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Intermittency and Synchronized Tumbling and Tank-treading in Red Blood Cell Dynamics in Steady and Oscillatory Shear Flows[1] PROSENJIT BAGCHI, DANIEL CORDASCO, Rutgers University — Red blood cells are known to exhibit a variety of rich and complex dynamics when subjected to a shear flow. Of particular interest is the intermittent behavior that is characterized by coexistence of the tumbling motion, and the tank-treading motion. Several reduced-order theoretical models assuming fixed cell shape emerged that either supported or rejected the possibility of such dynamics, although no full-scale computer simulation of deformable cells has conclusively observed such dynamics. Here we present the first computational evidence of intermittent dynamics of red blood cells in steady and oscillatory shear flows. Our model fully resolves the cell deformation taking in to consideration all essential properties of the cell membrane and internal fluid, and hence, contradicts the notion that intermittency is suppressed in deformable cells. For the intermittent dynamics, we observe sequences of tumbling interrupted by swinging, as well as sequences of swinging interrupted by tumbling. In the synchronized dynamics, the tumbling and membrane rotation occur simultaneously with integer ratio of rotational frequencies. These dynamics are shown to be dependent on the stress-free state of the cytoskeleton, and are explained based on the cell membrane energy landscape.

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