SHAPING AND DEFINING FIELDS









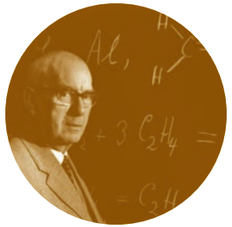





NOBEL LAUREATES AND FIELDS MEDALISTS IN THE PHYSICAL SCIENCES DIVISION AT THE UNIVERSITY OF CHICAGO







THE NOBEL PRIZE

Alfred Nobel, who was best known for the invention of dynamite, established the Nobel Prizes in Chemistry, Literature, Peace, Physics, and Medicine in 1895. The first prizes were awarded in 1901. The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel was established in 1968 after a donation from Sweden's central bank.

THE FIELDS MEDAL

The Fields Medal has long been considered the Nobel Prize for mathematics. It is awarded to mathematicians under forty years of age at the International Congress of the International Mathematical Union every four years. The medal was first awarded in 1936 and is named after Canadian mathematician John Charles Fields.

THE ABEL PRIZE

The Abel Prize is awarded annually by the King of Norway to outstanding mathematicians. The Norwegian government established the prize in 2002 to honor the 200th anniversary of Niels Henrik Abel's birth.

THE CRAFOORD PRIZE

The Crafoord Prize is awarded in partnership with the Swedish Royal Academy of Sciences and the Crafoord Foundation. The prize is awarded in four categories: astronomy and mathematics; geosciences; biosciences; and polyarthritis.

THE A.M. TURING AWARD

The A.M. Turing Award, considered the highest distinction in computer science, is an annual prize given by the Association for Computing Machinery in recognition of individual contributions to the field. The award is named for Alan Turing, who is considered one of founders of theoretical computer science and artificial intelligence.

LETTER FROM THE DEAN

The Physical Sciences Division (PSD) at the University of Chicago is home to visionary scholars who have redefined the frontiers of the physical and mathematical sciences throughout history. Many of the accomplishments of the division's faculty and alumni have earned recognition, including Nobel Prizes in Physics, Chemistry, and Economics, the Fields Medal in Mathematics, the Abel Prize, the Crafoord Prize, and the A.M. Turing Award.

This book honors UChicago physical scientists and mathematicians who have paved the way for researchers across the globe. Albert A. Michelson, who founded the Department of Physics at UChicago, revolutionized our concepts of light and vacuum with his interferometric experiments and was the first American scientist to win a Nobel Prize. Chemist Willard Libby developed the technique for dating organic compounds using carbon-14 in one of our laboratories. Former faculty member Maria Goeppert Mayer proposed the nuclear shell model of the atomic nucleus and became the second woman to win a Nobel Prize in Physics. As dean of the PSD, I have the unique opportunity to support the next generation of field-defining scientists who are following in the esteemed footsteps of these laureates and award-winners.

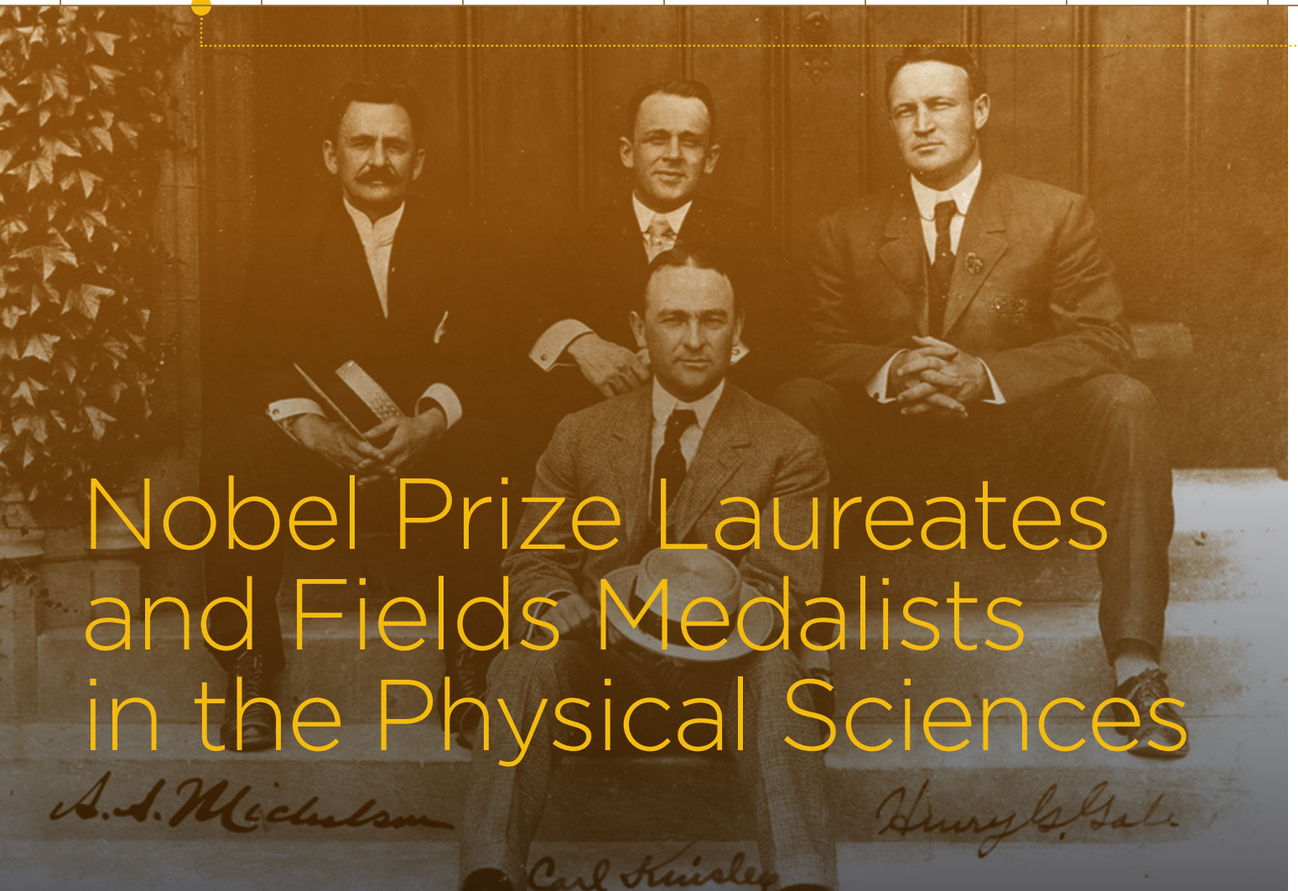
Like the award winners in this book, PSD researchers tackle the most important problems and questions of our time. Our mathematicians and statisticians develop fundamental structures and concepts that inform new areas of science. Our physicists study the most fundamental properties of nature—from the quantum world to new forms of matter and energy. Our chemists explore the molecular scale, creating new materials and developing new therapies to prevent and cure human diseases. Our computer scientists lead advances in artificial intelligence, machine learning, cybersecurity, and quantum computing. Our geophysical scientists study the geological history and structure of the Earth, its fragile biosphere, its climate, and the evolution and structure of other planets. Last but not least, in my department, astronomers and astrophysicists study how the universe began and evolved to contain all the wonders that challenge our imagination.

These pages illustrate a field-defining and interdisciplinary research tradition at UChicago, which continues to thrive throughout PSD's departments, institutes, centers, and committees today. I'm proud to serve a preeminent division at UChicago that is driving discovery and innovation and helping to shape the next generation of physical scientists and mathematicians.

Angela V. Olinto

Dean of the Physical Sciences Division

Albert A. Michelson Distinguished Service Professor
in the Department of Astronomy and Astrophysics



Nobel Prize Laureates and Fields Medalists in the Physical Sciences

1907

Albert A. Michelson

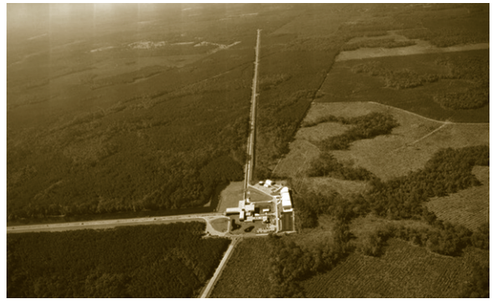
Faculty, 1892 – 1918; 1925 – 1929
1852 – 1931

NOBEL PRIZE IN PHYSICS
for his optical precision instruments and the spectroscopic and metrological investigations carried out with their aid.

