip Harbaugh Bowles, *Bethesda, Maryland.* Physics.
Eliot Brainerd Bradford, Jr., *Amityville, New York.* Physics.
Daniel Anthony Brogan, *San Francisco, California.* Engineering.
Robert David Bruner, *Alhambra, California.* Chemistry.
Richard Ray Burgess, *Seattle, Washington.* Chemistry.
John Robert Burke, *Castro Valley, California.* Astronomy.
George Richards Cannon, Jr., *Burbank, California.* Engineering.
Roger Edson Card, *Inglewood, California.* Engineering.
Herbert Hwa-sen Chen, *Flushing, New York.* Physics.
William S. Cheng, *State College, Pennsylvania.* Physics.
Bob Li-shyng Ching, *Shanghai, China.* Physics.
Robert Francis Christie, Jr., *Denver, Colorado.* Physics.
John Francis Clauser, *Pasadena, California.* Physics.
David Lem Colton, *Winslow, Arizona.* Mathematics.
Spicer Van Allen Conant, *Washington, D.C.* Physics.
Albert Edmund Cosand, *Alhambra, California.* Engineering.
Wayne Franklin Covington, *Ashland, Oregon.* Engineering.
Thomas Quinn Hayes Crocker, *Northridge, California.* Mathematics.
Joseph Francis Cullen, *Bozeman, Montana.* Chemical Engineering.
Francis Anthony Dahlen, Jr., *Winslow, Arizona.* Geology.
Gary Evald Dahlman, *Portland, Oregon.* Mathematics.
Donald Wayne Davies, *Spokane, Washington.* Physics.
Thomas Charles DeKlyen, *San Bruno, California.* Engineering.
Duygu Mehmet Demirlioglu, *Istanbul, Turkey.* Physics.
Donald Edward Dick, *Madison, Wisconsin.* Engineering.
Robert Watson Diller, *Wichita, Kansas.* Physics.
Fred William Dorr, Jr., *Portland, Oregon.* Mathematics.
Steven Mark Farber, *Tacoma, Washington.* Engineering.
Ronald Gary Findlay, *Chico, California.* Engineering.
Herbert Roy Flindt, *Reno, Nevada.* Physics.
Clarence Sigmund Fuzak, Jr., *Redondo Beach, California.* Engineering.

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

BACHELOR OF SCIENCE—continued

Keith Thomas Gillen, *Beverly Hills, California*. Chemistry.
Allen Roy Gillespie, *San Mateo, California*. Engineering.
Robert Reagan Gilman, *Long Beach, California*. Chemistry.
Steven Jonathan Goldner, *Los Angeles, California*. Physics.
Samuel Robert Gordon, *El Cerrito, California*. Mathematics.
Stephen Alan Gorman, *Atwater, California*. Chemistry.
Lawrence Russell Gowen, *Portland, Oregon*. Biology.
Ray E. L. Green, *Englewood, Colorado*. Physics.
Richard Rutherford Green, *Kankakee, Illinois*. Engineering.
Steven Michael Green, *Los Angeles, California*. Biology.
Mark Northrop Gurnee, *Silver Spring, Maryland*. Physics.
Russell Dean Hageman, *Ames, Iowa*. Chemistry.
Richard Danforth Hake, Jr., *Worland, Wyoming*. Physics.
David Andrew Hammer, *Los Angeles, California*. Physics.
Thor Palmer Hanson, *Pasadena, California*. Chemical Engineering.
Donald J. Harlow, *Sacramento, California*. Astronomy.
Howard Elliot Harry, Jr., *Des Plaines, Illinois*. Engineering.
David Russell Hearn, *Tucson, Arizona*. Physics.
David Jonathan Edward Helfman, *Hollywood, California*. Mathematics.
Floyd Leigh Herbert, *La Puente, California*. Astronomy.
David Allyn Hewitt, *Massapequa, New York*. Geology.
Douglas Wade Hill, *Wilmette, Illinois*. Engineering.
Steven Allen Hillyard, *Bellflower, California*. Biology.
Alan Carleton Hindmarsh, *Los Altos, California*. Mathematics.
James Winston Hole, *Ann Arbor, Michigan*. Engineering.
Charles Henry Holland, Jr., *Arcadia, California*. Physics.
David Holtz, *Montebello, California*. Chemistry.
William Henry Howard, *Cincinnati, Ohio*. Biology.
Robert Jay Howenstine, *Geneva, Switzerland*. Engineering.
John Bockett Hunter, *Mexico, D.F., Mexico*. Mathematics.
David Lawrence Hyde, *El Centro, California*. Chemical Engineering.
Arthur Edward Johnson, *Wheaton, Minnesota*. Chemistry.
Bruce Rene Julian, *Pacific Palisades, California*. Engineering.
Richard Alan Karp, *Van Nuys, California*. Mathematics.
W. Dale Knutsen, II, *West Covina, California*. Engineering.
Thomas Edward Krueger, *Capistrano Beach, California*. Engineering.
Chung-Mo Kwok, *Kwangtung Province, China*. Mathematics.
David Redmond Lambert, *Washington, D.C.* Engineering.
Michael John Lambert, *Sacramento, California*. Mathematics.
Ronald Wayne Larsen, *Inglewood, California*. Engineering.
Thomas Walker Latham, *Jamaica Plain, Massachusetts*. Engineering.
Edward Prentiss Lee, Jr., *Palo Alto, California*. Physics.

