Anomalous dynamics of cell migration

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Cell movement, for example, during embryogenesis or tumor metastasis, is a complex dynamical process resulting from an intricate interplay of multiple cellular components on different spatio-temporal scales. At first sight, the paths of migrating cells resemble those of thermally driven Brownian particles. However, cell migration is an active biological process putting a characterization in terms of normal Brownian motion into question. By analyzing the trajectories of both wild-type and mutated epithelial (transformed Madin-Darby canine kidney) kidney cells, we show experimentally that anomalous dynamics [1] characterizes cell migration. A superdiffusive increase of the mean square displacement, non-Gaussian spatial probability distributions and power-law decay of velocity autocorrelations are the basis for this interpretation. Almost all results can be explained with a fractional Klein-Kramers equation allowing the quantitative classification of cell migration by a few parameters [2]. This raises the question about biological significance of anomalous dynamics in view of optimizing the search for targets [3]. We also briefly outline experimental tests of fluctuation relations for cells under chemotaxis, which generalize the second law of thermodynamics [4].

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