Macromolecules

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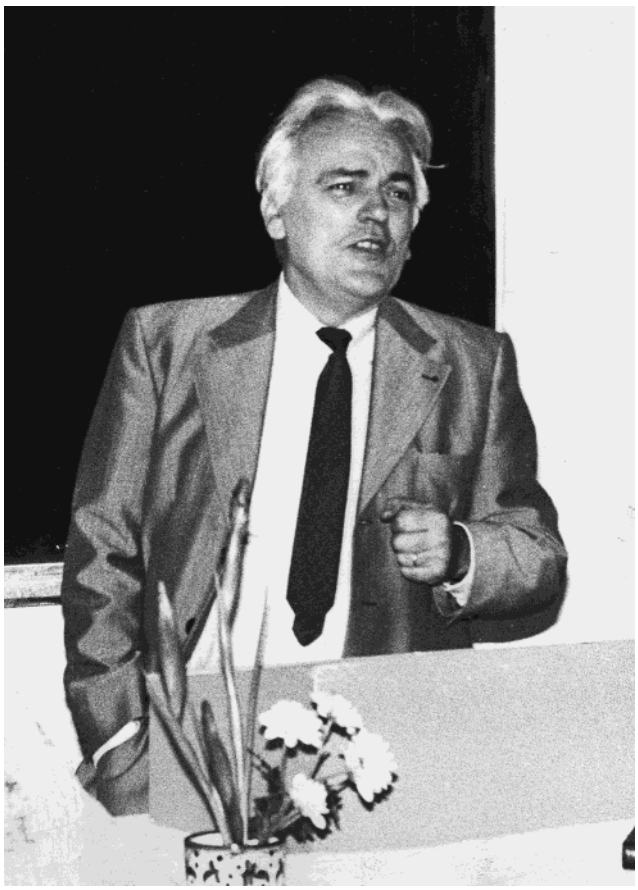
Henri C. Benoit



On July 11 of this year colleagues and friends celebrated the 80th birthday of Professor Henri Benoit in Prague. By happy chance this event fell during the 20th meeting on Scattering Methods for the Investigation of Polymers. Those attending therefore not only had the opportunity to see that Henri Benoit is as involved as ever in the interpretation of experimental results from polymers but also to share their pleasure on his birthday with him in person. Henri Benoit has been passionately involved in advancing our understanding of macromolecules for more than half a century, and he shows no sign of changing his trademark questioning approach to the field!

In France, in Europe, and further afield still, especially in the USA, his influence on the field of polymer physics has been immense. This influence, while firmly based on the importance of his research contributions, has also played an important part in the wider political field. From his base in Strasbourg Henri Benoit played a key role in France and an influential one in Europe in science policy and science funding in particular. While he has always assessed the political game at its true value, he has understood that it must be played well if new science is to be supported and young colleagues are to be recruited and developed.

Born in Montpellier in 1921, Henri Benoit graduated in 1945 from the Ecole Normale Supérieure in Paris. He then joined Professor Charles Sadron's Laboratory at the University of Strasbourg and received his doctoral degree in 1950. After a postdoctoral stay at Harvard University with Professor Paul Doty, he became Professor at the Université Louis Pasteur in Strasbourg and directed an effective and productive research team at the Centre de Recherches sur les Macromolecules (now Institut Charles Sadron). From 1967 to 1978 he directed this large research center, entirely devoted to polymer science in all its various aspects. In 1988 he was elected Professor Emeritus, and he still pursues his research activities at the Institut.

Henri Benoit's contributions to macromolecular science are chiefly concerned with structural characterization, thermodynamics, and chain dynamics of macromolecular compounds, in both theoretical and experimental aspects; they are documented in over 300 refereed publications. Benoit's efforts in chain statistics are well-known and are now part of the basis of polymer science. He introduced bond angles and limitations to free rotation on the valence cone into the expression for the mean-square end-to-end distance of a polymer chain. He demonstrated that any chain molecule becomes Gaussian when its length increases indefinitely.[1]

Henri Benoit has always shown a lively interest in techniques aimed at the study of dilute solutions of macromolecular compounds. His doctoral thesis[2] was devoted to the Kerr effect of rigid macromolecules, and he also contributed substantially to flow birefringence. He was the first to apply Cabanne's findings, relating the depolarization of scattered light to the anisotropy of the scattering particles, to macromolecules.[3] He also studied the scattering form factors of various architectures: semiflexible macromolecules,[4] chains with excluded volume arising from repulsive segment−segment

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interactions,[5] branched macromolecules,[6] and cyclic polymers.[7]

Benoit's seminal contribution to size exclusion chromatography was based on his demonstration that the hydrodynamic volume of the polymer molecules is the pertinent parameter that determines retention. The well-known "universal calibration" method derives from that result.[8] Professor Benoit pioneered investigations of the structure of copolymers in solution,[9] and he helped to understand the segregation effects caused by repulsion between unlike sequences.[10] Another area in which Benoit left his mark concerns the preferential solvation effects that are observed when polymer chains are dissolved in a mixture of two solvents, and he described the resulting volume expansion of the coils.[11] Benoit also stimulated the development of chemical methods for the synthesis of well-defined polymer samples: he was one of the first to recognize the importance of model macromolecules in research programs aiming at a better understanding of the relation between structure and properties.

The early 1970s were an exciting period in Europe. The French−German (and subsequently British) collaboration in the Institut Laue Langevin at Grenoble was about to provide experimentalists with the world's most powerful neutron source, equipped with novel techniques for investigating the molecular behavior of materials. Henri Benoit was among the first to recognize the unique possibilities offered by small-angle neutron scattering to investigate polymer physics. By using the contrast obtained from deuterating some molecules, this technique opened a very large field and provided new information that could not otherwise be obtained. The behavior of individual molecules in dense systems, such as melts, glasses, or networks, could be directly observed for the first time. His contributions include particularly important theoretical and experimental results on bulk polymers,[12] semidilute solutions,[13] polymer blends, and block copolymers.[14] In this context, Benoit has shown (in numerous publications and in his book[15] with one of us) that theoretical formulas commonly used to interpret neutron scattering data from polymers can be obtained on the basis of accessible physical models as well as via heavier mathematical developments. Of particular note is his demonstration that the formula introduced by de Gennes under the name of the random phase approximation may be derived from the formalism of Ornstein and Zernicke.[16] For his clarity in demonstrating the basic physical origins of such key formulas he has earned the immense gratitude of the experimental scientists in the field!

Professor Benoit has held a number of important positions at both national and international levels. He headed the CNRS Committee on Polymers for 8 years, and he was the Chairman of the IUPAC Division on Macromolecular Chemistry. He has been a corresponding member of the French Academy of Sciences since 1983. He has held visiting professorships at various institutions and been elected Doctor Honoris Causa of several European universities. Professor Benoit has received a number of awards, including the CNRS Silver Medal, the Gold Medal of the Czechoslovak Academy of Sciences, the Witco Award of the American Chemical Society, the Ford Prize of the American Physical Society, the Robin Award of the French Physical Society, and the Alexander von Humboldt Award. He has been nominated Officier de la Légion d'Honneur and Commandeur de l'Ordre National du Mérite, both witnessing the official recognition of Professor Benoit's outstanding achievements in research, in teaching, as head of the Institut Charles Sadron, and as one of the most brilliant and devoted scientists of his generation.

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