

Geometric properties of quantum graphs and vertex scattering matrices

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Differential operators on metric graphs are investigated. It is proven that vertex boundary conditions can be successfully parameterized by the vertex scattering matrix at the energy equal to 1. Connectivity and high energy asymptotics are investigated in detail. The trace formula is proven for energy independent vertex scattering matrices. Two new families of boundary conditions are investigated: hyperplanar Neumann and Dirichlet conditions. It is proven that the Euler characteristic of the metric graph can be determined from the spectrum of the Laplace operator with the boundary conditions from one of these classes.