Nontrivial magnetic structures in cubic quadruple perovskites

Y. Shimakawa, T. Saito, M. Amano Patino, F. Denis Romero

Institute for Chemical Research, Kyoto University, Uji, Kyoto 611-0011, Japan
shimak@scl.kyoto-u.ac.jp

Keywords: A-site magnetism, quadruple perovskites, magnetic interactions

Quadruple perovskite structure oxides with a chemical formula AA’ 3B4O12 can accommodate transition-metal ions at both A’ and B sites. When the B site is occupied by non-magnetic cations, the magnetic interactions between the spins at the orthogonally-oriented A’-sites provide a variety of nontrivial magnetic structures in the cubic symmetry sublattices. CaCu3Ge4O12 and CaCu3Sn4O12 show ferromagnetism of the A’-site Cu2+ (S = 1/2) spins due to Cu–Cu direct-exchange interaction, whereas CaCu3Ti4O12 shows the G-type antiferromagnetism, where the antiferromagnetic Cu–O–Ti–O–Cu superexchange interaction overcomes the Cu–Cu direct-exchange interaction. In the solid solution system of CaCu3(Ge-Ti-Sn)4O12, very unusual ferromagnetic-antiferromagnetic-ferromagnetic spin-structure change was observed [1,2]. In LaMn3V4O12, on the other hands, the nearest neighboring Mn2+ high spins (S = 5/2) align with each other with an angle of 120 degrees. The electrons of V at the B site are delocalized and do not apparently contribute to the magnetic behavior [3]. In CaFe3Ti4O12 and CaCo3Ti4O12 with respectively the A’-site Fe2+ (S = 2) and Co2+ (S = 3/2) spins, the magnetic structures consist of three interpenetrating mutually orthogonal magnetic sublattices. The fourth nearest neighbour spin exchanges as well as spin orbit coupling play an essential role for stabilizing the unusual spin structures [4,5].

Figure 1. Co2+ (S = 3/2) spin structure in A-site ordered quadruple perovskite CaCo3Ti4O12.