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Self-organized, near-critical behavior during aggregation in Dictyostelium discoideum GIOVANNA DE PALO, Imperial College London, DARVIN YI, THOMAS GREGOR, Princeton University, ROBERT ENDRES, Imperial College London — During starvation, the social amoeba Dictyostelium discoideum aggregates artfully via pattern formation into a multicellular slug and finally spores. The aggregation process is mediated by the secretion and sensing of cyclic adenosine monophosphate, leading to the synchronized movement of cells. The whole process is a remarkable example of collective behavior, spontaneously emerging from single-cell chemotaxis. Despite this phenomenon being broadly studied, a precise characterization of the transition from single cells to multicellularity has been elusive. Here, using fluorescence imaging data of thousands of cells, we investigate the role of cell shape in aggregation, demonstrating remarkable transitions in cell behavior. To better understand their functional role, we analyze cell-cell correlations and provide evidence for self-organization at the onset of aggregation (as opposed to leader cells), with features of criticality in this finite system. To capture the mechanism of self-organization, we extend a detailed single-cell model of D.discoideum chemotaxis by adding cell-cell communication. We then use these results to extract a minimal set of rules leading to aggregation in the population model. If universal, similar rules may explain other types of collective cell behavior.

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