While at the US Naval Academy and later as a naval officer, Albert Michelson became fascinated with measuring the speed of light. In the 1880s he developed a new tool, later named a Michelson interferometer, which uses a semitransparent mirror to split a light beam and measure differences of position in time and space with great precision. Michelson used the interferometer to prove the constancy of the speed of light, a principle at the foundation of Einstein's special theory of relativity. Today, interferometers measure gravitational waves from distant black holes. Michelson also founded the University of Chicago's Department of Physics in 1892. In 1907 he became the first American to win the Nobel Prize in Physics.

"Fullness of knowledge always means some understanding of the depths of our ignorance; and that is always conducive to humility and reverence."

—Robert A. Millikan



LIGO, a large-scale observatory to detect cosmic gravitational waves, is a modern-day interferometer. Its observations detected the merger of two binary black holes, which earned the 2017 Nobel Prize in Physics. Later in 2017, LIGO detected the collision of two neutron stars.

1923

Robert A. Millikan

Visiting student, 1894; Faculty, 1896 – 1921
Honorary degree recipient, 1941
1868 – 1953

NOBEL PRIZE IN PHYSICS
for his work on the elementary charge of electricity and on the photoelectric effect.

In 1910 Robert Millikan precisely determined the magnitude of an electron's charge using the now famous oil drop experiment: by balancing the downward force of gravity with the upward attraction of an electrical field, small electrically charged drops of oil could be suspended between two metal plates. Millikan showed that the oil droplet's charge was always an exact integer multiple of the electron's charge. Millikan also measured the photoelectric effect—the emission of electrons that results when light strikes certain metal surfaces—thereby confirming a key prediction of early quantum theory. Millikan's measurement provided an important value for quantum mechanical equations, which describe physics on the subatomic scale.

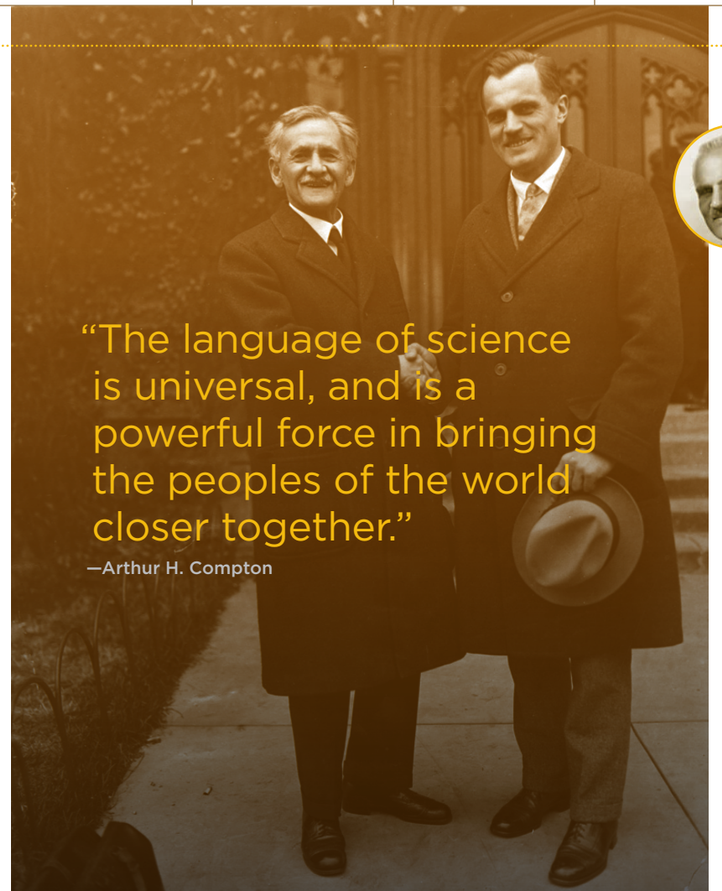
1925

James Franck

Faculty, 1938 – 1947
1882 – 1964

NOBEL PRIZE IN PHYSICS
with Gustav Hertz for their discovery of the laws governing the impact of an electron upon an atom.

James Franck and collaborator Gustav Hertz provided the first experimental evidence for the quantization of atomic energy levels, as suggested by Niels Bohr's atomic theory. Franck's studies also led to the Franck-Condon principle, which remains the basis for design and interpretation of many spectroscopic experiments today. He joined the University of Chicago's Department of Chemistry in 1938 to study photosynthesis and became part of the Manhattan Project on December 1, 1942, one day before the first self-sustaining, controlled nuclear reaction was achieved at UChicago. He also directed the Chemistry Division of the Metallurgical Laboratory at UChicago. In 1945 Franck delivered a report to Secretary of War Henry Stimson, recommending restraint in the use of nuclear weapons and predicting an international arms race. The James Franck Institute at UChicago, one of the longest-standing interdisciplinary academic research centers in the world, is named in his honor.



1927

Arthur H. Compton

Faculty, 1923 – 1945
Honorary degree recipient, 1952
1892 – 1962

NOBEL PRIZE IN PHYSICS
for his discovery of the effect named after him.

When Arthur Compton directed x-ray photons onto a metal surface, he discovered that the scattered x-rays had longer wavelengths than before. In 1922 he concluded that the x-rays' wavelength increased because some photon energy and momentum was transferred to the electrons. This phenomenon, now known as the Compton effect, directly showed for the first time that light is composed of elementary particles, like matter. Compton joined the University of Chicago shortly after this experiment. In 1941 he led a committee to report on the uranium program and was placed in charge of the plutonium project. In 1942 Compton's Metallurgical Laboratory became part of the Manhattan Project, and Compton worked with Enrico Fermi to build Chicago Pile-1—the world's first nuclear reactor.

1932

Werner Heisenberg

Visiting faculty, 1929
1901 – 1976

NOBEL PRIZE IN PHYSICS
for the creation of quantum mechanics, the application of which has, inter alia, led to the discovery of the allotropic forms of hydrogen.

1934

Harold C. Urey

Faculty, 1945 – 1958
Honorary degree recipient, 1963
1893 – 1981

NOBEL PRIZE IN CHEMISTRY
for his discovery of heavy hydrogen.

