Time-absorption Eigenvalue Searches using Diffusion Synthetic Acceleration

Information

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Introduction

Diffusion Synthetic Acceleration (DSA) used to accelerate inner (scattering) and outer (fission) source iterations. Time-absorption eigenvalue transport equation:

$$L\psi + \sigma_t \psi + \frac{\alpha}{v}\psi = \frac{1}{k_{\text{eff}}}\nu\sigma_f\phi.$$

For critical system ($\alpha = 0$), k_{eff} solved by PI. Define

$$\lambda^k = \frac{\langle \nu\sigma_f\phi\rangle^k}{\langle \nu\sigma_f\phi\rangle^{k-1}}$$

and update $k_{\text{eff}}^k = \lambda_k k_{\text{eff}}^{k-1}$. Procedure continues until desired convergence criterion is met. In outer DSA method, the multigroup transport operator is replaced by MG diffusion corrected DSA equation, increasing time efficiency of solution.

DSA Alpha Search Algorithm

α-eigenvalue problem solved within k_{eff} PI. k_{eff} set to constant (usually $k_{\text{eff}} = 1$) with α estimated by some value. Iterations performed as before with a new k_{eff} calculated. α is updated to achieve a value of λ^{k+1} closer to 1. New method: take two iterative states where α is nonzero, then

$$(\alpha^{k+1} - \alpha^k)\left\langle \frac{\phi}{v} \right\rangle^{k+1} = \langle \nu\sigma_f\phi\rangle^{k+1} - \langle \nu\sigma_f\phi\rangle^k.$$

We update α using

$$\alpha^{k+1} = \alpha^k + d\left[(\lambda^k - 1)\frac{\langle \nu\sigma_f\phi\rangle^k}{\left\langle \frac{\phi}{v} \right\rangle^k}\right]$$

d damping parameter used in early stages to prevent additive term from being much larger compared with α^k. Without damping parameter, effective removal term of the transport operator can become negative.