Chaotic diffusion in periodic lattices with repulsive potentials

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A simple model that has been widely studied to understand the origin of chaotic diffusion is the periodic Lorentz gas. This Hamiltonian system consists of a light particle that scatterers with heavy ones modeled as hard disks situated on a periodic lattice in the plane. It has been used to derive basic physical concepts such as Ohm's law from first principles. More recently, its diffusive properties have been explored with respect to changing the density of scatters by matching the dynamics to simple random walk approximations [1]. Not known is how diffusion in this model changes by perturbing parameters of this system. Here we study the behavior of the diffusion coefficient when the Lorentz gas is perturbed by softening the repulsive potential walls of the scatterers. Computer simulations show that the diffusion coefficient in the soft system is a highly irregular function of the lattice constant as a control parameter. Most surprisingly, we observe an anomalous enhancement of diffusion at specific parameter values. We show that these peaks are generated by special periodic trajectories of the moving particle that show up at these parameter values.

References

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