Power-law singularity in the local density of states induced by the point defect in graphene

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Defects in graphene give rise to zero modes that are often related to the sharp peak in the local density of states near the defect site. Here we solved all zero modes induced by a single defect in the finite-size graphene and show that their contributions to the local density of states vanish in the thermodynamic limit. Instead, lots of resonant states emerge at low energies and eventually lead to a power-law singularity in the local density of states. Our findings show that the impurity problem in graphene should be treated as a collective phenomenon rather than a single impurity state.