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Reducibility of the Fermi surface for periodic quantum-graph operators

The Fermi, or Floquet, surface for a periodic Schrdinger operator on a metric graph (a quantum graph) at a given energy level is an algebraic variety that describes all complex wave vectors admissible by the periodic operator at that energy. Its reducibility is intimately related to the construction of embedded eigenvalues supported by local defects. The rarity of reducibility is reflected in the fact that a generic polynomial in several variables cannot be factored. The "easy" mechanism for reducibility is symmetry. However, reducibility ensues in much more general and interesting situations. This work constructs different classes of non-symmetric periodic quantum graphs whose Floquet surface is reducible for all energies. One class of graphs is obtained by coupling two identical copies of a periodic quantum graph by edges to form a bilayer graph. Reducibility ensues when the coupling edges have potentials belonging to the same asymmetry class in the sense that their "spectral A-functions" are identical. Another class consists of bilayer graphs in which the single layer is bipartite, including graphene. This applies to both AA-stacked and AB-stacked graphene.