A spectral Analytic Discrete-ordinates Transport Method Based on Infinite Medium Green' s Fuction for Multiplying Fission Source Problems

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Abstract

Analytic solutions of the multigroup discrete ordinates transport equation with linearly anisotropic scattering and fission source for multi-layered slab problems are obtained by using the infinite medium Green's function (IMGF) and Placzek's lemma. In this approach, the infinite medium Green's function is derived analytically by using the spectral analysis for the multigroup discrete ordinates transport equation and its transposed equation, and this infinite medium solution is related to the finite medium solution by Placzek's lemma. In eigenvalue problems having fission source, complex eigenvalues can occur. As such equations involve the k eigenvalue as a non-linear parameter, to obtain criticality Newton's chord method combined with bisection is used. The resulting equation leads to an exact relation that represents the outgoing angular fluxes in terms of the incoming angular fluxes and fission source for each slab. For heterogeneous problems having multi-layered slabs, the slabs are coupled through the interface angular fluxes. Since all derivations are performed analytically, the method gives exact solution with no truncation error. After the interface angular fluxes are calculated by using an iterative method, the continuous spatial distribution of the angular flux (i.e. analytic solution) in each slab is given straightforwardly in terms of the IMGF and the boundary angular fluxes. Therefore, in our method, the number of meshes that is equal to the number of the homogeneous slabs is sufficient.