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Dynamics of a two-dimensional quantum spin liquid: signatures of emergent Majorana fermions and fluxes JOHANNES KNOLLE, Max Planck Institute for the Physics of Complex Systems, Dresden, DIMITRY KOVRIZHIN, Cavendish Laboratory, Cambridge, United Kingdom, JOHN CHALKER, Oxford University, United Kingdom, RODERICH MOESSNER, Max Planck Institute for the Physics of Complex Systems, Dresden — Topological states of matter present a wide variety of striking new phenomena. Prominent among these is the fractionalisation of electrons into unusual particles: Majorana fermions, Laughlin quasiparticles or magnetic monopoles. Their detection, however, is fundamentally complicated by the lack of any local order, such as, for example, the magnetisation in a ferromagnet. While there are now several instances of candidate topological spin liquids, their identification remains challenging. Here, we provide a complete and exact theoretical study of the dynamical structure factor of a two-dimensional quantum spin liquid in gapless and gapped (abelian and non-abelian) phases. We show that there are direct signatures–qualitative and quantitative–of the Majorana fermions and gauge fluxes emerging in Kitaev's honeycomb model. These include counterintuitive manifestations of quantum number fractionalisation, such as a neutron scattering response with a gap even in the presence of gapless excitations, and a sharp component despite the fractionalisation of electron spin. Our analysis identifies new varieties of the venerable X-ray edge problem and explores connections to the physics of quantum quenches.

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