Soft phonon modes in materials with competing phases

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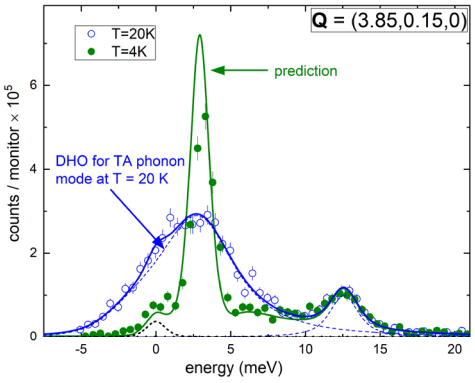
I will review work on two compounds featuring intertwined structural and superconducting phase transitions: The *A15* superconductor V_3Si features a structural/martensitic transition temperature of T_s = 18.9 K and T_c = 16.8 K whereas *2H*-$NbSe_2$ is a seminal charge-density-wave (CDW) compound in which charge order, T_{CDW} = 33 K, coexists with superconductivity, T_c = 7.2 K. For both compounds inelastic x-ray scattering (IXS) provides unique possibilities study lattice dynamics and, thereby, obtain a detailed understanding of the electron-phonon coupling (EPC) relevant for the intertwined phases.

Phonon measurements in single crystals of V_3Si were complicated in the past because of unfavourable neutron scattering properties. Hence, only few studies of the lattice dynamical properties with momentum resolved methods were published, in particular below the superconducting transition temperature T_c. In our combined experimental and theoretical investigation of lattice dynamics in V_3Si [1] we focus on the evolution of the transverse acoustic soft phonon mode of the structural phase transition at T_s = 18.9 K, and discuss its relevance with regard to the value of T_c. Furthermore, we explain superconductivity-induced anomalies in the line shape of several acoustic phonon modes using a model proposed by Allen et al.[2] (see Figure on the right).



2H-$NbSe_2$ turned out to be a seminal example of CDW order driven by momentum-dependent EPC. I will review EPC properties via studies of the soft phonon mode [3,4] and the Fermi surface [5] along with models explaining the surprisingly low CDW transition temperature [6,7]. Measurements in the superconducting phase of *2H*-$NbSe_2$ [8] will be discussed in comparison to results in V_3Si [1] revealing the detailed sampling of the Fermi surface [5] by phonons with strong EPC.

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