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Non-thermal fluctuations in living cells reveal nonlinear mechanical properties of the cytoskeleton[1] H. DANIEL OU-YANG, MING-TZO WEI[2], DIMITRIS VAVYLONIS, SABRINA JEDLICKA, Lehigh University — Living cells are a non-equilibrium mechanical system, largely because intracellular molecular motors consume chemical energy to generate forces that reorganize and maintain cytoskeletal functions. Persistently under tension, the network of cytoskeletal proteins exhibits a nonlinear mechanical behavior where the network stiffness increases with intracellular tension. We examined the nonlinear mechanical properties of living cells by characterizing the differential stiffness of the cytoskeletal network for HeLa cells under different intracellular tensions. Combining active and passive microrheology methods, we measured non-thermal fluctuating forces and found them to be much larger than the thermal fluctuating force. From the variations of differential stiffness caused by the fluctuating non-thermal force for cells under different tension, we obtained a master curve describing the differential stiffness as a function of the intracellular tension. Varying the intracellular tension by treating cells with drugs that alter motor protein activities we found the differential stiffness follows the same master curve that describes intracellular stiffness as a function of intracellular tension. This observation suggests that cells can regulate their mechanical properties by adjusting intracellular tension.

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