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Resolving the Role of Actoymyosin Contractility in Cell Microrheology

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Einstein's original description of Brownian motion established a direct relationship between thermally-excited random forces and the transport properties of a submicron particle in a viscous liquid. Recent work based on reconstituted actin filament networks suggests that nonthermal forces driven by the motor protein myosin II can induce large non-equilibrium fluctuations that dominate the motion of particles in cytoskeletal networks. Here, using high-resolution particle tracking, we find that thermal forces, not myosin-induced fluctuating forces, drive the motion of submicron particles embedded in the cytoskeleton of living cells. These results resolve the roles of myosin II and contractile actomyosin structures in the motion of nanoparticles lodged in the cytoplasm, reveal the biphasic mechanical architecture of adherent cells-stiff contractile stress fibers interdigitating in a network at the cell cortex and a soft actin meshwork in the body of the cell, validate the method of particle tracking-microrheology, and reconcile seemingly disparate atomic force microscopy (AFM) and particle-tracking microrheology measurements of living cells.

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