Programme and abstracts for the conference
"Correlations in Quantum Mechanics"
Copenhagen June 21-23, 2023
Place: AUDITORIUM 4

Wednesday 21/6	Thursday 22/6	Friday 23/6
9.00-9.15 Welcome		
9.15-10.05 Erdős	9.10-10.00 Frank	9.10-10.00 Lewin
	COFFEE BREAK	
10.30-11.20 Conlon 11.20-12.10 Graf	10.30-11.20 Yngvason 11.20-12.10 Grubb	10.30-11.20 Colding 11.20-12.10 Nam
	LUNCH BREAK	
13.40-14.30 Esteban	13.40-14.10 Tokus 14.10-14.40 Reuvers	13.40-14.10 Fialová 14.10-14.40 Boßmann
	COFFEE BREAK	
15.00-15.50 Vogelius 15.50-16.40 Lieb	15.10-16.00 Serfaty	15.10-16.00 Warzel 16.00-16.50 Benguria
17.00-18.00 Reception		16.50-16.55 Closing

Rafael Benguria, Pontificia Universidad Católica de Chile, Chile

Title: On a Thomas-Fermi–von Weizsäcker type equation with a critical exponent: nonexistence of solutions of large particle number
Abstract: In this talk, I will consider a Thomas-Fermi–von Weizsäcker type equation with a critical exponent and study the existence and nonexistence of positive solutions depending on the particle number. Since I am considering a critical exponent for the nonlinear term the behavior depends on the coupling constant. This is joint work with Heinz Siedentop from LMU.

Lea Boßmann, ISTA, Austria

Title: Focusing NLS and Bogoliubov correction for dilute Bose gases in the instability regime
Abstract: We consider the dynamics of a 2d Bose gas with singular attractive interactions in the instability regime, where the corresponding focusing nonlinear Schrödinger equation (NLS) has a blow-up. We show that the evolution of the condensate is effectively described by this NLS for all times before the blow-up. Moreover, we prove the validity of the Bogoliubov approximation for the dynamics of the fluctuations, resulting in a norm approximation of the many-body dynamics.
This is joint work with Charlotte Dietze and Phan Thành Nam.

Tobias Colding, MIT, USA

Title: Geometry and PDEs
Abstract: TBA

Joe Conlon, University of Michigan, USA

Title: Extensions of the Brascamp-Lieb Inequality and the Dipole Gas
Abstract: The Brascamp-Lieb (BL) inequality (1976) relates properties of log concave functions to Poincaré inequalities for certain probability distributions. In this talk we show how some extensions of the BL inequality obtained using the Malliavin calculus, combined with some classical results in harmonic analysis, may be used to prove Gaussian type estimates on correlation functions for the classical Coulomb dipole gas. The general methodology is due to Naddaf and Spencer (1997).

László Erdős, ISTA, Austria

Title: Condition numbers and eigenvector overlaps for random matrices
Abstract: It is well known that eigenvalues of general non-Hermitian matrices can be very unstable under tiny perturbations but adding a small noise regularises this

instability. The quantity governing this effect, called the eigenvalue condition number in numerical linear algebra, is also well known in random matrix theory as the eigenvector overlap. We present several recent results on almost optimal lower and upper bounds on this key quantity. For the lower bound we need to prove the strong form of quantum unique ergodicity (QUE) for the singular vectors of non-Hermitian random matrices. The upper bound requires very different tools: here we prove a Wegner type estimate for non-Hermitian matrices. The talk is based upon joint works with G. Cipolloni, J. Henheik, H.-C. Ji, O. Kolupaiev and D. Schroder.

Maria Esteban, CEREMADE, France

Title: Some conjectures concerning the ground state energy of a relativistic electron in a molecular configuration.
Abstract: In this talk I will present recent results and open problems concerning the lowest eigenvalue of a Dirac operator with a general multi-pole external electrostatic potential. It describes a relativistic quantum electron moving in the field of some (pointwise or extended) nuclei, possibly in a molecule. One of the main questions we ask is whether the eigenvalue is minimal when the nuclear charge is concentrated at one single point. This wellknown property in non-relativistic quantum mechanics has escaped all attempts of proof in the relativistic case. This is work in collaboration with M. Lewin and E. Séré.

Marie Fialová, ISTA, Austria

Title: Asymptotics of weakly coupled eigenvalues of the Pauli operator
Abstract: We are interested in the magnetic Pauli operator perturbed by a potential ϵV, where ϵ is a small parameter. In particular we want to find the asymptotics of the eigenvalues as ϵ tends to zero. In our project we consider the Aharonov–Bohm magnetic field. And show that both components of the Pauli operator are critical in the sense of not satisfying a Hardy-type inequality and consequently the small potential perturbation results in emergence of two eigenvalues compared to the usual result of only one eigenvalue for non-singular magnetic fields.
This is a joint work in progress with David Krejčiřík.

Rupert Frank, LMU Munich, Germany

Title: Endpoint Schatten class properties of commutators
Abstract: We are interested in trace ideal properties of commutators $[sgnD, f]$, as well as $[(-\Delta)^s, f]$ for $-d/2 < s \leq 1$, where f is a function on R^d and D is the Dirac operator. We show that these commutators belong to a certain weak Schatten class if and only if the function f belongs to an appropriate homogeneous Sobolev space, and in this case we determine the asymptotic behavior of the singular values. Our proofs use, among

other things, the tool of Double Operator Integrals.
The talk is based on joint work with F. Sukochev and D. Zanin.

