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Interplay of Electronic and Spin Degrees in Ferromagnetic $SrRuO_3$: Anomalous Softening of the Magnon Gap and Stiffness

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$SrRuO_3$ is one of the very few perovskite metallic ferromagnets; it exhibits anomalous transport, an invar effect, non-Fermi liquid behavior, a magnetic shape-memory effect and it is an important substrate for various oxide heterostructures. Strong spin-orbit coupling (SOC) is visible in the invar effect and the large magnetic anisotropy. Recently, we could grow large single crystals of $SrRuO_3$ using the floating-zone technique [1,2]. We report the first inelastic neutron scattering study of the spin dynamics on single crystals. Our results yield the expected quadratic spin wave dispersion of a ferromagnet. However the magnon gap and stiffness considerably deviate from an earlier inelastic neutron scattering study on powders [3]. In addition we find a non-monotonous temperature dependence of the anisotropy gap and a softening of the magnon stiffness upon cooling. These phenomena can be explained by Weyl physics. We discuss how Weyl modes caused by SOC in $SrRuO_3$ couple electronic and spin degrees of freedom and how this interplay leads to the characteristic behavior in the spin dynamics [4].

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[4] K. Jenni et al., Phys. Rev. Lett. 123, 017202 (2019)

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