Spin-phonon coupling in chromium spinels probed by infrared spectroscopy

T. Rudolf[1], *Ch. Kant*[1], *F. Mayr*[1], *J. Hemberger*[1], *V. Tsurkan*[1,2], *and A. Loidl*[1]

[1]Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, D-86135 Augsburg, Germany
[2]Institute of Applied Physics, Academy of Sciences of Moldova, MD-2028 Chisinau, Republic of Moldova

The B-site spinels $A\mathrm{Cr}_2X_4$ with A=Cd, Zn, Hg and X=S, O and Se were systematically investigated by Fourier Transform Infrared Spectroscopy. The temperature and magnetic field dependence of the phonon spectra in a range from 5 K to 300 K and in fields of up to 7 T where studied. At the magnetic ordering temperature most compounds show significant splittings of the phonon modes, driven by spin-phonon coupling. $\mathrm{CdCr_2O_4}$ and $\mathrm{ZnCr_2O_4}$ are geometrically frustrated, $\mathrm{ZnCr_2S_4}$ [1] is bond frustrated and $\mathrm{ZnCr_2Se_4}$ [2] is bond frustrated, but dominated by ferromagnetic exchange. The pattern of splittings is different for the different compounds and crucially depends on the nature of frustration and of the resulting spin order. $\mathrm{HgCr_2S_4}$ is almost a ferromagnet and exhibits no splitting of the eigenfrequencies, whereas $\mathrm{ZnCr_2Se_4}$ is a prominent example of a spin-driven Jahn-Teller effect, where the splitting of the low-energy phonon mode can be fully suppressed in an external magnetic field.
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[2] T. Rudolf *et al.*, Phys. Rev. B, in press