Magnetic order and excitations in quasicrystal approximants

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Quasicrystal is a solid that preserves the symmetry equivalent to a dodecahedron or icosahedron. Discovery of the quasicrystal has proved that the atomic long-range order is possible under the absence of a translation symmetry [1]. In addition, the recent discovery of the magnetic quasicrystal has revealed that magnetic moments can exhibit a long-range order in a quasiperiodic structure [2]. The microscopic mechanism to stabilize the magnetic long-range order is important to understand magnetic properties of quasicrystals. However, the limited number of the quasicrystals with the magnetic long-range order prevents further understanding.

To investigate the origin of the magnetic long-range order, we have investigated magnetic properties of quasicrystal approximants, which have the similar local structure as quasicrystals. A few neutron diffraction studies in quasicrystal approximants have indicated that uniaxial anisotropy of rare earth atoms and magnetic interactions mediated by conduction electrons are key to stabilize the noncollinear magnetic structures [3]. Magnetic interactions between magnetic moments were also investigated by inelastic neutron scattering experiments on $Au_{70}Al_{16}Tb_{14}$. As shown in Figure, a single mode with a steep dispersion extending over a single Brillouin zone was observed, indicating that spin waves can propagate in approximant crystals.

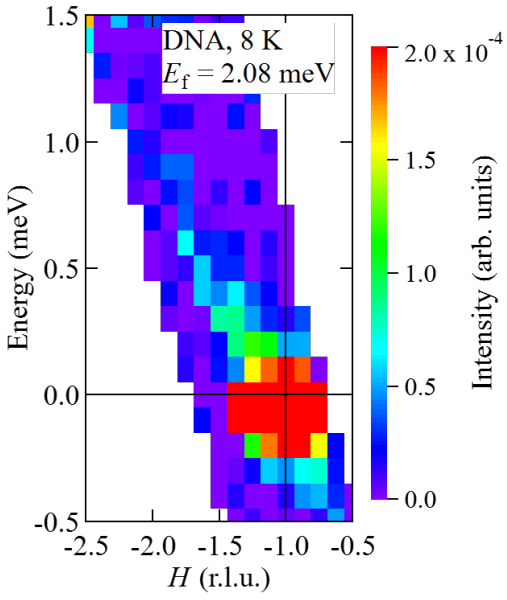

Figure Inelastic neutron scattering spectrum around the magnetic reflection of -120.

[1] D. Shechtman PRL **53**, 1951 (1984).
[2] R. Tamura et al., JACS **143**, 19938 (2021).
[3] K. Nawa *et al.,* JPCS **2461**, 012015 (2023), *etc*.