News and Comment

Nobel Award Winners Announced

Physics

Every nuclear physicist, and many others, greeted with joy the award of the 1963 Nobel prize in physics to Eugene Wigner, Princeton University Maria Goeppert Mayer, University of California, San Diego, and J. Hans D. Jensen, University of Heidelberg, Heidelberg, Germany.

Wigner is one of the truly great physicists of our time. It is amazing to how many fields he has contributed, and in each field his contributions have been profound. In the late 1920's, with von Neumann, he developed the theory of the energy levels of atoms on the basis of group theory. His book on group theory, originating from this work has taught many generations of physicists.

Wigner has made great contribtuions to field theory. With Jordan in 1928 he wrote one of the fundamental papers on second quantization, whose results are used by every field theorist. He made fundamental contributions to the theory of the relativistic wave equation, in particular its group theoretic properties, and to the understanding of parity and time reversal.

Solid-state theory began in earnest with the Wigner-Seitz method of treating electron wave functions in the solid, and with the work of Wigner and his collaborators on the cohesion energy of metals. And in the theory of chemical kinetics he is regarded as the master.

The Nobel prize was given for Wigner's contributions to nuclear physics. These cover a wide range over the last 30 years. In 1933, the year after the discovery of the neutron, he wrote a fundamental paper demonstrating that the forces between protons and neutrons must be of very short range in order to explain the large binding energy of the alpha particle as compared with the small binding energy of the deuteron. Soon thereafter he explained the large scattering of slow neutrons by protons by postulating the existence of a virtual singlet state of the deuteron, distinct from the ground state (triplet) which had been observed. This idea, which he did not find worth publishing, has been the basis of countless publications ever since.

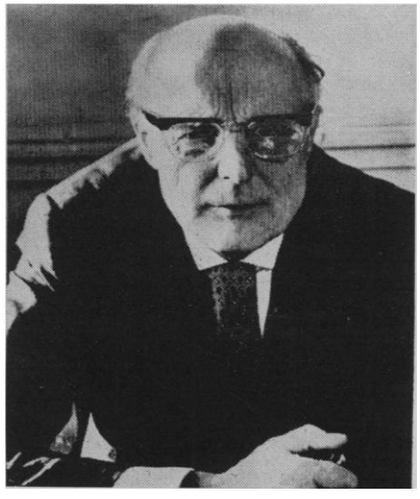
A major problem in nuclear physics has always been the saturation of nuclear forces. Wigner in 1936 gave the first rigorous derivation of the condition for the forces to saturate.

The study of nuclear binding energies in the 1930's revealed two separate regularities. Nuclei with even numbers of neutrons and protons generally are more strongly bound than those in which the neutron or proton number, or both, are odd (short periodicity). In addition, there are longer periods in binding energy, similar to the periodic system of the elements, showing particularly strong binding when the number of neutrons or protons, or both, is 2, 8, 20, 28, 40, 50, 82, or 126.

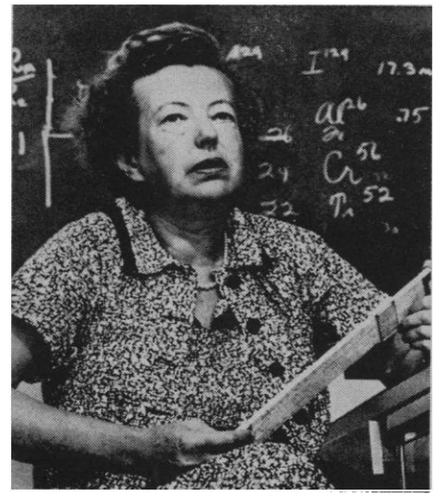
These long periods were attributed to a shell structure similar to that in atoms. Wigner, with Feinberg, wrote one of the first papers on the spectroscopic levels to be expected for nuclei on the shell model. Only nuclei up to O^{16} could at that time be successfully discussed in this manner.

One of Wigner's main works was related to the short periodicity, the even-odd alternation. He applied group theory to the levels of nuclei up to atomic weight about 50 and was able to account amazingly well for the observed regularities; this work included a quantitative determination of binding energies and excited states. Among other things he predicted the existence of S^{36}, which subsequently was found. His treatment in these papers of the symmetry energy of nuclei is still unsurpassed.

