Condensed Matter > Statistical Mechanics

A spatial model of autocatalytic reactions

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Biological cells with all of their surface structure and complex interior stripped away are essentially vesicles - membranes composed of lipid bilayers which form closed sacs. Vesicles are thought to be relevant as models of primitive protocells, and they could have provided the ideal environment for pre-biotic reactions to occur. In this paper, we investigate the stochastic dynamics of a set of autocatalytic reactions, within a spatially bounded domain, so as to mimic a primordial cell. The discreteness of the constituents of the autocatalytic reactions gives rise to large sustained oscillations, even when the number of constituents is quite large. These oscillations are spatio-temporal in nature, unlike those found in previous studies, which consisted only of temporal oscillations. We speculate that these oscillations may have a role in seeding membrane instabilities which lead to vesicle division. In this way synchronization could be achieved between protocell growth and the reproduction rate of the constituents (the protogenetic material) in simple protocells.

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