

Physics and Physical Oceanography Seminar

Inspired by Water: Self-compressing Droplets and Crystals that Melt on Cooling

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DATE: Thursday, Feb 25, 2021

TIME: 1:30 pm

Place: Webex (link will be sent out)

ABSTRACT: Everyday water has several special physical properties stemming from its ability to form a relatively low-density hydrogen-bonded tetrahedral network. Experiments showing a first-order-like transformation between high and low density glassy "phases" of water have given rise to the idea that there exists a first-order transition line between two liquid forms of water, one high density and one low density, that terminates in a liquid-liquid critical point (LLCP) located deep in the supercooled liquid.

On the one hand, this exotic idea has spurred much theoretical research into finding model particle interactions that produce a LLCP. Our calculated phase diagram for one such simple model reveals equally exotic thermodynamic behaviour in the form of a crystal that melts on cooling.

On the other hand, the proposed low temperature and high pressure of the LLCP for water place it in a region of the phase diagram where nucleation to the crystal is so far experimentally unavoidable on cooling. We simulate nanodroplets as a probe of the critical region, as their small size reduces likelihood of nucleation and the Laplace pressure due to the surface can raise the pressure of the droplet interior to hundreds of megapascals. We find bulk anomalies occurring in nanodroplets as small as 360 molecules as well as signatures of criticality, and also explore how the large radial density gradients within cold nanodroplets may affect the distribution of ions added to the nanodroplets.

Brief CV:

PhD 2003, UWO – Peter H. Poole, now at St. FX University, glassy dynamics and phase behavior of silica

Postdoc Jan. 2003 – Aug. 2004, University of Rome La Sapienza – Francesco Sciortino, glassy aging, colloidal gelation

Postdoc Sept. 2004 – May 2006, U. of Saskatchewan – Richard Bowles, crystal nucleation

Faculty member, Sept. 2006 – present, Memorial University

ALL ARE WELCOME!