# Titles and Abstracts for the TRR 352 Junior Meeting, January 21–24, 2025

**Pablo Costa Rico**

*Quantum Markov Chains*

The quantum divergence is a measure of distinguishability between two quantum states and also serves as a generator of many other quantities in quantum information theory, such as von Neumann entropy, mutual information, etc. A way to transmit information between parties, is between a quantum channel, which satisfy that after its application, the resulting states cannot be more distinguishable than the original ones. This property is called data-processing inequality.
In this talk, we will explore the case where they are equally distinguishable for tripartite systems and when the channel is a conditional expectation. States satisfying this property are called Quantum Markov Chains and we will see that they have many applications in quantum mechanics.

**Jonas Peteranderl**

*An introduction to the stability of functional inequalities*

When all optimizers of a functional inequality have been determined, it is natural to ask whether a function that "almost" optimizes the inequality is "almost" an optimizer. This question was first raised by Brezis and Lieb for the Sobolev inequality and answered by Bianchi and Egnell in a quantitative form, that is, in the form of a refinement of the original inequality.
If such a refinement holds, we say that the inequality is (quantitatively) stable. Such a stability result has various applications in mathematical physics and geometry.
This talk will be a gentle introduction to the stability of functional inequalities. We are going to review the original Bianchi-Egnell strategy and discuss novel stability phenomena under the influence of degeneracy and non-Hilbertian structures. The latter part will be based on joint work with Rupert Frank.

**Sara Terveer**

*The return probability on Galton-Watson trees*

Consider a simple random walk on a Galton-Watson tree. Work from Piau (1998) established bounds on the order of the decay of the annealed return probability to the root at time t depending on characteristics of the offspring distribution. It has been conjectured that the optimal bound obtained in this work for certain offspring distributions holds for a much wider class of distributions. In this talk, we will discuss recent advances towards proving this conjecture.

**François Visconti**

*On stability of trapped two-dimensional Bose gases with attractive interactions*

In this talk I will discuss questions and recent results on trapped two-dimensional Bose gases with attractive interactions. I will first present the general setting and explain why such systems are particularly difficult to deal with. In particular, I will try to explain why even the stability of the many-body system is not obvious. Then, I will discuss the convergence of the ground state energy per particle to that of a non-linear Schrödinger energy functional.

**Beatriz Dias**

*Sampling from a superposition of 'samplable' states*

We give a rejection sampling algorithm to sample from the outcome distribution defined by measuring a superposition of states given the ability to: 1) compute the distribution we wish to sample from, 2) compute and sample from the individual distributions defined by measuring each state in the superposition. The algorithm has runtime O(n) and it is particularly useful to sample from superpositions of bosonic Gaussian states.

**Tom Wessel**

*Equality of magnetization and edge current for interacting lattice fermions at positive temperature*

I will recall the mathematical description of interacting fermions on a discrete finite lattice at positive temperature. I will then use this description to model a quantum Hall system and prove that the magnetisation is equal to the edge current in the thermodynamic limit if the system satisfies local indistinguishability of the Gibbs state.

This latter assumption is known to hold for sufficiently high temperatures. The result implies that the edge currents in such systems are determined by bulk properties and are stable against perturbations near the boundaries.
The talk is based on doi.org/10.1007/s11040-024-09495-8.

**Paul Gondolf**

*An introduction to the Davies semigroup and some of its properties*

In this talk, we will explore families of Davies semigroups acting on finite-dimensional matrix spaces, associated with a commuting local Hamiltonian and an inverse temperature \beta. We will examine key properties of these semigroups, such as GNS symmetry and the resulting primitivity—i.e., convergence to a unique fixed point. Building on this, we will connect the speed of this convergence to geometric properties of the fixed point by analyzing the spectral gap. We will also briefly touch on their applications in the Gibbs sampling context and discuss some of the challenges they present. Time permitting, we will delve into the newly proposed semigroups by [Chen et al.], which address some of the earlier issues.

**Yifei Li**

*An Energy-stable Numerical Approximation for the Willmore Flow*

The Willmore energy has widespread applications in differential geometry, cell membranes, optical lenses, materials science, among others. The Willmore flow, as the L^2 gradient flow dissipating the Willmore energy, serves as a fundamental tool for its analysis.
Despite its importance, the development of energy-stable parametric methods for the Willmore flow remains open. In this talk, we present a novel energy-stable numerical approximation for the Willmore flow. We begin by introducing our method for planar curves, then demonstrating the underlying ideas -- the new transport equation and using time derivative of the mean curvature, which ensure the energy stability.
Finally, we discuss the extension of our approach to surfaces in 3D.

**Corlie Rall**

*The quantum capacity of the quantum broadcast channel*

One of the foundational problems of quantum information theory is to determine the quantum capacity of a communication channel from Alice to Bob. That is to say, what is the ultimate limit on how much quantum information a (noisy) channel can transmit? The capacity is defined as a regularized optimization problem and is not known to be computable in general, though some highly symmetric channels do have known capacity. The capacity of a general channel has been bounded by considering larger classes of /assisted/ channels, for which upper bounds on the capacity can be expressed as efficiently computable semidefinite programs. We complete another piece of the puzzle by extending existing techniques to a network setting - we find semidefinite programs for bounding the quantum capacity of the quantum broadcast channel with one sender and two receivers under some operationally meaningful classes of assistance.

**Anouar Kouraich**

*The Quantum Random Energy Model as a linit of Quantum p-spin glasses*

Classically it is known that the quenched free energy of the P-spin glass model converges to that of the REM as P increases. In this talk I talk about the convergence of the free energy of the quantum versions of both model.