

Time-resolved optical conductivity and Higgs oscillations in two-band dirty superconductors

Paul Froese,^{1,2} Rafael Haenel,^{1,2} Dirk Manske,¹ and Lukas Schwarz¹

¹*Max Planck Institute for Solid State Research, 70569 Stuttgart, Germany*

²*Quantum Matter Institute, University of British Columbia, Vancouver V6T 1Z4, Canada*

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I. INTRODUCTION

- Ultrafast spectroscopy
- Collective modes in superconductors: Higgs, Goldstone (shifted to plasma energy due to Anderson-Higgs)
- In two-band superconductors: Additional out-of-phase Leggett mode, can couple to Higgs in nonequilibrium
- Difficulties excitation Higgs mode, in clean-limit only weak coupling
- In dirty superconductors: Coupling is enhanced
- This work: 1) Higgs oscillations in two-band sc. with bands in different limits, 2) Nonequilibrium optical conductivity, 3) Leggett mode in dirty-limit, 4) Prediction for MgB₂

II. MODEL

- In this section show only the final formula, all derivation into the appendix A as the equations are similar to the Murotani paper.
- Show Hamiltonian, gap equation, Mattis-Bardeen replacement, general approach for calculating time evolution...
- I suggest putting the (final) equations for current, optical conductivity, $\delta\Delta(t)$ into the respective section, but in principle we could also put all equations in this section and show only the results in the following sections
- Used parameters (take general parameters for section III and IV where no Leggett mode occurs, Leggett mode is discussed later separately and MgB₂ will be also discussed later. Show the used parameters in these section)
- Implementation details? Are there any subtle points?

$$H_{p-p} = - \sum_{i\mathbf{k}\mathbf{k}'\sigma} \mathbf{J}_{i\mathbf{k}\mathbf{k}'} \cdot \mathbf{A} c_{i\mathbf{k}\sigma}^\dagger c_{i\mathbf{k}'\sigma} + \sum_{i\mathbf{k}\sigma} \frac{s_i e^2}{2m_i} \mathbf{A}^2 c_{i\mathbf{k}\sigma}^\dagger c_{i\mathbf{k}\sigma}$$

III. SINGLE-BAND SUPERCONDUCTIVITY

Appendix A: Derivation of nonequilibrium optical conductivity

- Put here all equations and derivations of the main results

Appendix B: Influence of pump pulse frequency

- Discuss influence of pump pulse frequency and bandwith to excite only one or both Higgs mode
- Show result in Fig. 7

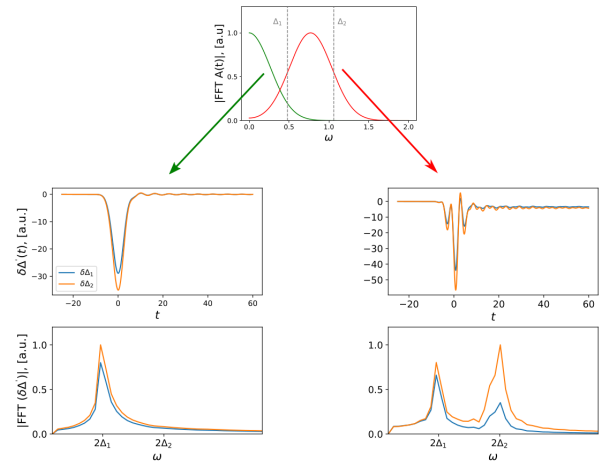


Figure 1. Influence of pump pulse frequency

$$H_{BCS} = \sum_{i\mathbf{k}\sigma} c_{i\mathbf{k}\sigma}^\dagger c_{i\mathbf{k}\sigma} + \sum_{i\mathbf{k}} \left(\Delta_i c_{i-\mathbf{k}\uparrow}^\dagger c_{i\mathbf{k}\downarrow}^\dagger \right) \quad (1)$$