ABSTRACT OF THE DISSERTATION

Raman scattering from layered superconductors: Effects of charge ordering, two-band superconductivity, and structural disorder

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Subject of this dissertation is the investigation with experimental means of how the Raman response of three structurally similar materials – MgB_2, $NbSe_2$, and CaC_6 – is affected by superconductivity (all three), charge ordering ($NbSe_2$), or crystalline order-to-disorder phase transitions (CaC_6). Universal characteristics of spectral renormalization pertaining to the superconducting phase transition are observed in all three compounds. Yet, the crystalline and electronic structures are sufficiently distinct, such that specific for each compound characteristics are imposed on this superconductivity-induced renormalization. Consequently, the method of polarized Raman scattering has been used to establish a variety of physical concepts:

- **Multi-band superconductivity in the layered superconductor MgB_2** and its primary mediation by the strongly coupled $640\,\mathrm{cm}^{-1}$ E_{2g} phonon. Additionally, it is shown how a Josephson-like coupling of two SC condensates in the reciprocal space is responsible for an exotic collective mode, the Leggett's resonance.

- **Interplay between the superconducting and the incommensurate charge-density-wave order parameters in $NbSe_2$**, which has been found to be consistent with an isotropic multi-band superconductivity scenario. This scenario is proposed in the frame of a picture that involves a combined 'superconductivity plus charge-density-wave' order parameter.

- **The Fano-Breit-Wigner line-shape formalism** to account for an anti-resonance interference in the low temperature Raman response from $NbSe_2$ in the polarization geometry corresponding to the non-symmetric E_{2g} symmetry channel.

- **Validity of the double resonant Raman scattering picture in the presence of disorder in the graphite intercalation compound CaC_6.** Simultaneously, it is explored how disorder suppresses superconductivity. To that end, the CaC_6 superconducting coherence peak, too, is presented.

All these phenomena are manifestations of electron-phonon coupling in solids. It is probed by inelastic light scattering under the specific constraints of respective crystalline symmetries. Each case, therefore, remains intriguingly unique.

The experiments have been performed in a state of the art optical laboratory with low temperatures and high magnetic fields infrastructure, of which a detailed account is given.