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Out-of-phase plasmons in double-layer electron systems B. TANATAR, Department of Physics, Bilkent University, Ankara, 06800, Turkey, G. VIGNALE, Department of Physics and Astronomy, University of Missouri-Columbia, Columbia MO 65211 — It is well known that a double-layer electron system supports an out-of-phase plasmon in which the densities of the two layers oscillate out of phase with each other. In RPA this mode exhibits acoustic behavior (i.e., a linear dispersion in q at small q). It has been suggested that at low density it may acquire an "optical" character , i.e., a gap at $q = 0$[1]. Here we investigate the long-wavelength dispersion relation of out-of-phase plasmons using dynamic exchange-correlation (xc) kernels within the density-density response function for a double-layer system. Starting from the recently formulated exact expression for the dynamic xc-kernel at long-wavelengths $f_{\mathrm{xc},\alpha\beta}(q,\omega) = [2\delta_{\alpha\beta} - 1]\frac{n^2}{n_\alpha n_\beta}\frac{A(\omega)}{q^2} + B_{\alpha\beta}(\omega) + \mathcal{O}(q^2)$ where α, β are the layer indices, $n_\alpha + n_\beta = 2n$, we obtain a workable formula for the frequency dependent function $A(\omega)$. A mode-decoupling form for $\mathrm{Im}[A(\omega)]$ together with the Kramers-Kronig relation and exact high and low frequency limits allows us to construct $A(\omega)$. Solving for the zeros of the dielectric function of the double- layer system we obtain the long-wavelength form of the out-of- phase plasmon dispersion and discuss the possibility of a gap developing at low density.

[1]G. Kalman, V. Valtchinov, and K. I. Golden, Phys. Rev. Lett. **82**, 3124 (1999)

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