Imaging Graphene Quantum Dots

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Electrostatic confinement of charge carriers in graphene is important for fundamental scientific research and industrial device applications. To understand and control quantum confinement in graphene, we created electrostatically confined graphene quantum dots and spatially imaged their electronic structure. Using a scanning tunnelling microscope, we engineered circular p-n junctions in graphene by patterning local, embedded gates in a gate-tunable graphene/boron nitride heterostructure[1]. Scanning tunnelling spectroscopy (STS) on these circular p-n junctions revealed resonances arising from quasi-bound states of trapped charge carriers[2]. By comparing spatially resolved STS with theoretical simulations of the massless Dirac equation, each experimentally observed resonance was identified as a quantum dot eigenstate with a unique set of radial and angular quantum numbers. Our findings reveal the role of Klein tunnelling in quantum confinement and provide a new experimental platform for spatially controlling charge carriers in graphene.

References

[1] Jairo Velasco Jr. et al., Nano Letters, 16 (2016) 1620-1625
[2] Juwon Lee et al., Nature Physics, 12 (2016) 1032-1036

Figures

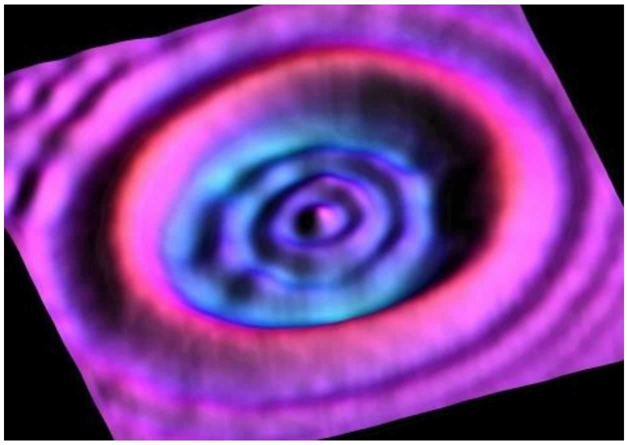

Figure 1: Graphene quantum dot wavefunction image (300 x 300 nm)

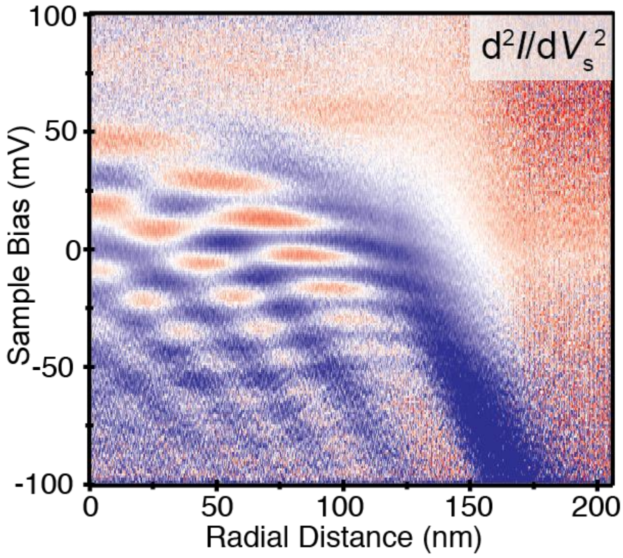

Figure 2: Spatially resolved STS showing the electronic structure of a graphene quantum dot