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Microscopic Coexistence of Magnetism and Superconductivity in $ErNi_2B_2C$

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Since their discovery in 1994, the borocarbide intermetallic superconductors $(RE)Ni_2B_2C$ have been of great interest due to their rich interactions between magnetism and superconductivity. Here the neutron scattering studies of the magnetic structures and flux line lattice in single crystal $ErNi_2B_2C$ are presented. Neutron measurements show that superconducting $ErNi_2B_2C$ (T_C=11K) develops antiferromagnetic spin-density-wave magnetic order (T_N=6K), which squares-up with decreasing temperature yielding a series of higher-order magnetic Bragg peaks with *odd* harmonics only. Below T_{WFM}=2.3K where magnetization indicates the onset of a net uncompensated moment, we observe the development of *even* order Bragg peaks, which low field (~3 Oe) polarized beam measurements show are magnetic in origin. The data directly demonstrate the existence of a net magnetization with a periodicity of 20**a**, confirming the microscopic coexistence of spontaneous weak-ferromagnetism with superconductivity. The impacts of weak-ferromagnetic ordering on flux line lattice was studied using small-angle neutron scattering, which show that the density of flux line lattice increases as the superconductor enters into the weak-ferromagnetic phase.