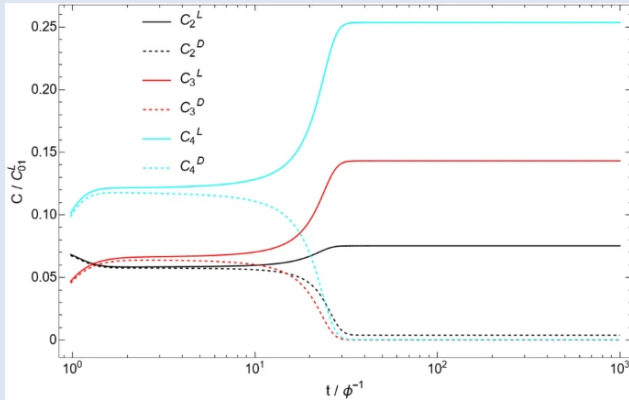
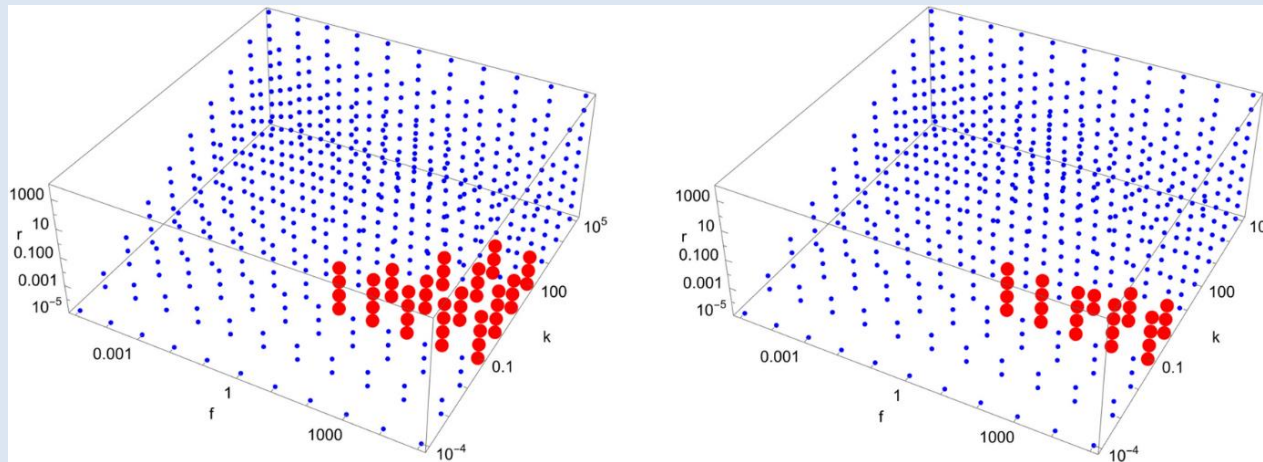


# Conditions for the origin of homochirality in primordial catalytic reaction networks



A characteristic dynamic mirror-symmetry breaking bifurcation in the concentrations  $C$  of the left- and right-handed oligomers. Shown here for the dimer  $C_2$ , trimer  $C_3$  and tetramer  $C_4$ .



Values of racemization ( $f$ ), aggregation ( $k$ ) and fragmentation ( $r$ ) where mirror symmetry breaking is greater than 50% (red dots) for networks with largest-size ( $N$ ) molecule:  $N=4$  (left) and  $N=40$  (right) achieved using only two catalyzed reactions.

Here on Earth biopolymers are composed from only L-amino acids and D-sugars: they use only a single unique handedness, or chirality (L: *laevus* and D: *dexter* from Latin for left- and right-handed). Theoretical proposals in prebiotic chemistry suggest that this uniformity in the chirality of the basic chemical building blocks, or *homochirality*, emerged in nature in abiotic times through either the action of deterministic or chance mechanisms. The abiotic scenario for the emergence of this homochirality in the biological world implies that the asymmetry could have emerged provided a small *chiral fluctuation* with respect to the unstable racemic composition can be amplified to a state useful for biotic evolution. Here we study the onset of homochirality in a general chemical model based on aggregation-fragmentation that complies with thermodynamic constraints and can be mapped onto known origin of life models. Using a combination of theoretical modeling and numerical simulations, we look for *minimal conditions* for which our polymerization model exhibits spontaneous mirror symmetry breaking. Our model spontaneously breaks mirror symmetry in various catalytic configurations that only involve a small number of catalyzed reactions. An important conclusion is that mirror symmetry breaking occurs in our model *without* (i) the need for either direct autocatalysis nor (ii) mutual inhibition, making our polymerization scheme of relevance for prebiotic chemistry.