BACHELOR OF SCIENCE—continued

Roger William Leezer, *Sacramento, California*. Physics.
Charles Franklin Leonard, *Arcadia, California*. Biology.
Kwok-Chu Leung, *Chungshan, Kwangtung Province, China*. Physics.
Robert Cooper Liebermann, *Patchogue, New York*. Geology.
Alan Joseph Limpo, *Lakewood, California*. Biology.
Arthur David Lipson, *North Haven, Connecticut*. Engineering.
Ponzy Lu, *Glendale, California*. Chemistry.
Tom C. Lubensky, *Quito, Ecuador*. Physics.
Thomas William MacDowell, *San Diego, California*. Mathematics.
John Michael Julius Madey, *Clark, New Jersey*. Physics.
George E. Mager, *Mahwah, New Jersey*. Physics.
Kenneth Fred Manly, *Westwood, Massachusetts*. Biology.
Terry Steven Mast, *Beverly Hills, California*. Physics.
Hans George Mattes, *San Marino, California*. Engineering.
Frank Fred Matthews, Jr., *Westlake, Ohio*. Mathematics.
Richard Dey Maxson, *Grand Ledge, Michigan*. Geology.
Peter Ogden Mazur, *Fargo, North Dakota*. Physics.
George Archibald McBean, *Evanston, Illinois*. Physics.
Roderick Canfield McCalley, *Boise, Idaho*. Chemistry.
Michael McCammon, *Hawthorne, California*. Mathematics.
John Henry McCoy, *Altus, Oklahoma*. Engineering.
Robert James McEliece, *Baltimore, Maryland*. Mathematics.
Richard Paul McGehee, *San Diego, California*. Mathematics.
John Herbert McKinley, *Pittsburgh, Pennsylvania*. Engineering.
Melvin Edward Medof, *Los Angeles, California*. Chemistry.
William Stuart Meisel, *El Campo, Texas*. Engineering.
Robert R. Meyer, *New Orleans, Louisiana*. Mathematics.
Guthrie Miller, *Downey, California*. Physics.
Roger Leon Minear, *Salem, Oregon*. Engineering.
Robert Alan Moline, *Santa Barbara, California*. Physics.
Malcolm Cameron Morrison, *Lubbock, Texas*. Chemical Engineering.
Terence Martin Murphy, *Seattle, Washington*. Biology.
Carter Graham Naylor, *Kemmerer, Wyoming*. Chemistry.
Donald James O'Hara, *Springfield, Missouri*. Mathematics.
Howard Ken Ono, *Los Angeles, California*. Chemistry.
Daniel Curtis Paxton, Jr., *Denver, Colorado*. Engineering.
Barry Wayne Peterson, *Glenside, Pennsylvania*. Chemistry.
Lee Louis Peterson, *Seattle, Washington*. Engineering.
George Thomas Preston, *Wayzata, Minnesota*. Chemical Engineering.
George Edward Radke, Jr., *Menlo Park, California*. Physics.
George Norman Reeke, *Green Bay, Wisconsin*. Chemistry.
Frank Scorgie Rhame, *San Antonio, Texas*. Biology.

BACHELOR OF SCIENCE—*continued*

Roy Johnson Riblet, III, *Brecksville, Ohio*. Biology.
William Rulon Ricks, *Mesa, Arizona*. Engineering.
William Joseph Rosenberg, *Los Angeles, California*. Mathematics.
Dennis Kent Ross, *Ogden, Utah*. Physics.
William Jay Schoene, *Norfolk, Virginia*. Engineering.
William Edward Schoknecht, *Milwaukee, Wisconsin*. Physics.
George Lawrence Scott, *Newhall, California*. Engineering.
David Henry Seib, *Exeter, California*. Engineering.
Laurence Ira Seide, *Syracuse, New York*. Engineering.
Richard John Shlegeris, *Los Altos, California*. Chemical Engineering.
LeRoy Edison Sievers, *Denver, Colorado*. Physics.
John Peter Slonski, Jr., *Minneapolis, Minnesota*. Physics.
William George Smith, Jr., *Phoenix, Arizona*. Chemical Engineering.
Richard Heath Stanton, *Santa Monica, California*. Physics.
Robert Martin Storwick, *Seattle, Washington*. Engineering.
William Calvin Stwalley, *Pasadena, California*. Chemistry.
Theodore John Tarby, *Auburn, New York*. Biology.
Joseph Dean Taynai, *Lincoln Park, New Jersey*. Engineering.
Lynn Forest TenEyck, *Lebanon, Oregon*. Biology.
Don William Terwilliger, *Springfield, Oregon*. Physics.
Gerald Harper Thomas, *Los Angeles, California*. Physics.
Harold Todd Thomas, *Trinidad, California*. Chemistry.
Leon Arthur Thomsen, *Tyler, Texas*. Geology.
Arthur P. L. Turner, *Des Moines, Iowa*. Engineering.
Alfred Ramsey Tyrrell, *Castro Valley, California*. Chemistry.
Richard Warren Uhrich, *Beaverton, Oregon*. Engineering.
Charles Irvin Vinsonhaler, *Seattle, Washington*. Mathematics.
Volker Michael Vogt, *Santa Barbara, California*. Chemistry.
Michael T. Wauk, II, *Covina, California*. Physics.
John Clinton Webber, *Corpus Christi, Texas*. Astronomy.
Willes Henry Weber, *Reno, Nevada*. Physics.
Martin E. Weiner, *New Rochelle, New York*. Physics.
Joseph Herman Weis, *Coulee Dam, Washington*. Physics.
Ray Franklin Weiss, *La Jolla, California*. Chemistry.
Dennis Ray White, *Alhambra, California*. Engineering.
James Carpenter Whitney, *Yonkers, New York*. Physics.
Mason Lamar Williams, III, *San Jose, California*. Engineering.
Paul Frank Winkler, Jr., *Chillicothe, Ohio*. Physics.
Lawrence Russell Yeagley, *Houston, Texas*. Engineering.
Alvin Bau Yuen Young, *Honolulu, Hawaii*. Engineering.
Ralph Howard Young, *San Luis Obispo, California*. Chemistry.

