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A time-dependent neutron transport method of characteristics formulation with time derivative propagation. (English) Zbl 1351.82077

J. Comput. Phys. 307, 696-714 (2016).

Summary: A new time-dependent Method of Characteristics (MOC) formulation for nuclear reactor kinetics was developed utilizing angular flux time-derivative propagation. This method avoids the requirement of storing the angular flux at previous points in time to represent a discretized time derivative; instead, an equation for the angular flux time derivative along 1D spatial characteristics is derived and solved concurrently with the 1D transport characteristic equation. This approach allows the angular flux time derivative to be recast principally in terms of the neutron source time derivatives, which are approximated to high-order accuracy using the backward differentiation formula (BDF). This approach, called Source Derivative Propagation (SDP), drastically reduces the memory requirements of time-dependent MOC relative to methods that require storing the angular flux. An SDP method was developed for 2D and 3D applications and implemented in the computer code DeCART in 2D. DeCART was used to model two reactor transient benchmarks: a modified TWIGL problem and a C5G7 transient. The SDP method accurately and efficiently replicated the solution of the conventional time-dependent MOC method using two orders of magnitude less memory.

MSC:

82C80 Numerical methods of time-dependent statistical mechanics (MSC2010)
65M25 Numerical aspects of the method of characteristics for initial value and initial-boundary value problems involving PDEs
82D75 Nuclear reactor theory; neutron transport

Keywords:

method of characteristics (MOC); reactor kinetics; backward differentiation formula (BDF)

Software:

CACTUS; DeCART; FCVODE

Full Text: DOI

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