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The first step from molecules to life: Formation of large random molecules acting as micro-environments

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The mathematician John von Neumann, through his work on universal constructors, discovered a generalized version of the central dogma of molecular biology biology in the 1940s, long before the biological version had been discovered. While his discovery played no role in the development of molecular biology, we may benefit from a similar mathematical approach to find clues on the origin of life. This then involves addressing those problems in the field that do not depend on the details of organic chemistry. We can then consider a general set of models that describe machines capable of self-maintenance and self-replication formulated in terms of a set of building blocks and their interactions.

The analogue of the origin of life problem is then to explain how one can get to such machines starting from a set of only building blocks. A fundamental obstacle one then faces is the limit on the complexity of low fidelity replicating systems, preventing building blocks from getting assembled randomly into low fidelity machines which can then improve due to natural selection [1]. A generic way out of this problem is for the entire ecosystem of machines to have been encapsulated in a micro-structure with fixed inner surface features that would have boosted the fidelity [2]. Such micro-structures could have formed as a result of the random assembly of building blocks, leading to so-called percolation clusters [2].

This then leads us to consider how in the real world a percolation process involving the random assembly of organic molecules can be realized. A well studied process in the literature is the assembly of organic compounds in ice grains due to UV radiation and heating events [3,4,5]. This same process will also lead to the percolation process if it proceeds for a sufficiently long period [2].

In this talk I will discuss the percolation process in more detail than has been done in [2], explaining how it leads to the necessary symmetry breakings such as the origin of chiral molecules needed to explain the origin of life.

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