Interplay between microscopic decoherence and superconducting proximity effect in a graphene Andreev interferometer

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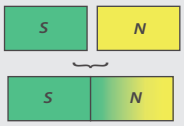
Proximity effect evolution as a function of gate

Proximity effect



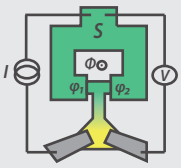
Induced superconductivity in normal metal

Graphene role

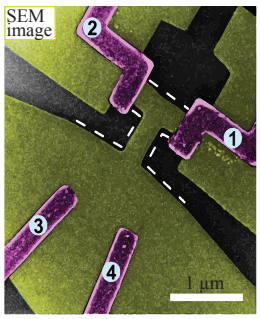
Gating to access different transport regimes

Reentrance of conductance amplitude

Conductance of N oscillates with relative phase at superconducting loop ends $\longrightarrow \delta\varphi = \frac{2\pi\Phi}{\Phi_0}$

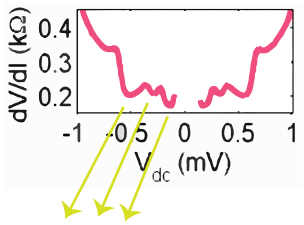


Device



S contacts - purple
Graphene - green color

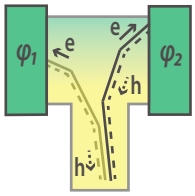
N/S interface quality



Presence of multiple Andreev reflections indicate high *N/S* transparency

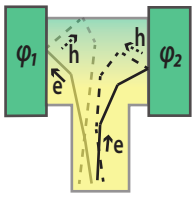
Conductance oscillations

Ensemble-average (EA) contribution



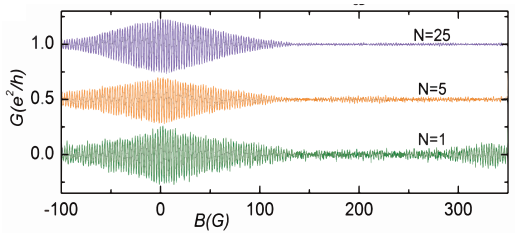
phase conjugation

Sample-specific (SS) contribution



no phase conjugation

Ensemble averaging using gate

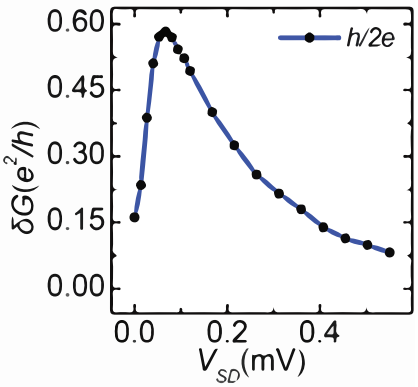


Low-*B* field
Averaging to extract *EA* oscillations

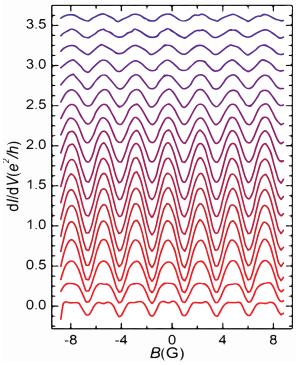
High-*B* field
Suppression of *SS* oscillations

Reentrance effect

Conductance amplitude increases up to a finite energy then vanishes at zero zzvalue



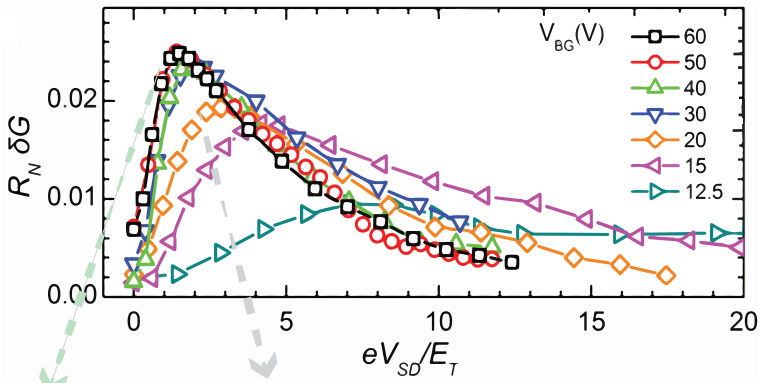
Ensemble-averaged *G* at low-*B* field as a function of energy



Theory for a fully coherent system predicts ***an universal scaling*** equal to $R_N\delta G = f(eV/E_{Th})$ $\longrightarrow$ ***Experimentally has never been verified!***

The $R_N\,\delta G = f(eV/E_{Th})$ scaling really universal?

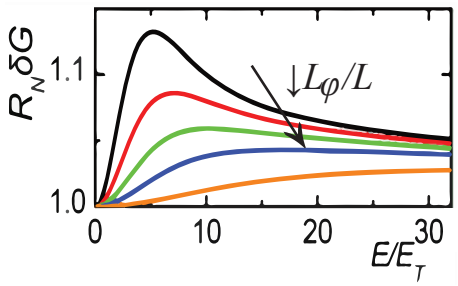
Gating graphene modifies R_N and E_{Th} $\longrightarrow$ way to prove it!



High V_g curves exhibit the perfect scaling

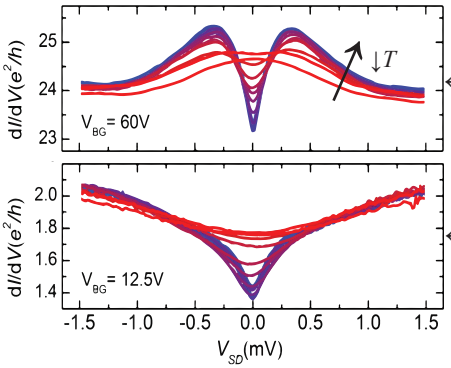
Low V_g measurements deviate strongly from the universality law $\longrightarrow$ **Crossover to a new regime**

Influence of dephasing



Theoretical curve maximums shifted to higher energies for smaller L_φ/L ratios

Origin of dephasing



High V_g
← *low e^--e^- interactions*

Low V_g
← *strong e^--e^- interactions*

+ other mechanisms

Conclusions:

- Graphene Andreev interferometer useful to investigate the proximity effect
- Observed new regime where induced superconductivity is suppressed mainly by electron dephasing
- Electron-electron interaction identified as one of the possible origins of dephasing

F. Deon, S. Šopić and A. F. Morpurgo, Physical Review Letters (2014).