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A Multiple Collision and Finite Volume Code for Photon Transport Simulation

M. Sumini, F. Teodori, J. E. Fernandez and V. Molinari

Laboratorio di Montecuccolino, DIENCA, University of Bologna, via dei Colli, 16, 40136 Bologna, Italy

We present a 3D deterministic code [1], which is able to solve the linear photon transport equation in integral form with a Neumann series approach. That approach physically stands for a multiple collision picture of the solution and allows an "analytic style" look up of the physics of the photon diffusion phenomena. The code lets the user obtain results from arbitrary sources and for targets of arbitrary composition. The target is described by 3D cartesian meshes. The user is able to retrieve results for the backward emitted radiation field for any order collisions of photons resolved both in energy and angle and for kind of collision event.
Moreover, the Neumann series approach avoids matrix inversion that could introduce severe numerical illnesses into the procedure.
The starting point is the target composition, the target dimensions, the source distribution and geometry and the number of collisions to be considered. After reading the input data, the code builds a regular 3D spatial grid, a uniform 2D angular grid and non uniform energy grid. After that, the interaction matrix is computed and dynamically stored and the equation is solved. The results are stored in some binary files, which can be read by specific post process utilities to retrieve the information needed.
Attention has been also paid on the I/O phase that let the user easily retrieve the simulation results.
The code is currently in a test phase and has been used successfully to study the fluorescence radiation field generated by a narrow monochromatic beam focused on a prismatic sample. This choice has been made in order to emphasize the effects of the system geometry and target dimension on the radiation field, taking into account several collision chains as photoelectric-photoelectric (P, P), photoelectric-Rayleigh (P, R), Rayleigh-Photoelectric (R, P), photoelectric-Compton (P, C), Compton-photoelectric (C, P).

References

[1] J. E. Fernandez, V. Molinari, F. Teodori, Analysis of the Geometry Effects on the Fluorescence Radiation Field in the Frame of Transport Theory, X-Ray Spectrometry, 34 (2005) 7.