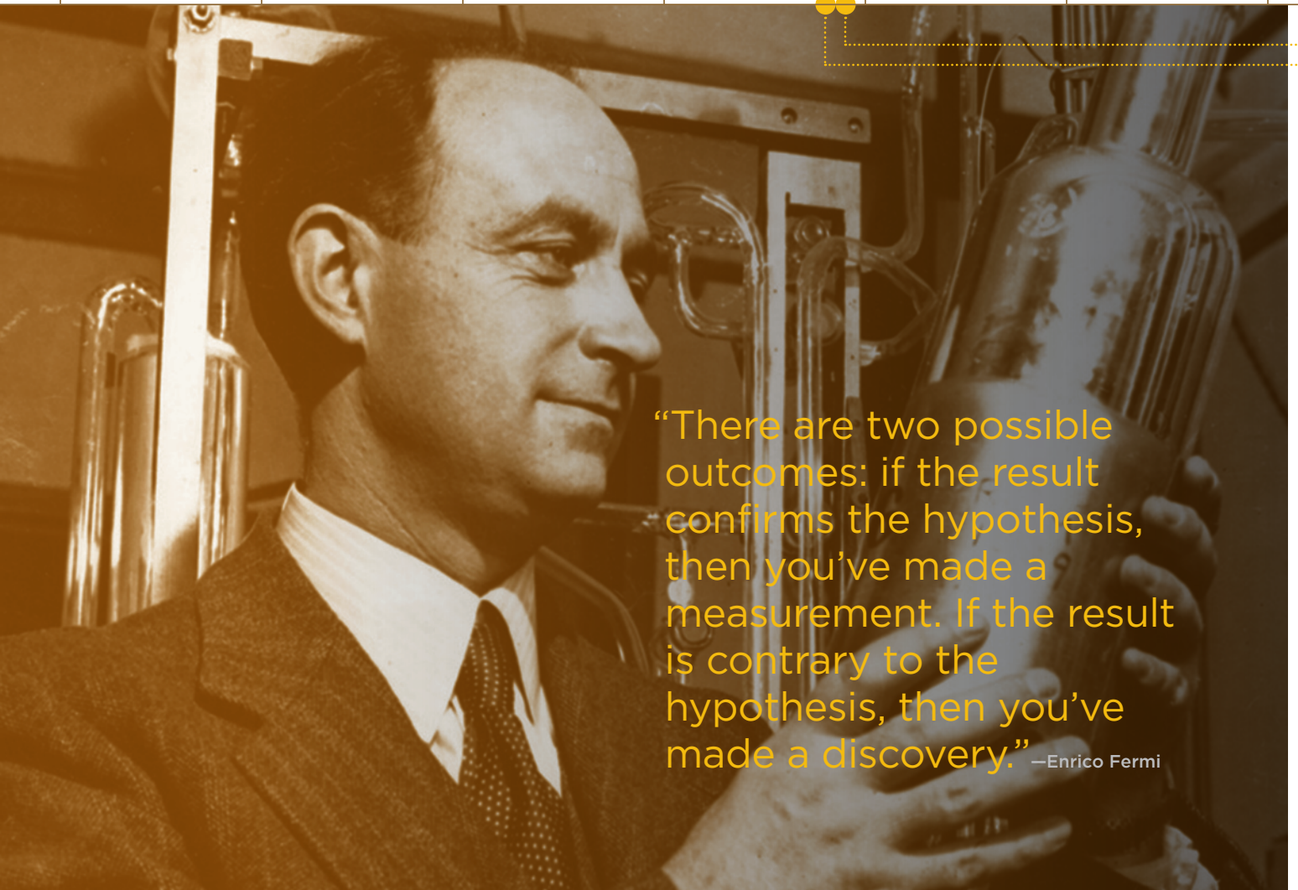
Harold Urey discovered deuterium, also known as heavy hydrogen, in 1931. Later, as a member of the Manhattan Project, Urey studied how to achieve uranium enrichment. He also worked to produce heavy water, which could be used in nuclear reactors. After World War II, he began to study cosmochemistry and was influential in the Apollo program to study Earth's moon. His seminal paper, "Thermodynamics of Isotopic Substances," forms the basis for most paleoclimate studies today.

1937

Clinton Davisson

Alumnus, SB 1908
1881 – 1958

NOBEL PRIZE IN PHYSICS
with George Paget Thomson for their experimental discovery of the diffraction of electrons by crystals.



1938

Enrico Fermi

Faculty, 1942 – 1954
1901 – 1954

NOBEL PRIZE IN PHYSICS
for his demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons.

Enrico Fermi made transformational contributions across many areas of experimental and theoretical physics and is widely acknowledged to be one of the greatest physicists of the twentieth century. His contributions to statistical and quantum physics are remembered by the name “fermions,” the label given to the class of elementary particles that includes all forms of matter. Fermi led a team at the Metallurgical Laboratory to design and construct an exponential pile, Chicago Pile-1, under one of the University of Chicago’s athletic fields. The first-ever controlled self-sustaining nuclear chain reaction took place in that pile on December 2, 1942. After working in Los Alamos on the Manhattan Project, Fermi returned to UChicago and became a member of a nuclear research institute that would later bear his name, the Enrico Fermi Institute.

1939

Ernest Orlando Lawrence

Visiting student, 1923 – 1924
Honorary degree recipient, 1941
1901 – 1958

NOBEL PRIZE IN PHYSICS
for the invention and development of the cyclotron and for results obtained with it, especially with regard to artificial radioactive elements.

Ernest Lawrence’s Cyclotron accelerated charged particles outwards from the center along a spiral path. The UChicago-affiliated Fermi National Accelerator Laboratory operates and builds modern-day particle accelerators influenced by Lawrence’s design.

1951

Glenn T. Seaborg

Visiting faculty, 1942 – 1946
1912 – 1999

NOBEL PRIZE IN CHEMISTRY
with Edwin M. McMillan for their discoveries in the chemistry of the transuranium elements.

Glenn Seaborg co-discovered ten elements and contributed to the discovery of more than 100 isotopes of elements. The element seaborgium was named in his honor. He joined the Metallurgical Laboratory of the Manhattan Project at the University of Chicago in 1942 and developed the chemical process to separate, concentrate, and isolate plutonium. While at UChicago, he developed the chemical elements curium and americium, which is used in household fire detectors. His theoretical work also resulted in a reconfiguration of the periodic table of elements.

1957

Tsung-Dao Lee

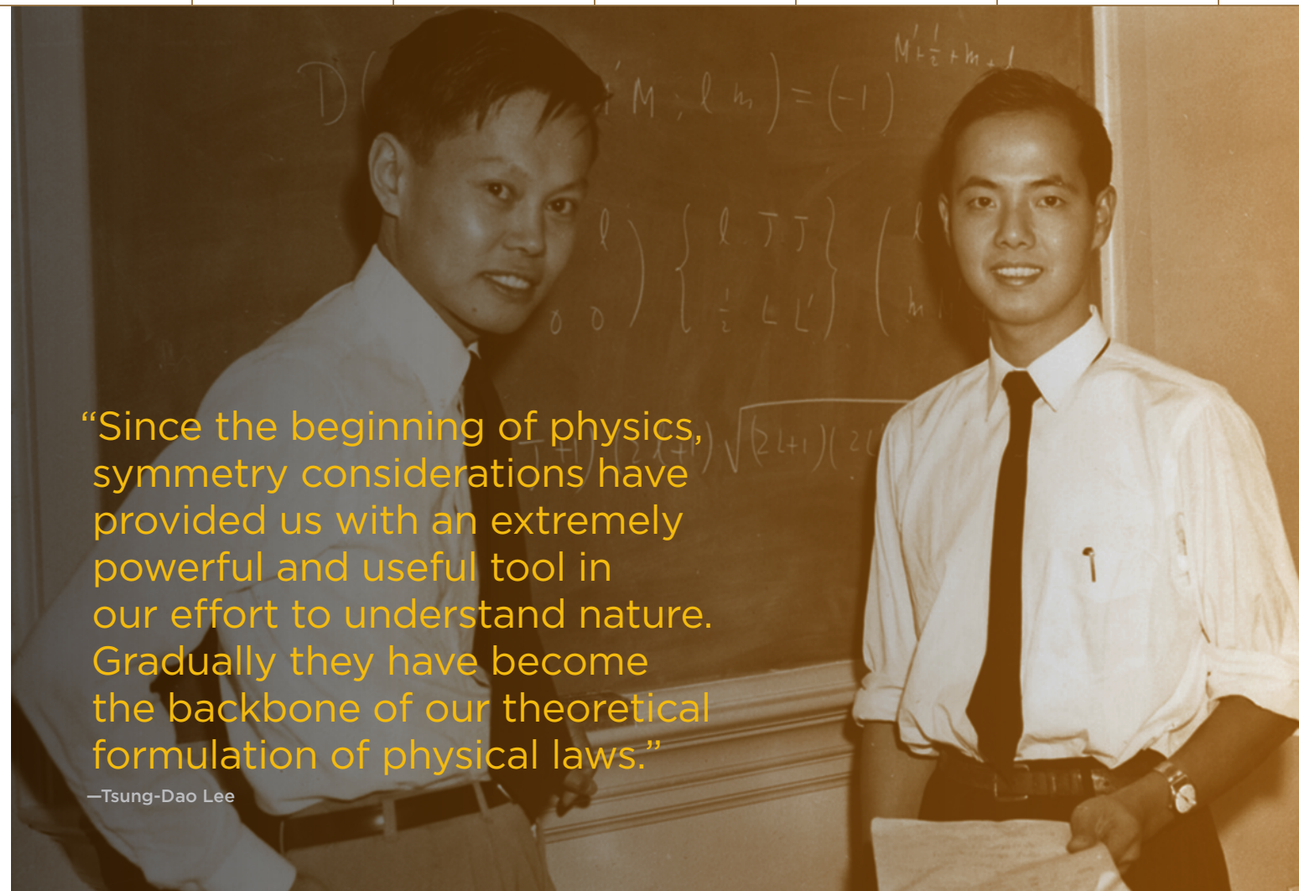
Alumnus, PhD in physics 1950
Faculty, 1950 – 1953
1926 –

Chen Ning Yang

Alumnus, PhD in physics 1948
Faculty, 1948
1922 –

NOBEL PRIZE IN PHYSICS
for their penetrating investigation of the so-called parity laws, which has led to important discoveries regarding the elementary particles.

