Symmetry and optical selection rules in graphene quantum dots

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Graphene quantum dots (GQD's) have optical properties which are very different from those of an extended graphene sheet. In this article we explore how the size, shape and edges of a GQD affect its optical conductivity. Using representation theory, we derive optical selection rules for regular-shaped dots. We find that GQD's whose point group operations do not commute - for example dots of a rectangular shape - can be distinguished using polarized light. We also carry out explicit calculations of the optical conductivity of GQD's described by a simple tight-binding model, and use these to examine how zigzag and armchair edges impact on their optical properties. For dots of intermediate size (>10nm) we find that an absorption peak in the low frequency range of the spectrum makes it possible to distinguish between zigzag and armchair edges. We also clarify the one-dimensional nature of states at the Van Hove singularity in GQD's and graphene, providing a possible explanation for very high exciton-binding energies. Finally we discuss the role of atomic vacancies and shape asymmetry.

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