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Relativistic artificial molecule realized by double graphene quantum dots

Abstract

Coupled quantum dots (QDs), usually referred to as artificial molecules, are important not only in exploring fundamental physics of coupled quantum objects, but also in realizing advanced QD devices. However, previous studies have been limited to artificial molecules with nonrelativistic fermions. Here, we show that relativistic artificial molecules can be realized when two circular graphene QDs are coupled to each other. Using scanning tunneling microscopy (STM) and spectroscopy (STS), we observe the formation of bonding and antibonding states of the relativistic artificial molecule and directly visualize these states of the two coupled graphene QDs. The formation of the relativistic molecular states strongly alters distributions of massless Dirac fermions confined in the graphene QDs. Moreover, our experiment demonstrates that the degeneracy of different angular-momentum states in the relativistic artificial molecule can be further lifted by external magnetic fields.

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Figures

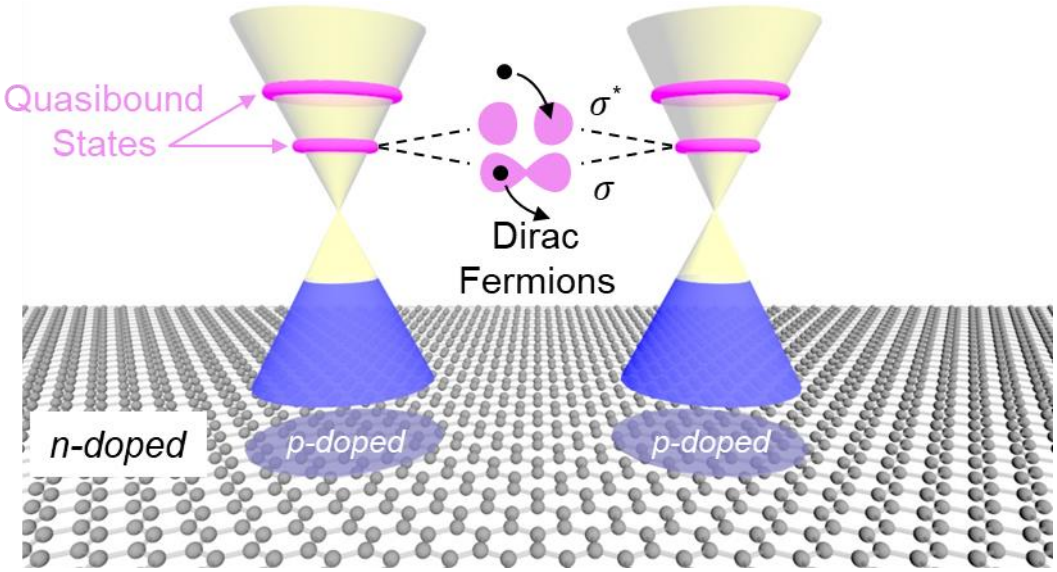

Figure 1 Illustrations from hydrogen molecule to graphene quantum dots molecule.