

Seminar

Enigma of two-dimensional melting in disordered environments

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We explore the melting in a two-dimensional system of classical particles with Gaussian-core interactions in disordered environments. The clean system validates the conventional two-step melting with a hexatic phase intervening between the solid and the liquid. This picture is significantly modified in the presence of disorder. Impurities in a random distribution of pinning centers force a hexatic-like low-temperature phase to extend up to $T=0$, which transits into the liquid at a single melting temperature $T_{\{RP\}}$. In contrast, pinning centers located at randomly chosen sites of a perfect crystal of the clean system anchor a solid at low temperatures, which undergoes a direct transition to the liquid at $T_{\{CP\}}$. Thus, the two-step melting is lost in either case of disorder. We demonstrate intriguing signatures of cooperative motion of particles in string-like paths, akin to glasses and supercooled liquids, found at low temperatures. Their effects on spatio-temporal correlations will also be discussed. We will also address the effects of quantum fluctuations (by tuning density) in our systems at $T=0$. Upon increasing the density, we find the system undergoes from a liquid to a solid state, which melts back again to a liquid at a larger critical density. We will elaborate on this re-entrant melting, as well as the role of impurities on it. The implications of our findings in light of recent experiments on vortex lattice melting will be discussed.

Thursday, Apr 16th 2026

16:00 Hrs (Tea / Coffee 15:45 Hrs)

Auditorium, TIFRH