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Arbitrary perturbations in Monte Carlo neutral-particle transport. (English) Zbl 1348.82079

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Summary: Monte Carlo techniques are widely used to model particle transport in complex models, as both the transport physics and level of geometric details can be simulated with arbitrary precision. The major draw-back of the Monte Carlo method is its computational cost. This is particularly true in design studies, where the effects of small changes in the model may be masked by statistical fluctuations unless prohibitively long simulation times are used. Perturbation methods have been developed to model the effects of small changes in material density, composition or reaction cross-sections. In this paper, I describe how this approach can be extended to allow nearly arbitrary perturbations in the transport problem specification to be made, including material properties, the model geometry and the radiation source description. The major problem, handling arbitrary variations in the model geometry, is overcome using a modified form of the Woodcock neutral-particle tracking algorithm. The approach has been implemented as an extension to the general-purpose Monte Carlo code EGSnrc. I discuss the details of this implementation, including how the specification of a perturbation simulation can be generated automatically from two or more unperturbed simulation models. I present an example of the application of the method to the modelling of a simple X-ray fluorescence instrument.

MSC:

82C80 Numerical methods of time-dependent statistical mechanics (MSC2010)
82C70 Transport processes in time-dependent statistical mechanics

Keywords:

Monte Carlo; perturbation methods; neutral-particle transport; EGS

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MCNP; EGSnrc

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