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Carroll at Phase Separation

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Recent years have witnessed growing interest in physical theories that go beyond the standard paradigm of Lorentz invariance, where Lorentz or Poincaré symmetry no longer governs the dynamics. This emerging direction, broadly referred to as non-Lorentzian physics, has proven to be a fertile ground for new insights across diverse areas such as condensed matter systems, hydrodynamics, and quantum gravity. Among these structures, Carrollian symmetry has garnered significant attention, which was first obtained from the Poincaré group through a contraction by taking the limit speed of light going to zero. Carrollian symmetry naturally emerges on null hypersurfaces, such as the event horizon of black holes and the null boundaries of asymptotically flat spacetimes. A particularly striking example arises in the context of the Luttinger liquid, which categorises an extensive range of many-body phases in one and quasi-one-dimensional systems. While relativistic conformal field theory (CFT) techniques successfully describe phases like the Luttinger liquid, they break down near phase separation (PS). In this talk, I will show that this breakdown can be realised as a signal of an emergent Carrollian conformal symmetry. Using analytic arguments based on Carrollian Ward identities, I will demonstrate that as the Luttinger velocity vanishes and the Luttinger parameter diverges, the system transitions from a relativistic CFT description to a Carrollian CFT. This predicts a qualitative change in the density–density structure factor, including a shift in the low-momentum scaling and a divergent compressibility at PS. I will present numerical evidence to confirm these predictions.

Presenter: MONDAL, Saikat