Symmetry breaking in simple models of cooperative polymerization

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Biological homochirality is the well-established preference of biomolecules for only one of two chiral isomers (or enantiomers), as for example observed in sugars (D enantiomer) and amino acids (Lenantiomer). Understanding how this symmetry breaking may have emerged remains a challenge for origin of life research. After discussing some fundamental experimental and theoretical findings, we investigate a kinetic rate equation model of nucleated cooperative enantioselective polymerization in closed systems [1]. The microreversible scheme includes (i) solution-phase racemization of the monomers, (ii) linear homochiral chain growth by stepwise monomer attachment and (iii) annealing or fusion of chains. Mechanically induced breakage of the longest chains maintains the system out of equilibrium and drives a breakage−fusion recycling mechanism. Spontaneous mirror symmetry breaking can be achieved starting from small initial enantiomeric excesses due to the intrinsic statistical fluctuations. We put our findings into the context of simpler models, trying to understand the onset of symmetry breaking.

[1] C. Blanco, M. Stich, D. Hochberg, J. Phys. Chem. B 121 (2017), 942.