

# “From Molecular Simplicity to Supramolecular Complexity: Low Symmetry Packings of Ionic Spherical Micelles”

Wednesday  
December 1, 2021

3:30 pm

Wu and Chen Auditorium  
Levine Hall



**Mahesh K. Mahanthappa**  
Professor of Chemical Engineering and  
Materials Science  
University of Minnesota

## Abstract

A delicate balance of noncovalent interactions drives hydrated molecular amphiphiles to self-assemble into lyotropic liquid crystals (LLCs) of varied topologies, the exquisite nanodomain structures of which suggest applications as separations membranes, mesoporous materials synthesis templates, and therapeutic delivery vehicles. Based on hard sphere colloidal crystals, spherical micelles are intuitively expected to form high symmetry face-centered cubic (FCC) and hexagonally close-packed (HCP) LLCs. However, we recently discovered that ionic surfactant micelles also form a zoo of low symmetry, tetrahedrally close-packed Frank-Kasper (FK) phases that mimic the structures of elemental metals and their alloys. The emergence of complex FK  $\sigma$ , A15, C14, and C15 LLCs arises from a frustrated non-covalent force balance that minimizes local variations in amphiphile solvation, while maximizing electrostatic cohesion in the ionic micelle ensemble. We describe how chemical features of the amphiphiles and the path-dependent processing of their aqueous dispersions drive LLC sphere packing symmetry selection, culminating in our discovery of the ability of oil-swollen ionic micelles to aperiodically order into lyotropic dodecagonal quasicrystals (DDQCs). Thus, engineering molecular frustration into simple amphiphiles begets high fidelity, (a)periodic pattern formation at length scales far exceeding those of their constituent molecular and supramolecular building blocks.

## Bio

Mahesh K. Mahanthappa received his B.A. degrees in Chemistry & Mathematics at the University of Colorado in 1997, and his Ph.D. in organometallic catalysis as a Hertz Fellow with Professor R. M. Waymouth at Stanford University in 2003. After postdoctoral studies with Professors F. S. Bates and M. A. Hillmyer from 2003–2006, he joined the Chemistry faculty of the University of Wisconsin–Madison in 2006. In 2015, Mahesh moved to the Department of Chemical Engineering & Materials Science at the University of Minnesota. He was promoted to the rank of Full Professor in 2019 and is currently the H. Ted. Davis Faculty Scholar. His group leverages chemical synthesis and materials characterization to identify new methods for manipulating block copolymer and lyotropic liquid crystal self-assembly into unique morphologies with unusual bulk properties. He has received an NSF CAREER Award, a 3M Non-Tenured Faculty Award, the Emil H. Steiger Distinguished Teaching Award at UW-Madison, and the 2013 American Physical Society Dillon Medal in Polymer Physics. He was named a 2015 Kavli Foundation Fellow, and received the 2020 American Chemical Society Division of Chemical Health & Safety Graduate Research Faculty Safety Award. In 2021, he was elected a Fellow of the American Physical Society.