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This Week's Citation Classic

Mika J R. Neutron transport with anisotropic scattering.
Nucl. Sci. Eng. **11**:415-27, 1961.
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The general procedure for solving the one-velocity Boltzmann equation is presented. It is assumed that scattering function can be expanded into the finite series of Legendre polynomials. The complete set of eigenfunctions of the Boltzmann equation is found. The orthogonality and completeness of the eigenfunctions are proved. By way of illustration, solutions to some basic problems of neutron diffusion are given. [The SCI® indicates that this paper has been cited in over 120 publications since 1961.]

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"In 1960, a paper appeared which was by far the most important, and most celebrated, in neutron transport theory.[1] It contained the presentation of what was later called Case's method. The method itself had been first developed by Van Kampen[2] and applied in plasma physics but neutron transport theory was the field in which the method made a worldwide impact.

"Around 1960, neutron transport theory was a collection of various techniques and approaches loosely connected with each other and seldom based upon a sound mathematical argument. All the scientists from various nuclear research institutes and nuclear engineering departments of universities were longing for something to make their work both interesting and relevant. Case's method appeared to be extremely interesting from the mathematical point of view. Even now after 20 years of existence it is the subject of serious mathematical studies. As for the relevance, it produced thousands of scientific articles and many review papers and books including the monograph written by Kenneth Case himself with Zweifel.[3] It became a favorite subject for PhD theses and has been a major theme of a great many scientific conferences and meetings.

"Case's method also has disadvantages which made some people, including myself, withdraw from the subject. The most disappointing one, which soon became evident, is that its applications for numerical calculations in neutron transport theory are limited essentially to one-velocity and simple geometry problems. It became more useful, however, in other domains of transport theory such as, for instance, radiative transfer.

"After graduating in 1955, I started my work at the Institute of Nuclear Research in Poland. For the first few years I was busy with my colleagues making routine calculations of reactor systems, at the same time studying neutron transport theory. One day in 1960, Roman Żelazny, then my boss, brought with him a copy of Case's paper claiming it to be of utmost interest in transport theory. He, Antoni Kuszell, and I started to study the paper and the mathematics behind it. We soon realized that one could try to extend Case's results to anisotropic scattering and we did it for the linear scattering kernel.[4]

"In January 1961, I received an International Atomic Energy Agency fellowship and arrived at the University of Michigan to fulfill partially my graduate studies. While there, I had the opportunity to work with Case, then a professor at the university. I already had an idea for my paper so that under his supervision I was able to finish it in a little more than two months. I spent only one year, which was long enough to get a PhD. I received my degree after coming back to Poland. I presented the paper as partial fulfillment of the requirements.

"I think it is clear why the paper has been relatively often cited by transport theory specialists. After Case had introduced his method for isotropic scattering, it was natural to seek its generalization to the anisotropic scattering of any finite order and many people have done that. I was lucky that I was the first."

1. **Case K M.** Elementary solutions of the transport equation and their applications.
Ann. Phys. NY 9:1-23, 1960.
[The *SCI* indicates that this paper has been cited in over 360 publications since 1961.]
2. **Van Kampen N G.** On the theory of stationary waves in plasmas. *Physica* **21**:949-63, 1961.
[The *SCI* indicates that this paper has been cited in over 175 publications since 1961.]
3. **Case K M & Zweifel P F.** *Linear transport theory*. Reading, MA: Addison-Wesley, 1967. 342 p.
[The *SCI* indicates that this book has been cited in over 510 publications since 1967.]
4. **Żelazny R, Kuszell A & Mika J.** Solution to the Boltzmann equation with the first-order anisotropic scattering.
Ann. Phys. NY **16**:69-80, 1961.