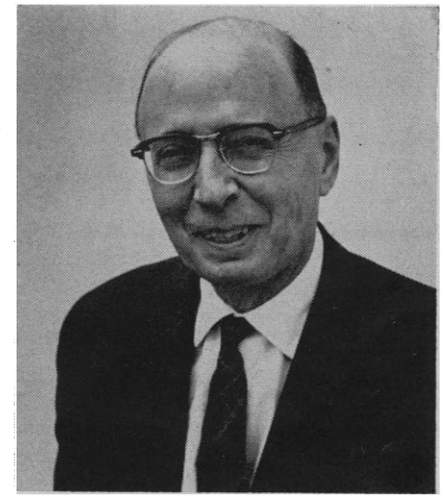
One application of his studies of the symmetry of nuclear wave functions was to the theory of beta decay. He pointed out that even if a beta transition is allowed, the lifetime should de-



J. Hans D. Jensen



Maria Goeppert Mayer



Eugene Wigner [all Wide World Photo]

pend strongly on the question of whether the wave functions of the parent and daughter nucleus have the same or different symmetries. This distinction of "favored and unfavored" transitions has been very fruitful.

With Breit, in 1938, he developed the theory of resonances in nuclear reactions. This theory he subsequently refined greatly in an impressive series of papers, largely with Eisenbud.

In 1939 he began to devote his attention primarily to the incipient project to obtain nuclear energy from fission. In 1941 he became the chief of the theoretical division of the Metallurgical Laboratory at Chicago, and, near the end of the war, director of the Oak Ridge Laboratory. To him are due many of the theoretical techniques of reactor calculations, some of which are contained in his scholarly textbook, with Weinberg, on reactor theory. But he is not merely a theorist; on several occasions he greatly impressed me by his remarkable knowledge of details of reactor design, including mechanical engineering.

Maria Goeppert Mayer and Hans Jensen, simultaneously and independently, found the solution to the long-recognized problem of the long periods in the behavior of atomic nuclei. In the 1930's it had been easy to account for the special stability of nuclei containing 2, 8, and 20 neutrons or protons (or neutrons and protons). One only needed to assume that the nucleons were subject to an attractive potential, either of the shape of a square well or an oscillator potential. Then the lowest quantum state would be an S state, containing 2 nucleons of each kind, the next state would be a P state containing 6 nucleons of each kind, and the next would be two nearly degenerate states of angular momentum 0 and 2, respectively. However this picture could not explain the nuclei of special stability of higher mass.

Mayer and Jensen suggested that there is, in nuclei, a strong coupling between spin and orbital momentum of each nucleon, such that these two vectors tend to be parallel. With this assumption they showed that special stability should exist for 28, perhaps 40, and certainly 50, 82, or 126 nucleons of one kind. They then demonstrated that these "magic numbers" corresponded indeed to nuclei of greatest stability, and that this was true not only for 82 protons (Pb), as had been known before, but also for 82 neutrons (this had been far less obvious), and similarly for the other magic numbers.

Their magic numbers have been fully confirmed by more accurate experiments since then—for example, by accurate determination of the masses of these and neighboring nuclei. The magic nuclei and their nearest neighbors behave in a special way in many respects. For instance, their first excited states always lie very high, and accordingly there is little inelastic scattering of neutrons by such nuclei until the neutron energy becomes quite high. The gamma-ray spectrum for nuclear reactions leading to magic nuclei has a specially strong component leading to the ground state of the nucleus and hence having very high energy, in contrast to most ordinary nuclei. Capture cross sections for slow neutrons are a minimum for magic nuclei; this explains, for example, the small neutron capture by Zr^{90} (50 neutrons) and by Pb^{208}, which is "magic" both in neutron and proton number. This list of properties of magic nuclei could be continued almost indefinitely.

From their model of spin orbit coupling, Mayer and Jensen deduced the expected angular momenta of nuclei. With few exceptions these predictions agreed with observation, and these exceptions have been explained subsequently. There are some particular regions of mass numbers for which the nucleons should have especially large angular momentum; in these regions, Mayer and Jensen predicted, nuclei isomers should occur frequently, and they found that this was indeed the case.

