TT 7 Correlated Electrons - (General) Theory II

Zeit: Freitag 16:30–18:45 Raum: TU H2053

Hauptvortrag

TT 7.1 Fr 16:30 TU H2053

Self-Energy Functionals: A New Approach to Strongly Correlated Electron Systems — •Michael Potthoff — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Germany

Since the seminal work by Luttinger, Ward, Baym and Kadanoff in the sixties, we know about a fundamental variational principle of the form $\delta\Omega[\Sigma] = 0$. This is interesting as it promises an access to the grand potential Ω and the self-energy Σ for a system of interacting fermions and, thereby, to the equilibrium thermodynamics as well as to (one-particle) excitations. While truncations of the functional form were frequently used in the past to construct weak-coupling ("conserving") approximations, it is surprising that there has not been a single *direct* application of the variational principle until recently. This stands in marked contrast to the widespread Ritz principle $\delta E[\Psi] = 0$ which, however, does not give information on excitation properties.

This talk shows how to make use of the Luttinger-Ward variational principle in various physical situations. In the high-T_c problem, for example, systematic and non-perturbative approaches are needed which accurately treat short-range correlations while directly working in the thermodynamic limit. This can be achieved with a novel variational cluster-perturbation theory. Contacts can be made to the cluster generalizations of the DMFT. For various transition metals and oxides, on the other hand, a local (mean-field) approximation is sufficient. Here the self-energy-functional approach shows up an efficient way to account for the temporal degrees of freedom. Extensions of the method to include phonons, non-local interactions and to disordered systems are discussed.

TT 7.2 Fr 17:00 TU H2053

Collective fields in the functional renormalization group for fermions, Ward identities, and the exact solution of the Tomonaga-Luttinger model — •Florian Schütz[1], Lorenz Bartosch[1,2], and Peter Kopietz[1] — [1]Institut für Theoretische Physik, Universität Frankfurt, Robert Mayer-Strasse 8, 60054 Frankfurt — [2]Department of Physics, Yale University, P. O. Box 208120 New Haven, CT 06520-8120, USA

We have developed [1] a new formulation of the functional renormalization group (RG) for interacting fermions. We decouple the interaction by means of a Hubbard-Stratonovich transformation and derive an exact hierarchy of RG flow equations for the irreducible vertices of the resulting coupled field theory involving both fermionic and bosonic fields. The freedom of choosing a momentum transfer cutoff for the bosonic soft modes in addition to the usual band cutoff for the fermions opens the possibility of new RG schemes. In particular, we show how the exact solution of the Tomonaga-Luttinger model emerges from the functional RG if one works with a momentum transfer cutoff. Then the Ward identities associated with the local particle conservation at each Fermi point are valid at every stage of the RG flow and provide a solution of an infinite hierarchy of flow equations for the irreducible vertices. The RG flow equation for the irreducible single-particle self-energy can then be closed and can be reduced to a linear integro-differential equation, the solution of which yields the result familiar from bosonization.

[1] Florian Schütz, Lorenz Bartosch and Peter Kopietz, cond-mat/0409404.

TT 7.3 Fr 17:15 TU H2053

Fermionic renormalization group flow into phases with broken symmetry — •Carsten Honerkamp[1], Manfred Salmhofer[2], Walter Metzner[1], and Oliver Lauscher[2] — [1]MPI Festkörperforschung, Stuttgart — [2]Theoretische Physik, Universität Leipzig

We present an extension of the fermionic functional RG which allows us to continue the RG flow into long-range ordered phases. For the example of Cooper pairing we discuss how the divergence of the RG flow without selfenergy corrections is cured and how BCS and Eliashberg gap equations are obtained from the RG. We describe how vertex corrections beyond the mean-field approach and the Kohn-Luttinger mechanism are included in this formalism.

TT 7.4 Fr 17:30 TU H2053

Contractor Renormalization Group Approach to the Strongly-Correlated Hubbard Model — •Sascha Brehm[1], Enrico Arrigoni[2,1], and Werner Hanke[1] — [1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Institut für Theoretische Physik, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Austria

In a first step, we apply the Contractor Renormalization Technique (CORE) to the 2-D Hubbard Model including bosonic plus fermionic excitations. The resulting Plaquette Boson-Fermion Model (PBFM) displays even qualitative changes (screening,etc.) compared to the so far exclusively considered purely bosonic Plaquette Model (E.Altman and A.Auerbach, Phys.Rev.B 65, 104508 (2002)). This is also shown in the case of the inter-layer Cooper-pair tunnelling theory. The phase diagram for the competing phases is then calculated within the slave-boson technique.

