Probing Multicriticality in "Even" and "Odd" Ising-Higgs Gauge Theories

The competition between charge condensation (the Higgs mechanism) and flux condensation (confinement) governs the breakdown of topological order in Ising-Higgs gauge theories. The nature of the phase transition along the self-dual line, where a discrete version of electromagnetic duality is realized, has remained a subject of intense debate. In this talk, I will present our recent investigations into two distinct versions of this model.

First, for the "Even" theory, which has no background charges or fluxes, I will discuss a machine learning-inspired study aimed at determining its low-energy operator content and conformal structure. Our results challenge the conjecture of an emergent U(1) symmetry at the multicritical point. We observe a notable absence of the associated current operator in the spectrum, a finding that casts significant doubt on the theory's classification within the XY* universality class.

Second, for the "Odd" theory, which possesses a uniform background of static 'e' and 'm' charges, our work uncovers a far richer scenario. Using large-scale DMRG simulations, we identify a novel and exotic multicritical point along the self-dual line. This transition is remarkable for the simultaneous onset of three distinct phenomena: a Higgs-confinement transition, the frustration-driven formation of a Valence-Bond Solid (VBS) order, and the spontaneous breaking of the self-duality symmetry itself.

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