

# On quantum graphs violating the time-reversal invariance

Pavel Exner

Doppler Institute for Mathematical Physics  
and Applied Mathematics, Prague

In this talk we discuss quantum graphs with the vertex coupling which does not preserve the time-reversal invariance. As a case study the simplest example with the asymmetry being maximal at a fixed energy will be analyzed. In this situation the high-energy scattering depends crucially on the vertex parity; we will demonstrate implications of this fact for spectral and transport properties in several classes of graphs, both finite and infinite periodic ones. In particular, we prove the Band-Berkolaiko universality for kagome lattices with this coupling. Furthermore, we discuss other time-asymmetric graphs and identify a class of such couplings which exhibits a nontrivial  $\mathcal{PT}$ -symmetry despite being self-adjoint; we also illustrate the role of the Dirichlet component in the vertex coupling. Finally, we show how a square lattice with such a coupling behaves in the presence of a magnetic field when the two time-asymmetry effects compete. The results come from a common work with Marzieh Baradaran, Jiří Lipovský, and Miloš Tater.

*Mailing addresses:*

Department of Theoretical Physics, NPI  
Czech Academy of Sciences  
Hlavní 130, CZ-25068 Řež near Prague;  
Department of Physics, FNSPE  
Czech Technical University  
Břehová 7, CZ-11519 Prague

*E-mail:* exner@ujf.cas.cz