Critical Properties of the Unconventional Spin-Peierls System

TiOBr J.P. CLANCY, B.D. GAULIN, Department of Physics and Astronomy, McMaster University, F.C. CHOU, Center for Condensed Matter Sciences, National Taiwan University — TiOBr is one of only three inorganic compounds which have been shown to undergo a spin-Peierls (SP) transition, developing a dimerized singlet ground state at low temperatures. However, unlike conventional SP systems, TiOBr exhibits not one, but two successive phase transitions: a continuous transition to an incommensurate SP state at $T_{c2}\sim48K$, followed by a discontinuous transition to a commensurate SP state at $T_{c1}\sim27K$. We have performed x-ray diffraction measurements on single crystal TiOBr, and carried out a detailed analysis of the critical exponent $\beta$ near $T_{c2}$. Our results yield a transition temperature of $T_{c2}=47.85(5)K$ and an exponent of $\beta=0.30(3)$. This value is consistent with conventional 3D Ising-like behavior ($\beta=0.326$), and closely compares to the exponent reported for CuGeO$_3$ ($\beta=0.36(3)$) [1], the canonical inorganic SP system. In contrast with measurements performed on isostructural TiOCl [2], we observe no evidence of commensurate dimerization fluctuations in either the incommensurate SP phase ($T_{c1}<T<T_{c2}$) or the so-called pseudogap phase ($T_{c2}<T<T^*\sim100-150K$). Furthermore, the incommensurate scattering between $T_{c1}$ and $T_{c2}$ appears to be shifted in Q-space relative to the commensurate scattering below $T_{c1}$. [1] M.D. Lumsden et al., PRL 76, 4919 (1996). [2] J.P. Clancy et al., PRB 75, 100401(R) (2007).