MASTER OF SCIENCE

AERONAUTICS

- Leslie Benjamin Anderson, III. B.S., *United States Air Force Academy*, 1963.
Johann Arbocz. B.S., *Northrop Institute of Technology*, 1963.
Tsun-Yung Chang. B.Sc., *Taiwan Provincial Cheng Kung University*, 1962.
Chia-Chun Chao. B.Sc., *Taiwan Provincial Cheng Kung University*, 1962.
Der-Shyr Chen. B.S., *National Taiwan University*, 1960.
Jay-Chung Chen. B.Sc., *Taiwan Provincial Cheng Kung University*, 1962.
Robert Frederick Davey. B.S., *United States Air Force Academy*, 1962.
Claude M. Delfosse. *Dipl. d'Ing., Ecole Nationale d'Ingenieurs Arts et Metiers*, 1963.
John Edward Dolby, Jr. B.S., *United States Naval Academy*, 1963.
Ulla Margareta Carlsdotter du Rietz. *Civ. Ing., Royal Institute of Technology (Sweden)*, 1962.
Cary Andrew Fisher. B.S., *United States Military Academy*, 1963.
Ralph Edwin Graham. B.S., *Mississippi State University*, 1961.
Jean-Marie Francois Grange. *Dipl. d'Ing. de l'Aeronautique, Ecole Nationale Supérieure de l'Aeronautique*, 1963.
Wayne William Haigh. B.Sc., *The University of Alberta*, 1962.
Keian Lowell Hoffman. B.E., *Cornell University*, 1963.
Hideo Igawa. B.S., *Northrop Institute of Technology*, 1962.
Raymond Dennis Klopotek. B.S., *United States Military Academy*, 1963.
Bruce Meno Lake. B.S.E., *Princeton University*, 1963.
John Seymour Letcher. B.S., *California Institute of Technology*, 1963.
Hans Karl Mueller. *Dipl. Ing., Technische Hochschule (Aachen)*, 1963.
Stanley Norman Nathanson. B.Ae.E., *Polytechnic Institute of Brooklyn*, 1960.
Andreas Puhl. *Dipl. Ing., Die Technische Hochschule Stuttgart*, 1961.
Edward Beeding Quill, Jr. B.S., *United States Military Academy*, 1957.
John Cottam Swonson, Jr. B.S., *United States Air Force Academy*, 1962.
Charlie Szu. B.S., *Taiwan Provincial Cheng Kung University*, 1960.
Keith Jordis Victoria. B.S.E., *The University of Michigan*, 1962.
Myles Alexander Walsh, III. A.B., *Harvard College*, 1963.
Patrick Dan Weidman. B.S., *California State Polytechnic College*, 1963.

APPLIED MATHEMATICS

- Fu-Wu Chang. B.S., *National Taiwan University*, 1957;
M.S., University of Houston, 1963.
Luis Gabriel Gorostiza. *Ing. Civ., La Universidad Nacional Autonoma de Mexico*, 1963.
Michael Philip Mortell. B.Sc., *University College, Cork, Ireland*, 1961; *M.Sc.*, 1963.

MASTER OF SCIENCE—continued

APPLIED MECHANICS

- John Randall Dickerson. B.S., *Illinois Institute of Technology*, 1963.
Melbourne Fernald Giberson. B.S., *University of Pennsylvania*, 1963.
Georges Pierre Giraudbit. *Dipl. d'Ing., Ecole Nationale d'Ingenieurs Arts et Metiers*, 1963.
Raúl Husid. C.E., *University of Chile*, 1960.
Takehiko Ikeda. B.Tech., *Yokohama National University*, 1963.

BIOLOGY

- Eudoxia Aliferis. B.S., *University of Massachusetts*, 1962.
Richard Joseph Levine. A.B., *Princeton University*, 1960.

CHEMICAL ENGINEERING

- Tzu-Ching Chang. B.S., *National Taiwan University*, 1960.
James Caldwell Hilton. B.S., *Texas Agricultural and Mechanical University*, 1963.
Jérôme Michel Montet. *Lic. es Sciences, Faculte des Sciences de Paris*, 1961;
Dipl. d'Ing., Ecole Nationale Supérieure de Chimie de Paris, 1962.
Francis Riggs Muncaster. B.Ch.E., *University of Virginia*, 1963.
Thomas Sturm Roberts, Jr. B.S., *Purdue University*, 1963.

CHEMISTRY

- Peter Baine. G.R.I.C., *Royal Technical College, England*, 1961.
John James Grocki. B.S., *Worcester Polytechnic Institute*, 1962.
Usha Shah. B.Sc., *University of Bombay*, 1961.

CIVIL ENGINEERING

- Kevin Laurence Carey. B.C.E., *Marquette University*, 1961.
Loh-Nien Fan. B.S., *National Taiwan University*, 1961.
Jonathan Akin French. A.B., *Harvard College*, 1961.
Nelson Mathew Skalbania. B.A.Sc., *The University of British Columbia*, 1961.
Hsueh-sheng Ts'ao. B.S., *National Taiwan University*, 1961.

ELECTRICAL ENGINEERING

- Jack Lee Arnold. B.S., *California Institute of Technology*, 1963.
Richard Craig Brandt Bemis. B.S., *California Institute of Technology*, 1951.
Michael William Blasgen. B.S., *Harvey Mudd College*, 1963.

