# Albert Warner Overhauser FREE

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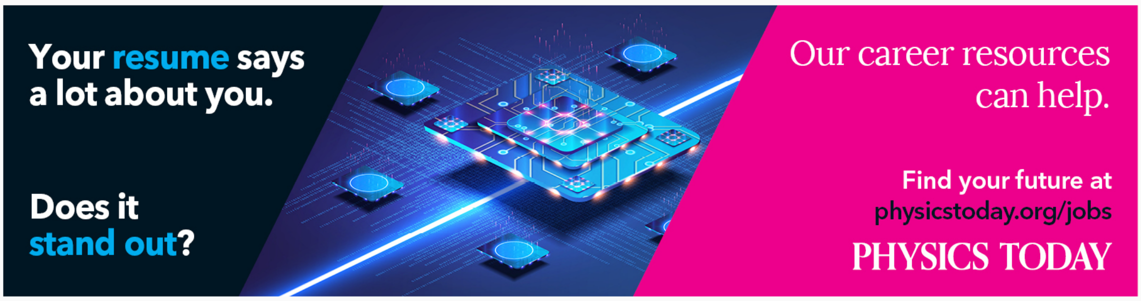

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# Albert Warner Overhauser

Albert Warner Overhauser, Stuart Distinguished Professor Emeritus of Physics at Purdue University, died on 10 December 2011 in West Lafayette, Indiana, of sudden cardiac arrest. Only the day before he was in his departmental office of 38 years, as was his custom—retirement notwithstanding. One of the last of a generation of American physicists to command a broad range of interests, Overhauser's fundamental and highly innovative ideas continue to make a significant impact on science and technology.

Overhauser was born in San Diego, California, on 17 August 1925. A precocious musical talent, he saw a career in music nipped in the bud by familial diktat. His walk across the Golden Gate Bridge on 27 May 1937—the day it opened—stoked his interest in civil engineering. In 1942 he entered the University of California, Berkeley. During World War II, he was a radar technical specialist in the US Navy Reserve. Back at Berkeley, his "most wonderful professors" lit a passion for physics that would remain with him for the rest of his life.

In 1948 Overhauser received a BS in physics and mathematics. That condensed-matter physics would be his main playground was due to serendipity; Overhauser's original aspirations to earn a PhD in nuclear physics at Berkeley were dashed when his adviser, Gian-Carlo Wick, decided to leave as a consequence of the loyalty-oath fiasco. Overhauser instead became one of the earliest students of Charles Kittel, who was in the process of moving to Berkeley from Bell Labs. During one visit to Berkeley, Kittel assigned Overhauser his thesis subject: a thorough study of the possible spin-relaxation mechanisms in metals. Astonishingly, Overhauser had completed the task by the time Kittel returned a few months later, and he earned his PhD in 1951.

From 1951 to 1953, Overhauser was research associate at the University of Illinois at Urbana-Champaign; he then joined the faculty at Cornell University, where he remained until 1958. He was recruited to be a key scientist and eventually became the director of the Physical Sciences Laboratory of the Ford Motor Co. There he alternated research on modern theoretical topics with successful forays into optimization and industrial design. In 1973 he left Ford for Purdue.

AIP ESVA, OVERHAUSER COLLECTION

**Albert Warner Overhauser**

Perhaps Overhauser's most famous and important discovery is that of the effect that bears his name. That stroke of genius occurred to him in 1953 while he was at Illinois. While considering the problem of a spin system out of equilibrium, he devised the paradigm that underlies the dynamical Overhauser effect (DOE). His idea was to polarize the nuclear spins indirectly by pumping and saturating the conduction electrons' spin resonance. Spectacularly, the technique achieved nuclear polarizations thousands of times larger than one could have expected from the strength of the Fermi nuclear coupling constant. Exemplifying a notable feature of his style, Overhauser's theory was based on a physically and mathematically simple model, only the first example of his subtle and incisive use of Ockham's razor.

In spite of initial skepticism, the DOE was quickly demonstrated experimentally by Charles Slichter and his student Richard Norberg, also at Illinois. A few years later, Ionel Solomon at CNRS in Paris showed that the DOE mechanism also works between the spins of two nuclear species in ordinary liquids, an effect now known as the nuclear Overhauser effect (NOE). Both the DOE and NOE have proven invaluable mechanisms in the development of ever more powerful nuclear magnetic resonance techniques used to image and determine the structure of proteins and other biological macromolecules in solution.

