SOLUTION OF THE RADIATIVE TRANSFER EQUATION BY A FINITE ELEMENT DISCRETIZATION OF THE SOLID ANGLE

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ABSTRACT. Among the various numerical solution methods of the radiative transfer equation the Discrete Ordinate Method and the Spherical Harmonics are considered as the most powerful. By the Discrete Ordinate Method the solid angle is discretized into distinct directions, and the radiative transfer equation is solved for each direction. The quantities of interest, like radiosity and radiative flux are calculated afterwards by a weighted sum. This approach works well in most cases, but suffers from unphyiscal results in some configurations. If strongly confined radiating sources are present, the heat flux is highly overpredicted along the distinct directions (*ray effect*). In the framework of the Spherical Harmonics Method the angular distribution of the radiative intensity is approximated by continous functions with a prescribed symmetry in the solid angle (associated Legendre Polynomials) and, thus ray effects are excluded. However, the derivation of the boundary conditions is arbitrary and cumbersome and a mathematically sound derivation is not available up to now.

To overcome the restrictions of these popular solution methods, a new approach has been developed which is based on a Finite Element discretization of the solid angle. Because of the continuous approximation of the angular distribution of the intensity, even the use of first order nodal functions in the angular domain promises an efficient reduction of ray effects. The capability of this new method to provide accurate predictions of the heat flux is demonstrated for standard test cases. A second more rigorous test case reveals that a significant mitigation of ray effects compared to the conventional Discrete Ordinate Method can be achieved.

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