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Understanding synthesis-driven structure-property relationships in quantum materials

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Quantum materials are a broad class of systems that exhibit many unusual and exotic phenomena [1]. However, the complexity of these materials often leads to debates about how these exotic phenomena are manifested within them. One such material in which a consensus over the chemical and magnetic ground states are lacking is ZnV2O4. ZnV2O4 is an S = 1, cubic spinel which contains a geometrically frustrated pyrochlore sublattice. Previous studies have shown that the magnetic ground state for ZnV2O4 appears to be highly sample dependent, ranging from a conventional antiferromagnet to an unconventional and highly frustrated spin glass [2-7]. We hypothesise that local deviations from the average chemical structure, which arise during the sample preparation, are at the heart of this problem. To explore this, we have prepared two powder samples of ZnV2O4 using different synthetic routes, one via a conventional solid-state route and the other via a novel rapid microwave-assisted method [8]. In this talk we will explore how synthesis impacts the evolution of the chemical and magnetic ground states of ZnV2O4, using high-resolution powder neutron and synchrotron X-ray diffraction and magnetometry to reveal the average structural and magnetic behaviour, and, X-ray pair distribution function analysis and diffuse neutron scattering data to understand the local structure.

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