At Cornell, Overhauser and his student Bertram Dick developed the "shell model" for the dynamics of bound electrons, a theoretical breakthrough that allowed a 10-fold improvement in the parameterization and the quantitative understanding of lattice dynamics in semiconductors. The theory is still employed in conjunction with modern ab initio and molecular dynamics techniques.

At Ford, Overhauser contributed some of the pioneering work in the many-body theory of the electron gas by introducing the modern concepts of spin- and charge-density waves (CDW), which represent spontaneously broken symmetry states in an otherwise uniform and isotropic interacting electron system. Both were immediately observed in chromium and later in many other materials. The appearance of a CDW-type ground state in some alkali metals is a theme to which Overhauser often returned. He also produced what is referred to as the Hartree–Fock instability theorem, which shows how the popular Slater determinant of plane waves, though it solves the Hartree–Fock equations, is not a stable ground state in the approximation.

A fundamental and imaginative contribution of Overhauser's was an experiment that probed the interplay of both quantum mechanics and gravitation. That elegant, technically challenging work, carried out in collaboration with Roberto Colella (Purdue) and one of us (Werner, then also at Ford), measured the effect of a tiny change in the gravitational potential of a neutron beam on its self-interference pattern; in modern terminology, the effect can be described in terms of a gravitationally induced Berry phase. Overhauser contributed to both the theoretical conception and the experimental realization; even felt strips of his home pool table made their way into the apparatus.

For the variety, relevance, and creativity of his contributions, Overhauser received several prestigious awards, including the 1975 Oliver E. Buckley Prize of the American Physical Society, the 2009 Russell Varian Prize at the EUROMAR

Magnetic Resonance Conference, and the 1994 National Medal of Science. Many of his publications, all characterized by his signature clarity and simplicity, are classics.

Overhauser was widely regarded as a valuable colleague and a superb teacher and adviser. Anecdotes abound about his legendary condensed-matter and statistical mechanics lectures, notes, and creative homework sets. At Purdue, students and even faculty sought his advice on quantum mechanics. His door was always open, as it was the day before his passing.

Although we have lost a distinguished colleague, a teacher, and a friend, the intellectual reverberations and practical relevance of Overhauser's fertile mind still shine.

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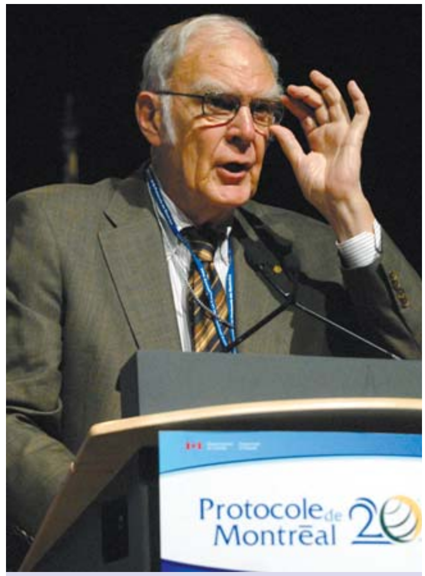
## Frank Sherwood Rowland

Chemist, physicist, Earth champion, and Nobel laureate Frank Sherwood "Sherry" Rowland died from complications of Parkinson's disease on 10 March 2012 at his home in Corona del Mar, California. With Mario Molina in 1974, Sherry warned that chlorofluorocarbons (CFCs) were destroying the ozone layer and immediately called for a ban on aerosol products containing those chemicals; he persisted in advocating atmospheric protection throughout his career.

Stratospheric ozone protects Earth from UV radiation that causes skin cancer and cataracts, suppresses the human immune system, and damages agricultural crops and ecosystems. Absent early warnings and subsequent national and international action under an agreement called the Montreal Protocol on Substances that Deplete the Ozone Layer, up to two-thirds of the ozone layer would have been destroyed by 2065, with a resultant millions of deaths from skin cancer and the loss of half or more of global agricultural production. Furthermore, most ozone-depleting substances are also greenhouse gases: If left unregulated, they would have reached the equivalent of 24–76 gigatons of carbon dioxide and would potentially change climate at a rate too fast for human civilization to adapt.



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**Frank Sherwood Rowland**

Fortunately, the public reacted quickly to the 1974 warning by Sherry and Molina. Product boycotts were so successful that US sales of CFC hairspray and deodorant crashed long before those products were banned in 1978. For a decade and more after publication of the pair's seminal article, skeptics of stratospheric ozone deple-