MASTER OF SCIENCE—continued

ELECTRICAL ENGINEERING—continued

- John Millard Caywood. B.S., California Institute of Technology, 1963.
Wilfred P. Charette. B.S., California Institute of Technology, 1962.
Dikran Damlamayan. B.S., California Institute of Technology, 1963.
Guy J. de Balbine. Dipl. d'Ing., Ecole Centrale des Arts et Manufactures, Paris, 1963.
Marc Jozef Celina De Block. Ing., Katholieke Universiteit te Leuven, 1963.
Andrea De Mari. Ing., Politecnico de Torino, 1962.
Nathan Marvin Greenblatt. B.S., Illinois Institute of Technology, 1963.
Robert Henderson Hearn. B.S., California Institute of Technology, 1962.
Joseph Adamec Jurca. B.S., California Institute of Technology, 1959.
Karl Herman Kanus. S.B., Massachusetts Institute of Technology, 1961.
John Joseph Kenny. B.S., University of Rhode Island, 1963.
Steven Stuart Lavenberg. B.E.E., Rensselaer Polytechnic Institute, 1963.
Don Howard Lee. B.A., Whitman College, 1963;
B.S., California Institute of Technology, 1963.
Robert Russell Marley. B.E.Sc., University of Western Ontario, 1963.
Horacio Augusto Mendez. Dipl., Electronics Officers School, Argentine Navy, 1960.
John Brian Murphy. B.S.E.E., Bradley University, 1961.
Jacques Andre Parisot. Dipl. d'Ing., Ecole Supérieure d'Electricite, 1963.
Carl Elliott Patton, III. S.B., Massachusetts Institute of Technology, 1963.
Eugene Herbert Poppel. B.S., University of Pennsylvania, 1963.
Philippe Sidin. Ing. Civ., Ecole Nationale Supérieure des Telecommunications (Paris), 1963.
Michel Emile Sivirine. Dipl. Ing., Université de Grenoble, 1963.
George Frederick Soulé. B.A., Occidental College, 1963;
B.S., California Institute of Technology, 1963.
Stafford Emanuel Tavares. B.Eng., McGill University, 1962.
Karvel Kuhn Thornber. B.S., California Institute of Technology, 1963.
Charles Robert Trimble. B.S., California Institute of Technology, 1963.
Gary Burgess Turner. B.S., California Institute of Technology, 1962.
Dwayne Robert VanBesien. B.S., Bradley University, 1962.
Alexander Stephen Vertis. B.E., Stevens Institute of Technology, 1963.
David John Wahl. B.S., Washington State University, 1962.
Janusz Warszawski. B.Eng., McGill University, 1962.
Dan Webster Weller, Jr. B.S.M.E., University of Maryland, 1962; B.S.E.E., 1963.
Gerard Thomas Wrixon. B.E., National University of Ireland (Cork), 1961.
John Ying-Bun Wu. B.S., California Institute of Technology, 1963.
Geary Ralph Younce. B.S., California Institute of Technology, 1962.

MASTER OF SCIENCE—*continued*

ENGINEERING SCIENCE

Luc Olivier Bauer. *Dipl. d'Ing. Physicien, Ecole Polytechnique de l'Universite de Lausanne, 1963.*

GEOLOGY

Kevin Laurence Carey. *B.C.E., Marquette University, 1961.*

GEOPHYSICS

Alan Oliver Ramo. *S.B., Massachusetts Institute of Technology, 1963.*

MATERIALS SCIENCE

Raymond Dean Ayers. *B.S., California Institute of Technology, 1963.*

Richard Clark Blish, II. *B.S., California Institute of Technology, 1963.*

Chien-hsin Hsiung. *B.S., National Taiwan University, 1960.*

MATHEMATICS

Bruce Jerome Aborn. *B.Sc., Ohio State University, 1961.*

John Meurig John. *B.Sc., University of Swansea (Wales), 1961; M.Sc., 1963.*

Ralph Vencil Skarda, Jr. *B.A., Pomona College, 1961.*

MECHANICAL ENGINEERING

Mahmoud Khairy Abdel-Gawad. *B.Sc., Alexandria University (Egypt), 1960.*

James Richmond Barnes. *B.S., Stanford University, 1960.*

Paul Wilfred Butler. *B.S., Michigan State University, 1963.*

Jean-Michel Calle. *Dipl. d'Ing., Ecole Centrale des Arts et Manufactures, 1963.*

Wayne Robert Cooper. *B.Sc., University of Saskatchewan, 1961.*

Jerry Wayne Crossett. *B.S., Iowa State University, 1961.*

David Gee-Clough. *B.Sc., University of Wales, 1963.*

Lynn Walter Glover, Jr., *B.S., University of California (Los Angeles), 1963.*

Tomifumi Godai. *B.S., University of Tokyo, 1957.*

Chee Leung Ho. *B.Sc., Queens University (Ontario), 1963.*

Ramani Mani. *B.E., University of Bombay, 1963.*

Francis Kamp McGinnis, III. *B.S., Southern Methodist University, 1963.*

John Richard Schuster. *B.S., California State Polytechnic College, 1963.*

MASTER OF SCIENCE—*continued*

PHYSICS

- Fred Andrew Blum, Jr. B.S., *University of Texas*, 1962.
Robert Franklin Poe. B.S., *California Institute of Technology*, 1961;
A.B., *University of California (Berkeley)*, 1962.
David Herbert Rogstad. B.S., *California Institute of Technology*, 1962.
Wesley Loren Shanks. B.S., *California Institute of Technology*, 1960.
Randle William Ware. B.S., *California Institute of Technology*, 1963.

ENGINEER

AERONAUTICAL ENGINEER

- ✓ Harvey Worth Burden, Lt., U.S.N. B.S., *United States Naval Academy*, 1955.
Hans Werner Grellmann. B.S., *Purdue University*, 1962; M.S., 1963.
✓ Robert Theodore Herzog, Lt., U.S.A.F. B.S., *California Institute of Technology*,
1956; M.S., 1963.
✓ Peter John Mantle. D.C.Ae., *The College of Aeronautics (Cranfield, England)*,
1958.
✓ Demetrius Philippou. D.L.C. (Hons), *Loughborough College (England)*, 1954;
M.S., *California Institute of Technology*, 1961.
William John Henry Smithey, Lt., U.S.N. B.M.E., *University of Virginia*, 1957.

ELECTRICAL ENGINEER

- ✓ Michael Stewart Shumate. B.S., *Purdue University*, 1955; M.S.E., 1956.

DOCTOR OF PHILOSOPHY

E. Olabisi Akinrimisi (*Biology and Chemistry*). B.Sc., Michigan State University, 1960.

Thesis: I. Properties of Helical Polycytidylic Acid.
II. Interaction of Purine with Proteins and Amino Acids.
III. Binding of Basic Proteins to DNA.

