NEUTRON POWDER DIFFRACTION STUDIES OF MAGNETIC STRUCTURES IN "GREEN PHASE" R_2BaCuO_5, *R–Y, Gd, Dy, Ho, Er, Tm, Yb* AND "BROWN PHASE" Nd_2BaCuO_5

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Now there are no doubts that magnetism plays an essential role in the CuO_2-based high temperature superconductors. Therefore any information about magnetic properties of stable compounds from the triangle BaO–CuO_x–R_2O_3 is very important for evaluations of interactions. It is a reason why cuprates R_2BaCuO_5 known as "green" and "brown" phases are being extensively investigated now. Another reason is that these compounds with two magnetic subsystems of copper and rare-earth and highly anisotropic interactions are very interesting and promising objects for investigations of magnetism by themselves.

The neutron diffraction measurements of powder samples were carried out on the multicounter diffractometer of PNPI, on the diffractometer DMC of Paul Scherrer Institute (Switzerland) and on the diffractometer with the position-sensitive detector of CENG (Grenoble). For treatment of experimental data different methods: profile analysis, deconvolution (Pawley), direct calculations of structure factors were used. The possible models of magnetic ordering were selected at the base of group-theoretical analysis proceeding from the experimentally observed wave vector.

A large variety of types of magnetic ordering and transitions are observed in the series of isomorphic compounds studied. This pronounced diversity is caused by distinction in the ground states of $4f$-ions and anisotropy of interactions between rare earth and copper sublattices. There were certain features in common.

It was shown that in Y_2BaCuO_5, with the only magnetic sublattice of Cu spins, the simple collinear magnetic structure with one wave vector was found [1], not the structure with two wave vectors that claimed in [2]. The similar structure for sublattice of copper was found in other compounds of "green" phase.

From compounds of "green" phase in Er_2BaCuO_5 only [3] the magnetic order appears obviously simultaneously in the both sublattices. Another picture is observed in Dy_2BaCuO_5

and Ho_2BaCuO_5 [3]. At decreasing the temperature the Cu subsystem orders first. In spite of weak coupling between copper and rare-earth subsystems this ordering results in partial polarization of the rare-earth moments. Further cooling causes ordering of the rare earth subsystem by exchange interaction, which in turn reorients the copper spins. For Dy_2BaCuO_5 and Ho_2BaCuO_5 the "own" magnetic order of copper and rare-earth sublattices is described by different wave vectors that leads to spin-reorientation transition with changing of wave vector. In Gd_2BaCuO_5 the copper and rare earth sublattices order with the same wave vector but accordingly by different irreducible representations with orthogonal basis functions. This results in extended magnetic transition through intermediate incommensurate structures [4].

For Yb_2BaCuO_5 at the lowest temperature 1.3 K a few weak peaks that can be indexed in the cell doubled in b and c directions are observed [3]. The measurements of temperature dependence of the strongest magnetic reflection show transition at about 2 K. For Tm_2BaCuO_5 the diffuse scattering only is observed at liquid helium temperatures [3]. At 1.3 K only one weak reflection, apparently caused by ordering of copper spins, is seen.

Unlike orthorhombic "green phase" Nd_2BaCuO_5 has tetragonal crystal structure. For magnetic structure found from symmetry reasons it follows that mean effective field from Cu sublattice at the place of any Nd atom is equal to zero. The same is valid for mean field coming from all Nd moments at the places of Cu atoms. In this case the symmetrical part of exchange interaction is absent. Hence the interaction between sublattices has to be attributed to anti-symmetrical part of exchange interaction only. In the frame of bilinear coupling this part consists of Dzialoshinsky-Moriya term and dipolar interaction. The evaluation of the last one gives a value about 0.03 K, which is too low comparing with the Neel temperature 7.5 K. It means that the interaction of Dzialoshinsky-Moriya is the only one responsible for long range ordering [5].

REFERENCES

1. *Golosovsky I.V., Boni P., Fischer P.* Solid State Communications, 1993. V.87. P.1035–1037.
2. *Chattopadhyay T., Brown P.J., Kobler U., Wilheim M.* Europhysics Letters,1989. V.8(7). P.685–689.
3. *Golosovsky I.V., PLakhty V.P., Harchenkov V.P., Zoubkova J., Mill B.V., Bonnet M., Roudeau E.* Fizika Tverdogo Tela (Solid State Physics, Russian), 1992. V.34. N°5. P.1483–1492.
4. *Golosovsky I.V., Boni P., Fischer P.* LNS ETHZ and PSI, Progress-Report, 1992. P.110–111.
5. *Golosovsky I.V., Boni P., Fischer P.* Physics Letters A, 1993. V.182. P.161–164.