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Phase transitions and their energetics in calcite biominerals

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Biominerals include mollusk shells and the skeletons of algae, sponges, corals, sea urchins and most other animals. The function of biominerals are diverse: mechanical support, attack, defense, grinding, biting, and chewing, gravitational and magnetic field sensing, light focusing, and many others. The exquisite nanostructure of biominerals is directly controlled by the organisms, which have evolved to master the chemico-physical aspects of mineralization. By controlling the inorganic precursor nanoparticle size, packing, and phase transitions, organisms efficiently fill space, produce tough and hard structures, with micro- or macroscopic morphology optimized for their functions. Specifically, this talk will address two key questions: Q: How are the beautiful biomineral morphologies achieved? A: Using amorphous precursor phases, with phase transitions kinetically regulated (retarded) by proteins. Q: How do organisms co-orient their single-crystalline biominerals? A: Controlling the propagation of crystallinity one nanoparticle at a time, not atom-by-atom.