Spectral Theory by the Lakes

Lancaster University, 9-10 April, 2026

Program & Abstracts

Thursday 09.04.2026

08'50 - 09'20 Registration (Charles Carter Foyer)

- Charles Carter A15 -

09'20 - 90'30	Opening
09'30 - 10'30	*Eugene Shargorodsky:* Estimate for the Morse index of a Stokes wave
10'30 - 11'00	*Sukrid Petpradittha:* Lieb–Thirring type inequalities for Schrödinger operators with complex potentials

11'00 - 11'30 Coffee Break (Charles Carter Foyer)

- Charles Carter A15 -

11'30 - 12'30	*Mira Shamis:* Area Law for the entanglement entropy of free fermions in nonrandom ergodic field.

12'30 - 14'00 Lunch Break

- Charles Carter A15 -

14'00 - 15'00	*Alexander Pushnitskii:* Periodic Hankel operators
15'10 - 16'10	*Leonid Pastur:* Ergodic Hankel operators

16'10 - 16'30 Coffee Break (Charles Carter Foyer)

- Charles Carter A15 -

16'30 - 17'30	*Jakob Reiffenstein:* Eigenvalues of self-adjoint exit space extensions

Friday 10.04.2026

- Charles Carter A15-

09'30 - 10'30	*Catherine Drysdale:* Universal Methods for Computing Spectra of Linear and Nonlinear Eigenvalue Problems
10'30 - 11'00	*Benedikt Buchecker:* An upper bound for the Widom factors on Jordan arcs

11'00 - 11'30 Coffee Break (Charles Carter Foyer)

- Charles Carter A15 -

11'30 - 12'30	*Leonid Parnovski:* Classical spectral asymptotics with a modern twist

12'30 - 14'00 Lunch Break

- Charles Carter A15 -

14'00 - 15'00	*Yan-Long Fang:* Scattering resonances of transmission problems

15'00 - 15'30 Coffee Break (Charles Carter Foyer)

- Charles Carter A15 -

15'30 - 16'00	*Ghada Jameel:* Eigenvalue Bounds for Perturbed Periodic Dirac Operators
16'00 - 17'00	*Noema Nicolussi:* Optimal eigenvalues on a metric graph with densities

Spectral Theory by the Lakes 2026 – Abstracts

An upper bound for the Widom factors on Jordan arcs

Buchecker Benedikt

It is a long-standing problem to compute asymptotics of Chebyshev polynomials for smooth Jordan arcs in the complex plane, i.e., homoeomorphic images of the unit interval. For a given compact set K, these are monic polynomials minimizing the sup-norm on K. Following a 1969 work of Widom on extremal polynomials, the Widom factors are defined by rescaling the norm of the n-th Chebyshev polynomial by the logarithmic capacity of K taken to the n-th power.

While the limits of Widom factors as $n \to \infty$ are well-understood if the compact set is a closed C^{2+}-Jordan curve, even for analytic Jordan arcs it is not known whether the sequence converges. Widom conjectured that the limit is 2 based on his results for intervals. However, this was later proven to be wrong when the limit was computed for circular arcs. Based on these results, a suitable candidate for the limit was found recently, given by the reproducing kernel of an associated Hardy space. We will confirm that this candidate indeed provides an asymptotic upper bound for the Widom factors on smooth Jordan arcs. This reports on ongoing joint work with Benjamin Eichinger, Olof Rubin, and Aron Wennman.

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Universal Methods for Computing Spectra of Linear and Nonlinear Eigenvalue Problems

Drysdale Catherine

In this talk, I will discuss the algorithms and corresponding assumptions needed to compute spectra for linear and nonlinear problems. These algorithms ensure that a spectrum is calculated without spectral pollution or spectral invisibility for particular classes of operators. The mathematical machinery needed for nonlinear problems is a natural extension to what is needed for the linear eigenvalue problems. I will show the computed spectrum some key examples including the Imaginary Cubic Oscillator and the Klein Gordon equation.