TT 7.5 Fr 17:45 TU H2053

Non-Equilibrium Scaling Analysis of the Kondo Model with Voltage Bias — •Stefan Kehrein — Theoretische Physik III - Elektronische Korrelationen und Magnetismus, Institut für Physik, Universität Augsburg

We study the scaling equations for the Kondo model with voltage bias. We discuss how their structure changes from the well-known equilibrium form to the non-equilibrium situation for nonzero voltage bias. Our analysis is done using the flow equation method (infinitesimal unitary transformation method) that makes the many-body Hamiltonian increasingly more energy-diagonal (cond-mat/0410341). In particular, it becomes apparent that the conventional expansion of the scaling equations in powers of the running coupling constant needs to be reconsidered carefully in non-equilibrium. Our observations should be of general importance for deriving the scaling flow of similar non-equilibrium quantum many-body problems.

TT 7.6 Fr 18:00 TU H2053

Violation of the Fluctuation-Dissipation Theorem in the Kondo Model with a Non-Equilibrium Initial State — •Dmitry Lobaskin and Stefan Kehrein — Theoretische Physik III - Elektronische Korrelationen und Magnetismus, Institut für Physik, Universität Augsburg

The fluctuation-dissipation theorem (FDT) plays a fundamental role in understanding equilibrium quantum many-body problems. However, the FDT does in general not hold in non-equilibrium situations. In this talk we present exact results for the violation of the FDT in the Kondo model where the impurity spin is frozen for all negative times, and set free to relax towards its equilibrium value at positive times. Exact results at the Toulouse point of this model (cond-mat/0405193) make it possible to investigate the FDT violation on all time scales: for times much later than the initial non-equilibrium preparation, for times immediately after the relaxation starts, and for the crossover between these two regimes. General aspects of the FDT and the reason for its violation in non-equilibrium are discussed as well.

TT 7.7 Fr 18:15 TU H2053

Selbstenergie-Funktional-Theorie für wechselwirkende Elektronensysteme mit Unordnung — •Matthias Balzer und Michael Potthoff — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland D-97074 Würzburg

Die Selbstenergie-Funktional-Theorie[1] bietet einen nicht-pertubativen Zugang zur Berechnung wechselwirkender Elektronensysteme. Approximative Lösungen können variationell unter Verwendung eines Referenzsystems bestimmt werden. Wir stellen hier die Verallgemeinerung der Theorie auf ungeordnete Systeme vor. Dazu wird ein erweitertes Funktional von Unordnungs- und Wechselwirkungs-Selbstenergie betrachtet, ein entsprechendes Variationsprinzip aufgestellt und gezeigt, wie dieses durch Bezugnahme auf ein Referenzsystem zur Konstruktion von Approximationen angewendet werden kann. Die Wahl des Referenzsystems bestimmt den Charakter der Approximation. Z.B. ergibt sich als optimale lokale Näherung die DMFT-CPA. Darüberhinaus sind aber auch einfachere und dennoch konsistente Näherungen konstruierbar. Um die Anwendbarkeit der Theorie zu demonstrieren, diskutieren wir eine Zwei-Platz-

(Mean-Field-)Näherung zur Bestimmung des T=0-Phasendiagramms des Anderson-Hubbard-Modells mit binärer Legierungsunordnung.
[1] M. Potthoff, Eur. Phys. J. B 32, 429 (2003)

TT 7.8 Fr 18:30 TU H2053

Localization of non-interacting electrons in thin layered disordered systems — •V. Z. Cerovski, R. K. Brojen Singh, and M. Schreiber — Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz

Localization of electronic states in disordered thin layered systems with b layers is studied using the transfer-matrix method and finite-size scaling of the inverse smallest Lyapunov exponent. The results support the one-parameter scaling theory of localization for disorder strengths W studied and $b = 1, \ldots, 6$. The obtained results for the localization length are in good agreement with both the analytical results of the self-consistent theory of localization and the numerical scaling studies of the two-dimensional Anderson model. The localization length near the band center grows exponentially with b for a fixed W but no localization-delocalization transition takes place.