Stephen Alfred Andrea (*Mathematics and Physics*). B.A., Oberlin College, 1960.

Thesis: On the Embedding of Homeomorphisms of the Plane in Flows.

Robert James Arenz (*Aeronautics*). B.S., Oregon State College, 1945;
M.S., Lic. in Phil., St. Louis University, 1957.

Thesis: Theoretical and Experimental Studies of Wave Propagation in Viscoelastic Materials.

Claude Arpigny (*Astronomy and Physics*). Lic. Sci., University of Liège, 1958.

Thesis: A Study of Molecular and Physical Processes in Comets.

Boris Auksmann (*Mechanical Engineering*). B.A.Sc., University of British Columbia, 1955; M.S., California Institute of Technology, 1958; M.Eng., 1959.

Thesis: Investigation of Mechanical Seals.

Donald Baganoff (*Aeronautics*). B.S., Purdue University, 1957;
M.S., Washington University, 1960.

Thesis: Experiments on the Wall-Pressure History in Shock Reflection Processes.

Shawn Biehler (*Geophysics*). B.S.E., Princeton University, 1958; M.S.E., 1959;
M.S., California Institute of Technology, 1961.

Thesis: A Geophysical Study of the Salton Trough, Southern California.

Robert Roy Blandford (*Geophysics and Physics*). B.S., California Institute of Technology, 1959.

Thesis: Stratified Inertial Flow in the Gulf Stream.

William B. Bush (*Aeronautics*). B.S., Princeton University, 1955.

Thesis: On the Viscous Hypersonic Blunt-body Problem.

William Masee Chapple (*Geology and Mathematics*). B.S., California Institute of Technology, 1956; M.S., 1957.

Thesis: Mathematical Study of Finite-Amplitude Rock-Folding.

Barry Gillespie Clark (*Astronomy and Physics*). B.S., California Institute of Technology, 1959.

Thesis: The 21 Cm Hydrogen Line in Absorption.

DOCTOR OF PHILOSOPHY—continued

Peter Osgoode Clark (*Electrical Engineering and Physics*). B.E.Ph., McGill University, 1960; M.S., California Institute of Technology, 1961.

Thesis: An Analysis of Multireflector Optical Resonators.

René Clément Collette (*Electrical Engineering and Physics*). Ing. Civil A.I.M., University of Liège, 1958; M.S., California Institute of Technology, 1960.

Thesis: Domain Walls, Demagnetizing Fields and Anisotropy in Thin Ferromagnetic Films.

Robert Fredrick Cuffel (*Chemical Engineering*). B.S., Iowa State College, 1959; M.S., California Institute of Technology, 1960.

Thesis: I. Latent Heat of Vaporization of 1-Pentene.
II. Thermal Transfer from a Small Wire in Isothermal and Nonisothermal Boundary Flows about a Cylinder.

Roger Fred Dashen (*Physics*). A.B., Harvard College, 1960.

Thesis: S-Matrix Methods for Electromagnetic Corrections to Strong Interactions with an Application to the Proton-Neutron Mass Difference.

Frank Sigel Dietrich, III (*Physics*). B.A., Haverford College, 1959.

Thesis: A Study of the $\text{Li}^7(\text{He}^3, n)\text{B}^9$ Reaction by Time-of-Flight Techniques.

David Arthur Evensen (*Aeronautics*). B.S., Worcester Polytechnic Institute, 1959; M.S., California Institute of Technology, 1960.

Thesis: Non-Linear Flexural Vibrations of Thin Circular Rings.

William Thomas Fehlberg (*Engineering Science*). B.S.E., University of Michigan, 1960.

Thesis: Thermal Neutron Distributions near Material Discontinuities.

Efthymios Stefanos Folias (*Aeronautics and Mathematics*). B.S., University of New Hampshire, 1959; M.S., 1960.

Thesis: The Stresses in a Spherical Shell Containing a Crack.

Lorraine Lois Turnbull Foster (*Mathematics and Philosophy*). B.A., Occidental College, 1960.

Thesis: On the Characteristic Roots of the Product of Certain Rational Integral Matrices of Order Two.

John Kelsey Gardner (*Geophysics*). B.S., University of Arizona, 1953; M.S., 1958.

Thesis: Earthquakes in the Walker Pass Region, California, and their Relation to the Tectonics of the Southern Sierra Nevada.

DOCTOR OF PHILOSOPHY—*continued*

Edward George Gibson (*Mechanical Engineering and Physics*). B.S., University of Rochester, 1959; M.S., California Institute of Technology, 1960.

Thesis: Ionization Phenomena in a Gas-Particle Plasma.

Robert Goldstein (*Engineering Science and Physics*). B.S., Columbia University, 1959; M.S., California Institute of Technology, 1960.

Thesis: Quantitative Spectroscopic Studies on the Infrared Absorption by Water Vapor and Liquid Water.

James Alexander Grant (*Geology*). B.Sc.(hons.), Aberdeen University, 1957; M.A., Queen's University (Ontario), 1959.

Thesis: The Nature of the Grenville Front near Lake Timagami, Ontario.

Augustine Heard Gray, Jr. (*Engineering Science*). S.B., Massachusetts Institute of Technology, 1959; S.M., 1959.

Thesis: Stability and Related Problems in Randomly Excited Systems.

Charles Kenneth Grimes (*Aeronautics*). B.S., University of Alabama, 1949; S.M., Massachusetts Institute of Technology, 1956.

Thesis: Studies on the Propagation of Elastic Waves in Solid Media.

Fletcher Ivan Gross (*Mathematics and Physics*). B.S., California Institute of Technology, 1960.

Thesis: The 2-length of a Finite Solvable Group.

Charles Robert Hamilton (*Psychobiology and Biochemistry*). B.S., University of the South, 1957.

Thesis: Studies on Adaptation to Deflection of the Visual Field in Split-Brain Monkeys and Man.