Tsung-Dao Lee and Chen Ning Yang studied with the University of Chicago Professor Enrico Fermi. After earning his PhD, Yang served as a UChicago instructor before joining the Institute for Advanced Study at Princeton. Lee, who was chosen as Fermi's doctoral student, worked as a research associate and lecturer at Yerkes Observatory after graduation. The pair theorized in 1956 that the left-right symmetry law is violated by the weak interaction. Yang went on to collaborate with Robert Mills, developing the Yang-Mills theory, which forms the basis of our understanding of the Standard Model of particle physics.

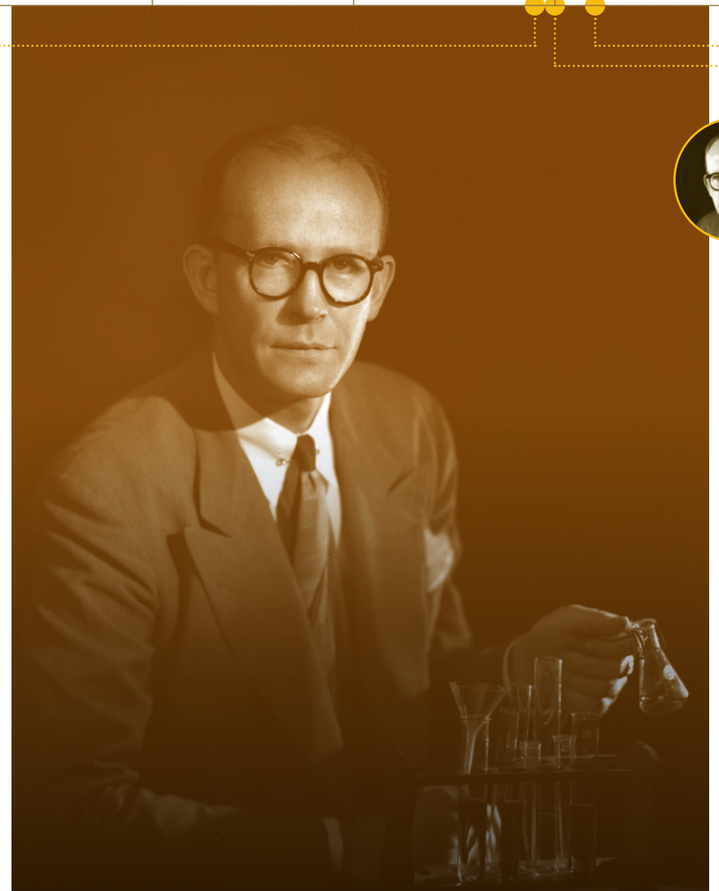


1959

Owen Chamberlain

Alumnus, PhD in physics 1949
1920 – 2006

NOBEL PRIZE IN PHYSICS
with Emilio G. Segrè for their discovery of the antiproton.



1960

Willard F. Libby

Faculty, 1945 – 1954
1908 – 1980

NOBEL PRIZE IN CHEMISTRY
for his method to use carbon-14 for age determination in archaeology, geology, geophysics, and other branches of science.

In the mid-1940s Willard Libby and his colleagues developed radiocarbon dating at the University of Chicago. This revolutionary method allowed scientists to use the fixed rate of decay of carbon-14 to determine the age of fossils and archeological relics. Carbon-14 has also become an essential natural tracer for oceanographic and atmospheric processes. Libby's discovery prompted the study of other radioactive nuclides, which allow researchers to study natural processes at the Earth's surface. In 2016 the American Chemical Society designated the discovery of radiocarbon dating as a National Historic Chemical Landmark.

1962

Lars Hörmander

Visiting Faculty, 1956
1931 – 2012

FIELDS MEDAL
for his work in the theory of partial differential equations, specifically for contributions to the general theory of linear differential operators.

1963

Maria Goeppert Mayer

Faculty, 1946 – 1960
1906 – 1972

NOBEL PRIZE IN PHYSICS
with J. Hans D. Jenson for their discoveries concerning nuclear shell structure.

Maria Goeppert Mayer worked on separating uranium isotopes as part of the Manhattan Project. When her husband became a professor of chemistry at the University of Chicago, US regulations prohibited Goeppert Mayer from accepting employment at the same university. She taught courses in UChicago's Department of Physics and the Institute for Nuclear Studies on a voluntary basis. She also worked at Argonne National Laboratory as a senior physicist. In 1949 Goeppert Mayer and Hans Jensen developed a quantum model of the internal structure of atomic nuclei wherein nucleons were distributed in shells with different energy levels, which explained many features of nuclear stability for the first time.

1963

Eugene Wigner

Faculty, 1942 – 1945
Honorary degree recipient, 1957
1902 – 1995

NOBEL PRIZE IN PHYSICS
for his contributions to the theory of the atomic nucleus and the elementary particles, particularly through the discovery and application of fundamental symmetry principles.

In 1933 Eugene Wigner discovered that the nuclear force binding neutrons and protons together is very strong when the nucleons are close but weak when they are farther apart. This work, along with the description of several other characteristics of the nucleon and nuclear force, later earned him the Nobel Prize. In 1939 he participated in a meeting with Leó Szilárd and Albert Einstein that resulted in the Einstein-Szilárd letter, which prompted President Roosevelt to initiate the Manhattan Project to develop atomic bombs. Wigner was present when the world's first atomic nuclear reactor, Chicago Pile-1, achieved a controlled nuclear chain reaction at the University of Chicago.

1963

Karl Ziegler

Visiting faculty, 1936
1898 – 1973

NOBEL PRIZE IN CHEMISTRY
with Giulio Natta for their discoveries in the field of the chemistry and technology of high polymers.

"We had known that we were about to unlock a giant; still, we could not escape an eerie feeling when we knew we had actually done it."

—Eugene Wigner

1965

Julian Schwinger

Visiting faculty, 1943
1918 – 1994

NOBEL PRIZE IN PHYSICS
with Richard P. Feynman and Sin-Itiro Tomonaga for their fundamental work in quantum electrodynamics, with deep-ploughing consequences for the physics of elementary particles.

1966

Paul J. Cohen

Alumnus, SM 1954; PhD in mathematics 1958
1934 – 2007

FIELDS MEDAL
for using a technique called 'forcing' to prove the independence in set theory of the axiom of choice and of the generalized continuum hypothesis. The latter problem was the first of Hilbert's problems of the 1900 Congress.

1966

Stephen Smale

Faculty, 1956 – 1958; 2004 – 2009
1930 –

FIELDS MEDAL
for working in differential topology where he proved the generalized Poincaré conjecture in dimension n>=5: Every closed, n-dimensional manifold homotopy-equivalent to the n-dimensional sphere is homeomorphic to it. He introduced the method of handle-bodies to solve this and related problems.

1966

Robert S. Mulliken

Alumnus, PhD in chemistry and physics 1921
Faculty, 1928 – 1961
1896 – 1986

NOBEL PRIZE IN CHEMISTRY
for his fundamental work concerning chemical bonds and the electronic structure of molecules by the molecular orbital method.

