Walkshop KIT 2019

Walkshop "Mathematical Physics" at Karlsruhe Insitut of Technology, 11.-12.04.2019:

A Walkshop in Mathematical Physics at KIT is organized from 11-April-2019 until 12-April-2019. More precisely,

- the walkshop starts on Thursday, 11-April-2019, at 13.30 h;
- The hike (which justifies the name of the event) will take place on Friday around noon;
- the walkshop ends on Friday evening, 12-April-2019, at 18.00.

The program includes the following highlights:

- Scientific presentations of new results, but also review talks of established fields;
- Particular emphasis on young researchers;
- A 90-minute walk through Karlsruhe;

Registration:

- To register for participation and all other questions concerning the walkshop please send an e-mail to Ioannis Anapolitanos (ioannis.anapolitanos@kit.edu).
- Please, also indicate whether we may publish your name online in the list of participants.
- We cannot offer any financial support, but the participation is free, and there is no registration fee.
- For hotels we have 3 possibilities where guests of us have lived several times One of them is called Kuebler and another is called Erbprinzenhof (Klick on the names to go to be forwarded to the respective links). The third is the Gastdozentenhaus, which belongs to the University. If there is any free spot reservation is possible per Email info@gdh.kit.edu. Please indicate in your email, that you visit for a Workshop organised by KIT.

Preliminary Schedule

All talks take place in Nachrichtentechnik Hörsaal, Engesserstraße 5, 76131 Karlsruhe. The lecture hall has 3 big blackboards and 6 small ones. It offers the posibility to use projector with the 6 small blackboards at the same time or all blackboards together.

Day	Time	Event/Speaker+Title	Cl
Thursday	13:30-13:40	Opening	
11-April 2019	13:40-14:25	David Mitrouskas: Effective dynamics of tracer particles coupled to a Fermi gas in the high-density limit	
	14:30-15:15	Andreas Deuchert: Gross-Pitaevskii Limit of a Homogeneous Bose Gas at Positive Temperature	
	15:20-16:00	Coffee Break	
	16:00-16:45	Marvin R. Schulz: On the Bogolubov de-Gennes Equations in a homogeneus magnetic field	
	16:50-17:35	Fiona Gottschalk: Phase Transitions for Ferromagnetic Models	
	17:40-18:25	Nikolai Leopold: Mean-field Dynamics for the Nelson Model with Fermions	
	19:00	Conference dinner at the Restaurant of Gastdozentenhaus	
Friday	09:00-09:45	Ruth Schulte: A logarithmically enhanced area Liquid law for the entanglement entropy in the random dimer model	
12-April 2019	09:50-10:20	Coffee Break	
	10:20-11:05	Tobias König: Liquid Drop Model for Nuclear Matter in the Dilute Limit	
	11:10-11:55	Michael Fleermann: Random Matrices with Curie-Weiss Entries	
	12:00-15:30	Lunch break and Walk	
	15:30-16:15	Gabor Toth: Asymptotic results for two Groups in a Curie Weiss Model	
	16:20-17:05	Michael Hartig: van der Waals-London interaction of atoms with pseudorelativistic kinetic energy	
	18:30	Dinner with the remaining people	

List of Abstacts

David Mitrouskas: Effective dynamics of tracer particles coupled to a Fermi gas in the high-density limit The dynamics of tracer particles coupled to a dense and homogeneous ideal Fermi gas in two spatial dimensions is analyzed. We prove closeness of the time evolution to an effective dynamics for large densities of the gas and for time scales of the order of some power of the density. For a single tracer particle, the effective dynamics is generated by the free Hamiltonian with a large but constant energy shift whose main contribution is given by the mean field approximation. In the case of two tracer particles, the effective Hamiltonian includes an additional term that modifies the interaction between the two tracer particles. Both results are in contrast to a dense bosonic gas in which the motion of tracer particles would be disturbed already on very short time scales. Our proof is based on the use of strong phase cancellations in the deviations of the microscopic dynamics from the effective time evolution. The talk is based on joint work with Maximilian Jeblick, Soren Petrat and Peter Pickl.

Andreas Deuchert: Gross-Pitaevskii Limit of a Homogeneous Bose Gas at Positive Temperature

We consider a dilute, homogeneous Bose gas at positive temperature. The system is investigated in the Gross-Pitaevskii (GP) limit, where the scattering length α is so small that the interaction energy is of the same order of magnitude as the spectral gap of the Laplacian, and for temperatures that are comparable to the critical temperature of the ideal gas. We show that the difference between the specific free energy of the interacting system and the one of the ideal gas is to leading order given by $4\pi\alpha(2\rho^2 - \rho_0^2)$. Here ρ denotes the density of the system and ρ_0 is the expected condensate density of the ideal gas. Additionally, we show that the one-particle density matrix of any approximate

minimizer of the Gibbs free energy functional is to leading order given by the one of the ideal gas. This in particular proves Bose-Einstein condensation with critical temperature given by the one of the ideal gas to leading order. One key ingredient of our proof is a novel use of the Gibbs variational principle that goes hand in hand with the c-number substitution. This is a joint work with Robert Seiringer.

