Effect of electron-hole inhomogeneity on specular Andreev reflection and Andreev retroreflection in a graphene-superconductor hybrid system (LT26)

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The electron-hole inhomogeneity in graphene has been confirmed by recent experiments, and the largest energy displacement of electron and hole puddles with respect to the Dirac point can reach nearly $30meV$. Here we focus on how electron-hole inhomogeneity affects the specular Andreev reflection as well as Andreev retroreflection by using a four-terminal graphene-superconductor hybrid system. We find that the Andreev coefficients can hardly be affected even under rather large electron-hole inhomogeneity (typically $30meV$), although the charge puddles strength $W = 30meV$ is much larger than the superconductor gap $\Delta = 1meV$. Furthermore when charge puddles are two orders larger than superconductor gap, a specific kind of Andreev reflection can be still obviously detected. In order to quantitatively describe what degree of the boundary blurred, a quantity D is introduced, from which we confirm that the boundary blurring are much smaller than the charge puddles strength W. In addition, we study the effect of Anderson disorder as well for comparison. We found that the boundary is held much more obviously in this case. The retroreflection and specular reflection can be clearly distinguished and detected in the presence of electron-hole inhomogeneity.