The nuclear shell model has been fully verified, and is now the basis of all theories of nuclear structure. Many refinements have been added to it, some of which permit the detailed prediction of nuclear energy levels. Other ideas have been added, such as the collective model of Bohr, Mottelson, and Rainwater, but they all are ultimately based on the shell model.

Initially a difficulty of the shell model was that it postulated a strong coupling between spin and orbital momenta which was not predicted by the meson theory of nuclear forces. The detailed study of scattering of nucleons by protons has shown that there is a strong spin-orbit coupling even in this elementary interaction of nucleons. More recently this fact has also been reconciled with meson theory. Thus, Mayer and Jensen, by their brilliant analysis of the behavior of complex nuclei, were able to predict a fundamental force between nucleons which had not been suspected.

HANS A. BETHE
Laboratory of Nuclear Studies,
Cornell University, Ithaca, New York

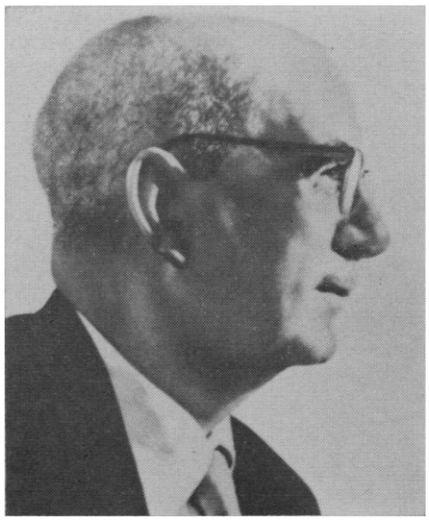
Chemistry

The Nobel prize in chemistry this year was given to two distinguished scientists—Karl Ziegler, director of the Max Planck Institute of Carbon Research, Mülheim, Germany, and Giulio Natta, director of the Industrial Chemistry Research Center at the Polytechnic Institute of Milan.

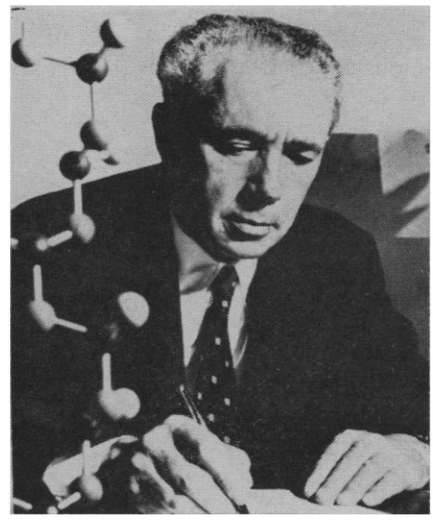
Ziegler's interests have not been primarily in the area of macromolecules; his earlier work was in the field of synthetic organic chemistry to which he made many significant contributions. These contributions are a clear example of how outstanding experimentation and observation lead to new discoveries. These qualities of observation and the perception that one has something new has been very evident throughout Ziegler's work. The discovery of linear polyethylene is an example of these attributes.

Natta's background is in physical chemistry. His early interest in catalytic processes under pressure made him familiar with catalyst systems. He discovered isotactic polypropylene and his awareness that a stereoregular polymer that crystallized in a particular conformation had been created was the key to all that followed. His background in x-ray crystallography enabled him to characterize the macromolecule that had been prepared with the transition metal catalyst systems. The determination of the unit cell and the establishment of the helical structure in the crystalline state provided the basis for the tremendous growth and understanding of the macromolecular structure to follow. This concept of configurational control with subsequent restrictions on conformation has bridged the gap very effectively between natural macromolecules and synthetic macromolecules.