Charles Woods Harper, Jr. (*Geology*). S.B., Massachusetts Institute of Technology, 1959; S.M., 1961.

Thesis: The Brachiopods of the Arisaig Series (Silurian-Lower Devonian) of Nova Scotia.

James Burkett Hartle (*Physics*). A.B., Princeton University, 1960.

Thesis: Complex Angular Momentum in Three-Particle Potential Scattering.

Gilbert Arthur Hegemier (*Aeronautics*). B.E.S., Brigham Young University, 1959; M.S., California Institute of Technology, 1960.

Thesis: Stability of Thin Cylindrical Shells Subjected to a Class of Axially Symmetric Moving Loads.

DOCTOR OF PHILOSOPHY—continued

Wallace Irving Honeywell (*Chemical Engineering and Chemistry*). B.S., Stanford University, 1959; M.S., 1960.

Thesis: X-Ray Diffraction Studies of Dense Fluids.

Gordon Frierson Hughes (*Electrical Engineering*). B.S., California Institute of Technology, 1959; M.S., 1960.

Thesis: A Threshold Gate Feed-Forward Switching Net Algorithm.

Johannes Huisman (*Chemical Engineering*). Dipl., Dordrecht Technical College, The Netherlands, 1956; Dipl., Royal Melbourne Technical College, 1959; M.S., California Institute of Technology, 1962.

Thesis: I. Latent Heat of Vaporization of n-Hexane.

II. Volumetric and Latent Heat of Vaporization Measurements for trans-2-Butene.

III. Partial Enthalpy Change upon Vaporization for n-Butane in the n-Butane-n-Decane System.

Thomas Kintzing Hunt (*Physics*). B.A., Pomona College, 1959; M.S., California Institute of Technology, 1961.

Thesis: Fluxoid Conservation by Superconducting Thin Film Rings.

Alexander Donald Jacobson (*Electrical Engineering*). B.S., University of California (Los Angeles), 1955; M.S., 1958.

Thesis: On the Theory of Noise-like Electromagnetic Fields of Arbitrary Spectral Width.

Noel Duane Jones (*Chemistry*). B.S., Rensselaer Polytechnic Institute, 1959.

Thesis: I. Alpha-keto-1,1'-trimethyleneferrocene.

II. The Chloranil-Hexamethylbenzene Complex, a Refinement.

III. Two Phenazine Derivatives from *Pseudomonas aureofaciens*.

Lisle Thomas Jory (*Geology and Geochemistry*). B.A.Sc., University of British Columbia, 1950.

Thesis: Mineralogical and Isotopic Relations in the Port Radium Pitchblende Deposit, Great Bear Lake, Canada.

Boris Jules Kayser (*Physics*). A.B., Princeton University, 1960.

Thesis: Dynamical Model of the Σ .

Willard Otis Keightley (*Applied Mechanics*). B.S., Wayne State University, 1951; M.S., 1956.

Thesis: Vibration Tests of Structures.

DOCTOR OF PHILOSOPHY—*continued*

- Robert Ching-Yee Koh (*Applied Mechanics and Mathematics*). B.S., California Institute of Technology, 1960; M.S., 1961.
Thesis: Viscous Stratified Flow towards a Line Sink.
- Warner Bruce Kover (*Chemistry*). B.S., Yale University, 1959.
Thesis: Carbonium Ion Intermediates from Allylcarbiny and Cyclopropylcarbiny Derivatives.
- Robert Leroy Kruse (*Mathematics and Economics*). B.A., Pomona College, 1960; M.S., California Institute of Technology, 1962.
Thesis: Rings with Periodic Additive Group in which All Subrings are Ideals.
- Kelvin Shun-Hung Lee (*Electrical Engineering*). B.S., California Institute of Technology, 1960; M.S., 1961.
Thesis: On the Doppler Effect in a Medium.
- Robert Cary Leif (*Chemistry*). B.S., University of Chicago, 1959.
Thesis: The Distribution of Buoyant Density of Human Erythrocytes in Bovine Albumin Solutions.
- Mark Levinson (*Aeronautics*). B.Ae.E., Polytechnic Institute of Brooklyn, 1951; M.S., 1960.
Thesis: Variational Principles and Applications in Finite Elastic Strain Theory.
- Alfred George Lieberman (*Electrical Engineering and Physics*). B.S., Polytechnic Institute of Brooklyn, 1958; M.S., California Institute of Technology, 1959.
Thesis: Mode Excitation and Propagation in Waveguides Containing Anisotropic Plasmas.
- Ronald Keith Linde (*Materials Science*). B.S., University of California, 1961; M.S., California Institute of Technology, 1962.
Thesis: Kinetics of Transformation of Metastable Silver-Copper Solid Solutions.
- Joseph Tsu Chieh Liu (*Aeronautics*). B.S., University of Michigan, 1957; M.S., 1958.
Thesis: Problems in Particle-Fluid Mechanics.
- Louis Aloysius Lopes, Jr. (*Mathematics*). B.S., Stanford University, 1948; M.S., 1949.
Thesis: Operator Differential Equations in Hilbert Space.
- Huey-Lin Luo (*Engineering Science*). B.S., National Taiwan University, 1956; M.S., Iowa State College, 1959.
Thesis: Metastable Amorphous Phase of Tellurium-Base Alloys.

DOCTOR OF PHILOSOPHY—*continued*

Jack William Macki (*Mathematics and Physics*). B.S., University of Idaho, 1960.

Thesis: Singular Perturbations of a Boundary-Value Problem for a System of Nonlinear Differential Equations.

Malcolm McColl (*Electrical Engineering and Physics*). B.S., Wayne State University, 1957; M.S., California Institute of Technology, 1958.

Thesis: Electron Current through Thin Mica Films.

Edward Rae Held McDowell (*Chemical Engineering*). B.Chem.E., Cornell University, 1955; M.S., California Institute of Technology, 1960.

Thesis: Transient Heat Transfer in Solids.

