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Van Vleck Nature of Carrier-Free Ferromagnetic Order in Vanadium-Doped Three-Dimensional Topological Insulators MINGDA LI, CUI-ZU CHANG, MIT, LIJUN WU, JING TAO, Brookhaven National Lab, WEIWEI ZHAO, MOSES H W CHAN, Pennsylvania State University, JAGADEESH MOODERA, JU LI, MIT, YIMEI ZHU, Brookhaven National Lab, MIT TEAM, BROOKHAVEN NATIONAL LAB TEAM, PENNSYLVANIA STATE UNIVERSITY COLLABORATION — We experimentally demonstrate that the long-range ferromagnetic (FM) order in vanadium (V)-doped topological insulator Sb_2Te_3 has the nature of van Vleck-type ferromagnetism, using the state-of-art low-temperature Electron Energy Loss Spectroscopy (EELS). Contrary to the temperature-independent Te $M_{4,5}$ peak, there is an unusual redshift of the V L_3 and L_2 peak positions and unambiguous change of the L_3:L_2 peak ratio at T=10K. Further high-order Green's function's EELS simulation and magnetotransport show that the shift of the peak position and change of the L_3:L_2 ratio are originated from the development of the core-level FM order, indicating that in V-doped Sb_2Te_3, partially filled core states will also contribute to FM order. Since van Vleck magnetism is a result of summing over all states, this magnetization of core level verifies the van Vleck-type ferromagnetism in a direct manner.

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