Ziegler received his doctorate at the University of Marburg and was a pupil of von Auwers. He taught at Heidelberg for 10 years and during this time his work on free radicals and the synthesis of many-membered ring systems earned him the 1935 Liebig memorial medal. In 1936 he became pro-



Karl Ziegler



Giulio Natto [both Wide World Photos]

fessor and director of the chemical institute at the University of Halle where he continued his work in fundamental organic chemistry, particularly in the field of organometallic compounds. In 1943 he was appointed director of the Kaiser Wilhelm Institute, now known as the Max Planck Institute, and left the formal academic atmosphere. However, Ziegler never left the academic pattern. He continued his work on organometallic compounds and discovered that aluminum alkyls and ethylene undergo addition reactions that produce short-chain aluminum alkyls. Since ethylene was available in large amounts from the coal industries in the Ruhr, this area of investigation was pursued. In 1952, a new catalyst for adding ethylene to aluminum alkyls was discovered when an experiment was conducted in an autoclave that contained traces of nickel remaining from an earlier experiment. During the ensuing search for other metal catalysts, titanium was tried and a white solid was obtained instead of the normally liquid product mixture. The recognition that this white material was polyethylene and its characterization as a high molecular weight polyethylene with very few branches was the significant breakthrough. The idea of the complex metal-catalyst system of the transition-metal type to produce high molecular weight material was born. Ziegler also recognized the technical possibilities of his discovery and industrial participation was initiated.

This discovery of the titanium catalyst system, titanium tetrachloride, and aluminum alkyl immediately intrigued Natta. Having previously developed catalytic syntheses for methanol, formaldehyde, and butyraldehyde, and visualizing the type of mechanism that might explain this unique type of polymeric catalyst system, he experimented with the monomer propylene and found a high molecular weight crystalline material. He immediately suggested that the crystallinity was due to the fact that all of the secondary carbon atoms of the polymer chain have almost the same configuration. Drawing on his earlier background in x-ray crystallography, Natta's group determined the unit cell of crystalline isotactic polypropylene. These polyproplylene molecules crystallize in a "so-called" 3 to 1 helix with a unit cell of about 6.5 Å containing three propylene units. With appropriate modification, virtually any alpha-olefin was then polymerized. The Natta group also investigated the asymmetric synthesis of optically active polymers and stereoregular alternation copolymers.

These are only a few of Natta's research interests. His work has made the Polytechnic Institute of Milan one of the major centers for macromolecular chemistry throughout the world. Natta believed that scientists should orient their research efforts toward something useful, but at the same time they should also work on problems of pure research which may not have immediate practical interest. He recognized the great practical significance of the new polymers and their application to commercial processes. With the aid of the Montecatini Organization, he developed processes and techniques for producing isotactic polypropylene, and other polymers and copolymers from alpha-olefins.

Natta received his doctorate in chemical enginering from the Polytechnic Institute of Milan. Before his present post, he was professor of general and inorganic chemistry at the University of Pavia, then professor of physical chemistry at the University of Rome, then professor of industrial chemistry at the University of Torino.

Both Ziegler and Natta have demonstrated their unique abilities to excel as chemists not only in exploratory research of a basic type but also in pursuing an interest in the utilization of these materials.

Unfortunately, Natta has Parkinson's disease and this has immobilized him to some extent. However, his interest and enthusiasm for research has not abated.

The scientific community extend their best wishes and most sincere congratulations to Ziegler and Natta, to their co-workers, and their families.

CHARLES G. OVERBERGER
Polytechnic Institute of Brooklyn, Brooklyn, New York

Wiesner Successor: Donald Hornig, Princeton Chemistry Head, Named To Take Over Top Science Posts

Donald F. Hornig, chairman of the department of chemistry at Princeton University, has been named to succeed Jerome F. Wiesner as the President's science adviser and director of the White House Office of Science and Technology.

Hornig, 43, is expected to take up his new duties at the beginning of February. Wiesner, who came into office at the beginning of this administration, is returning to M.I.T., from which he has been on leave. The position he will occupy there has not been announced.

Hornig, a physical chemist, received his undergraduate and doctoral degrees from Harvard and served as a group leader at Los Alamos during World War II. He subsequently was on the faculty of Brown University, joining the Princeton faculty in 1957. As a member of the President's Science Advisory committee, to which he was appointed in 1960, he is said to have been particularly involved with matters relating to space.

Hornig's appointment breaks Cambridge's hold on the office (Wiesner