LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS

Sommerfeld Phd-Prize Colloquium

Wednesday, 9th December 2020
at 16.15 h

Dr. Daniel Kläwer
(Universität Mainz)

The Swampland Program: Shaking the Foundations of String Phenomenology

String Theory is a remarkable framework for the unification of effective quantum field theories (EQFTs) with gravity. Our favourite EQFT, the standard model of particle physics, has been probed up to a few TeV which is many orders of magnitude below the Planck scale. As a result, there is seemingly an infinite amount of freedom for QFT model building beyond the standard model, as long as we respect low energy constraints such as anomaly cancellation. Since the string scale can be close to the Planck scale, we could hope for such an amount of freedom also in string phenomenology, where we use stringy ingredients to engineer EQFTs. The plausible existence of a gigantic landscape of compactifications from ten to four dimensions provides support for this line of thinking. Recent developments in the swampland program are pointing in a very different direction. Not every EQFT can originate from string theory. In fact, the low energy limits of consistent string constructions should form a measure zero subset of the space of all EQFTs, at least as long as gravity is kept dynamical. In this talk, I will give an introduction to the basic ideas underlying the swampland program and showcase some of the results that have emerged in this context over the past few years.

Ralph Blumenhagen, Dieter Lüst

Turn page

Dr. Fabian Kugler

(LMU Munich, Rutgers University)

Multiloop functional renormalization group approach to strongly correlated electron systems

The functional renormalization group (fRG) is a versatile, quantum-field-theoretical formulation of the powerful RG idea and has seen a large number of successful applications. In its vertex expansion, suitable for fermionic systems, it involves an infinite hierarchy of flow equations. The hierarchy starts from the one-particle self-energy and the two-particle vertex and is typically truncated by neglecting effective three-particle interactions altogether. This truncation may be problematic for strongly correlated systems and leads to a number of undesirable properties, such as the infamous problem that results of an RG flow depend on the choice of RG regulator.

Here, we present a multiloop fRG (mfRG) approach that circumvents such a rigid truncation and yields results independent of the choice of RG regulator [1]. On the one hand, mfRG can be understood as substituting all contributions of the three-particle vertex that can be kept efficiently, thereby complementing the truncated flow equations to a total differential [2]. On the other hand, the multiloop flow equations can be derived as the differential form of the self-consistent parquet equations [3]. We explain the underlying parquet approximation as well as routes to overcome this approximation by using correlated starting points for the flow, like the solution of dynamical mean-field theory. We discuss several mfRG applications, ranging from a simple model of x-ray absorption in metals [1], the two-dimensional Hubbard model [4,5], and the Kagome-Heisenberg model [6] to a pioneering Keldysh treatment of the single-impurity Anderson model [7].

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[3] F. B. Kugler and J. von Delft, New J. Phys. 20, 123029 (2018)
[4] A. Tagliavini, C. Hille, F. B. Kugler, S. Andergassen, A. Toschi, C. Honerkamp, SciPost Phys. 6, 009 (2019)
[5] C. Hille, F. B. Kugler, C. J. Eckhardt, Y.-Y. He, A. Kauch, C. Honerkamp, A. Toschi, S. Andergassen, Phys. Rev. Research 2, 033372 (2020)
[6] J. Thoenniss, M. K. Ritter, F. B. Kugler, J. von Delft, M. Punk, arXiv:2011.01268
[7] S. Aguirre, Master thesis, LMU (2020)

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