Title:	Dynamic Spin Correlations in the Honeycomb Lattice Na2IrO3 Measured by Resonant Inelastic x-Ray Scattering
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Abstract:	A Kitaev quantum spin liquid is a prime example of novel quantum magnetism of spin-orbit entangled pseudospin-1/2 moments in a honeycomb lattice. Most candidate materials such as Na2IrO3 have many competing exchange interactions beyond the minimal Kitaev-Heisenberg model whose small variations in the strength of the interactions produce huge differences in low-energy dynamics. Our incomplete knowledge of dynamic spin correlations hampers identification of a minimal model and quantification of the proximity to the Kitaev quantum spin-liquid phase. Here, we report momentum- and energy-resolved magnetic excitation spectra in a honeycomb lattice Na2IrO3 measured using a resonant inelastic x-ray scattering spectrometer capable of 12 meV resolution. Measured spectra at a low temperature show that the dynamic response lacks resolution-limited coherent spin waves in most parts of the Brillouin zone but has a discernible dispersion and spectral weight distribution within the energy window of 60 meV. A systematic investigation using the exact diagonalization method and direct comparison of high-resolution experimental spectra and theoretical simulations allow us to confine a parameter regime in which the extended Kitaev-Heisenberg model reasonably reproduces the main feature of the observed magnetic excitations. Hidden Kitaev quantum spin-liquid and Heisenberg phases found in the complex parameter space are used as references to propose the picture of renormalized magnons as explaining the incoherent nature of magnetic excitations. Magnetic excitation spectra are taken at elevated temperatures to follow the temperature evolution of the resonant inelastic x-ray scattering dynamic response in the paramagnetic state. Whereas the low-energy excitation progressively diminishes as the zigzag order disappears, the broad high-energy excitation maintains its spectral weight up to a much higher temperature of 160 K. We suggest that the dominant nearest-neighbor interactions keep short-range correlations up to quite high temperatures with a specific short-range dynamics which has a possible connection to a proximate spin-liquid phase.
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