Critical behavior of the quasicrystal approximant $Au_{72}Si_{12.5}Eu_{13.5}$

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Magnetism in the quasicrystals and quasicrystal approximants has attracted interest due to the expectation of nontrivial ground states, which can be induced by the formation of the magnetic clusters or competing interactions. Recently, neutron diffraction experiments have revealed that the 1/1 quasicrystal approximant Au-Al-Tb [1,2], Au-Ga-Tb [3,4], and Au-Si-Tb [5] show noncollinear magnetic structures. In addition, the neutron powder diffraction pattern of the 1/1 quasicrystal approximant $Au_{72}Si_{12.5}Eu_{13.5}$ collected by HERMES diffractometer suggests that the magnetic structure is completely different from those observed in Au-Al-Tb and Au-Ga-Tb [6]. The difference indicates that the presence or the absence of the local easy-axis anisotropy largely modifies the magnetic structure.

The aim of this proposal is to investigate critical behavior of the antiferromagnetic order in $Au_{72}Si_{12.5}Eu_{13.5}$. The difference in the critical behavior between the quasicrystal and quasicrystal approximant Au-Al-Yb has suggested the presence of unique electronic state of quasicrystals [7]. In this analogy, the critical behavior of the magnetic long-range order in quasicrystals can reflect their unique magnetic properties. To understand the possible differences in quasicrystals and quasicrystal approximant, it is necessary to understand the critical behavior of the magnetic quasicrystal approximant. The critical exponents of Au-Al-Tb [1,2] and Au-Ga-Tb [3,4] estimated from the temperature dependence of the magnetic reflections are close to the mean field value of β = 0.5. Thus, the value of 0.5 might be common among quasicrystal approximants. To confirm if the critical exponent of 0.5 is also observed in the system with a weak local easy-axis anisotropy, we have investigated the detailed temperature dependence of the magnetic reflections in $Au_{72}Si_{12.5}Eu_{13.5}$ by using a general-purpose triple axis spectrometer GPTAS in JRR-3. The spectrometer was operated in a three-axis mode with a wavelength of 1.638 Å by using pyrolytic graphite (002) reflections and a collimation of 40'-40'-40'-80'.

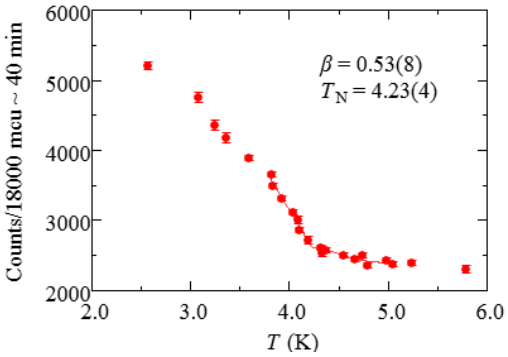

Figure Temperature dependence of the 210 magnetic reflection.

Figure shows the temperature dependence of the 210 reflection. The intensity observed in the range of 3.8 to 5.0 K was fitted to a power-law function proportional to $(T_N - T)^{2\beta}$ with a constant background. A Gaussian function centered at T_N was also included to fit the diffuse scattering empirically. The fit yielded a transition temperature of T_N = 4.23(4) K, which is consistent with the value of 4.2 K estimated from the magnetic susceptibility. The estimated critical exponent of 0.53(8) is close to 0.5, suggesting that the value of 0.5 might be common among quasicrystal approximants.

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