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Dynamics of the incommensurately modulated phase Rb_2ZnCl_4

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The Rb_2ZnCl_4 phase displays a crystal structure where the orientations of its ZnCl_4 tetrahedrons plays a crucial role. Whereas in the high temperature phase tetrahedra are disordered, they order incommensurately along the c^* axis from $T_i=303$, down to $T_c=195\text{K}$ where the modulation get locked-in with a $1/3$ ratio of the periodicity at lower temperature.

In the incommensurately modulated region, phason modes are expected to be observed [1]. Moreover the modulation function goes from an harmonic to a strongly anharmonic shape as T decreases and approaches the lock-in transition. Finally, the transition is of the order/disorder type related to the tetrahedron orientation, with thus expected overdamped phason modes, as predicted by the theory [2,3]. This phase offers thus a variety of phases to probe the dynamics of phason modes and its relation with acoustic phonon modes.

We have tackled this problem using inelastic and quasielastic neutron scattering measurement on a large single crystal, to investigated the dynamics of this phase as a function of temperature between 140 and 350 K.

The picture that emerges from this study is more complex than the one predicted by long wavelength theories. Nevertheless, we confirm that phason modes are most likely overdamped harmonic oscillators, leading to a diffusive like excitation in the long wavelength limits, whereas there are broad and dispersive excitations in a very small energy range for higher wave-vectors. On the other hand in the lock-in phase at least at temperature of the order 150K the picture is much simpler, as expected from theory.

[1] T. Janssen, G. Chapuis, and M. de Boissieu, *Aperiodic Crystals. From modulated phases to quasicrystals (second edition)* (Oxford University Press, Oxford, 2018), Vol. 20, IUCr Monographs on Crystallography.

[2] R. Currat and T. Janssen, *Sol. Stat. Phys.* **41**, 201 (1988).

[3] M. de Boissieu, R. Currat, and S. Francoual, in *Handbook of Metal Physics: Quasicrystals*, edited by T. Fujiwara, and Y. Ishii (Elsevier Science, Amsterdam, 2008), pp. 107.