Inelastic neutron study on the spin dynamics of the spin-liquid candidate $PrMgAl_{11}O_{19}$

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Quantum spin liquids (QSLs) are exotic magnetic states in which long-range magnetic order is suppressed by strong quantum fluctuations even at the lowest temperatures. Triangular-lattice systems with strong geometric frustration provide an important platform for searching for QSL behavior. $PrMgAl_{11}O_{19}$, containing non-Kramers Pr^{3+} ions arranged on a frustrated triangular lattice, has attracted considerable interest because no structural or magnetic phase transition has been observed down to 50 mK. These properties make it a promising candidate for investigating unconventional spin dynamics associated with a QSL ground state.

We successfully carried out single-crystal inelastic neutron scattering measurements on $PrMgAl_{11}O_{19}$ using the HODACA spectrometer. A high-quality single crystal with a mass of 1.2 g was measured with the (HHL) scattering plane. The measurements were performed at 0.3 K, well below the characteristic temperature where quantum spin liquid behavior is expected.

Figure 1 presents the elastic scattering intensity over the largest reciprocal-space region covered in the experiment. To isolate the low-temperature signal, the data were background-subtracted using measurements collected at 20 K. Strong nuclear Bragg reflections are clearly observed at the (002), (004), and (006) positions, demonstrating the excellent crystal quality. In contrast, no magnetic Bragg peaks were detected at the corresponding M or K points of the Brillouin zone, indicating the absence of long-range magnetic order within the experimental sensitivity.

Figure 2 summarizes the inelastic neutron scattering spectra measured along three high-symmetry directions, (H, H, 2), (-2/3, -2/3, L), and (-1/2, -1/2, L). The energy-transfer range covers 0–3 meV with an energy step of 0.1 meV, approaching the instrumental energy-resolution limit. The observed excitation intensity is highly diffuse in both momentum and energy space, without sharp dispersive spin-wave modes that would be expected for a magnetically ordered state.

The HODACA measurements demonstrate that $PrMgAl_{11}O_{19}$ remains free of detectable long-range magnetic order down to 0.3 K, while exhibiting broad, diffuse low-energy magnetic excitations. These observations are consistent with strong quantum fluctuations expected in a frustrated triangular-lattice system and support the possibility of an unconventional quantum-disordered ground state. A detailed quantitative analysis of the diffuse excitations, together with theoretical modeling, will be carried out in future work to further clarify the nature of the low-energy spin dynamics in $PrMgAl_{11}O_{19}$.

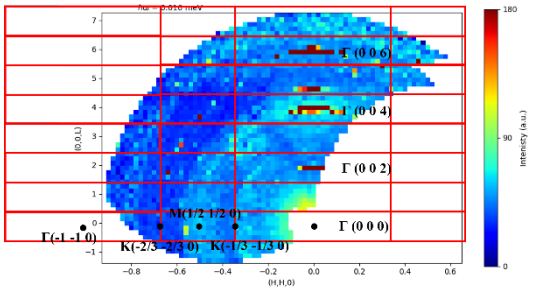

Fig.1 Elastic neutron scattering map of $PrMgAl_{11}O_{19}$ measured at 0.3 K on HODACA after subtraction of the 20 K background.

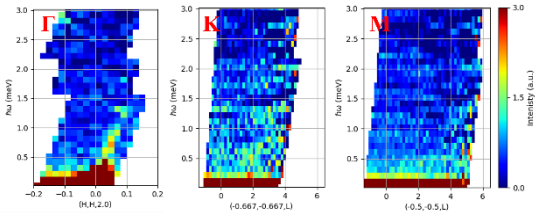

Fig.2 Inelastic neutron scattering spectra of $PrMgAl_{11}O_{19}$ measured at 0.3 K along the (H, H, 2), (-2/3, -2/3, L), and (-1/2, -1/2, L) directions.