Third Harmonic Terahertz Generation in Monolayer and Bilayer Graphene

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Abstract: It has been predicted that due to the linear dispersion of monolayer graphene near the Dirac points, there should be strong third harmonic generation in doped graphene at terahertz (THz) frequencies [1]. Despite this prediction, the only experimental evidence of third harmonic generation at THz frequencies has been in a 45 layer sample [2]. Our recent theoretical work has predicted that there is a different and potentially stronger way to generate the third harmonic in monolayer graphene, which relies on the strong interplay between interband and intraband carrier dynamics at THz frequencies [3]. This interplay arises due to the zero-bandgap, high mobility, controllable Fermi energy and strong intra- and interband absorption. As all of these are also features in bilayer graphene, *it* should also exhibit a strong third harmonic.

In this talk, I will review our formalism and present the results of our calculations of third harmonic generation in undoped monolayer and bilayer graphene as a function of field strength and THz frequency. Our model employs nonperturbative dynamic equations for the electron density matrix within the length gauge, with the inclusion of both interband and intraband carrier dynamics. We find that the emitted third harmonic field in undoped, unbiased, suspended bilayer graphene at low temperature is 53% of the reflected fundamental field for an incident single-cycle pulse at 2 THz with an amplitude of 2.5 kV/cm. Surprisingly, this is slightly larger than obtained for monolayer graphene [3]. I will finally examine third harmonic generation in *biased* bilayer graphene, for biases such that the bandgap opened is on the order of the THz photon energy.

References

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