Slow Neutrons. By V. F. Turchin, a translation from the Russian by the Israel Program for Scientific Translations, published in Israel by Sivan Press, Jerusalem, and in the US by Daniel Davey and Co., Inc., New York (1965), vi + 304 pages, $16.50.

It is reasonable that we should condone many imperfections in a book that is novel in providing a systematic and and thorough exposition of the principles of the subject with which it deals. I believe that this benevolent attitude will be approved by those readers of *Slow Neutrons* who can recall learning a subject, the approach to which has not been softened by the availability of a systematic treatise.

Turchin's book is divided into two parts; the first deals with slow-neutron scattering, the second with the thermalization and diffusion of neutrons. In his treatment of slow-neutron scattering, which takes about two-thirds of the book, the author is successful in presenting to the reader just about every important facet of the subject, from the relevant nuclear physics to the magnetic scattering of neutrons. On the experimental side, he describes briefly the production and detection of slow neutrons, and the methods of slow-neutron spectrometry. The book, however, has a predominantly theoretical cast. After introducing the basic elements in the theory (the scattering length, Fermi pseudopotential, and the concept of coherence), the author presents an elementary exposition of the theory of scattering as it applies to the neutron problem. By means of simple examples (Einstein oscillator, free particle), the reader is made comfortable with the mathematical formalism that has been put at his disposal.

If the reader is already familiar with the diffraction, reflection, and refraction of neutrons, his knowledge may be slightly reinforced by the author's treatment of these phenomena. Quite properly, however, these phenomena are considered more for reasons of continuity, than as an attempt to improve on the thorough treatment that they have received in other books.

To understand the theory of slow-neutron scattering in its most concise and elegant form requires a somewhat more than elementary knowledge of quantum-mechanical formalism. Though terse, Turchin is systematic in making the connection between slow-neutron scattering and the time dependence of atomic motions, and more specifically, the space-time correlations of these motions in macroscopic systems. He aptly illustrates the power of the formalism by applying it to the development of well-known approximate formulas for slow-neutron cross sections. The theoretical utility of expressing the microscopic behavior of macroscopic systems in terms of space-time correlation functions is clarified by his treatment of the Singwi–Sjölander model for the motion of an atom in a liquid.

Not every problem of scattering by real, or perhaps I should say almost real, systems is carried out within the framework of the time-dependent formalism. The theory of scattering by harmonic crystals, for example, is developed by explicit calculation of matrix elements between initial and final states of the crystal. Although this is not the most concise procedure, it has the advantage of clarifying certain physical aspects of the problem.

The criteria which dispose me favorably toward the first part of the book force me to be unimpressed with the last few chapters, which deal with the thermalization and diffusion of neutrons. One chapter is devoted to already well-developed topics such as the derivation of the transport equation and the theory of slowing down. The remaining chapters deal with stationary and nonstationary distributions, treating such topics as thermalization in an infinite medium, gas models, the effect of the chemical bond, and the use of scattering-law data to calculate neutron spectra.

Part of my dissatisfaction with Turchin's treatment of neutron theralization stems from the fact that many significant developments have taken place in the field since the the Russian language version of the book first appeared in 1962. I refer in particular to recent advances in our understanding of the nature of the eigenvalue spectrum of the thermal neutron transport equation. Even in 1962, however, I would have considered Turchin's treatment of thermalization as scanty and old-fashioned. Finally, he makes no real connection between the developments in neutron thermalization and the problems of reactor design physics.

There are many imperfections in this book which, if there were other books on the same subject, would make it difficult to render a favorable recommendation. The book is marred by a few serious errors: an occasional sentence constructed in the incoherent approximation, a plethora of misprints, and the absence of an index. Among the most serious errors is the implication that the term "coherent," as it is used in neutron scattering, derives from the possibility of interference between scattered and incident waves; in fact, it derives from the possibility of interference between waves scattered from different nuclei in a system of nuclei with uncorrelated spins. Another serious error occurs on p. 143; here the equations for one-phonon absorption and emmission lack well-known factors involving the gradient of the phonon frequency in reciprocal lattice space.

The bibliography at the end of the book is by no means complete, but as Turchin remarks in the preface, he refers, with rare exceptions, only to works whose results are used explicitly in the book. In citing sources of information, the author is careful, though not impeccably so, to assign credit where credit is due. Is the author really a Russian?

In spite of many deficiencies, this book is the best of a set consisting, at present, of only one element. To whomever is willing to pay the price, I recommend it as a useful introduction to or reference on the basic principles of slow-neutron scattering.

Donald E. Parks

General Atomic
P.O. Box 609
San Diego, California

Received January 5, 1966

About the Reviewer: Donald E. Parks received his PhD in physics from Carnegie Institute of Technology in 1958. He is currently a theoretical physicist at the General Atomic Division of General Dynamics Corporation in San Diego, California. He has been active in problems of slow-neutron scattering and thermalization.