

Abstract Submitted  
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**Phonon self-energy corrections to non-zero wavevector phonon modes in single-layer graphene** PAULO ARAUJO, Massachusetts Institute of Technology, DANIELA MAFRA, Universidade Federal de Minas Gerais, KENTARO SATO, RICHIRO SAITO, Tohoku University, JING KONG, MILDRED DRESSELHAUS, Massachusetts Institute of Technology — Phonon self-energy corrections have mostly been studied theoretically and experimentally for phonon modes with zone-center ( $q=0$ ) wave-vectors. Here, gate-modulated Raman scattering is used to study phonons of a single layer of graphene (1LG) in the frequency range from 2350 to 2750  $\text{cm}^{-1}$ , which shows the  $G^*$  and the  $G'$ -band features originating from a double-resonant Raman process with  $q \neq 0$ . The observed phonon renormalization effects are different from what is observed for the zone-center  $q=0$  case. To explain our experimental findings, we explored the phonon self-energy for the phonons with non-zero wave-vectors ( $q \neq 0$ ) in 1LG in which the frequencies and decay widths are expected to behave oppositely to the behavior observed in the corresponding zone-center  $q=0$  processes. Within this framework, we resolve the identification of the phonon modes contributing to the  $G^*$  Raman feature at 2450  $\text{cm}^{-1}$  to include the  $i\text{TO}+\text{LA}$  combination modes with  $q \neq 0$  and the  $2i\text{TO}$  overtone modes with  $q=0$ , showing both to be associated with wave-vectors near the high symmetry point  $\mathbf{K}$  in the Brillouin zone.

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