Marvin R. Schulz: On the Bogolubov de-Gennes Equations in a homogeneus magnetic field

We review results on the Bogolubov de-Gennes Equations of superconductivity in the presence of a uniform magnetic field. Recently, I.M. Sigal and L. Chen showed the instability of the normal solution for the BCS-Functional. In this talk we discuss the techniques used there to obtain this result. The talk is based on my master thesis.

Fiona Gottschalk: Phase Transitions for Ferromagnetic Models

Subject of our considerations are the infrared bounds established by Fröhlich, Simon, and Spencer in 1976 for classical statistical mechanical lattice systems with a continuous symmetry. These bounds imply the existence of a phase transition at sufficiently low temperature in three or more spatial dimensions. In our present approach, instead of using reflection positivity, we aim for reproducing and generalizing the result by means of the Helffer-Sjöstrand Formula and the Witten Laplacian, allowing for weaker assumptions on the model's translation invariance. This is joint work in progress with Volker Bach.

Nikolai Leopold: Mean-field Dynamics for the Nelson Model with Fermions Mean-field Dynamics for the Nelson Model with Fermions The Nelson model (with ultraviolet cutoff) describes a quantum system of non-relativistic particles coupled to a positive or zero mass quantized scalar field. We take the non-relativistic particles to obey Fermi statistics and discuss the time evolution in a mean-field limit of many fermions which is coupled to a semiclassical limit. At time zero, we assume that the bosons of the radiation field are close to a coherent state and that the state of the fermions is close to a Slater determinant with a certain semiclassical structure. We show that the many-body state approximately stays a Slater determinant and retains its semiclassical structure at later times and that its time evolution can be approximated by the fermionic Schrödinger-Klein-Gordon equations. This is proven in terms of reduced density matrices with explicit rates of convergence and for all semiclassical times. The talk is based on work in progress with Sören Petrat.

Ruth Schulte: A logarithmically enhanced area law for the entanglement entropy in the random dimer model

We consider the random dimer model in one space dimension with Bernoulli disorder. For sufficiently small disorder, we show that the entanglement entropy exhibits (at least) a logarithmically enhanced area law if the Fermi energy coincides with a critical energy of the model where the localisation length diverges. This is a joint work with Peter Müller.

Tobias König: Liquid Drop Model for Nuclear Matter in the Dilute Limit

Abstract: We consider the liquid drop model for nuclei interacting with a neutralizing homogeneous background of electrons. The regime we are interested in is when the fraction between the electronic and the nuclear charge density is small. We show that in this dilute limit, the thermodynamic ground state energy is given to leading order by that of an isolated nucleus. This is joint work with Lukas Emmert and Rupert Frank.

Michael Fleermann: Random Matrices with Curie-Weiss Entries

We present global and local semicircle laws as well as Marchenko-Pastur laws for random matrices and random band matrices with Curie-Weiss entries. These are correlated -1,+1-valued random variables that are used in statistical mechanics as a toy model for magnetism. Each variable represents a magnetic up or down spin, and spins are more likely to be aligned than chaotic. This alignment pressure is governed by a temperature parameter, resembling the behavior of magnetic effects in the real world. Not surprisingly, our results will strongly depend on the temperature considered.

Gabor Toth: Asymptotic Results for two Groups in a Curie-Weiss Model

We present a Curie-Weiss model with two groups of spins. Coupling within and between groups can be homogeneous or heterogeneous. We show two-dimensional laws of large numbers and central limit theorems under the high-temperature regime. Time permitting we discuss some applications of these results to the determination of the optimal weights each member of a council should receive in order to minimise the so called democracy deficit. This is a joint work with Werner Kirsch.

Michael Hartig: Van der Waals-London interaction of atoms with pseudo-relativistic kinetic energy

We consider a multiatomic system where the nuclei are assumed to be point charges at fixed positions. Particles interact via Coulomb potential and electrons have pseudo-relativistic kinetic energy. We prove the van der Waals-London law, which states that the interaction energy between neutral atoms decays as the sixth power of the distance $|D|$ between the atoms. We rigorously compute all the terms in the binding energy up to the order $|D|^{-9}$ with error term of order $O(|D|^{-10})$. As intermediate steps we prove exponential decay of eigenfunctions of multiparticle Schrdinger operators with permutation symmetry imposed by the Pauli principle and new estimates of the localization error. This is a joint work with Jean-Marie Barbaroux, Dirk Hundertmark and Semjon Vugalter.

List of participants:

Anapolitanos Ioannis (KIT)
Bach Volker (TU Braunschweig)
Deuchert Andreas (IST Vienna)
Fleermann Michael (FernUniversität in Hagen)
Gottschalk Fiona (TU Braunschweig)
Müller Marvin (KIT)
Hartig Michael (Universit de Toulon)
König Tobias (LMU München)
Lange Markus (KIT)
Leopold Nikolai (IST Vienna)
Mitrouskas David (Universtität Stuttgart)
Rauch Robert (TU Braunschweig)
Schulte Ruth (LMU München)
Schulz Marvin R. (KIT)
Toth Gabor (FernUniversität in Hagen)
Witt Ingo (Göttingen)
Wugalter Semjon (KIT)