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Physico-chemical conditions for self-replication SUMANTRA SARKAR, JEREMY ENGLAND, Physics of Living Systems, MIT — Self-replication is a process by which an object creates a near identical copy of itself. It is the process by which asexual reproduction happens and, arguably, it was the most important process that led to the formation of living objects from inanimate matter. However, it is not clear why some systems, characterized by the fundamental interactions and the reaction rates between their constituents, can grow via self-replication, while others do not. In this talk, we aim to answer this question through the computational investigation of a simple chemical system, where we can independently control the interaction energies of the fundamental building blocks, called atoms, and the reaction rates between the molecules formed by them. Our simulation suggests that exponential growth, characteristic of self-replication, is observed in parts of the parameter space where (a) the self-replicator reacts very specifically with a few molecules, and (b) the reactions that deplete the self-replicator happen at time-scales longer than the replication reactions. We use this insight to create classes of self-replicators that have slightly different reaction rates from each other, and investigate how this variation in the reaction rates affects their replicative fitness.

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