What Is a Phase of Matter in a Cavity?

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A solid in a cavity marries condensed matter physics and quantum optics, while breaking paradigmatic assumptions used in each area. The long-range coupling of the cavity modifies the usual assumption of local interactions that underpins much many-body theory, while the local interactions of the solid break the permutation invariance underlying much of the theory of cavity quantum optics. Understanding the interplay of these is crucial to mapping the landscape of physics that can be engineered in cavities, especially the robustness of their phase diagrams and entanglement.

In this talk, I will describe our advances on this front. As one example, I will describe how correlations grow dynamically under the combination of local interactions and the cavity: while these violate the structure imposed by traditional bounds that account only for local interactions, they still maintain much special structure. Such results are important in understanding and even defining phases of matter.

The talk will also introduce the idea of "Dicke materials", materials in which a bosonic mode such as a magnon plays a role analogous to a cavity, and many of the same issues arise.