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**Phonon instabilities in graphene**[1] KLAUS ZIEGLER, Universitaet Augsburg, Germany, EUGENE KOGAN, Bar–Ilan University, Israel — We study the thermal distribution of phonons in graphene and compare in-plane and out-of-plane contributions with a focus on two in-plane modes that represent intervalley scattering. Due to the two electronic bands there are also two out-of-plane phonon modes with respect to the two sublattices. The electron-phonon interaction softens the phonon modes with a tendency to create instabilities for a sufficiently large electron-phonon coupling. The instabilities are characterized by phase transitions, where one of the out-of-plane mode undergoes an Ising transition by spontaneously breaking the sublattice symmetry. The in-plane modes undergo a Berezinskii-Kosterlitz-Thouless transition. We calculate the critical points of the instabilities, the renormalization of the phonon frequencies and the phonon frequency splitting for in-plane modes. The possibility to observe these instabilities in doped graphene and their consequences for transport are discussed.

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