Edge Plasmons in Two-Component Electron Liquids in the Presence of Pseudomagnetic Fields

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We study the properties of edge plasmons in two-component electron liquids in the presence of pseudomagnetic fields, which have opposite signs for the two different electronic populations and therefore preserve the time-reversal symmetry. The physical realizations of such systems are many. We discuss the case of strained graphene, solving the problem with the Wiener-Hopf technique. We show (i) that two charged counter-propagating acoustic edge modes exist at the boundary and (ii) that, in the limit of large pseudomagnetic fields, each of them involves oscillations of only one of the two electronic components. We suggest that the edge pseudo-magnetoplasmons of graphene can be used to selectively address the electrons of one specific valley, a feature relevant for the emerging field of valleytronics.
We speculate that electrons in proximity to a Skyrmion lattice could exhibit the same phenomenology, and that the resulting spin-polarized plasmons at the boundary of Skyrmion lattices could be exploited for spintronics applications.
Our solution highlights new features missing in previous (similar) results obtained with uncontrolled approximations, namely a logarithmic divergence of the plasmon velocity, and the absence of gapped edge modes inside the bulk-plasmon gap.

References

1.A. Principi, M.I. Katsnelson, and G. Vignale, Phys. Rev. Lett. **117**, 196803 (2016)

Figures

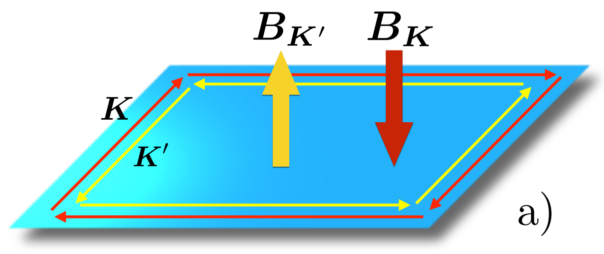

Figure 1: a schematic view of the theoretical model: the two electronic components experience opposite pseudomagnetic fields. Two counter-propagating plasmons appear at the edge of the system, each of them mainly due to density oscillations in a specific valley.

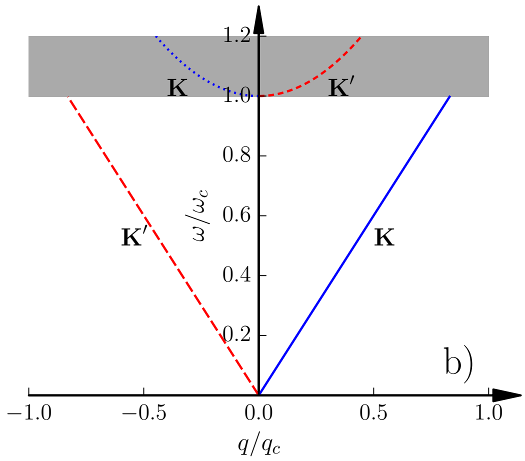

Figure 2: the dispersion of edge collective modes in units of the cyclotron frequency as a function of the momentum. Each electronic component, depending on the range of frequencies explored, can support up to two charged collective modes, one of which lives inside the gap of the particle-hole continuum (shaded region).