Gian Michele Graf, ETH Zürich, Switzerland

Title: Infrared scattering states in the massless Nelson model
Abstract: The Nelson model describes a particle coupled to a (bosonic) field. In the case where the field is massless, the model is a simple caricature of QED, as both theories share some traits in the infrared, and in particular the difficulty of defining scattering states. A possible solution, to be discussed, is that the particle emits an ever growing number of ever softer bosons. A precise and asymptotically (in time) exact description of the process will be given, motivated, and compared to earlier work by others.

Gerd Grubb, University of Copenhagen, Denmark

Title: Fractional-order operators in n dimensions.
Abstract: The subject of the talk is pseudodifferential operators P of order $2a$, $0 < a < 1$, where the basic example is the fractional Laplacian $(-\Delta)^a$ with symbol $|\xi|^{2a}$, but the theory also aims at operators $P = Op(p(x,\xi))$ with x-dependent symbols $p(x,\xi)$. We intend to give an overview of results on:
1) The homogeneous Dirichlet problem,
2) nonzero Dirichlet- and Neumann-type boundary values,
3) Integration by parts formulas,
4) Evolution equations,
5) Spectral theory.

Mathieu Lewin, CEREMADE, France

Title: Open problems for Coulomb and Riesz gases
Abstract: As I learned with Jan Philip, long range systems such as Coulomb are very difficult to handle in statistical mechanics. In this talk I will present some open problems and recent advances, taken from the review paper "Coulomb and Riesz gases: The known and the unknown", published last year in J. Math. Phys.

Elliott Lieb, Princeton University, USA

Title: Study of a simple equation that describes the ground-state energy of a Bose gas at a low and high density and in dimensions one, two and three
Abstract: I will start with a quick review of the simple equation derived in 1963 to calculate the ground state energy E of a dilute Bose gas with 2-body repulsive interactions. It yielded the famous LHY second order term for E. Beyond that it has recently

been shown to agree remarkably well with Monte Carlo calculations in 3 dimensions for ALL densities, revealing what might be previously unsuspected changes at intermediate density.

Phanh Thàn Nam, LMU Munich, Germany

Title: Correlation energy of the electron gas in the mean-field regime
Abstract: In 1957, Gell-Mann and Brueckner predicted that the correlation energy of the electron gas is equal to $c_1\rho\log(\rho) + c_2\rho$ in the high density limit. I will discuss a rigorous version of this formula in the mean-field regime, where the electrons are trapped in a torus and the interaction is sufficiently weak. We use a quasi-bosonic diagonalization method which justifies the random phase approximation in an appropriate sense. The talk is based on recent joint work with Martin Ravn Christiansen and Christian Hainzl.

Robin Reuvers, Università Roma Tre, Italy

Title: Strongly interacting fermions in $1D$
Abstract: I will discuss $1D$ fermions with a strong repulsive interaction. Contrary to 2 and $3D$, this can be thought of as a low-density limit. In the spin-1/2 case, the Heisenberg antiferromagnet appears in the effective, low-energy Hamiltonian, which was only understood in the physics literature around 2014. I will discuss ongoing work with Johannes Agerskov and Jan Philip to try to understand this rigorously.

Sylvia Serfaty, NYU Courant, USA

Title: Recent developments on the classical Coulomb gas
Abstract: We will present a review of recent and less recent results on the classical Coulomb gas in general dimension: local laws describing the system down to the microscale, LDP for the empirical process, fluctuations and hyperuniformity in dimension 2.

Sabiha Tokus, University of Tübingen, Germany

Title: On the ground state energy of fermions in one dimension - semiclassical scaling limit and Luttinger model
Abstract: I will present some ongoing work joint with Niels Benedikter and Jan Philip on the ground state energy of a system of interacting fermions in one dimension. In a certain semiclassical scaling regime, we find an upper bound on the ground state energy where we rediscover the energy of the Luttinger Hamiltonian as a next to leading order term.

Michael Vogelius, Rutgers University, USA

Title: Implications of Non-scattering.
Abstract: In this talk I will discuss some recent results concerning non-scattering phenomena in the context of the Helmholtz equation. In particular, I will discuss the regularity of nonscattering (invisible) inhomogeneities. Time permitting, I shall also briefly describe these results with a view towards transmission eigenvalues, and draw some connections to the socalled Schiffer conjecture. This work is joint with F. Cakoni and J. Xiao.

Simone Warzel, TUM, Germany

Title: Recent Results on Quantum Spin Glasses
Abstract: We present a variational expression for the free energy of mean-field spin glasses such as the Sherrington-Kirkpatrick model in a transversal magnet field. This includes a clarification of the order parameter of such quantum glasses. (Based on joint work with Chokri Manai)

Jakob Yngvason, Universität Wien, Austria

Title: Pseudopotentials as scaling limits.
Abstract: We consider the magnetic Hamiltonian of a two-dimensional many particle system with short range interactions. The magnetic field is assumed to be homogeneous and perpendicular to the two-dimensional plane; it can also be an artificial gauge field generated, e.g., by rapid rotation. We show that Haldane's pseudopotential operators in the lowest Landau level and for arbitrary scattering channels emerge as suitable short-distance scaling limits of the Hamiltonian. For this it is essential to take the kinetic energy in all Landau levels into account and not to replace the Hamiltonian from the outset by its projection to the lowest Landau level. (Joint work with Robert Seiringer.)