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Towards non-invasive quantification of intracellular activity

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To investigate intracellular activity and the associated deviations from thermodynamic equilibrium, we study the fluctuations of endogenous vesicles and phagocytosed beads in various cell types. Experimentally, we combine darkfield microscopy with high-speed imaging and advanced image post-processing techniques, enabling the acquisition of trajectories with spatial and temporal resolution in the order of nanometers and milliseconds, respectively.
We apply a novel observable, termed *Mean Back Relaxation* (MBR) [Münker et al., Nature materials, 2024], to these trajectories. The MBR quantifies non-equilibrium in confined systems by linking the fluctuations of intracellular particles to their effective energies. In doing so, we aim to extend the principles of passive microrheology to non-equilibrium environments. The MBR of our obtained trajectories exhibits pronounced anisotropies, which we seek to correlate to local cellular structures.

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