

CCSU
DEPARTMENT OF MATHEMATICAL SCIENCES
COLLOQUIUM

Friday, October 24
3:00 – 4:00 PM
Maria Sanford, Room 101

MODELING COMPLEX SYSTEMS
WITH QUANTUM GRAPHS:
TWO AND A HALF EXAMPLES
BINAN GU

WORCESTER POLYTECHNIC INSTITUTE

Abstract: A quantum graph is a metric graph on which differential equations are posed. First introduced by Linus Pauling to model electrons in organic molecules, quantum graphs have long been studied by analysts for their spectral and functional properties. In recent years, they have also become a versatile framework for modeling transport, diffusion, and reaction processes on network-like structures across the sciences.

I will present two and a half applications that adapt this framework to problems of increasing complexity: flow and filtration in porous materials, reactive and thermal transport in aquifer energy storage, and tissue growth on engineered scaffolds. Each example illustrates how physical laws can be consistently imposed on networks to capture large-scale behavior as a function of graph geometric and topological properties. Together, they highlight how the language of partial differential equations on graphs can connect fine-scale structure to effective network dynamics.

At the same time, these models expose a tension between analytical convenience and physical realism. The standard Neumann–Kirchhoff vertex conditions often fail to capture phenomena such as wave reflections at sharp junctions -- an issue observed, for instance, in shallow-water waves on graphs. Recognizing and addressing such limitations opens the way toward more physically grounded formulations of quantum graph models.

To join us online use the following link: <https://ccsu.webex.com/meet/gotchev>

For further information: gotchevi@ccsu.edu; 860-832-2839;

<http://mathcolloquium.sites.ccsu.edu/>