Driven Diffusion in Fractals

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Abstract

We study anomalous diffusion of charged particles on fractals with static external fields applied. We utilize different methods to calculate important quantities of the diffusive process as for example the mean square displacement $\langle r^2(t)\rangle$. Applying different bias amplitudes on several SIERPINSKI carpets we obtain maximal drift velocities for weak field strengths. According to $\langle r^2(t)\rangle \sim t^{\frac{2}{r_w}}$, we determine random walk dimensions of $r_w < 2$ for applied external fields on certain time scales. These r_w corresponds to superdiffusion, although diffusion is hindered by the structure of the carpet, containing dead ends, i.e. $r_w > 2$. This seems to result from two competing effects arising within an external field. Though the particles prefer to move along the biased direction, some particles get trapped by dead ends. To escape from there they have to move against the field direction. Due to these two effects the probability distribution gets wider and thus $r_w < 2$. Furthermore we find a drift of particles not only along the bias direction but also perpendicular to the external field depending on the structural properties of the fractal pattern.