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Spectral Geometry in Discrete Case: Some Results, Applications and Speculations

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My major objective in this talk is to show the strength of the ties between discrete mathematics and spectral geometry by trying to develop a common language, which may hopefully give rise to some deeper applications of results available in these different areas of mathematics. Maybe, one reason these connections have been slow to emerge is that the fields involved are quite far apart, at least from the traditional viewpoint.
In the first part of this talk I will try to explain some (classical) connections between the spectral properties and the geometric properties of (not necessarily simple) graphs (as discrete geometric objects) which will have a focus on all combinatorial, geometric and probabilistic aspects of the subject. My ultimate aim in this part is to set forward some applications of these spectral methods in combinatorics and graph theory.
In the second part, I will try to focus on some new and recent aspects of the spectral geometry of graphs with an emphasis on the applications and connections of these methods in discrete mathematics, computer science, and geometry of manifolds, which is mainly based on the recent developments emerged between (representations of) discrete subgroups of Lie groups (in connection with automorphic forms and arithmetic) on the one hand, and questions in discrete mathematics, combinatorics, and graph theory (e.g. construction of expander graphs) on the other.