The Emergence of Topological, Morphological and Textural Order in Nacre

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Living organisms form a large variety of hierarchically structured extracellular functional tissues. Remarkably, these materials exhibit regularity and structural coherence across multiple length scales, far beyond the size of the cells that produce them. I will present a study where synchrotron-based nanotomographic imaging in combination with machine-learning-based segmentation was used to reveal the structural synchronization process of a forming nacre in the shell of the mollusc *Unio pictorum*. I will show that the emergence of this highly regular layered structure is driven by a disorder-to-order transition achieved through the motion and interaction of screw-like structural dislocations with an opposite topological sign. Using an analogy to similar processes observed in liquid-crystalline systems, I will demonstrate that these microstructural faults act as dissipative topological defects coupled by an elastic distortion field surrounding their cores. Their mutual annihilation results in structural synchronization that is simulated using the classical Kuramoto model.