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Dynamical structure factor and Raman scattering of Kitaev spin liquids – signatures of fractionalization

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Topological states of matter present a wide variety of striking new phenomena, most prominently is the fractionalization of electrons. Their detection, however, is fundamentally complicated by the lack of any local order. While there are now several instances of candidate topological spin liquids, their identification remains challenging. We provide a complete and exact theoretical study of the dynamical structure factor and the inelastic Raman scattering response of a two-dimensional quantum spin liquid in Abelian and non-Abelian phases. Our analysis of dynamical properties of the Kitaev model identifies new varieties of the venerable X-ray edge problem and explores connections to the physics of quantum quenches. We discuss the effect of bound states and bond disorder on the response. Overall, we show that there are salient signatures of the Majorana fermions and gauge fluxes emerging in Kitaev's honeycomb model. We make connection to recent experiments and explore more generally the influence of integrability breaking for Kitaev spin liquid response functions.

[1] Dynamics of a two-dimensional quantum spin liquid: signatures of emergent Majorana fermions and fluxes, J. Knolle, D. L. Kovrizhin, J. T. Chalker, R. Moessner, Phys. Rev. Lett. 112, 207203 (2014)
[2] Raman Scattering Signatures of Kitaev Spin Liquids in A_2IrO_3 Iridates with A=Na or Li, J. Knolle, Gia-Wei Chern, D. L. Kovrizhin, R, Moessner, N. B. Perkins, Phys. Rev. Lett. 113, 187201 (2014)