Nonlinear response induced by dissipation

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Nonlinear response in condensed matter physics is now paid a lot of attention because they have information of the symmetry of the system [1,2] and the potential to be applied to high-frequency devices [3], which is said to be necessary for the auto-driving system, for an example. Conventionally, we analyze nonlinear responses by the semi-classical treatment [4,5] or the reduced density matrix method [6,7]. However, these methods are not good at considering correlation effects and dissipation effects. About the dissipation effects, they partially include the dissipation effect through the relaxation time approximation. Our previous work shows that, in optical response, the relaxation time approximation is not justified while it is justified in DC limit when considering the effect of lifetime.[8]

In this talk, we reveal the another effect of dissipation, which is the smearing of the density of states (DOS), on nonlinear conductivity[9]. First, we introduce the Green function formula for nonlinear conductivity and transform it into the band-index form. After the frequency integration, the effect of smearing of DOS results in the imaginary part of the Fermi distribution function. While the terms including the real part of the Fermi distribution function represent the conventional terms, such as the Drude term, the Berry curvature dipole term, shift term, the terms including the imaginary part of Fermi distribution function represent a new term, which is the quantum metric dipole term. Interestingly, although it stems from the dissipation, the quantum metric dipole term seems to be independent from the strength of dissipation.

Because the idea and the results are so simple, I think I will give a pedagogical talk with a bit detail derivation.

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References

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