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(I) Nuclear Magnetic Resonance as a Local Probe of the Disordered Ground State of Proximate Quantum Spin Liquid Materials

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Understanding the nature of the quantum spin liquids (QSL) is the holy grail of quantum condensed matter physics with a broad range of implications to other research fields. Many materials, such as the kagome lattice Heisenberg antiferromagnet (KLHA) consisting of Cu^{2+} ions with spin S=1/2 arranged in a corner sharing triangle geometry, have been proposed as the model system for the QSL. However, they all suffer from various complications, such as the phase transition into the long-range ordered ground state (which should not take place in the real QSL). The few materials that do not undergo a long-range order tend to have structural disorder. Recent research indicated that structural disorder often affects the properties of the proximate QSL materials in a profound manner, making the interpretation of the experimental findings non-trivial. Nuclear magnetic resonance is a local probe, and in principle suited for characterizing the disorder effects in materials. In practice, the distribution of the NMR spin-lattice relaxation rate $1/T_1$ induced by disorder prevented proper data interpretation for decades. In this talk, we will explain how one can deduce the **distribution function** $P(1/T_1)$ of $1/T_1$ based on inverse Laplace transform (ILT) of the nuclear magnetization recovery [1]. $P(1/T_1)$ provides rich information, such as the fraction of spin singlets in the KLHA [2].

[1] P.M. Singer et al., Phys. Rev. B 101, 174508 (2020).

[2] J. Wang, W. Yuan et al., Nature Physics 17, 1109-1113 (2021). DOI: 10.1038/s41567-021-01310-3

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