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# Numerical methods for the generation of the spectrum of the multigroup slab-geometry discrete ordinates operator in neutron transport theory

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## Abstract

We describe two numerical methods applied to the first-order form of the multigroup slab-geometry discrete ordinates equations modelling fixed-source neutron transport problems with anisotropic scattering. The numerical methods described in this article generate the spectrum and a vector basis for the null space of the multigroup slab-geometry discrete ordinates operator defined in a homogeneous domain. The first method is a more general approach of a numerical method described in a recent work by others. We then come to consider numerical and computational aspects of the first method and we propose a second method. The second method is a multigroup extension of a numerical method described in a more recent work by the present author. In order to provide those interested in implementing either method with a reference set, we present numerical results for some multigroup slab-geometry model problems with anisotropic scattering. We conclude this article with a discussion and directions for future work. © 2002 Elsevier Science Ltd. All rights reserved.

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## 1. Introduction

We call for two recently developed numerical nodal methods applied to multigroup slab-geometry discrete ordinates ( $S_N$ ) problems in neutron transport theory—

*E-mail address:* mabreu@iprj.uerj.br (M. P. de Abreu).

# Numerical Methods In The Theory Of Neutron Transport

**S Baum**



## **Numerical Methods In The Theory Of Neutron Transport:**

**Numerical Methods in the Theory of Neutron Transport** Guriĭ Ivanovich Marchuk, Viacheslav Ivanovich Lebedev, 1986      **Computational Methods in Transport** Frank Graziani, 2006-02-17

There exist a wide range of applications where a significant fraction of the momentum and energy present in a physical problem is carried by the transport of particles. Depending on the specific application the particles involved may be photons, neutrons, neutrinos or charged particles. Regardless of which phenomena is being described, at the heart of each application is the fact that a Boltzmann-like transport equation has to be solved. The complexity and hence expense involved in solving the transport problem can be understood by realizing that the general solution to the 3D Boltzmann transport equation is in fact really seven dimensional: 3 spatial coordinates, 2 angles, 1 time and 1 for speed or energy. Low order approximations to the transport equation are frequently used due in part to physical justification but many in cases simply because a solution to the full transport problem is too computationally expensive. An example is the diffusion equation which effectively drops the two angles in phase space by assuming that a linear representation in angle is adequate. Another approximation is the grey approximation which drops the energy variable by averaging over it. If the grey approximation is applied to the diffusion equation the expense of solving what amounts to the simplest possible description of transport is roughly equal to the cost of implicit computational fluid dynamics. It is clear therefore that for those application areas needing some form of transport, fast, accurate and robust transport algorithms can lead to an increase in overall code performance and a decrease in time to solution.

Numerical Solution of Transient and Steady-state Neutron Transport Problems Bengt G. Carlson, 1959      *Computational Methods of Neutron Transport* Elmer Eugene Lewis, W. F. Miller, 1984      **Deterministic Numerical Methods for Unstructured-Mesh Neutron Transport Calculation** Liangzhi Cao, Hongchun Wu, 2020-08-30. Deterministic Numerical Methods for Unstructured Mesh Neutron Transport Calculation presents the latest deterministic numerical methods for neutron transport equations (NTEs) with complex geometry which are of great demand in recent years due to the rapid development of advanced nuclear reactor concepts and high performance computational technologies. This book covers the well-known methods proposed and used in recent years, not only theoretical modeling but also numerical results. This book provides readers with a very thorough understanding of unstructured neutron transport calculations and enables them to develop their own computational codes. The fundamentals, numerical discretization methods, algorithms and numerical results are discussed. Researchers and engineers from utilities and research institutes are provided with examples on how to model an advanced nuclear reactor which they can then apply to their own research projects and lab settings. Combines the theoretical models with numerical methods and results in one complete resource. Presents the latest progress on the topic in an easy-to-navigate format.      *Mathematical Analysis and Numerical Methods for Science and Technology* Robert Dautray, Jacques-Louis Lions, 1999-11-23. These six volumes are the result of a ten-year collaboration between two distinguished

