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Active Stresses Drive Random Fluctuations in the Cytoplasm of Cells MING GUO, ALLEN EHRLICHER, Harvard University, MIKKEL JENSEN, JEFFREY MOORE, Boston University, JENNIFER LIPPINCOTT-SCHWARTZ, NIH, FRED MACKINTOSH, Vrije Universiteit, DAVID WEITZ, Harvard University — The cytoplasm of living cells is a highly dynamic environment with continuous intracellular motion that is essential for life. Some intracellular movements appear directional, and are clearly actively transported. However, most intracellular movement appears random in nature. These random movements have often been interpreted as Brownian motion, and have been used to infer cellular mechanics. Here we describe direct quantifications of the random intracellular motion by using submicron beads, and independent micromechanical measurements of the local cellular environment using optical tweezers. We demonstrate that the random intracellular motion is driven by active stress fluctuations in a nearly elastic cytoskeletal matrix. The combination of our two measurements allows us to quantify the frequency spectrum of the intracellular forces, and directly shows that non-thermal active stresses dominate thermal forces in the cellular interior at long time scales ($t>0.1s$), which results in the random intracellular motion. By using the photoconvertible fluorescent protein Dendra2, we also show that the movement of very small particles ($\sim$ nm) are also accelerated by active fluctuations. These active-stress driven movements may be an essential part of rapid transport in life.

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