PHASE TRANSITIONS IN NEW 2D FRUSTRATED MAGNETS $CU_3R(SEO_3)_2O_2CL$ STUDIED BY OPTICAL SPECTROSCOPY

S. A. Klimin

Institute of Spectroscopy, Russian Academy of Sciences,
5, Fizicheskaya Str., Troitsk, Moscow, 108840, Russia
e-mail: klimin@isan.troitsk.ru

Cu_3*RE*$(SeO_3)_2O_2Cl$ is a new family of magnetic compounds in which an interplay between two magnetic subsystems exists, namely, between rare-earth (RE) and copper ones. Parent compound, natural mineral francisite $Cu_3Bi(SeO_3)_2O_2Cl$, has one magnetic ion, Cu^{2+} and orders antiferromagnetically at T_N=24 K. In the crystal, copper atoms compose two-dimensional (2D) layers with a buckled Kagome lattice. Due to that, francisites attract interest of the magnetic community as a 2D frustrated magnet [1,2]. Up to now a series of Cu_3*RE*$(SeO_3)_2O_2Cl$ compounds were synthesized with replacement of bismuth by a rare earth (RE) element, while the crystallographic structure remains the same [3]. Introduction of a RE magnetic subsystem influences the magnetism of copper subsystem and leads to various scenarios of magnetic behavior. In this paper the results of studying of magnetic properties of RE francisites by means of a temperature-dependent high-resolution spectroscopy are presented.

Magnetic ordering was registered either by splitting of Kramers doublets or by repulsion of CF levels of *f*-ions in a staggered magnetic field. The splittings demonstrate anisotropic behaviour: $\Delta_k = \sqrt{\Sigma(g_{ki}B_{eff,i})^2}$, where g_{ki}, $B_{eff,i}$ are *i*-th ($i = x, y, z$) components of *g*-factor and effective magnetic field acting on *k*-th doublet, respectively. Experimental optical data enabled to calculate the contribution of the RE ions into the thermodynamic characteristics.

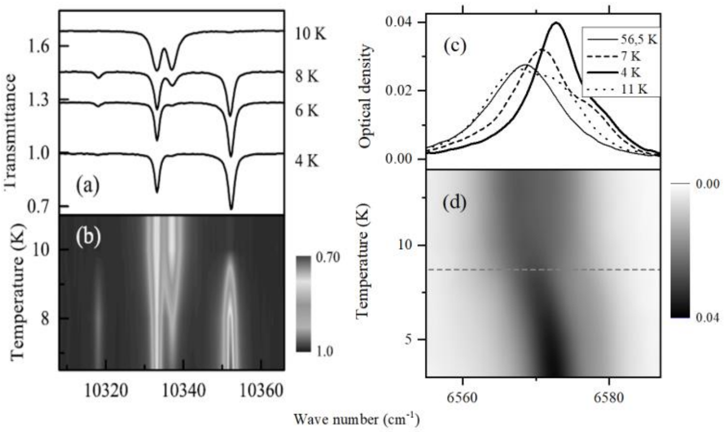

Fig.1 SR transition in (a,b) Y and (c,d) Sm fracisites.

The most interesting effect of the *d*- and *f*- magnetic subsystems interplay is spin-reorientation (SR) transitions found in the cases with RE = Sm and Yb [4,5]. The SR transitions take place due to the single-ion anisotropy of RE ion when it does not coincide with the anisotropy of copper magnetic subsystem and is strong enough to reorient copper moments. However, different scenarios for SR transition are realized in samarium and ytterbium compounds, namely, the second order and the first one, respectively (Fig. 1). The reason for that could lie in the different types of single-ion anisotropies of samarium and ytterbium. The situation in francisites could be the same as in another family of RE compounds (R_2BaNiO_5) with similar symmetry properties of the RE cite, where different types of single-ion anisotropies for different rare earths are realized. Depending on anisotropic interactions in a crystal, in one case the spin-reorientation transition can be realized as spin-flop-like (first order) or as gradual rotation (second order).

The support of RFBR (grant 19-02-00251) is acknowledged.

[1] M. Pregelj, O. Zaharko, A. Günther et al., Phys. Rev. B, 2012, Vol. 86, 144409.
[2] K.V. Zakharov, E.A. Zvereva, P.S. Berdonosov et al., Phys. Rev. B, 2014, Vol. 90, 214417.
[3] P.S. Berdonosov, V.A. Dolgikh, Rus. J. Inorg. Chem., 2008, Vol. 53, 1353.
[4] Zakharov K.V., Zvereva E.A., Markina M.M., et al., Phys. Rev. B, 2016, Vol. 94, pp. 054401
[5] Markina M.M., Zakharov K.V., E. A. Ovchenkov., et al., Phys. Rev. B, 96, 134422 (2017).