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Review of Inverse Spectral Problems for Differential Operators on Graphs and Defined Geometrical Domains

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Abstract: *Inverse spectral problems constitute a fundamental area of mathematical physics and applied analysis, focusing on the reconstruction of operators, coefficients, or geometrical structures from spectral characteristics. While classical inverse spectral theory was initially developed for ordinary differential operators on intervals, recent decades have witnessed significant extensions to complex systems such as metric graphs and bounded geometrical domains. These developments are motivated by applications in quantum mechanics, wave propagation, vibration analysis, and networked physical systems. This review paper presents a comprehensive overview of inverse spectral problems for differential operators defined on graphs and geometrical domains. Emphasis is placed on foundational theories, uniqueness and reconstruction results, analytical methods, and emerging research directions. The paper highlights how spectral data encode both topological and geometrical information, bridging operator theory, geometry, and mathematical physics.*

Keywords: Quantum Graphs, Metric Graphs, Geometrical Domains

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