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Scattering resonances of transmission problems

Fang Yan-Long

Understanding wave propagation in the presence of an obstacle requires detailed knowledge of the associated scattering resonances. In this talk, I will outline how the geometry of the obstacle is reflected in the distribution of these resonances. Beyond geometric effects, the refractive index of the obstacle also plays a crucial role in shaping the resonance structure. In particular, for a certain range of negative refractive indices, a new class of resonances emerges, which are known as surface plasmons. I will discuss key properties of these plasmons, along with a Weyl-type asymptotic formula that describes their distribution. This is based on a joint work with Jeffrey Ga

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Optimal eigenvalues on a metric graph with densities

Jameel Ghada

Consider the one-dimensional Dirac operator $H = H_0 + V$ in $L^2(\mathbb{R})^2$,

$$H = -i\sigma_2 d/dx + m\sigma_3 + q(x) + V(x)(x \in \mathbb{R}),$$

where σ_2, σ_3 are Pauli matrices, and $m \geq 0$ is the particle mass, q is real-valued and periodic of period a and V is a 2×2 matrix-valued function with entries in $L^1(\mathbb{R})$. The free Dirac operator H_0 is self-adjoint and its spectrum has a band-gap structure, i.e. it is purely absolutely continuous and consists of a sequence of closed intervals in $\mathbb{R}$. The Dirac operator $H = H_0 + V$ has the same essential spectrum as H_0 but can have additional eigenvalues in $\mathbb{C}$. We aim to establish regions in $\mathbb{C}$ which contain all eigenvalues of H. We have proved that $\lambda \in \mathbb{C}$ cannot be an eigenvalue if

$$\|V\|_1 < \Gamma(M(\lambda))\gamma_+(\lambda)\gamma_-(\lambda),$$

where $M(\lambda)$ is the monodromy matrix of the periodic problem and Γ is a matrix function related to the angle between the eigenvectors of the matrix; $\gamma_+(\lambda), \gamma_-(\lambda)$ relate to the size of Floquet solutions of the periodic problem. We then show that $\gamma_\pm(\lambda)$ are strictly positive and that $\Gamma(M(\lambda))$ is strictly positive except at the end-points of spectral bands, where it tends to 0.

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Optimal eigenvalues on a metric graph with densities

Nicolussi Noema

Motivated by the notion of conformal eigenvalues for surfaces, we investigate Laplacians on a metric graph with varying mass density. This setting provides a common framework for several well-studied classes of operators: discrete Laplacians, Dirichlet-to-Neumann operators on graphs, and Kirchhoff Laplacians (a.k.a. quantum graph operators).

Our main interest is the spectral optimization problem for eigenvalues with respect to the underlying mass density, which turns out to behave rather differently than in the manifold setting. In particular, we discuss the relation of optimal eigenvalues with geometrical properties, including a complete geometric description of the first optimal eigenvalue and a Weyl law.

Based on joint work with Kiyan Naderi (University of Innsbruck).

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Classical spectral asymptotics with a modern twist

Parnovski Leonid

The existence of spectral asymptotics of Laplace or Schroedinger operators acting on Riemannian manifolds is a classical problem studied for more than 100 years. It has ben known for a long time that obstacles to the existence of spectral asymptotic expansions are periodic and looping trajectories of the geodesic flow. A conjecture formulated in 2016 stated that these trajectories are the only such obstacles. I will discuss the history of this problem and describe the resent progress: proving this conjecture in special cases, as well as constructing some counterexamples. This is a joint work with Jeff Galkowski (UCL) and Roman Shterenberg (UAB)

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Ergodic Hankel operators

Pastur Leonid

Abstract. We introduce a new class of operators: ergodic families of selfadjoint Hankel operators. Inspired by the spectral theory of differential and finite-difference operators with ergodic coefficients, we develop a spectral theory of this class. We define the Integrated Density of States (IDS) measure and establish its fundamental properties. In particular, we determine the total mass of the IDS measure in the positive semi-definite case. We also consider in more detail the subclass of ergodic Hankel operators which we call the random Kronig–Penney–Hankel (rKPH) model. We prove the counterparts of the cornerstone results of the spectral theory of random Schrödinger operators: Lifshitz tails at the edges of the spectrum, the Wegner estimates for the IDS, and the Anderson localisation in a natural asymptotic regime. This is joint work with Alexander Pushnitsky (King's College London).

