LadHyX Seminar – June 16, 11:00, – LadHyX Library

Jasna Brujic
(Center for Soft Matter Research, NYU)

How can we program the folding of colloidomer chains into functional materials?

The cutting edge of materials science consists of self-organizing matter into desired, reconfigurable shapes to perform wide-ranging functions. The past decade has witnessed major innovations in the versatility of the building blocks, ranging from DNA and RNA on the nanoscale, through designer colloids, to handshaking materials on the macroscale. As in a jigsaw puzzle, one can reliably self-assemble structures with an arbitrary shape if all the pieces are distinct, but simpler systems with fewer species have so far been limited to the assembly of exotic crystals. Inspired by Nature's strategy of folding biopolymers into specific protein and RNA structures, here we introduce a model system of alternating droplet chains (ABAB...) with programmable DNA interactions that fold downhill into unique geometries, i.e., foldamers, in 2D. Combining experiments, simulations and theory, we show that optimizing the order in which secondary interactions are switched on selects a dozen out of 619 folded geometries with a near-perfect yield in chains up to N=13 droplets. Randomizing droplet sequence and adding a third flavor improves the folding success rate to more than half of all geometries, outlining the limits of a minimal folding alphabet. These supracolloids can in turn interact to make more complex architectures, such as dimers, tubules and mosaics, seeding a new generation of life-like materials. Our results are independent of dynamics and therefore apply to polymeric materials with hierarchical interactions on all length scales, from organic molecules all the way to Rubik's snakes.