Persistence Properties of Interacting Steps: Qualitative Failure of Mean Field

HAILU GEBREMARIAM, T. L. EINSTEIN, U. of Maryland, College Park, CHANDAN DASGUPTA, Indian Inst. of Science, Bangalore — In studying the persistence properties of fluctuating steps on a vicinal surface, we examine the effect of interactions between steps on the correlation function $C(t)$ of step excursions from their mean position. For times much longer than the correlation time $\tau_c$, $C(t) \propto \exp(-t/\tau_c)$. The standard way to include step repulsions ($\propto A/l^2$) simply is the mean field, Gruber-Mullins (GM) approximation, in which each step experiences a harmonic potential that narrows with increasing repulsion. Monte Carlo simulations of a terrace-step-kink model show that $\tau_c$ then decreases with increasing $A$. Including the full repulsion between neighboring steps, we find the opposite trend: $\tau_c$ increases with $A$, due to in-phase meandering absent in GM. However, the time constant $\tau_s$ associated with the exponential decay of the survival probability decreases with $A$. The ratio $\tau_s/\tau_c$ decreases slowly with $A$, from 0.38 at $A = 0$, thereby satisfying the theorem that this ratio be $< 1$. We also discuss the scaling properties of autocorrelation and survival, in particular the dependence on sampling time and on lateral system size.

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