MAR05-2004-002068

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Anomalous dynamics of translocation

MEHRAN KARDAR, Physics Department, MIT

We consider the passage of long polymers of length N through a pore in a membrane. If the process is slow, it is in principle possible to focus on the dynamics of the number of monomers s on one side of the membrane, assuming that the two segments are in equilibrium. The dynamics of $s(t)$ in such a limit is diffusive, with a mean translocation time scaling as N^2 in the absence of a force, and proportional to N when a force is applied. We demonstrate that the assumption of equilibrium must break down for sufficiently long polymers (more easily when forced), and provide lower bounds for the translocation time by comparison to unimpeded motion of the polymer. These lower bounds exceed the time scales calculated on the basis of equilibrium, and point to anomalous (sub–diffusive) character of translocation dynamics. This is explicitly verified by numerical simulations of the unforced translocation of a self-avoiding polymer. Forced translocation times are shown to strongly depend on the method by which the force is applied. In particular, pulling the polymer by the end leads to much longer times than when a chemical potential difference is applied across the membrane. The bounds in these cases grow as N^2 and $N^{1+\nu}$, respectively, where ν is the exponent that relates the scaling of the radius of gyration to N. Our simulations demonstrate that the actual translocation times scale in the same manner as the bounds, although influenced by strong finite size effects which persist even for the longest polymers that we considered ($N = 512$).