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Hybridized spin-lattice correlations in quantum magnets

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The coupling of spin waves to phonons allows to probe the collective spin dynamics in quantum materials via phonon spectroscopy. This allows for novel experiments and the control of magnetic interactions via lattice degrees of freedom. In this presentation, I˘will show, that the strong magnon-phonon coupling in the triangular lattice Heisenberg antiferromagnets $LiCrO_2$ and $PdCrO_2$ enables the measurement of magnetic correlations throughout the Brillouin zone via inelastic x-ray scattering. Our studies reveal intrinsic details of the magnetoelastic excitation spectrum. We find single particle excitations with momentum dependent lifetime and continuum scattering at low temperature [1]. In a˜high-pressure experiment at cryogenic temperatures we furthermore show that tuning the lattice allows for efficient control of magnetic interactions. With help of {\it ab initio} phonon calculations combined with linear spin wave theory we are able to quantify the spin lattice coupling and address the coupling to the two-magnon continuum. I furthermore introduce a novel methodology that allows for high-precision measurements of the full elasticity tensor from thermal diffuse scattering [2].

Refs
[1] S. Tóth, B. Wehinger, K. Rolfs, T. Birol, U. Stuhr, H. Takatsu, K. Kimura, T. Kimura, H.˘M. Rønnow and Ch. Rüegg, {\it Electromagnon dispersion probed by inelastic X-ray scattering in $LiCrO_2$}, Nat. Commun. {\bf 7}, 13547 (2016).
[2] B. Wehinger, A. Mirone, M. Krisch and A. Bosak, {\it Full Elasticity Tensor from Thermal Diffuse Scattering}, Phys. Rev. Lett. {\bf 118}, 035502 (2017).

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