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Experimental investigations of single crystals of spin chains: in search of new relaxation processes

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Spin chains can possess many extraordinary magnetic properties, e.g. photomagnetism, superparamagnetism, or *slow relaxation of magnetisation*. The latter phenomenon is the delay of the system in the return to the magnetic equilibrium state after applying a pulse of a magnetic field. This *memory effect* places spin chains as a prospective material for new generation high-density data storage. Spin chains displaying the phenomenon of magnetic relaxation are called Single Chain Magnets (SCMs), and the process occurs through the diffusion of a domain wall (Fig. 1.).

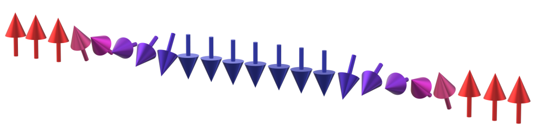

Figure 1: A scheme of a spin chain with a ferromagnetic interaction between spins along a chain. Domain walls are the borders between the 1-dimensional regions of the opposite direction of the magnetic moment.

An example of such spin chains is the family of compounds comprising Co(II) ions and thiocyanate bridges: $[Co(NCS)_2(ligand)_2]_n$. Most of them are quasi-1D nanomaterials in which the magnetic ordering of single chains occurs. So far, for these compounds, all the investigations were performed on powder samples. In such samples, microcrystals are randomly positioned, which generates a large distribution of relaxation times. This may hide some relaxation processes. Using single crystals of these compounds is in such a case of advantage for analysis of the relaxation processes - their quality is far better, so the distribution is significantly lower. The investigation of single crystals should, therefore, enable observing some previously visible processes for powder samples with better accuracy, preclude the observation of others, or may reveal the presence of new ones. The preliminary investigations on a single crystal of $[Co(NCS)_2(4\text{-methoxypyridine})_2]_n$ (Fig.2.) confirmed that hypotheses.

The main purpose of the project is the search of new magnetic relaxation processes in single crystals from family $[Co(NCS)_2(ligand)_2]_n$, which have not been previously noted for powder samples and explanation of their origin. The secondary purpose of the project is to develop methods of obtaining single crystals of $Co(NCS)_2$-based spin chains. At the very beginning, the crystal will be synthesised and the crystal structures confirmed. Then, the crystals will be thoroughly characterized magnetically to obtain information on the relaxation phenomena. The results will be analyzed and interpreted according to the current state of knowledge.

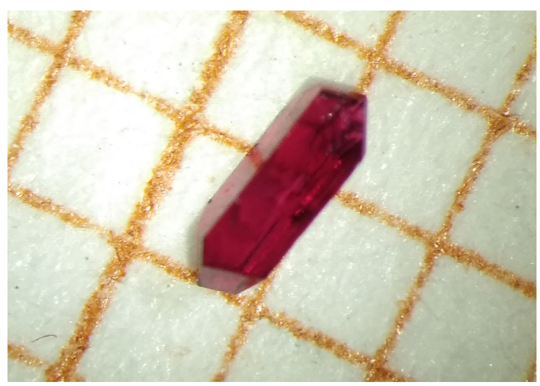

Figure 2: A photo of a single crystal of $[Co(NCS)_2(4\text{-methoxypyridine})_2]_n$.

Such basic research is of immense significance for the solid state physics as it may reveal the presence of new effects potentially important for the industrial applications. The results of this project will undoubtedly help in designing the new Single Chain Magnets with the desired properties.