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Probing mechanics and activity of cytoskeletal networks using carbon nanotubes[1]

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We use single-walled carbon nanotubes (SWNTs) as multi-scale micro-probes to monitor transport and fluctuations in cytoskeletal networks. SWNTs are nanometer-diameter hollow carbon filaments with micrometer lengths and a tunable bending stiffness. Their persistence length varies between 20-100 microns. We study the motion of individual SWNTs in reconstituted actin networks by near-infrared fluorescence microscopy. At long times, SWNTs reptate through the networks. At short times, SWNTs sample the spectrum of thermal fluctuations in the networks. We can calculate complex shear moduli from recorded fluctuations and observe power-law scaling in equilibrium actin networks. In the non-equilibrium cytoskeleton of cells we have targeted SWNTs to kinesin motors and thereby to their microtubule tracks. We observe both transport along the tracks as well as active fluctuations of the tracks themselves.

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