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Particle transport in stochastic media: beyond the Boltzmann equation

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In the context of reactor physics, the simulation of the transport of neutrons and photons (which obeys the Boltzmann equation) is based on deterministic or stochastic methods. The stochastic approach resorts to Monte Carlo codes, such as TRIPOLI-4®. Developed by the CEA, this code is used for criticality, shielding and nuclear instrumentation. In this context, the random walks of the particles are assumed to occur in a perfectly known medium. However, several applications require the simulation of particle trajectories within random media. Examples are widespread and concern, for instance, the evaluation of severe accidents with reactor core melt-down (the so-called corium), the analyis of the impact of the grain size in MOX fuel, the study of neutron diffusion in water-vapour mixtures, or the modeling of double-heterogeneity problems in HTR or pebble-bed reactors. All such problems can be addressed within the framework of stochastic geometries, which allow representing the heterogeneity of the traversed media by assigning probabilities for their physical properties. Isotropic Poisson geometries are particularly relevant for application in reactor physics, but their statistical properties, only partially known, are still the subject of intensive research efforts.

Auteur principal: Mlle LARMIER, Coline (CEA DEN-DANS)

Orateur: Mlle LARMIER, Coline (CEA DEN-DANS)

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