Higher Rank Quantum Spin Liquids

Quantum spin liquids are phases of matter exhibiting a variety of interesting properties, such as fractionalized excitations and long-range quantum entanglement. These exotic phases possess a natural description in the language of gauge theory. While most spin liquids studied to date have been well-described by familiar vector gauge fields, there exists a broader class of spin liquids described by higher rank tensor gauge fields. In this talk, I will give an overview of the physics of three-dimensional spin liquids described by symmetric tensor gauge theories. Such theories are notable for their “subdimensional” excitations, which are restricted to motion within lower-dimensional subspaces. As a special case, some of these theories possess completely immobile excitations, in a manifestation of the “fracton” phenomenon. I will review the basic physics of subdimensional particles and their relationship with tensor gauge fields. As an illustrative example, I will discuss rank 2 spin liquids which exhibit both subdimensional behavior and gravitational phenomena. In particular, I will discuss how the fracton phenomenon can be understood in the language of Mach’s principle.