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A Generalized Framework for In-Line Energy Deposition in Monte Carlo Radiation Transport Simulations

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A rigorous treatment of energy deposition in a Monte Carlo transport calculation, including coupled transport of all secondary and tertiary radiations, increases the computational cost of a simulation dramatically, making fully coupled heating impractical for many large calculations, such as 3-D analysis of nuclear reactor cores. However, in some cases, the added benefit from a full-fidelity energy-deposition treatment is negligible, especially considering the increased simulation run time. In this presentation we discuss a generalized framework for the in-line calculation of energy deposition during Monte Carlo transport simulations. This framework gives users the ability to select among several energy-deposition approximations with varying levels of fidelity. The presentation describes the computational framework, along with derivations of four distinct energy-deposition treatments. Each treatment uses a unique set of self-consistent approximations, which ensure that energy balance is preserved over the entire problem. By providing several energy-deposition treatments, each with different approximations for neglecting the energy transport of certain secondary radiations, the proposed framework provides users the flexibility to choose between accuracy and computational efficiency. Challenges associated with ensuring energy balance in certain situations (e.g., quasistatic simulations, time-dependent simulations, and/or simulations involving coupled transport of multiple radiation types) are discussed and several unresolved issues related to energy balance are highlighted.

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