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Uncommon spectra of periodic quantum graphs: three simple examples

A typical picture of a periodic quantum graph spectrum is that it consists of bands separated by an infinite number of gaps, with the asymptotic band-gap ratio determined by the vertex coupling. We present three simple examples showing that neither of this needs to be true. Specifically, the spectrum may be a Cantor set, number of gaps may be finite, and the band-gap ratio may be determined by the topology of the graph. The first example is a chain in a linearly changing magnetic field, the other two use non-magnetic graphs, first a rectangular lattice with a δ coupling, then square and hexagonal lattices with a particular coupling violating the mirror symmetry.