“Challenging” Steiner’s formula: Pathways to stabilize the gyroid in colloidal self-assembly

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Mimicking assembly processes of highly complex and functional bicontinuous cubic phases (BPC) found in living organisms still marks a challenge in bio- and soft matter physics. Despite the first synthetically created BPCs being reported in the 1960s their scalability and orientability still fall short of nature's efficiency. In pursuit of novel methods for producing BCPs, I present a stabilization mechanism for gyroid structures in colloidal self-assembly, that features collective packing rules to obey Steiner’s formula. Using computational simulations of purely repulsive, non-additive pear-shaped particles, I demonstrate that the colloids organize into interdigitated sheets with negative Gauss curvature, leading to the formation of gyroids [1]. Furthermore, the shape sensitivity of the stability of the gyroid phase reveals an underlying two-step assembly mechanism, fundamentally distinct from those observed in both lipid-water and di-block copolymer systems [2].

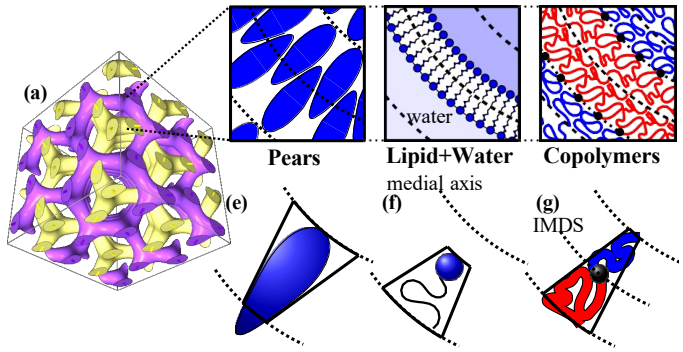

Figure 1 Particle arrangements within the gyroid phase (a) of pear-shaped colloids (b), lipids in water (c), and di-block copolymers (d). At the bottom are the effective shapes of the pears (e), lipids (f), and di-block copolymers (g) within the curved bilayers [1].

[1] P.W.A. Schönhöfer, L.J. Ellison, M. Marechal, D.J. Cleaver, and G.E. Schröder-Turk, *Interface Focus*, **7,** 20160161 (2017)
[2] P.W.A. Schönhöfer, M. Marechal, D.J. Cleaver, and G.E. Schröder-Turk, *Journal of Chemical Physics*, **153(3),** 034903 (2020)

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