

Investigation Of the Manipulation and Interaction Of Magnetic And Electric Dipoles On The Pyrochlore Lattice

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The pyrochlore structure exhibits a myriad of technologically relevant properties including superconductivity, ferroelectricity, photocatalysis, and frustrated magnetism. While there exists a wealth of studies on pyrochlores, the intricacies of this system leave many questions about intentionally manipulating the chemistry and structure for the desired functionality. The pyrochlore structure is inherently complex due to two interpenetrating subnetworks, and structural changes can be driven by substitution or vacancies on either network. Additionally, the triangular arrangement of cations on each sublattice leads to questions of topology due to geometrical considerations. This work aims to study the drivers of polarity on the pyrochlore lattice through two primary hypotheses: (1) magnetic cations, regardless of long-range correlation, play a role in magnetoelectric interactions on both a local and crystallographic scale and (2) the crystallographic ordering of vacancies/dopants dictates the ordering of dipoles and is key to driving long range polarity. The hypothesis will be investigated in the context of the systems $A_2B_2O_{7-x}$, where $A = \text{Bi}^{3+}, \text{Ho}^{3+}, \text{Dy}^{3+}/\text{Pb}^{2+}, \text{Sn}^{2+}$ and $B = \text{Ti}^{4+}, \text{Zr}^{4+}/\text{Nb}^{5+}/\text{Ta}^{5+}$ through a combination of total scattering analysis, density functional theory, and physical property measurements.