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Nonergodic dynamics in the plasma membrane of living cells

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Tracking individual proteins on the surface of live mammalian cells reveals complex dynamics involving anomalous diffusion and clustering into nanoscale domains. Theoretical models show that anomalous subdiffusion can be caused by different processes. Here we study the nonergodic dynamics of voltage gated ion channels in human embryonic kidney (HEK) cells and in hippocampal neurons. We perform time series and ensemble analysis of extensive single-molecule tracking. We show that in HEK cells, weak ergodicity breaking is found to be maintained by immobilization events that take place when the proteins are captured within clathrin-coated pits. However, in hippocampal neurons, ergodicity breaking is caused by transient confinement into nanoclusters with a 230-nm mean diameter. Ergodicity breaking in these cells is manifested in two different ways. First, significant differences are observed between time- and ensemble-averaged mean square displacements. Second, a dynamical functional test unmasks ergodicity breaking at the individual trajectory level.

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