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Nonlinear force propagation, anisotropic stiffening and non-affine relaxation in a model cytoskeleton DAISUKE MIZUNO, Kyushu University, DAVID HEAD, Leeds University, EMI IKEBE, AKIKO NAKAMASU, SUGURU KINOSHITA, Kyushu University, ZHANG PEIJUAN, Kyushu Univeristy, SHOJI ANDO, Sojo University — Forces are generated heterogeneously in living cells and transmitted through cytoskeletal networks that respond highly non-linearly. Here, we carry out high-bandwidth passive microrheology on vimentin networks reconstituted in vitro, and observe the nonlinear mechanical response due to forces propagating from a local source applied by an optical tweezer. Since the applied force is constant, the gel becomes equilibrated and the fluctuation-dissipation theorem can be employed to deduce the viscoelasticity of the local environment from the thermal fluctuations of colloidal probes. Our experiments unequivocally demonstrate the anisotropic stiffening of the cytoskeletal network behind the applied force, with greater stiffening in the parallel direction. Quantitative agreement with an affine continuum model is obtained, but only for the response at certain frequency $\sim$ 10-1000 Hz which separates the high-frequency power law and low-frequency elastic behavior of the network. We argue that the failure of the model at lower frequencies is due to the presence of non-affinity, and observe that zero-frequency changes in particle separation can be fitted when an independently-measured, empirical nonaffinity factor is applied.

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