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Nanoscale Magnetic Structure of Non-Joulian Magnets RAVINI CHANDRASENA, WEIBING YANG, Department of Physics, Temple University, ANDREAS SCHOLL, Advanced Light Source, LBNL, JAN MINAR, Department of Chemistry, Ludwig Maximillian University, PADRAIC SHAFER, ELKE ARENHOLZ, Advanced Light Source, LBNL, HUBERT EBERT, Department of Chemistry, Ludwig Maximillian University, ALEXANDER GRAY, Department of Physics, Temple University, HARSH DEEP CHOPRA, Mechanical Engineering Department, Temple University — Strain dependence of magnetic anisotropy energy produces Joule magnetostriction that is a volume conserving process, whereas sensitivity of isotropic exchange energy to interatomic distance is the cause of volume magnetostriction. In a typical magnet, Joule magnetostriction dominates as the volume fraction occupied by regions of uniform spin alignment (domains) is 2-4 orders of magnitude higher than that which is occupied by regions with magnetoelastic gradients (domain walls). Recently, 'giant' non-volume conserving or non-Joulian magnetostriction has been discovered in iron-gallium alloys. Here we show using high-resolution polarization-dependent photoelectron microscopy that non-Joulian magnetism arises from an unusual partition of the crystal into nm-scale lamellar domains and domain walls within highly periodic magnetic microcells. High-resolution x-ray circular dichroism measurements at the Fe and Ga L absorption edges further provide evidence of weak iron-induced magnetism on gallium atoms via negative exchange. The results are in excellent agreement with the state-of-the-art theoretical electronic-structure calculations.

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