Manuel E. Méndez (*Astronomy*). Ch.E., University of Mexico, 1959; M.S., California Institute of Technology, 1962.

Thesis: Spectrophotometry of the Orion Nebula.

Arthur William Merkl (*Chemistry and Physics*). B.S., University of Cincinnati, 1958.

Thesis: I. Spectrometer for Zero-Field Spin Resonance.

II. Triplet Exciton Spin Resonance in Zero Field.

Dimitri Manuel Mihalas (*Astronomy and Physics*). A.B., University of California (Los Angeles), 1959; M.S., California Institute of Technology, 1960.

Thesis: Model Atmosphere Studies of Early Type Stars.

Kenneth Martin Mitzner (*Electrical Engineering*). S.B., Massachusetts Institute of Technology, 1958; M.S., California Institute of Technology, 1959.

Thesis: Theory of the Scattering of Electromagnetic Waves by Irregular Interfaces.

Elliott Robert Nagelberg (*Electrical Engineering*). B.E.E., The City College of New York, 1959; M.E.E., New York University, 1961.

Thesis: Microwave Interaction with Bounded Gyroelectric Plasmas.

John Carl Nickel (*Physics*). B.A., University of California (Riverside), 1958; M.S., California Institute of Technology, 1960.

Thesis: Experimental Study of Plasma Wave Resonances in a Hot Nonuniform Plasma Column.

Niels Norby Nielsen (*Civil Engineering*). C.E., Technical University (Copenhagen), 1954.

Thesis: Dynamic Response of Multistory Buildings.

DOCTOR OF PHILOSOPHY—*continued*

Robert Henry Norton (*Astronomy and Physics*). B.S., California Institute of Technology, 1957; M.S., 1958.

Thesis: HeH⁺ in Model Stellar Atmosphere.

Harris Anthony Notarys (*Physics*). S.B., Massachusetts Institute of Technology, 1954.

Thesis: Megacycle Frequency Second Sound.

Michael Edmond James O'Kelly (*Applied Mechanics, Electrical Engineering and Economics*). B.E., National University of Ireland (Cork), 1958; M.S., California Institute of Technology, 1960; M.Eng., 1961; M.S., Columbia University, 1962.

Thesis: Vibration of Viscously Damped Linear Dynamic Systems.

Edwin Soland Olson (*Chemistry and Physics*). B.A., St. Olaf College, 1959.

Thesis: I. The Structure of the Orange Pigment from *Pseudomonas aureofaciens*.

II. The Biogenesis of Strychnine.

III. Beckmann Fission of a gamma-Keto Oxime.

Patrick Gerard O'Regan (*Electrical Engineering*). B.E., University College (Cork), 1957; M.S., California Institute of Technology, 1959.

Thesis: The Application of Tunnel Diodes to Switching and Logical Circuits.

Jerald Vawer Parker (*Physics*). B.S., California Institute of Technology, 1960.

Thesis: Theory of Plasma Wave Resonance in a Hot Nonuniform Plasma.

R. Reid Parmerter (*Aeronautics*). B.S., California Institute of Technology, 1958; M.S., 1959.

Thesis: Asymmetrical Buckling of a Spherical Cap under Uniform Pressure.

Richard Walker Patch (*Engineering Science*). B.S., Purdue University, 1953; M.S., California Institute of Technology, 1958.

Thesis: I. Radiative Transfer Studies and Opacity Calculations for Heated Gases.

II. Absolute Intensity Measurements for the 2.7 Micron Band of Water Vapor in a Shock Tube.

Charles William Peck (*Physics*). B.S., New Mexico College of Agriculture and Mechanic Arts, 1956.

Thesis: K⁺ Lambda Photoproduction at 1200 MeV in the Forward Atmosphere.

Philip Carl Peters (*Physics*). B.S., Purdue University, 1960.

Thesis: Gravitational Radiation and the Motion of Two Point Masses.

DOCTOR OF PHILOSOPHY—continued

John Marlan Poindexter (*Physics*). B.S., United States Naval Academy, 1958;
M.S., California Institute of Technology, 1961.

Thesis: Electronic Shielding by Closed Shells in Thulium Compounds.

James Ray Rapp (*Chemistry*). A.B., Harvard College, 1960.

Thesis: I. Stereospecificity in *alpha*-Chymotrypsin-Catalyzed Reactions.

II. The Structural Specificity of *alpha*-Chymotrypsin: Some New Substrates.

III. A Further Study of Monofunctional Aromatic Inhibitors of *alpha*-Chymotrypsin.

Bernard Charles Reardon (*Electrical Engineering and Mathematics*). B.E.,
University College (Cork), 1957; M.S., California Institute of Technology,
1959.

Thesis: Deposited Loops Coupling Magnetic Films as Fast Computer Elements.

Ira Richer (*Electrical Engineering and Physics*). B.E.E., Rensselaer Polytechnic
Institute, 1959; M.S., California Institute of Technology, 1960.

Thesis: Properties of an Arbitrarily Doped Field-Effect Transistor.

Sergio Enrique Rodriguez (*Chemical Engineering and Chemistry*). B.S.,
California Institute of Technology, 1951; M.S., 1952.

Thesis: X-Ray Diffraction Studies of Stable and Supercooled Liquid Gallium.

Allan Joseph Rosen (*Chemistry*). A.B., Harvard College, 1959.

Thesis: Studies of Cyclopropylcarbiny- Allylcarbiny Free Radicals.

Jack Saltiel (*Chemistry*). B.A., Rice University, 1960.

Thesis: Photoisomerization of the Stilbenes: An Application of Chemical
Spectroscopy.

Stanley Arthur Sawyer (*Mathematics*). B.S., California Institute of Technology,
1960.

Thesis: On Inequalities of Weak Type.

Steven Emanuel Schwarz (*Electrical Engineering and Physics*). B.S., California
Institute of Technology, 1959; A.M., Harvard College, 1960; M.S., California
Institute of Technology, 1961.