international figures compile the mathematical knowledge required by researchers in mechanics physics engineering chemistry and other branches of application of mathematics for the theoretical and numerical resolution of physical models on computers It is a comprehensive and up to date publication that presents the mathematical tools needed in applications of mathematics Handbook of Nuclear Engineering D. G. Cacuci,2010-09-14 This is an authoritative compilation of information regarding methods and data used in all phases of nuclear engineering Addressing nuclear engineers and scientists at all levels this book provides a condensed reference on nuclear engineering since 1958 **Neutron Transport** Ramadan M. Kuridan,2023-09-26 This textbook provides a thorough explanation of the physical concepts and presents the general theory of different forms through approximations of the neutron transport processes in nuclear reactors and emphasize the numerical computing methods that lead to the prediction of neutron behavior Detailed derivations and thorough discussions are the prominent features of this book unlike the brevity and conciseness which are the characteristic of most available textbooks on the subject where students find them difficult to follow This conclusion has been reached from the experience gained through decades of teaching The topics covered in this book are suitable for senior undergraduate and graduate students in the fields of nuclear engineering and physics Other engineering and science students may find the construction and methodology of tackling problems as presented in this book appealing from which they can benefit in solving other problems numerically The book provides access to a one dimensional two energy group neutron diffusion program including a user manual examples and test problems for student practice An option of a Matlab user interface is also available **Numerical Formulation and Solution of Neutron Transport Problems** Bengt G. Carlson,1964 **Nuclear Science Abstracts** ,1976 Computational heat and mass transfer - CHMT 2001- Vol. I , Nuclear Computational Science Yousry Azmy,Enrico Sartori,2010-04-15 Nuclear engineering has undergone extensive progress over the years In the past century colossal developments have been made and with specific reference to the mathematical theory and computational science underlying this discipline advances in areas such as high order discretization methods Krylov Methods and Iteration Acceleration have steadily grown Nuclear Computational Science A Century in Review addresses these topics and many more topics which hold special ties to the first half of the century and topics focused around the unique combination of nuclear engineering computational science and mathematical theory Comprising eight chapters Nuclear Computational Science A Century in Review incorporates a number of carefully selected issues representing a variety of problems providing the reader with a wealth of information in both a clear and concise manner The comprehensive nature of the coverage and the stature of the contributing authors combine to make this a unique landmark publication Targeting the medium to advanced level academic this book will appeal to researchers and students with an interest in the progression of mathematical theory and its application to nuclear computational science **University of Michigan Official Publication** University of Michigan,1989 Each number is the catalogue of a specific school or college of the University Boundary

Value Problems for Transport Equations Valeri Agoshkov, 2012-12-06 In the modern theory of boundary value problems the following approach to investigation is agreed upon we call it the functional approach some functional spaces are chosen the statements of boundary value problems are formulated on the basis of these spaces and the solvability of problems and their dependence on the original data of the problems are analyzed These stages are put on the basis of the correct statement of different problems of mathematical physics or of the definition of ill posed problems For example if the solvability of a problem in the functional spaces chosen cannot be established then probably the reason is in their unsatisfactory choice Then the analysis should be repeated employing other functional spaces Elliptical problems can serve as an example of classical problems which are analyzed by this approach Their investigations brought a number of new notions and results in the theory of Sobolev spaces  $W_2^k$  which in turn enabled us to create a sufficiently complete theory of solvability of elliptical equations Nowadays the mathematical theory of radiative transfer problems and kinetic equations is an extensive area of modern mathematical physics It has various applications in astrophysics the theory of nuclear reactors geophysics the theory of chemical processes semiconductor theory fluid mechanics etc 25 29 31 39 40 47 52 78 83 94 98 120 124 125 135 146

*Numerical Methods* George Em Karniadakis, 2019-04-15 This multi volume handbook is the most up to date and comprehensive reference work in the field of fractional calculus and its numerous applications This third volume collects authoritative chapters covering several numerical aspects of fractional calculus including time and space fractional derivatives finite differences and finite elements and spectral meshless and particle methods

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