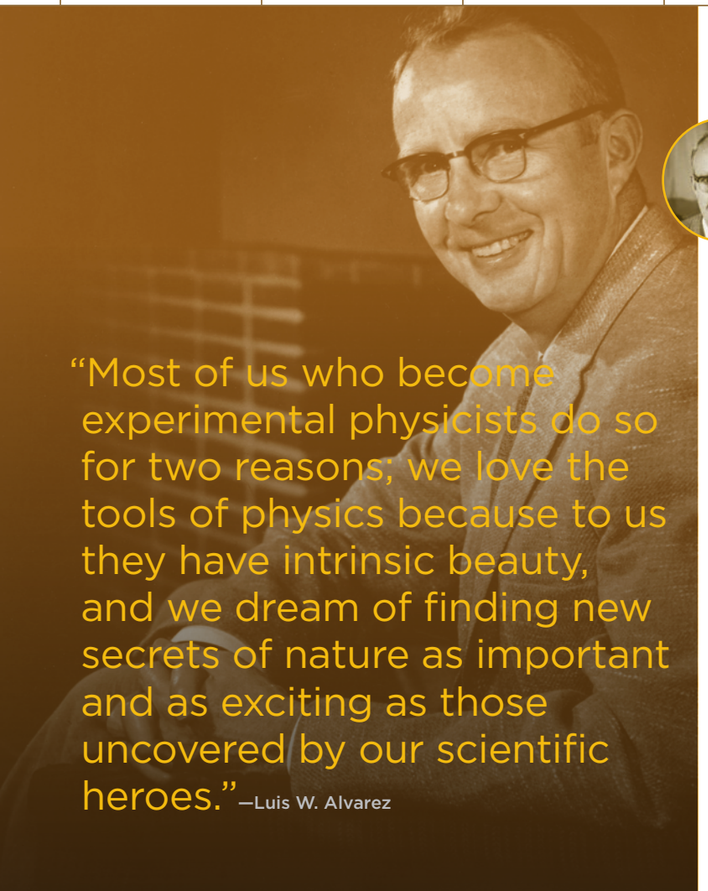
While pursuing his PhD at the University of Chicago, Robert Mulliken studied under Nobel Prize-winning physicist Robert Millikan. Beginning in the mid-1920s, Robert Mulliken developed models for molecular orbitals—the movement of electrons within a molecule. He later returned to UChicago as a faculty member, ultimately holding a joint position in both the physics and chemistry departments.

1967

Hans A. Bethe

Visiting faculty
Honorary degree recipient, 1953
1906 – 2005

NOBEL PRIZE IN PHYSICS
for his contributions to the theory of nuclear reactions, especially his discoveries concerning the energy production in stars.



"Most of us who become experimental physicists do so for two reasons; we love the tools of physics because to us they have intrinsic beauty, and we dream of finding new secrets of nature as important and as exciting as those uncovered by our scientific heroes."—Luis W. Alvarez

1968

Luis W. Alvarez

Alumnus, SB 1932; SM 1934; PhD in physics 1936
Honorary degree recipient, 1967
1911 – 1988

NOBEL PRIZE IN PHYSICS
for his decisive contributions to elementary particle physics, in particular the discovery of a large number of resonance states, made possible through his development of the technique of using the hydrogen bubble chamber and data analysis.

As a student at the University of Chicago, Luis Alvarez had the opportunity to use the equipment of Nobel Prize-winning physicist Albert Michelson. He investigated cosmic rays under the tutelage of Arthur Compton, another Nobel Prize-winning physicist. In the fall of 1943, Alvarez returned to UChicago to spend a few months working with Enrico Fermi before joining the Manhattan Project.

1968

Richard W. Hamming

Alumnus, SB 1937
1915 – 1998

TURING AWARD
for his central role in creating, shaping, promoting, and advancing the field of artificial intelligence.

1969

Murray Gell-Mann

Faculty, 1952 – 1955
Honorary degree recipient, 1967
1929 – 2019

NOBEL PRIZE IN PHYSICS
for his contributions and discoveries concerning the classification of elementary particles and their interactions.

1970

John G. Thompson

Alumnus, SM 1956; PhD in mathematics 1959
Faculty, 1962 – 1968
1932 –

FIELDS MEDAL
for proving jointly with Walter Feit that all non-cyclic finite simple groups have even order. The extension of this work by Thompson determined the minimal simple finite groups, that is, the simple finite groups whose proper subgroups are solvable.

John Thompson completed his doctorate at the University of Chicago under the supervision of Saunders Mac Lane, a mathematician who co-founded category theory. His doctoral thesis included the solution of a problem in finite group theory that had stood since 1901. He joined the faculty of UChicago before moving to the University of Cambridge and, later, the University of Florida. In 1963 he and Walter Feit proved that every finite group of odd order is solvable—now known as the Feit-Thompson or odd order theorem.

1971

Gerhard Herzberg

Faculty, 1945 – 1948
Honorary degree recipient, 1967
1904 – 1999

NOBEL PRIZE IN CHEMISTRY
for his contributions to the knowledge of electronic structure and geometry of molecules, particularly free radicals.

1972

J. Robert Schrieffer

Faculty, 1957 – 1960
1931 – 2019

NOBEL PRIZE IN PHYSICS
with John Bardeen and Leon N. Cooper for their jointly developed theory of superconductivity, usually called the BCS-theory.

1972

William H. Stein

Visiting faculty, 1961
1911 – 1980

NOBEL PRIZE IN CHEMISTRY
with Stanford Moore for their contribution to the understanding of the connection between chemical structure and catalytic activity of the active center of the ribonuclease molecule.

1975

Herbert A. Simon

Alumnus, SB 1936; PhD 1943 in political science
Honorary degree recipient, 1967
1916 – 2001

TURING AWARD
with Allen Newell for basic contributions to artificial intelligence, the psychology of human cognition, and list processing.

1976

Dana S. Scott

Faculty, 1958 – 1960
Honorary degree recipient, 1967
1932 –

TURING AWARD
with Michael O. Rabin for their joint paper “Finite Automata and Their Decision Problem,” which introduced the idea of nondeterministic machines.

1977

Ilya Prigogine

Visiting faculty, 1961 – 1966
Honorary degree recipient, 1969
1917 – 2003

NOBEL PRIZE IN CHEMISTRY
for his contributions to non-equilibrium thermodynamics, particularly the theory of dissipative structures.

1978

Charles L. Fefferman

Faculty, 1970 – 1973
1949 –

FIELDS MEDAL
for contributing several innovations that revised the study of multidimensional complex analysis by finding correct generalizations of classical (low-dimensional) results.

1978

Robert W. Floyd

Alumnus, AB 1953; SB 1958
1904–1999

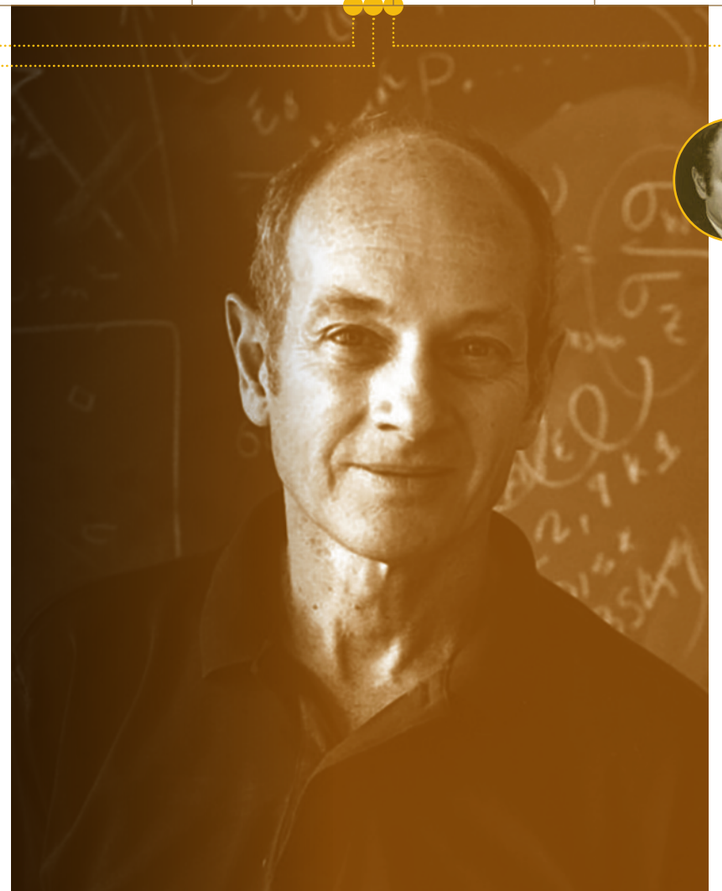
TURING AWARD
for having a clear influence on methodologies for the creation of efficient and reliable software, and for helping to found the following subfields of computer science: the theory of parsing, the semantics of programming languages, automatic program verification, automatic program synthesis, and analysis of algorithms.