Thesis: Plasma Diagnosis by Means of Photon-Electron Scattering.

Richard A. Scott (*Engineering Science*). B.S., University College (Cork), 1957;
M.Sc., 1960.

Thesis: Transient Wave Propagation in Elastic Plates with Cylindrical
Boundaries, Studied with the Aid of Multi-integral Transforms.

DOCTOR OF PHILOSOPHY—*continued*

L. S. Senhouse, Jr. (*Physics*). B.M.E., College of the City of New York, 1955;
M.S., University of California (Los Angeles), 1957.

Thesis: A Study of d-He⁴ Elastic Scattering.

William Lewis Shackelford (*Engineering Science and Physics*). B.E., Yale
University, 1959; M.S., California Institute of Technology, 1960.

Thesis: I. Measurement of gf-Valves for Singly Ionized Chromium Using
the Reflected Wave Region of a Shock Tube.

II. Experimental Investigation of the Approach to Equilibrium Ionization and
Electronic Excitation in Shock-Heated Mixtures of Chromium and Argon.

III. Approximate Spectral Absorption Coefficient Calculations for Electronic
Band Systems Belonging to Diatomic Molecules.

Lawrence Fred Shampine (*Mathematics*). B.S., California Institute of
Technology, 1961.

Thesis: Asymptotic L₂ Inequalities of Markoff Type.

David Howland Sharp (*Physics*). A.B., Princeton University, 1960.

Thesis: On the Dynamical Determination of High Energy Scattering Cross
Sections.

Alex Shumka (*Electrical Engineering*). B.A.Sc., University of Toronto, 1957;
M.S., California Institute of Technology, 1958.

Thesis: Space-Charge-Limited Current in Germanium.

Harris Julian Silverstone (*Chemistry and Physics*). A.B., Harvard College, 1960.

Thesis: A Theoretical Study of the Electron Spin Resonance Spectra of
Cycloheptatrienyl.

Robert Edmund Singleton (*Engineering Science*). B.S., North Carolina State
College, 1960; M.S., California Institute of Technology, 1962.

Thesis: Fluid Mechanics of Gas-Solid Particle Flow in Boundary Layers.

Lionel Joseph Skidmore (*Electrical Engineering*). B.S., Tulane University, 1957;
M.S., 1959.

Thesis: Discrete and Continuous Estimation in Correlated Noise with Finite
Observation Time.

Frank William Spaid (*Mechanical Engineering*). B.S., Oregon State College,
1959; M.S., California Institute of Technology, 1961.

Thesis: A Study of Secondary Injection of Gases into a Supersonic Flow.

William Dean Squire (*Electrical Engineering*). B.S., California Institute of
Technology, 1950; M.S., 1960.

Thesis: The Effects of Bias on Polarity-Coincidence Detection.

DOCTOR OF PHILOSOPHY—*continued*

Donal Diepen Thomas (*Chemistry*). B.S., University of California, 1960.

Thesis: I. The Magnetic Resonance of Triplet Excitons in Solid Free Radicals.

II. A Zero Field Magnetic Resonance Spectrometer.

Mitchell Thomas (*Engineering Science and Physics*). A.B., Harvard College, 1958; M.S., University of Illinois, 1959.

Thesis: Radiative Transfer and Opacity Calculations.

Richard Ripley Tracy (*Aeronautics*). B.S., California Institute of Technology, 1952; M.S., 1957.

Thesis: Hypersonic Flow Over a Yawed Circular Cone.

Wai Keung Tso (*Civil Engineering*). B.Sc., University of London, 1959; M.S., California Institute of Technology, 1960.

Thesis: Dynamics of Thin-Walled Beams of Open Section.

Harold Paul Waits (*Chemistry*). B.S., University of Illinois, 1959.

Thesis: Cage Effects in the Thermal Decomposition of 1,1'-Azocyanocyclohexane and the Related Ketenimine.

Kenneth Watson (*Geophysics*). B.A., University of Toronto, 1957; M.S., California Institute of Technology, 1959.

Thesis: I. The Thermal Conductivity Measurements of Selected Silicate Powders in Vacuum from 150° to 350°K.

II. An Interpretation of the Moon's Eclipse and Lunation Cooling as Observed through the Earth's Atmosphere from 8-14 μ .

George McClelland Whitesides (*Chemistry*). A.B., Harvard College, 1960.

Thesis: I. The Configurational Stability of Primary Grignard Reagents.

II. Applications of Nuclear Magnetic Resonance Spectroscopy to the Study of Molecular Asymmetry.

Thomas Henry Wirth (*Chemistry*). A.B., Cornell University, 1959.

Thesis: Mercury-amine Complexes and Aromatic Mercurials. A Study of Compounds Containing Mercury-nitrogen and Mercury-carbon Bonds in Aqueous Solution.

David Eldon Wood (*Chemistry*). B.S., Oklahoma State University, 1960; M.S., California Institute of Technology, 1961.

Thesis: I. Electron Spin Resonance of Cycloheptatrienyl.

II. Auxiliary Apparatus.

George Zweig (*Physics*). B.S., University of Michigan, 1959.

Thesis: Two Topics in Elementary Particle Physics:

I. The Reaction $\gamma + N \rightarrow \pi + N$ at High Energies.

II. K Leptonic Decay and Partially Conserved Currents.

Prizes and Awards

DON BAXTER, INC., PRIZES

Awarded for outstanding undergraduate research in chemistry.

First prize shared by:

JESSE LEE BEAUCHAMP and KEITH THOMAS GILLEN

Honorable mention:

GEORGE NORMAN REEKE and WILLIAM CALVIN STWALLEY

EASTMAN KODAK SCIENTIFIC AWARDS

Awarded to doctoral students on the basis of outstanding contributions and progress either in graduate studies and research or in teaching.

Physics: ROGER FRED DASHEN

DAVID JOSEPH MACPHERSON PRIZE

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

STEVEN MARK FARBER

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.

(Recipient to be announced)

FREDERIC 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)