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Diffusion in an array of cavities in two and three dimensions MYKYTA V. CHUBYNSKY, FRANCIS TORRES, GARY W. SLATER, Department of Physics, University of Ottawa, Canada — We consider diffusion of point-like particles in arrays of cavities separated by infinitely thin walls with holes. We show that in the small-hole limit, the effective diffusion coefficient D is related to the electrical capacitance of a plate of the same shape as the hole. Applying this result to elongated holes in 3D, we find an interesting logarithmic dependence of D on the hole width. A logarithmic dependence is also obtained in 2D. As a consequence, the diffusion rate reaches 10% of the free diffusion rate when the hole widths are only about 10^{-6} of the cavity size. The theoretical predictions are validated using a numerically exact computational method. In the opposite limit, when holes span the cavity boundaries nearly completely and only small pieces of walls remain, analytical calculations are also possible. The result in this case is interesting, since a finite reduction in the diffusion coefficient is obtained even for infinitely thin walls, contrary to predictions of various effective-medium theories that this reduction should be proportional to the excluded volume fraction.

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