第 559 回物性セミナー

Dynamic spin fluctuations investigated using neutron scattering and μSR in a quasi-2D distorted honeycomb lattice compound $Li_3Cu_2SbO_6$

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場　所　先端科学総合研究棟 302S

Low-dimensional honeycomb layered oxide materials that consist of alkali-metal atoms sandwiched between slabs of transition metal and chalcogen or pnictogen atoms arranged in a honeycomb fashion are of great interest at present because these materials play host to fascinating symmetry-protected topological phases, and they are crucial for next-generation cathode materials for rechargeable batteries [1]. The $3d^7$ quasi-2D honeycomb lattice $A_3A'_2BO_6$ (A = Li, Na; A' = Co, Ni; B = Sb, Te) depending upon the anisotropy and frustration triggered by the competition between antiferromagnetic (AFM) and ferromagnetic (FM) exchange interactions, numerous forms of unusual ordering are found such as FM, AFM, zigzag AFM, and stripe order AFM. In the present work, we have investigated d^9 S = 1/2 $Li_3Cu_2SbO_6$ compound, which crystallizes in a distorted honeycomb lattice with edge-sharing CuO_6 octahedra [2]. The bond geometry of the Cu-O-Cu bond angle resembling ≈ 90◦ puts this material close to a quantum spin-liquid (QSL)-like state. We investigated the ground-state spin dynamics of $Li_3Cu_2SbO_6$ through muon spin relaxation (μSR) and inelastic neutron scattering along with a theoretical model. Our μSR study reveals a novel and unusual spin state appears below 4 K, which does not reveal any long-range magnetic ordering down to 50 mK. The saturation of the zero-field (ZF) relaxation rate at low temperature, together with its weak dependence on the longitudinal field, indicates the presence of dynamic spin fluctuations persisting even at 80 mK without static order. Neutron scattering study reveals the gapped magnetic excitations with three modes at 7.7, 13.5, and 33 meV. Our density functional theory calculations reveal that the next-nearest neighbour (NNN) antiferromagnetic (AFM) exchange (JAFM = 31 meV) is stronger than the NN ferromagnetic (FM) exchange (JFM = −21 meV), indicating the importance of the orbital degrees of freedom. Our results suggest that the physics of $Li_3Cu_2SbO_6$ can be explained by an alternating AFM chain rather than the honeycomb lattice. If time permit, I will also discuss our finding on a quasi-one-dimensional spin-1 (S = 1) compound $Ba_4Ru_3O_{10}$ [3].

[1] W. Li, E. M. Erickson, and A. Manthiram, Nat. Energy **5**, 26 (2020).

[2] A. Bhattacharyya et. Al., Phys. Rev. B **103**, 174423 (2021).

[3] J. Sannigrahi et al, Phys. Rev. B **103**, 144431 (2021).

共同セミナー「理工学融合共同演習」（博士課程前期）の認定科目です。

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