

WOLF PRIZE GOES TO CONDENSED-MATTER THEORISTS DE GENNES AND THOULESS

Pierre-Gilles de Gennes of the Collège de France in Paris and David J. Thouless of the University of Washington, Seattle, shared this year's Wolf Prize in Physics. The \$100 000 award was presented on 20 May by Chaim Herzog, President of Israel, at the Israeli House of Parliament in Jerusalem. According to the prize citation, each of the two winners was selected for a "wide variety of pioneering contributions" to the understanding of complex condensed matter systems.

In 1961, three years after finishing his doctoral work at the Nuclear Research Center at Saclay, France, de Gennes became a professor at the University of Paris at Orsay, where he organized a group of theorists and experimenters working on type II superconductors. The "Orsay Superconductivity Group," as they were called in their collectively-written papers, became highly respected worldwide. Among their many developments was a successful experiment, proposed by de Gennes, in which neutron scattering was used to detect magnetic vortices found in superconductors in strong magnetic fields.

Pierre-Gilles de Gennes



They also predicted, and found, that surface superconductivity persists above the magnetic field at which the bulk becomes a normal conductor. De Gennes summarized many of the team's results in his book *Superconductivity in Metals and Alloys* (1964).

Around 1968, when superconductivity research started demanding more technical sophistication, de Gennes, who preferred simple experiments, switched to liquid-crystal research. He convinced six groups at Orsay, representing an eclectic sampling of physics, materials science and chemistry, to join in his effort. The "Orsay Group for Liquid Crystals," which often published its most significant papers collectively, did research revealing a deep link between superconductors and the smectic family of liquid crystals. They showed, for example, that smectic crystals resist twisting forces in much the same way that type I superconductors expel magnetic flux. But perhaps the group's major effect was in renewing the ancient field of liquid crystals and making it into one of the most active disciplines of condensed matter research. An important consequence of their work was the formation of generalized ideas about phase transitions, order parameters and topology; such generalizations are needed for the study of liquid crystals and other complex systems.

In 1971 de Gennes left Orsay to accept a chair in condensed matter physics at the Collège de France in Paris, where he soon began an excursion into polymer science. Invoking the same sort of renormalization-group analysis that Kenneth Wilson, Michael Fisher and Leo Kadanoff had employed in investigating phase transitions, de Gennes found a deep relation between phase-transition theory and polymer statistics. De Gennes also produced the now-famous "reptation" model to describe the relaxation and flow of entangled polymer melts (see PHYSICS TODAY, June 1983, page

33). In creating this model he considered the Brownian diffusion of a single polymer chain as it snakes its way through the knots and tangles of the other polymer molecules.

Later, de Gennes became interested in the adsorption of polymers and the resulting "protection" of colloidal suspensions by polymers. He shifted progressively toward colloid science, as his group produced the first detailed neutron data on microemulsions. Currently the group studies wetting and drying processes. De Gennes is also trying, in his words, "to bring some law and order" to the multidisciplinary field of adhesion science. Since 1976 de Gennes has been the director of the Ecole Supérieure de Physique et de Chimie Industrielles in Paris.

Thouless, the other Wolf Prize winner, received his PhD in 1958 from Cornell University, where he studied under Hans Bethe. In 1965, after appointments at the Lawrence Radiation Laboratory in Berkeley, the University of Birmingham in England and Cambridge University, Thouless returned to Birmingham as a professor of mathematical physics.

David J. Thouless



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A few years later Thouless began working on the phase transitions of the two-dimensional "x-y model," a planar array of magnetic vectors free to rotate only in their plane. (This model represents such systems as thin superconducting films and liquid helium films.) He identified spin vortices as the objects whose interactions would very likely determine the phase transitions.

Thouless suspected that the x-y model might admit the same sort of renormalization-group techniques that Philip Anderson, Gideon Yuval and Donald Hamann had used recently in their work on Kondo alloys. The three had shown that a Kondo alloy was, for certain purposes, equivalent to a one-dimensional strip of "charges" whose interaction energy varies as the logarithm of their separation distance. Having found that a vortex pair in the x-y model also behaves logarithmically, Thouless wished to further explore the analogy between the two problems; for this project he enlisted the help of J. Michael Kosterlitz, a postdoctoral fellow in high-energy physics. The renormalization-group analysis yielded some of the first specific predictions about the phase transition in the x-y model—in particular, the prediction that the transition would be accompanied by a discrete drop in superfluid density (see PHYSICS TODAY, August 1978, page 19). Later, Kosterlitz applied a somewhat more sophisticated renormalization argument, which gave a number of more quantitative predictions. (V. L. Berezinskii of the Soviet Union had made considerable progress on the same problem roughly a year earlier.)

Much of Thouless's work in the 1970s was directed toward the problem of electron localization in disordered systems, a phenomenon that had been predicted much earlier by Anderson, Nevill Mott and Rolf Landauer but was still poorly understood. Today, Thouless's ideas on the topic underlie the whole field of mesoscopic systems. His work emphasized the key roles played by the conductance measured as a multiple of e^2/h and by the suppression of inelastic scattering at very low temperatures. One of the most dramatic predictions was that the resistance of a very thin wire would increase exponentially with its length at sufficiently low temperatures.

While working on spin glasses, Thouless, together with Jairo de Almeida, arrived at the conclusion that the mean-field-theory model of spin glasses would exhibit a phase transition at a certain curve in the magnetic

field-temperature plane—the so-called Almeida-Thouless line. An earlier paper, by Thouless, Anderson and Richard Palmer, has also been the basis for some significant recent developments.

When he left Birmingham in 1978, Thouless became a professor of applied science at Yale. He left Yale in 1980 to become a physics professor at the University of Washington. Much of Thouless's work at Washington has centered on topological quantum numbers, particularly those found in the quantum Hall effect.

—MATT SIEGEL

AUSTON WINS AWARD FOR WORK IN ULTRAFAST OPTICS

David H. Auston of Columbia University has won this year's Quantum Electronics Award of the IEEE/Lasers and Electro-Optics Society. The award, presented on 21 May at a joint session of the Conference on Lasers and Electro-Optics and the International Quantum Electronics Conference, was made in recognition of Auston's "pioneering and fundamental contributions to the field of picosecond optoelectronics and ultrafast optical phenomena."

In 1975 Auston demonstrated that picosecond light pulses could be used to activate photoconductive switches and gates in electrical circuits; this work helped lay the foundations of the now-rich research area of picosecond optoelectronics. In 1984 he introduced pulses as short as a few femtoseconds into electro-optic materials to induce in the crystal a conical electromagnetic shock wave (electro-optic Čerenkov radiation), which Aus-

David H. Auston

