**Phases of generalized 3D instanton crystals and holographic nuclear matter**

Abstract

Nuclear matter at large number of colors is necessarily in a solid phase. In particular holographic nuclear matter takes the form of a crystal of instantons of the flavor group. In this talk we will show, by analyzing the ADHM equations, that at low densities the solid structure is determined by two body interactions. We will then describe the analysis of the three- dimensional crystal structures and the orientation patterns that follow from the two-body potential. The outcome of the analysis includes several unexpected results. We will shown the simulations of ensembles of O(10000) instantons whereby the lattice structure and orientations for the different values of the weight factors of the non-Abelian orientation terms in the two-body potential was determined. We will show that the resulting phase diagram is surprisingly complex, including a variety of ferromagnetic and anti-ferromagnetic crystals with various global orientation patterns, and various "non-Abelian" crystals where orientations have no preferred direction. The latter include variants of face-centered-cubic, hexagonal, and simple cubic crystals which may have re- markably large or small aspect ratios. We will augment the simulation results with an analytic analysis of the long-distance divergences, and numerical computation of the (divergence free) energy differences between the non-Abelian crystals, which allows us to precisely determine the structure of the phase diagram.