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Coupled electron-hole bilayer graphene sheets: Superfluidity, Charge Density Waves, and Coupled Wigner Crystals[1] MOHAMMAD ZARENIA, FRANCOIS PEETERS, Department of Physics, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium., DAVID NEILSON, Dipartimenti di Fisica, Universitá di Camerino, 62032 Camerino, Italy. — The juxtaposition of superconducting and charge density wave (CDW) phases that is often observed in connection with High-Temperature Superconductors, is attracting considerable attention. In these systems, the crystal lattice provides a polarizable background, needed to drive the CDW phase. We report on a different system that exhibits the association of superfluid and CDW phases, but in which the polarizable background is uniform. Our system consists of two coupled two-dimensional bilayers of graphene, one bilayer containing electrons and the other holes interacting through the long range Coulomb interaction. To account for the inter-layer correlation energy accurately, we introduce a new approach which is based on the random phase approximation at high densities and interpolation between the weakly- and strongly-interacting regimes. We determine the zero temperature phase diagram in which the two control parameters are the equal electron and hole densities and the thickness of the insulating barrier separating the two bilayers. We find in addition to an electron-hole superfluid and a one-dimensional CDW phases that there exist also a coupled electron-hole Wigner crystal. The structure of the crystal background plays no role in determining the phase diagram.

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