Active random transport in cells: High-resolution mapping of non-equilibrium cytoskeletal fluctuations using carbon nanotubes

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Abstract

Cells are active systems with molecular force generation that drives complex dynamics at the supramolecular scale. We performed a quantitative study of molecular motions in cells over times from ms to hours. We observed a regime of active random "stirring" that constitutes an intermediate mode of transport, different from both thermal diffusion and directed motor activity. We imaged the highly stable, near-infrared luminescence of single-walled carbon nanotubes (SWNTs) targeted to kinesin-1 motor proteins in COS-7 cells for non-invasive tracking. High-frequency motion is thermally driven. At times >100 ms, non-equilibrium dynamics dominate. In addition to directed transport along microtubules, we observed strong random dynamics driven by myosins that can drive non-specific transport.