Magnetic Order Beyond the Heisenberg-Kitaev Limit in Triangular Ba$_3$IrTi$_2$O$_9$

Frustrated transition metal compounds in which spin-orbit coupling (SOC) and electron correlation work together have been a hot topic recently. In the case of 5d transition metals, where SOC is large, $j_{\text{eff}} = 1/2$ bands near the Fermi level are thought to encompass the essential physics of the material, potentially leading to a concrete realization of exotic magnetic phases such as the Kitaev spin liquid. Here we examine the 5d transition metal compound Ba$_3$IrTi$_2$O$_9$, in which the Ir$^{4+}$ ions form layered two dimensional triangle lattices. We argue that the bands near the Fermi level are well described by pseudospin $j_{\text{eff}} = 1/2$ states, and we compute the band structure and nearest neighbor hopping parameters using *ab-initio* calculations. We further derive a spin model based on these $j_{\text{eff}} = 1/2$ pseudospins which includes antiferromagnetic Heisenberg ($J$) and Kitaev ($K$) exchanges, and crucially, an anisotropic $\Gamma$ exchange. Our classical analysis of the spin model reveals that the stripy and ferromagnetic phases dominate the $J$-$K$-$\Gamma$ phase diagram. By combining our *ab-initio* and classical analyses, we predict that Ba$_3$IrTi$_2$O$_9$ has a stripy-ordered magnetic ground state near the Kitaev spin liquid.