Poster Presentation

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Magnetic structure and excitations in the Au-Si-Tb quasicrystalline approximant

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The icosahedral quasicrystal is a solid with a quasiperiodic arrangement of Matryoshka-like icosahedral atomic clusters, giving rise to sharp Bragg reflections with forbidden rotational symmetry, such as the five-fold symmetry. Approximant is a conventional periodic crystalline phase made of the same atomic clusters found in the icosahedral quasicrystals. Study on the magnetic behavior of the approximant phases is of fundamental interest not only to understand related quasicrystalline magnetism, but also for its own sake, i.e., to reveal collective behavior of magnetic moments in high symmetry magnetic clusters.

The recently found Au-Si-Tb approximant is of particular interest, since it shows long-range magnetic order at low temperatures below Tc = 8.3 K [1]. From the extensive macroscopic measurements, it is suggested that the long-range order is either ferro- or ferrimagnetic. The crystal structure of Au-Si-Tb approximant has been solved using conventional x-ray diffraction [2], and the local atomic structure around the Tb magnetic ion is well characterized, having unique pseudo five-fold axis in addition to the mirror plane. In this work, we have performed both neutron diffraction and inelastic scattering experiments on the Au-Si-Tb approximant to reveal its magnetic structure and crystalline electric field (CEF) effect. The neutron diffraction was performed using HB-3A diffractometer at ORNL, whereas the inelastic scattering was carried out using HRC spectrometer at J-PARC. From neutron diffraction data, we confirmed the ferrimagnetic structure below Tc. The neutron inelastic scattering measurement shows a single very broad inelastic peak centered at 4 meV (Fig. 1) in a wide temperature range, indicating that the dominant CEF term is the B20 term. Nonetheless, the finite five-fold term is necessary to reproduce the significantly broadened feature of the inelastic peak, as indicated by the calculated solid lines in the figure. The five-fold term (B65) in the CEF Hamiltonian is prominent unique feature in this Au-Si-Tb approximant, which has been suggested in theory decades ago [3], and has been long sought after for observation in real magnetic materials.

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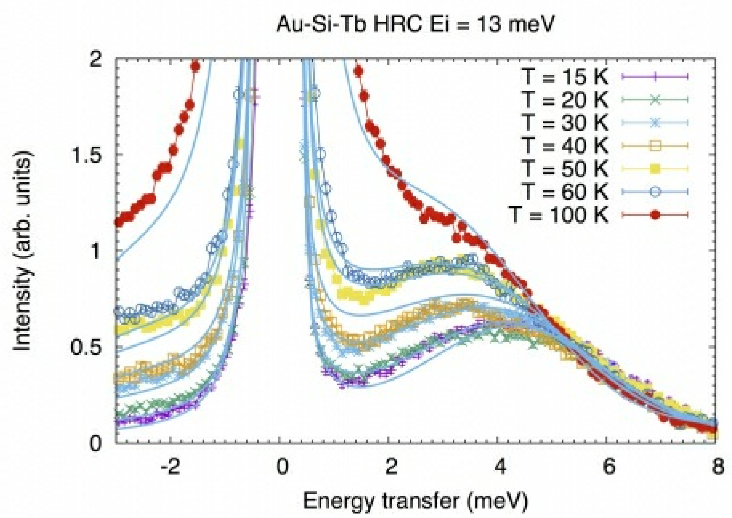

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