1979

Herbert C. Brown

Alumnus, SB 1936; PhD in chemistry 1938
Faculty
Honorary degree recipient, 1968
1912 – 2004

NOBEL PRIZE IN CHEMISTRY
with Georg Wittig for their development of the use of boron- and phosphorus-containing compounds, respectively, into important reagents in organic synthesis.



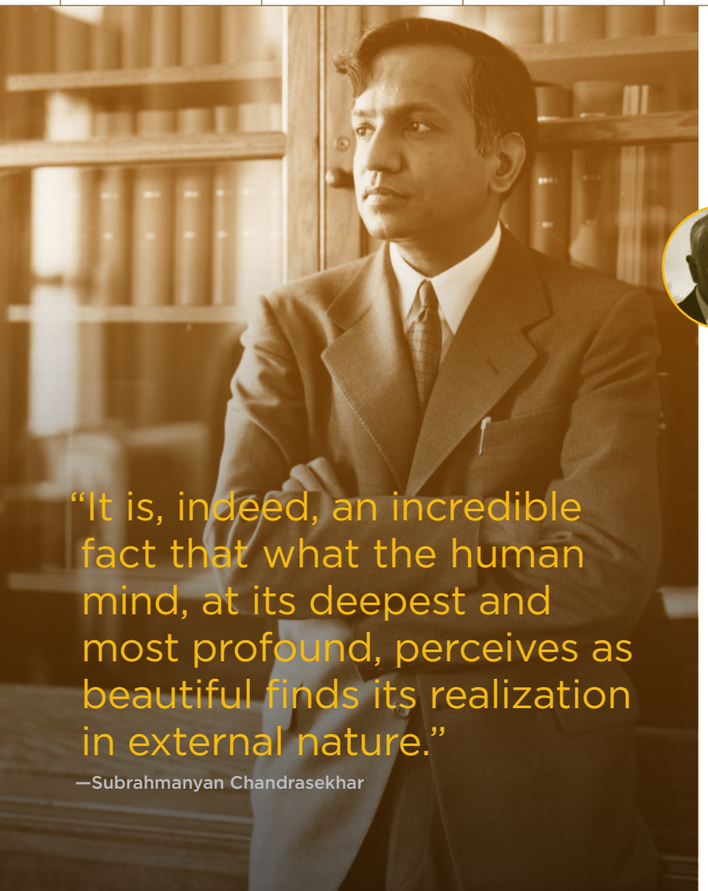
1980

James W. Cronin

Alumnus, SM 1953; PhD in physics 1955
Faculty, 1971 – 1997
1931 – 2016

NOBEL PRIZE IN PHYSICS
with Val L. Fitch for the discovery of violations of fundamental symmetry principles in the decay of neutral K-mesons.

While conducting research in the 1960s at Brookhaven National Laboratory, James Cronin and his colleague, Val Fitch, studied subatomic particles from collisions between protons and atom nuclei and made the first observation of nature's preference for matter over antimatter. At the University of Chicago, Cronin shifted course to study the origin of cosmic rays and co-founded the Pierre Auger Observatory in Argentina, a massive system of giant water tanks and telescopes that is designed to measure the highest energy cosmic rays.



"It is, indeed, an incredible fact that what the human mind, at its deepest and most profound, perceives as beautiful finds its realization in external nature."

—Subrahmanyan Chandrasekhar

1983

Subrahmanyan Chandrasekhar

Faculty, 1936 – 1995
1910 – 1995

NOBEL PRIZE IN PHYSICS
for his theoretical studies of the physical processes of importance to the structure and evolution of the stars.

Subrahmanyan Chandrasekhar started as an assistant professor of physics at the Yerkes Observatory in 1936 and spent nearly 60 years of his career at the University of Chicago. Early in his career, Chandrasekhar determined that stars with a mass greater than 1.4 times that of the sun—a value now known as the Chandrasekhar limit—must eventually collapse past the stage of a white dwarf into enormously dense objects, such as a neutron star or black hole, which were considered scientific impossibilities at the time. His work also contributed to the contemporary understanding of black holes, stellar structure, white dwarfs, turbulence, general relativity, radiative transfer, and many more phenomena.

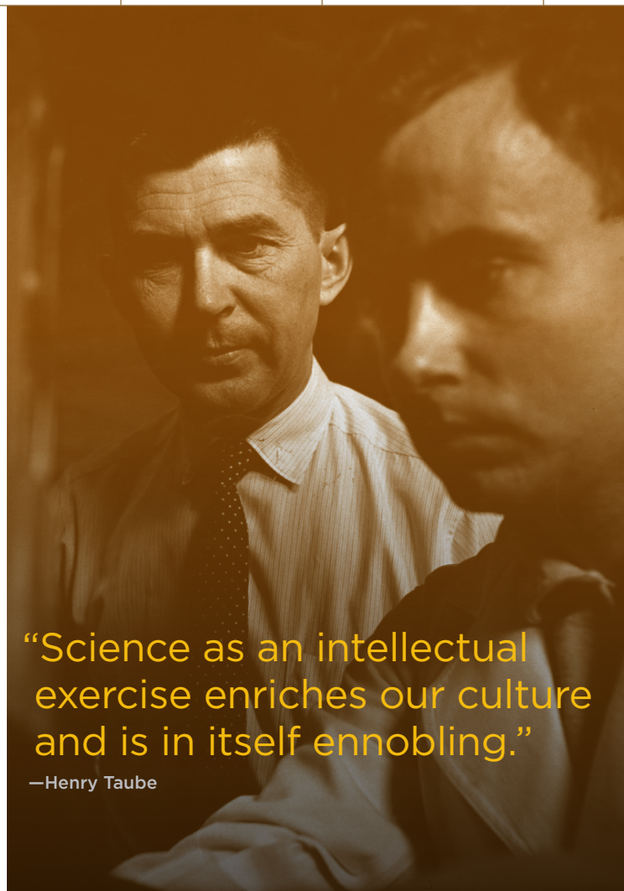
1983

Henry Taube

Faculty, 1946 – 1961
Honorary degree recipient, 1983
1915 – 2005

NOBEL PRIZE IN CHEMISTRY
for his work on the mechanisms of electron transfer reactions, especially in metal complexes.

Developing an inorganic chemistry course for the University of Chicago's Department of Chemistry sparked Henry Taube's interest in coordination complexes, which consist of a central atom or ion, usually metallic, and a surrounding array of bound molecules or ions. In these complexes, electrons can change from a metallic atom of one type to another. While at UChicago, Taube showed that molecules form a chemical bridge between the metallic atoms rather than directly exchanging electrons.



"Science as an intellectual exercise enriches our culture and is in itself ennobling."

—Henry Taube

1986

Yuan T. Lee

Faculty, 1968–1974
1936–

NOBEL PRIZE IN CHEMISTRY
with Dudley R. Herschbach and John C. Polanyi for their contributions concerning the dynamics of chemical elementary processes.

