Quantum interference effects in light absorption

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When light is absorbed by a semiconductor, electrons move from valence bands to conduction bands, and the charge distribution changes. In the sketch below the situation is shown for GaAs, with the charge distribution in the valence bands on the left (a) and its modification shown on the right (b) after photons are absorbed. But the *way* in which the charges move from the left to the right sketch depend on how the absorption occurs. If both one- and two-photon absorption are present, quantum interferences between these two absorption processes can in some materials lead to the injection of net currents, a "shift current" associated with the motion of charges from one centre to another, and a "polarization current" that has to do with the change in the dipole moment of the charges around their lattice sites.

This project will focus on the calculation of these processes, in typical materials and in topologically nontrivial materials where to date they have been much less investigated. A comfortable familiarity with 3rd year quantum mechanics is required, as well as an openness to do a "quick study" of the kind of perturbation theory required to describe absorption processes, and to familiarize yourself with the Bloch functions (if you're not familiar with them already!) that are introduced in condensed matter physics. You should not be averse to writing and using computer codes.

We also hope to look at how these processes are affected if nonclassical light, such as squeezed states of light, are used in the absorption processes. So an interest in quantum optics is required, although an initial familiarity with it is not.