

Quantum Junction Plasmons in Graphene Dimers

Sukosin Thongrattanasiri¹,
Alejandro Manjavacas¹,
Peter Nordlander², and
F. Javier García de Abajo¹

¹IQFR – C SIC, Serrano 119, 28006 Spain

²Department of Physics and Astronomy, M.S. 61,
Rice University, Houston 77005-1892, United States

sukosin@gmail.com

The interaction between doped graphene nanoislands connected by narrow junctions constitutes an ideal testbed to probe quantum effects in plasmonic systems. Here, we predict that the interaction between graphene plasmons in neighboring nanoislands is extremely sensitive to the size and shape of the junctions [1]. Due to the two-dimensional character of this material, the addition of a small number of atoms (<10) is sufficient to dramatically modify the absorption spectrum of the entire dimer. Our ab initio calculations predict three different regimes of interactions: For narrow bridges (<4 carbon-atom rows) the conductance of the junction is too low to allow electron transport and the optical response is a characteristic bonding dipolar dimer mode that also appear in a classical description; for wider junctions (4-8 carbon rows), a pronounced charge polarization is induced across the junction which gives rise to a novel "junction plasmon" that has no counterpart in a classical description; for wider junctions (>8 rows) the conductance of the junction is sufficiently large to allow charge transport between the two graphene islands, resulting in a pronounced charge transfer plasmon which can also be described classically. The intermediate regime between the classical narrow and wide junction regimes is marked by a plasmon localized at the junction that is absent in classical-electrodynamics calculations [2]. Also in contrast to classical theory, our quantum description predicts a minor dependence on the length of the junction and a strong dependence on its width, thus confirming the importance of a quantum mechanical description of the optical properties of bridged graphene dimers.

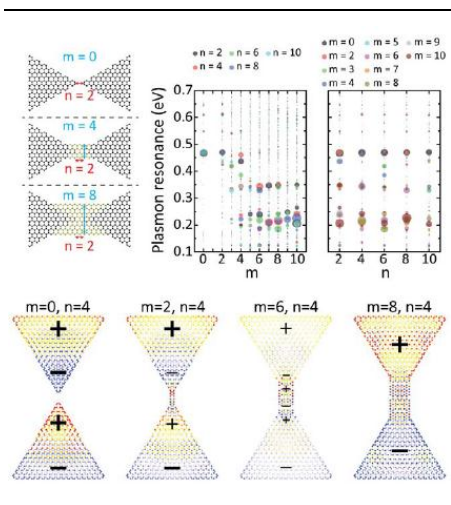


Figure 1

References

- [1] S. Thongrattanasiri, A. Manjavacas, P. Nordlander, and F.J. García de Abajo, submitted (2012).
- [2] R. Esteban, A.G. Borisov, P. Nordlander, and J. Aizpurua, Nature Commun. 3, 825 (2012).