S 5-5
Design and preparation of quantum spin liquid in κ-type ET salts

Gunzi Saito , Yukihiro Yoshida, Takaaki Hiramatsu, Akihiro Otsuka [2],
Mitsuhiko Maesato [3], Yasuhiro Shimizu [4], Hiroshi Ito, Hideo Kishida [5]
[1]*Faculty of Agriculture, Meijo University, 1-501 Shiogamaguchi, Tempaku-ku, Nagoya 468-8502, Japan*
[2]*Research Center for Low Temperature and Materials Sciences, Kyoto University, Sakyo-ku, Kyoto 606-8501, Japan*
[3]*Division of Chemistry, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan*
[4]*Division of Physics, Graduate School of Science, Nagoya University, Chikusa-ku, Nagoya 464-8602, Japan*
[5]*Department of Applied Physics, Nagoya University, Chikusa-ku, Nagoya 464-8603, Japan*

Email: gsaito@meijo-u.ac.jp

Molecular and crystal designs of ET system for triangular spin lattice having spin liquid state next to metallic state were examined utilizing band parameters and anion structures. Many κ-(ET)$_2$X include polymerized anions which exhibit periodic triangular patterns of anion opening, and an ET dimer (1 spin) fits to the anion opening resulting in the two-dimensional isosceles triangular spin lattice. The electron correlation in terms of U/W (U: on-site Coulomb repulsion, W: upper band width) and the shape of the triangular spin lattice in terms of t'/t (t, t': transfer interactions in triangular spin lattice) are the key parameters whether κ-(ET)$_2$X exhibits metallic (and superconducting), antiferromagnetic, or spin liquid ground state. A dimer-type Mott insulator κ-(ET)$_2$Cu$_2$(CN)$_3$ has nearly equilateral triangular spin lattice (U/W = 0.93, t'/t = 1.06 - 1.09). As a consequence, the salt exhibited no long-range spin ordering and is the best candidate for quantum spin liquid. A superconducting state as well as a metallic state appears next to the quantum spin liquid state without passing through the antiferromagnetic state. A newly obtained dimer-type Mott insulator with discrete anion exhibits no long-range spin ordering down to 2 K with $|J|$ = 160 - 180 K (U/W = 1.1) though it has a considerably large t'/t(= 1.4). Another dimer-type Mott insulator with polymerized anion has the band parameters suitable for the spin liquid (U/W = 1.04, t'/t = 0.97. Preparation, crystal and band structures, and physical properties of them will be discussed.