

## DOCUMENTS OF THE GENERAL FACULTY

**REPORT OF THE MEMORIAL RESOLUTION COMMITTEE FOR  
ILYA PRIGOGINE**

The special committee of the General Faculty to prepare a memorial resolution for Ilya Prigogine, professor, chemical engineering and physics, has filed with the secretary of the General Faculty the following report.

Sue Alexander Greninger, Secretary  
The General Faculty

**IN MEMORIAM  
ILYA PRIGOGINE**

Ilya Prigogine, Regental Professor of Physics and Chemical Engineering and director of the Ilya Prigogine Center for Studies in Statistical Mechanics and Complex Systems at The University of Texas at Austin died on May 28, 2003. He joined the UT faculty in 1967 and remained a very active member of the faculty until his death in 2003. Prigogine was a leader in the fields of nonlinear chemistry and physics, whose research helped create a greater understanding of the role of time in the physical sciences and biology. He contributed significantly to scientists' ability to analyze dynamical processes in complex systems. He greatly enhanced our understanding of irreversible processes in systems that are far from equilibrium, particularly in chemical and biological systems.

Prigogine developed the concept of "dissipative structures" to describe the coherent space-time structures that form in open systems in which an exchange of matter and energy occurs between a system and its environment. Ilya Prigogine received the Nobel Prize in Chemistry in 1977 for "*his contributions to nonequilibrium thermodynamics, particularly the theories of dissipative structures.*" In his speech presenting Prigogine at the Nobel award ceremony, Professor Stig Claesson of the Royal Academy of Sciences of Sweden made the following remarks which well describe the great importance of Prigogine's work ([www.nobel.se/chemistry/laureates/1977/presentation-speech.html](http://www.nobel.se/chemistry/laureates/1977/presentation-speech.html)):

The discoveries for which Ilya Prigogine has been awarded this year's Nobel Prize for Chemistry come within the field of thermodynamics, which represents one of the most sophisticated branches of scientific theory and is of enormous practical relevance...

Prigogine's great contribution lies in his successful development of a satisfactory theory of non-linear thermodynamics in states which are far removed from equilibrium. In doing so he has discovered phenomena and structures of completely new and completely unexpected types, with the result that this generalized, nonlinear and irreversible thermodynamics has already been given surprising applications in a wide variety of fields.

Prigogine has been particularly captivated by the problem of explaining how ordered structures - biological systems, for example - can develop from disorder...

Prigogine...chose...to study systems which follow non-linear kinetic laws and which, moreover, are in contact with their surroundings so that energy exchange can take place - open systems, in other words. If these systems are driven far from equilibrium, a completely different situation results. New systems can then be formed which display order in both time and space and which are stable to perturbations. Prigogine has called these systems dissipative systems, because they are formed and maintained by the dissipative processes which take place because of the exchange of energy between the system and its environment and because they disappear if that exchange ceases. They may be said to live in symbiosis with their environment.

The method that Prigogine has used to study the stability of the dissipative structures to perturbations is of very great general interest. It makes it possible to study the most varied problems, such as city traffic problems, the stability of insect communities, the development of ordered biological structures and the growth of cancer cells to mention but a few examples...

Prigogine's researches into irreversible thermodynamics have fundamentally transformed and revitalized the science, given it a new relevance and created theories to bridge the gaps between chemical, biological and social scientific fields of inquiry. His works are also distinguished by an elegance and a lucidity which have earned him the epithet "the poet of thermodynamics".

Over the course of his scientific career, Prigogine was the recipient of fifty-three honorary degrees, and he authored twenty books and more than 1000 research articles. He was a member of many national academies around the world, including those of the United States, Russia, Belgium, France, Germany, Austria, England, Italy, Korea, and Argentina. He also received numerous international awards for his scientific work, including the Gold Medal of the Swante Arrhenius, Swedish Academy, 1969; Rumford Gold Medal, Royal Society of London, 1976; Descartes Medal, Paris, 1979; Commander of the Legion of Honor, France, 1988; Imperial Order of the Rising Sun, Japan, 1991; and the Medal of the President of the Italian Senate, 1997. He received the University Peace and Science Gold Medal, Albert Schweitzer International University, for humanitarianism in science in 2001. Prigogine was awarded the title of Viscount by the King of Belgium in 1989.

Ilya Prigogine was born in Moscow on January 25, 1917, a few months before the Russian revolution. Events in Russia caused his family to leave Russia in 1921. They went first to Germany and then settled in Belgium in 1929. Perhaps because of this history, Prigogine was fluent in the French, English, Russian, and German languages. Under the influence of his mother, Prigogine studied music from an early age and received a rigorous classical education in Belgium. Prigogine studied chemistry at the Universite' Libre de Bruxelles and obtained his doctorate there in 1941. In 1947, Prigogine was appointed professor at the Universite' Libre, and in 1962, he was named director of the Solvay Instituts Internationaux de Physique et de Chimie, a position he held until the end of his life. In 1967, Prigogine joined the physics and chemical engineering faculties at The University of Texas at Austin, as a half-time professor. At that time he founded the Center for Statistical Mechanics and Thermodynamics (renamed the Ilya Prigogine Center for Statistical Mechanics and Complex Systems in 1977 when he received the Nobel Prize). In 1979, Prigogine was appointed Regental Professor of Physics and Chemical Engineering at The University of Texas as Austin.