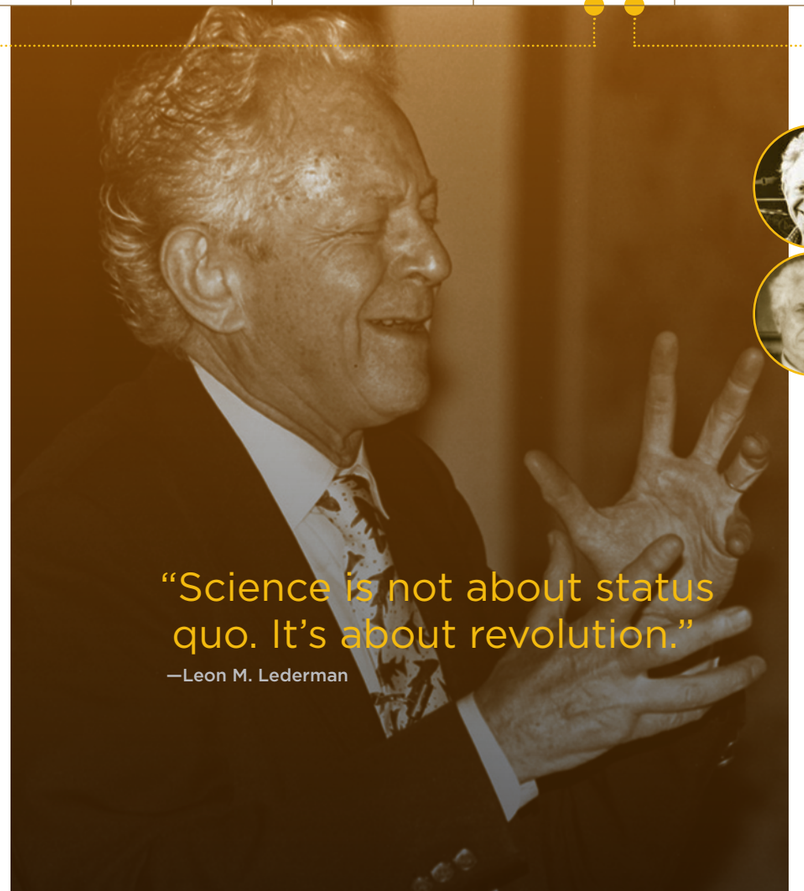
At the University of Chicago, Yuan Lee developed a new generation of a "universal" crossed molecular beams apparatus that enabled him to probe the mechanisms of chemical reactions by analyzing the collisions of molecules with well-controlled amounts of energy. In 1974 Lee joined the faculty at his alma mater, the University of California, Berkeley.

1986

Gerald J. Wasserburg

Alumnus, SB 1951; SM 1952; PhD 1954
1927 – 2016

CRAFOORD PRIZE
with Claude Allègre for their pioneering work in isotope geology.



1988

Leon M. Lederman

Honorary degree recipient, 1983
Faculty, 1989 – 1992
1922 – 2018

Jack Steinberger

Alumnus, SB 1942; PhD in physics 1949
1921 –

NOBEL PRIZE IN PHYSICS
with Melvin Schwartz for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino.

In 1962 Leon Lederman, Melvin Schwartz, and Jack Steinberger discovered the existence of a new type of neutrino, named the muon neutrino. This discovery confirmed that elementary particles are grouped in pairs—a cornerstone of the Standard Model, which classifies all known elementary particles. Lederman later led a team at Fermilab that discovered the bottom quark. As Fermilab director, he rallied the particle physics community to build the Tevatron, the world's highest energy particle collider for 39 years. Lederman worked with members of the Illinois government to start the Illinois Math and Science Academy and collaborated with officials to strengthen the science curriculum in Chicago's public schools.

1990

Vladimir Drinfeld

Faculty, 1999 – present
1954 –

FIELDS MEDAL
for his work on quantum groups and for his work in number theory.

In 1974 Vladimir Drinfeld used elliptic modules, now known as Drinfeld modules, to prove parts of the Langlands program, a far-reaching network of conjectures and sometimes theorems that connect number theory, algebraic geometry, representation theory, and mathematical physics. Drinfeld also coined the term "quantum group," which denotes various kinds of noncommutative algebras with additional structure.

1990

Jerome I. Friedman

Alumnus, AB 1950; SM 1953;
PhD in physics 1956
1930 –

NOBEL PRIZE IN PHYSICS
with Henry W. Kendall and Richard E. Taylor for their pioneering investigations concerning deep inelastic scattering of electrons on protons and bound neutrons, which have been of essential importance for the development of the quark model in particle physics.

1994

Pierre-Louis Lions

Visiting Faculty, 2014 – present
Honorary degree recipient, 2019
1956 –

FIELDS MEDAL
for unique contributions covering a variety of areas, from probability theory to partial differential equations.

1994

Efim Zelmanov

Faculty, 1994 – 1995
1955 –

FIELDS MEDAL
for his solution to the restricted Burnside problem.

1995

Paul J. Crutzen

Faculty, 1987 – 1991
1933 –

F. Sherwood Rowland

Alumnus, SM 1951; PhD in chemistry 1952
Honorary degree recipient, 1985; 1989
1927 – 2012

NOBEL PRIZE IN CHEMISTRY
with Mario J. Molina for their work in atmospheric chemistry, particularly concerning the formation and decomposition of ozone.

1996

Richard E. Smalley

Faculty, 1973 – 1976
Honorary degree recipient, 1995
1943 – 2005

NOBEL PRIZE IN CHEMISTRY
with Robert F. Curl Jr. and Sir Harold W. Kroto for their discovery of fullerenes.

Richard Smalley was a postdoctoral scholar at the University of Chicago in the 1970s, working with Lennard Wharton and longtime faculty member Donald Levy. At UChicago, Smalley pioneered the development of supersonic jet laser spectroscopy, which enabled high-resolution studies of large molecules in the gas phase. These studies provided the foundation for Smalley's later work at Rice University, where he co-discovered fullerenes, a structurally different form of carbon.

1998

Daniel C. Tsui

Alumnus, SM 1963; PhD in physics 1967
Honorary degree recipient, 1999
1939 –

NOBEL PRIZE IN PHYSICS
with Robert B. Laughlin and Horst L. Störmer for their discovery of a new form of quantum fluid with fractionally charged excitations.

2002

Masatoshi Koshiba

Faculty, 1955 – 1962
1926 –

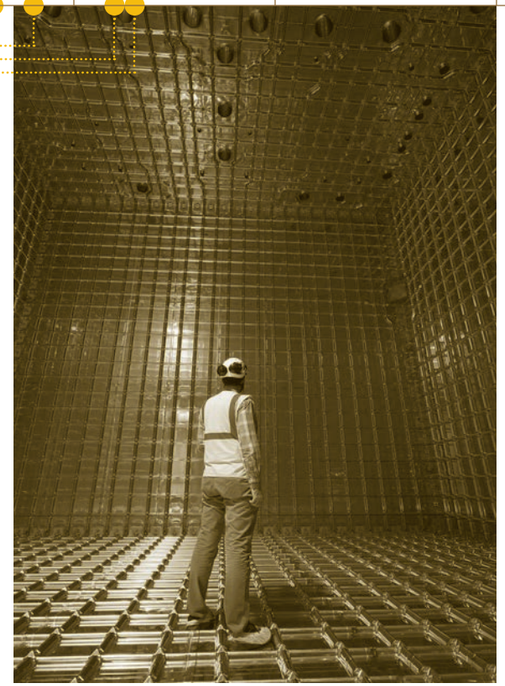
NOBEL PRIZE IN PHYSICS
with Raymond Davis Jr. for pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos.

2003

Alexei A. Abrikosov

Faculty
1928 – 2017

NOBEL PRIZE IN PHYSICS
with Vitaly L. Ginzburg and Anthony J. Leggett for pioneering contributions to the theory of superconductors and superfluids.



In the 1980s Koshiba constructed Kamiokande II, an underground neutrino detector in a zinc mine in Japan. The University of Chicago is designing and building components of a modern-day underground neutrino detector, DUNE, which is hosted at Fermilab and currently under construction in South Dakota.

2004

Irwin Rose

Alumnus, SB 1948;
PhD in biological chemistry 1952
1926 – 2015

NOBEL PRIZE IN CHEMISTRY
with Aaron Ciechanover and Avram Hershko for the discovery of ubiquitin-mediated protein degradation.

2004

Frank Wilczek

Alumnus, SB 1970
1951 –

NOBEL PRIZE IN PHYSICS
with David J. Gross and H. David Politzer for the discovery of asymptotic freedom in the theory of the strong interaction.

2006

Andrei Okounkov

Faculty, 1996 – 1999
1969 –

FIELDS MEDAL
for his contributions bridging probability, representation theory, and algebraic geometry.

2008

John G. Thompson

Alumnus, SM 1956; PhD in mathematics 1959
Faculty, 1962 – 1968
1932 –

ABEL PRIZE
with Jacques Tits for their profound achievements in algebra and in particular for shaping modern group theory.

