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Advanced Seminar SuSe 2026

The Laplacian on infinite graphs

Graph structures play an immense role in science and technology. For instance, in mathematical physics, graphs serve as a model with nodes representing possible positions of an electron and with edges (connections between the nodes) representing its possible paths of travel. These dynamic processes can in part be described by spectral properties of Schrödinger operators, and in particular, by the discrete Laplacian. The latter detects many geometric and dynamic phenomena of graphs, some of which become especially interesting when dealing with infinitely many nodes.

The goal of this advanced course is to dip into current directions of research around the discrete Laplace operator and its implications for graphs. The successful participant is required to give an 1h talk on a recent research topic, and to provide a short paper on the results.

Since I am on leave until summer, the talks will be held in a small workshop in July. Consultation hours will be offered via zoom. Prerequisites for taking the seminar are a sound knowledge in functional analysis and measure theory. For our studies we have a great variety of topics to choose from. The outline will also depend on the number of participants, and potential topics will be presented in a first zoom meeting at the beginning of the semester.

Every student who wishes to participate should do all of the following.

(1) Enroll in the moodle2 course (which is to be set up soon). All course announcements and material will be provided there.

(2) Send me an email expressing your tentative interest in presenting a topic.

(3) Study Chapter 1 of [1] (an online link will be provided in moodle2) in order to get acquainted with the basics on graphs and their Laplacians.

In case of any question, just send me an email.

Target group: diploma and master (10-MAT-MM5AS) students with strong interest in operator or spectral theory.

First online meeting: beginning of April, concrete dates and login data provided in due course in moodle2.

Literatur

[1] Matthias Keller, Daniel Lenz and Radoslaw Wojciechowsky. *Graphs and discrete Dirichlet spaces* Grundlehren der mathematischen Wissenschaften, Springer 2021.

[2] Rainer Nagel. *A short course on operator semi-groups.* Springer Verlag Berlin Heidelberg New York, 1998.

[3] Michael Reed and Barry Simon. *Methods of Modern Mathematical Physics I, II and IV.* Academic Press New York and London.

[4] Konrad Schmüdgen. *Unbounded Self-adjoint Operators on Hilbert Space*, GTM Springer-Verlag.

[5] Joachim Weidmann. *Lineare Operatoren in Hilberträumen I: Grundlagen* (for German speakers). B.G.Teubner Stuttgart Leipzig Wiesbaden (in German).

[6] Dirk Werner. *Funktionalanalysis* (in German). Springer-Verlag.

[7] Wolfgang Woess. *Random Walks on Infinite Graphs and Groups.* Cambridge University Press, New York, 2000.