heavy-ion physics is still done in this energy domain. Further, the techniques discussed here can be extrapolated to the higher energies; possibly this will be touched upon in the upcoming second volume.

Part 2 consists of new material on transfer reactions. It is nearly as long as part 1 and covers the description of heavy-ion collisions in which one or more nucleons are transferred from one nucleus to the other. Again, the semiclassical approach is used and the energy domain below 10 MeV per nucleon is emphasized. Particular attention is paid to the transfer of two nucleons and the importance for this process of pairing correlations in nuclear structure; again this is a subject to which both authors have contributed significantly for many years.

In summary, anyone expecting from this book a broad coverage of all aspects of heavy-ion reactions will be disappointed. But such expectations will have been unreasonably high. This volume is a valuable and useful contribution to a particular aspect of the field and can be recommended to anyone working in it or interested in the application of semiclassical techniques.

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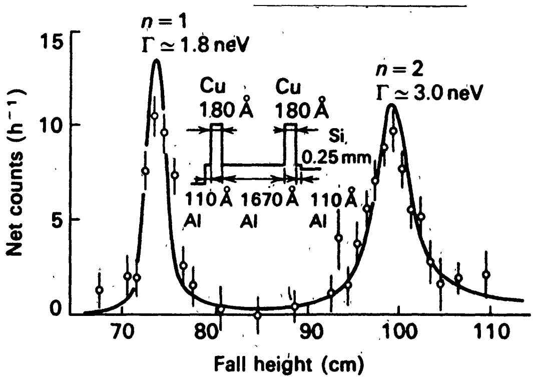
Neutrons in a Bottle

The Physics of Ultracold Neutrons. V. K. IGNATOVICH. Clarendon (Oxford University Press), New York, 1990. xiv, 397 pp., illus. $105. Oxford Series on Neutron Scattering in Condensed Matter, 5. Translated from the Russian edition (1986) by G. B. Pontecorvo.

Ultracold neutrons are neutrons with such low energy that they have velocities less than 10 meters per second; they can climb only a few meters against gravity; they have wave lengths on the order of 100 to 1000 angstroms; they can be collected and stored in material bottles for times comparable to the neutron half-life, 10 minutes. Once captured in bottles, they can be studied or can be used to study material surfaces. In sum, they are unique in their ability to express both quantum and classical characteristics. As such, they are intrinsically interesting to physics.

This book tells the story of ultracold neutrons, from the first experiments in the late 1960s to the present. Though most of the book describes laboratory-based measurements involving ultracold neutrons and the theoretical analysis of these experiments, the author does digress briefly on related topics such as neutron stars and the model of the skyrmion. The study of ultracold neutrons has been confined to a relatively small community of researchers, and the author has included as an appendix an updated bibliography of the papers published on this subject. Hence, to an unusual degree, this book is a complete story, albeit from the Russian perspective, of this very interesting topic.



Results of experiment and theory (solid line) for the relationship between the transmission of ultracold neutrons through a double barrier and the energy of the neutrons as measured by the height from which they have fallen in the gravitational field. The two peaks represent the $n = 1$ and $n = 2$ resonances through this double barrier, which consists of 180 Å of copper separated by 1670 Å. [From *The Physics of Ultracold Neutrons*; after K. A. Steinhauser *et al.*, *Phys. Rev. Lett.* **44**, 1306 (1980)]

The book is organized into a logical series of chapters on the production, detection, transport, and storage of ultracold neutrons in both material and magnetic bottles. Each chapter starts with a readable commentary on the topic followed by a presentation of technical details (both theoretical and experimental). Hence, though the book contains a large amount of technical information that makes it essential to workers in this field, it is written in such a way as to make it easily accessible to the general physicist interested in these novel particles.

A long-term discrepancy between theory and experiment for neutron containment in material bottles is described in some detail: the amount of time that ultracold neutrons can be kept in an enclosed vessel is, in practice, significantly less than that predicted by theory. The basic question is whether there is some fundamental new physics being revealed or the discrepancy is caused by "dirt" (surface hydrogen) on the bottle walls. On balance, the evidence seems to indicate the latter explanation, but the author holds open the possibility that ultracold neutrons may be trying to tell us some new fundamental physics.

For some, perhaps the most interesting chapter will be "The applications of ultracold neutrons," which starts with a description of the use of ultracold neutrons in the search for the electric dipole moment of the neutron (a test of time-reversal symmetry) and then goes on to discuss less well-known applications, such as the search for the gravitational dipole moment, the investigation of the wave properties of the neutron (resonant transmission and reflection from macroscopic targets), the search for neutron-antineutron oscillations, the neutron microscope, and the use of ultracold neutrons to study materials.

In sum, this book provides both an introduction and a review of ultracold neutrons, the only heavy particles that can be obtained with such low energy that their wave length becomes macroscopic. Because these particles dramatically display characteristics that are at the heart of modern physics and because these characteristics are difficult to observe in other systems, the topic of this book will be of interest to a wide audience. Its readability will make it additionally attractive to this audience.

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Cryobiology

Insects at Low Temperature. RICHARD E. LEE, JR., and DAVID L. DENLINGER, Eds. Chapman and Hall, New York, 1991. x, 513 pp., illus. $99.50.

Whether to freeze, vitrify, or supercool is the question faced by insects that overwinter in alpine and polar climates. This volume addresses the diversity of adaptations from the biochemical, cellular, ecological, and ultimately population levels that combine to permit the winter survival of insects. The book is a collection of 20 chapters grouped in four sections of nearly equal length. The initial chapter is appropriately a tribute to the many contributions of Reginald W. Salt (including a complete bibliography of his published work), who first classified overwintering insects into the two currently recognized broad groups: freeze-tolerant (species that can survive some degree of extracellular, and perhaps intracellular, ice formation) and freeze-susceptible (species that do not survive freezing and instead overwinter in either a supercooled or a vitrified state).

The first section, in addition to defining basic concepts and terminology, describes