As a young man, Prigogine was strongly influenced by the thinking of Henri Bergson, who emphasized the differences between the concept of time used in science and the time of ordinary experience. At the Universite' Libre, he was strongly influenced by two professors, Jean Timmermans and Theophile de Donder. Timmermans was interested in application of equilibrium thermodynamics to the study of solutions and other complex systems. De Donder was interested in the applications of thermodynamics to nonequilibrium situations. These became two major themes in Prigogine's research career. Prigogine's book, *Chemical Thermodynamics*, co-authored with R. Defay, is one of the most cited books on this subject. His book, *The Molecular Theory of Solutions*, co-authored with V. Mathot and A. Bellemans, summarizes many of his important contributions to the theory of solutions. However, Prigogine's primary interest was in nonequilibrium irreversible phenomena because in these systems the arrow of time becomes manifest.

Prigogine viewed the arrow of time and irreversibility as playing a constructive role in nature. For him the arrow of time was essential to the existence of biological systems, which contain highly organized irreversible structures. Prigogine's first major work on irreversible systems was his theorem of minimum entropy production which was applicable to nonequilibrium stationary states near equilibrium. This theorem was the focus of his Ph.D. dissertation in 1945 and is the subject of his first book, *Etude Thermodynamique des Phenomenes Irreversibles* (1947) and the English translation *Thermodynamics of Irreversible Processes* (1955).

Prigogine next began to work on far-from-equilibrium irreversible phenomena, both in hydrodynamic systems and chemical systems. Such systems, because of nonlinear interactions, can form spatial and temporal structures (dissipative structures) that can exist as long as the system is held far from equilibrium due to a continual flow

of energy or matter through the system. Over the years, Prigogine co-authored several classic books on far from equilibrium phenomena including *Thermodynamic Theory of Structure, Stability and Fluctuations* with P. Glansdorff and *Self-organization in Nonequilibrium Systems: From Dissipative Structures to Order through Fluctuations* with G. Nicolis.

Irreversible systems have an arrow of time which appears to be incompatible with Newtonian and quantum dynamics, which are reversible theories. This incompatibility of the reversible foundations of science with the irreversible behavior that is actually observed in chemical, hydrodynamic, and biological systems remains one of the great mysteries of science. What is the origin of the arrow of time? Is it a fundamental property of nature, or is it only an illusion? Prigogine's view was that it must be a fundamental property of nature. In the 1950s, he began to work on the foundations of statistical mechanics and the question of how to reconcile Newtonian mechanics with an irreversible world. One of his early books, *Nonequilibrium Statistical Mechanics* (1962), remains a classic in this field. The Newtonian foundations of equilibrium statistical mechanics require that the Newtonian dynamics be chaotic. Prigogine's early work at UT was focused on the problem of dissipative structures, but in later years he became more and more involved with the problem of reconciling the arrow of time with Newtonian and quantum dynamics. Indeed, much of the research in the Prigogine Center focused on the nonlinear dynamics of conservative chaotic systems and the manifestations of chaos in statistical mechanics and quantum mechanics. Many of the questions raised in this area are critical to understanding dynamics at nanometer and atomic length scales, a topic of considerable current interest. At the end of his life, Prigogine believed that he and his students had discovered how the arrow of time manifests itself in Newtonian dynamics. The key can be found in simple chaotic maps. When analyzed in terms of single trajectories, they appear to be reversible. However, when analyzed in terms of the flow of probabilities in their phase space, they decay to an equilibrium probability distribution. The rate of decay to equilibrium appears in the spectrum of the Frobenius-Perron operator that describes the dynamics of probability distributions in these systems.

While working with non-equilibrium chemical systems, it was a natural step to extend concepts found in these systems to complex social and economic systems. Prigogine is considered one of the founders of complexity science. His book, *Kinetic Theory of Vehicular Traffic* with R. Herman, is one of the first practical books on complexity science. His book, *Exploring Complexity* with G. Nicolis, is a classic in the field.

Ilya Prigogine was a great optimist and a gifted teacher. Perhaps his optimism grew out of his science, which was the science of creation. He had the ability to transmit his excitement about ideas to students and give them confidence to carry those ideas in new directions. His lectures were fascinating. He preferred to leave out many of the tedious details in his science lectures and instead included perspectives on art, music, and philosophy, which wove the science into the broader fabric of life. He wrote a number of best selling popular books for general audiences, including *Order Out of Chaos* (1984) and *The End of Certainty – Time's Flow and the Laws of Nature* (1997) with I. Stengers.

Prigogine was a true Renaissance Man in every sense of the word. In addition to his remarkable scientific achievements, he had a profound knowledge of history, music, philosophy and archaeology. His death closes an important chapter in the history of science. He is greatly missed by his many friends and colleagues.

Ilya Prigogine is survived by his wife, Marina, and his two sons Yves and Pascal.

This memorial resolution was prepared by a special committee consisting of Professors Linda Reichl (chair), Robert Schechter, and George Sudarshan.

Distributed to the dean of the College of Natural Sciences, the executive vice president and provost, and the president on September 13, 2004. Copies are available on request from the Office of the General Faculty, FAC 22, F9500. This resolution is posted under "Memorials" at: <http://www.utexas.edu/faculty/council/>.