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# Valley-Mixing-Induced Splitting in Conductance Resonances through a Single Magnetic Quantum Dot in Graphene

Charge and spin transport through quantum dots is one of major research interests in mesoscopic and condensed matter physics. In particular, graphene has received the attention as a promising playground for both experimental and theoretical investigations due to its extraordinary transport properties and stability[1,2]. Also, the presence of an additional degree of freedom in graphene, so-called `valley, leads to another aspect of graphene in terms of research: valley transport and its device applications. In this study, we have shown that Dirac fermions are strongly localized in a magnetic quantum dot (MQD), which is created by screening out an external magnetic field with the circular geometry, and conductance through the MQD exhibits resonances when Dirac fermion energies meets eigenenergies of the MQD. Interestingly, the conductance resonances are revealed to be split into two distinct resonant peaks: symmetric Breit-Wigner and asymmetric Fano resonances. We have demonstrated that such a dual resonant feature is because of the two-level splitting as a consequence of valley mixing in the MQD, in a finite-size system.

## References

[1] A. S. Mayorov *et al.*, Nano Letters, 11 (2011) 2396-2399
[2] J. Xue *et al.*, Nat. Nanotechnol., 10 (2012) 282-285

## Figures

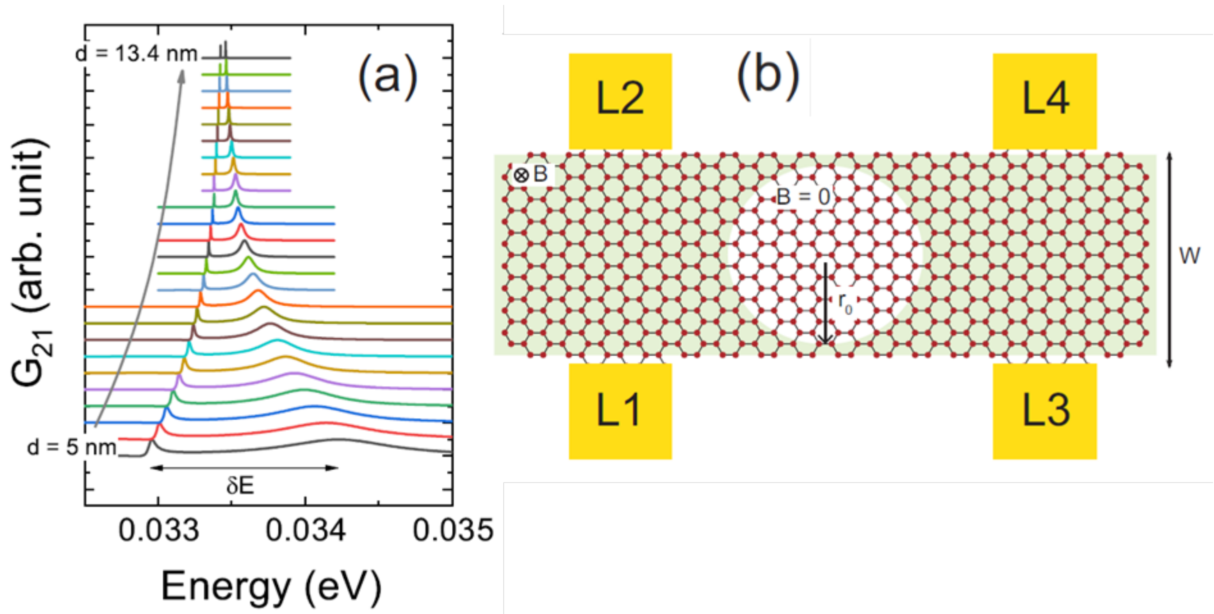


**Figure 1:** (a) Conductance spectra through the MQD for various MQD-edge distances. Each curves are calculated from the S-matrix approach between L1 and L2 leads. (b) Schematic model of the system. Uniform magnetic fields are applied to the graphene Hall bar with four leads, and screened out in the circular region, resulting in the MQD.