2008

Yoichiro Nambu

Faculty, 1954 – 1991
1921 – 2015

NOBEL PRIZE IN PHYSICS
for the discovery of the mechanism of spontaneous broken symmetry in subatomic physics.

In 1960 Yoichiro Nambu formulated a mathematical theory for understanding spontaneous symmetry breaking—the change from symmetric to asymmetric states among large numbers of subatomic particles. His work explained why some substances become superconductors and why particles carrying a weak nuclear force could obtain mass. This theory is now an important component of the Standard Model of particle physics and the foundation for other important discoveries, including the discovery of the Higgs-Boson particle.

2009

George E. Smith

Alumnus, SM 1956; PhD in physics 1959
1930 –

NOBEL PRIZE IN PHYSICS
with Willard S. Boyle for the invention of an imaging semiconductor circuit—the CCD sensor.

2009

Ada E. Yonath

Visiting faculty, 1977 – 1978
1939 –

NOBEL PRIZE IN CHEMISTRY
with Venkatraman Ramakrishnan and Thomas A. Steitz for studies of the structure and function of the ribosome.

"The challenge of science is like climbing Mount Everest. Getting to the top is fantastic, but the climb is also an adventure."

—Ada E. Yonath

2010

Ngô Bảo Châu

Faculty, 2010 – present
1972 –

FIELDS MEDAL
for his proof of the Fundamental Lemma in the theory of automorphic forms through the introduction of new algebro-geometric methods.

2013

Lars Peter Hansen

Faculty, 1981 – present
1952 –

SVERIGES RIKSBANK PRIZE IN ECONOMIC SCIENCES IN MEMORY OF ALFRED NOBEL
with Eugene F. Fama and Robert J. Shiller for their empirical analysis of asset prices.

Lars Peter Hansen holds a joint appointment in the University of Chicago’s Departments of Economics and Statistics. He is internationally recognized for making fundamental advances in the use of statistical methods to assess dynamic economic models and to enhance our understanding of how economic agents cope with changing and risky environments.

2017

Yves Myer

Visiting faculty
1939 –

ABEL PRIZE
for his pivotal role in the development of the mathematical theory of wavelets.

2019

John B. Goodenough

Alumnus, SM 1950; PhD in physics 1952
1922 –

NOBEL PRIZE IN CHEMISTRY
with M. Stanley Whittingham and Akira Yoshino for the development of lithium-ion batteries.

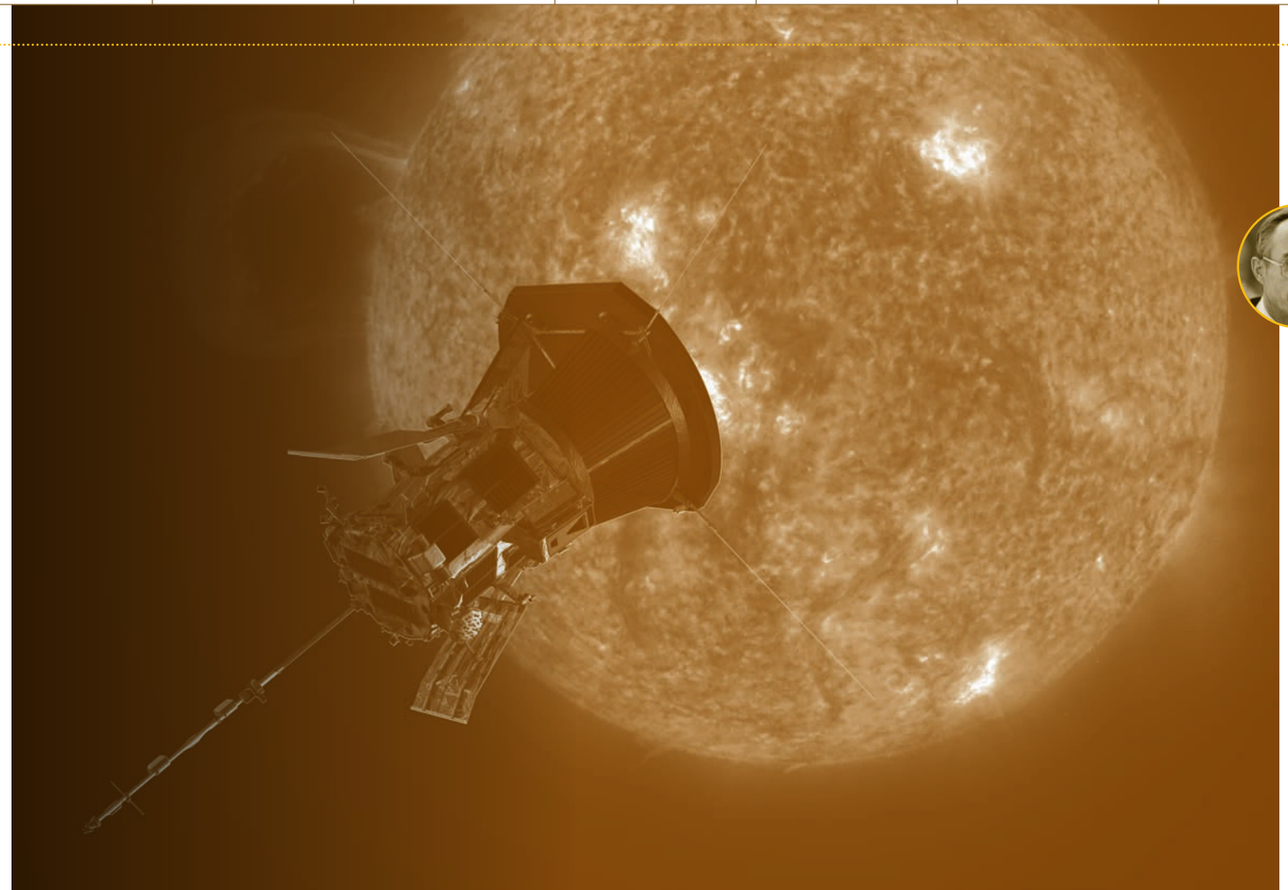
John Goodenough arrived at the University of Chicago after World War II. He studied physics under Nobel laureate Enrico Fermi and Clarence Zener, who invented a diode that became a critical component of modern electronics. After graduation, Goodenough pursued his interest in batteries at MIT’s Lincoln Lab and Oxford University. In the 1970s Stanley Whittingham developed the first functional rechargeable battery using lithium. Goodenough replaced the titanium disulfide in the cathode of Whittingham’s battery with cobalt oxide, doubling the voltage produced and greatly stabilizing the structure. In 1985 Akira Yoshino used Goodenough’s cathode and created the first commercially viable lithium-ion battery. Today, Goodenough’s cathode materials are used worldwide in power tools, electric cars, smart phones, laptops, and other wireless devices.

2019

Karen Uhlenbeck

Faculty, 1983 – 1987
1952 –

ABEL PRIZE
for her pioneering achievements in geometric partial differential equations, gauge theory and integrable systems, and for the fundamental impact of her work on analysis, geometry and mathematical physics.



2020

Eugene Parker

Faculty, 1955 – present
1927 –

CRAFOORD PRIZE
for pioneering and fundamental studies of the solar wind and magnetic fields from stellar to galactic scales.

Eugene Parker first predicted the solar wind in 1957. The idea that the sun emitted a stream of electrically charged particles radically changed scientists' understanding of the solar system, making it possible to expound the causes of magnetic storms, auroras and other solar-terrestrial phenomena. In 2018, NASA launched the Parker Solar Probe, the first mission to be named after a living person. The probe has already traveled closer to the sun than any previous mission, returning valuable information about the sun's corona, solar flares, and solar radiation.

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Atomic Heritage Foundation
Argonne National Laboratory, Nuclear Engineering Division
Biographical Memoirs, Vol 78: Robert Sanderson Mulliken, 1896 – 1986, by R. Stephen Berry
Kevin Corlette, Professor and Chair, Department of Mathematics at the University of Chicago
Craig Hogan, Department of Astronomy and Astrophysics at the University of Chicago; Enrico Fermi Institute
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