Diffusion in arrays of obstacles: beyond homogenisation

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Abstract

We examine the diffusion of a chemical or heat released in a homogeneous medium interrupted by an infinite number of impermeable obstacles arranged in a periodic lattice. We extend classical results due to Maxwell, Rayleigh and Keller by applying ideas of large-deviation theory to describe the concentration or temperature distribution at large distances from the point of release. We use matched asymptotics to obtain explicit results in the case of nearly touching obstacles, when the transport is strongly inhibited. The technique developed can be applied to complex systems including porous media and composite materials. This is based on joint work with Y. Farah, D. Loghin and J. Vanneste.