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Lieb–Thirring type inequalities for Schrödinger operators with complex potentials

Petpradittha Sukrid

In this talk, I will present recent developments in Lieb–Thirring (LT) type inequalities for non-self-adjoint Schrödinger operators. In view of joint work (2025) with S. Bögli and F. Štampach, we show that the spectral bound concerning a possible generalization of the LT inequality, announced by Demuth, Hansmann, and Katriel in the Integral Equations and Operator Theory in 2013, is false. Then, in recent joint work (2026) with S. Bögli, we prove new LT type inequalities by means of a new eigenvalue counting estimate for non-self-adjoint operators.

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Periodic Hankel operators

Pushnitskii Alexander

I will discuss spectral properties of a class of self-adjoint Hankel operators H, realised as integral operators on the positive semi-axis. Operators of this class (we call them periodic Hankel operators) are those that commute with dilations by a fixed factor. In analogy with the spectral theory of periodic Schroedinger operators, periodic Hankel operators H admit the Floquet-Bloch decomposition, which represents H as a direct integral of certain fiber operators with discrete spectra. As a consequence, operators H have band spectra (the spectrum of H is the union of disjoint intervals). A striking feature of this model is that flat bands (i.e. intervals degenerating into points, which are eigenvalues of infinite multiplicity) are possible; I will discuss some simple explicit examples of this nature. The spectral analysis of periodic Hankel operators is based on the theory of elliptic functions; if time permits, I will explain this connection. This is joint work with Alexander Sobolev (University College London).

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Eigenvalues of self-adjoint exit space extensions

Reiffenstein Jakob

Finding eigenvalues of a self-adjoint operator often amounts to determining zeroes or singularities of analytic functions. Our recent work provides the theoretic background for this principle for self-adjoint extensions $\widetilde{A}$ of an underlying symmetric operator S with defect (n, n). These are parametrised by Krein's formula

$$\mathcal{P}_{\mathcal{H}}(\widetilde{A} - \lambda)^{-1}|_{\mathcal{H}} = (A - \lambda)^{-1} - \gamma(\lambda)(m(\lambda) + \tau(\lambda))^{-1}\gamma(\overline{\lambda})^{*}. \quad (1)$$

Here A is a "default" extension with defect family $\gamma(\lambda)$ and Weyl function m. The function τ is seen as the parameter on the right-hand side.

In this talk I will present a complete characterization of the eigenvalues of $\widetilde{A}$ in terms of the values of m and τ. I will explain the role of *pole cancellation functions* in the description of the eigenvalues and why we need to extend this notion in order to make the characterization explicit in m and τ.

Based on joint work with A. Luger.

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Area Law for the entanglement entropy of free fermions in nonrandom ergodic field.

Shamis Mira

In this talk we will discuss systems of free fermions whose one-body Hamiltonian is a discrete ergodic Schrödinger operator with quasi-periodic, limit-periodic potentials, as well as potentials generated by more complicated dynamical systems – subshifts of finite type. We will discuss the cases where the corresponding entanglement entropy obeys the Area Law.

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Estimate for the Morse index of a Stokes wave

Shargorodsky Eugene

Stokes waves are steady periodic water waves on the free surface of an infinitely deep irrotational two-dimensional flow under gravity without surface tension. They can be described in terms of critical points of a certain functional; this allows one to define the Morse index of a Stokes wave. I will discuss some known and new estimates for the Morse index of a Stokes wave.

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