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Collective properties of two-dimensional Dirac electron system with a superconducting pairing interaction DAISUKE INOTANI, Graduate School of Pure and Applied Sciences, University of Tsukuba, YOJI OHASHI, Faculty of Science and Technology, Keio University, SUSUMU OKADA, Graduate School of Pure and Applied Sciences, University of Tsukuba — Recently, the possibility of the superconductivity in graphene are attracting a lot of attention because of its novel properties associated with the pure two-dimensionality, as well as the Dirac fermion nature of the electrons. In this work, we investigate the collective properties of the superconducting graphene. Including the attractive s-wave pairing interaction, as well as the long range Coulomb interaction between the electrons in the tight-binding model for the honeycomb lattice, we calculate the generalized density-density correlation function within the random phase approximation in both normal and superconducting state at T=0. In normal state, we find that a stable collective excitation associated with the superconducting pairing fluctuations appears due to the linear dispersion relation of the electrons. On the other hand, in superconducting state, the phase mode remains stable even at T=0, although the dispersion relation of the phase mode is strongly modified by the Coulomb interaction in the long wave-length region. This result is in contrast to the conventional superconductors in which the phase mode disappears at T=0 by the so-called Anderson-Higgs mechanism. We show that this novel property of the phase mode arises from the pure two-dimensionality of the system.

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