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Magnetic properties of the noncentrosymmetric tetragonal antiferromagnet $EuPtSi_3$

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We report a comprehensive study of single crystals of the noncentrosymmetric rare-earth compound $EuPtSi_3$ grown by the optical floating-zone technique. Measurements of the magnetization, ac susceptibility, and specific heat consistently establish antiferromagnetic order of localized Eu^{2+} moments below the Néel temperature $T_N = 17$ K, followed by a second magnetic transition at $T_{N1} = 16$ K. For a magnetic field along the easy $[001]$ axis, the magnetic phase diagram is composed of these two phases. For fields applied in the magnetically hard basal plane, two additional phases emerge under magnetic field, where the in-plane anisotropy is weak with $[100]$ being the hardest axis. At the phase transitions, the magnetic properties exhibit hysteresis and discrepancies between differential and ac susceptibility, suggesting slow reorientation processes of mesoscale magnetic textures. Consistently, powder and single-crystal neutron diffraction in zero field identify magnetic textures that are modulated on a length scale of the order of 10 nm. Using a full linear polarization analysis of resonant elastic x-ray scattering data, we identify the four long-range ordered phases as variations of noncollinear antiferromagnetic order.

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