New magnetic structure study of TbNi₅: Evidence of incommensurate structure

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RE₅Ni₅ (RE=rare-earth ions) intermetallic compounds crystallize in the hexagonal CaCu₅ structure (space group P6/mmm) [1] and have been extensively studied for various reasons over the last decades. Magnetocrystalline anisotropy of rare-earth ions as well as indirect exchange interaction between them, so-called RKKY interaction, is important to understanding the magnetism of these systems.

We have investigated the magnetic structure of TbNi₅ using neutron diffraction from 2.2 to 30 K using neutron diffraction studies to understand new magnetic satellites below T_C = 23 K, which have never been reported before. These satellites can be indexed as (0, 0, 1 ± τ), (1, 0, 1 ± τ), (0, 0, 2 ± τ), and (1, 0, 2±τ), where τ is equal to 0.0194 r.l.u. (reciprocal lattice units) by analyzing the diffraction patterns. We have observed these new peaks in addition to magnetic peaks seen in previous measurements. We can understand this long-period incommensurate structure in terms of two propagation vectors: k₁ = (0, 0, 0) and k₂ = (0, 0, τ). Our neutron diffraction measurements clearly show that TbNi₅ has an incommensurate magnetic structure over the whole temperature range below the magnetic ordering of T_C = 23 K. Our studies, together with bulk measurements, suggest that TbNi₅ should have a modulated magnetic structure over the whole temperature range from 23 to 2 K, in contradiction to the long held view that TbNi₅ is a collinear ferromagnet below T_C = 23 K.