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Investigating Kitaev physics in Co honeycomb lattice materials

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The recent Kitaev model (2006) provides an exact model to achieve a quantum spin liquid ground state in a 2D honeycomb lattice system through Ising-like bond- dependent interactions [1]. While first considered as a toy model, a theoretical work from Jackeli and Khaliullin has paved the way towards the realization of Kitaev physics in bulk materials. They first showed that bond-dependent interactions can be achieved through the interplay between crystal field, spin-orbit coupling and bond geometry using 4d and 5d transition metal ions, that exhibit a strong spin-orbit coupling [2]. Since then, a significant amount of experimental works have focused on iridate and ruthenate compounds to find suitable candidate materials. Co2+ ions have been recently put forward for realising Kitaev interactions [3,4,5], despite hosting a weaker spin-orbit coupling than their 4d and 5d counterparts, a prediction we have tested by investigating spin dynamics in two cobalt honeycomb lattice compounds, Na2Co2TeO6 and Na3Co2SbO6, using inelastic neutron scattering. We used linear spin wave theory to show that the magnetic spectra can be reproduced with a spin Hamiltonian including a dominant Kitaev nearest-neighbour interaction, weaker Heisenberg interactions up to the third neighbour and bond-dependent off-diagonal exchange interactions [6]. As the relevance of Kitaev interactions in these materials is still debated, it interrogates the importance of the interplay between spin-orbit coupling and electronic correlations for achieving a Kitaev quantum spin liquid.

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