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Homogenization methods for thermal dispersion problems

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ABSTRACT

In the last decades, many efforts have been made to develop suitable mathematical methods for modeling thermal diffusion phenomena in order to obtain the macroscale behavior and the properties of some heterogeneous complex thermal systems. These methods include the generalized method of moments, variational methods, center-manifold techniques, projection-operator techniques and also some probabilistic methods. In this paper, we shall be especially interested in getting a macrotransport paradigm for a class of thermal diffusion phenomena occuring in some complex periodic adiabatic systems. Our analysis is based on two alternative methods: the generalized method of moments and a probabilistic method based on a central limit theorem for Markov processes. The viability of these models can be justified by introducing the notion of a generic conserved tracer entity, called a "thermion", in the case of internal energy transport. In this manner we are able to establish a macrotransport paradigm for thermal transport phenomena and to express the macroscale coefficients in terms of the prescribed microscale data and the system geometry. We shall be also interested in getting the asymptotic behavior of these macroscale coefficients as functions of the velocity and the spatial scale parameters which characterize our transport processes. Specific examples are given to illustrate the computation of the macroscale coefficients as functions of the comparable microscale data.

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