Renormalization in statistical physics and lattice field theories

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
9:00 - 9:45 : welcome 10:00 - 11:00 : SLADE (Lecture 1) 11:15 - 12:15 : TÄUBER (Lecture 1)	9:30 - 10:30 : SLADE (Lecture 2) 11:00 - 12:00 : TÄUBER (Lecture 2)	9:30 - 10:30 : SLADE (Lecture 3) 11:00 - 12:00 : RIVASSEAU (Lecture 3)	9:30 - 10:30 : RIVASSEAU (Lecture 4) 11:00 - 12:00 : TÄUBER (Lecture 3)	9:30 - 10:30 : SLADE (Lecture 4) 11:00 - 12:00 : CLAVIER (talk)
Lunch	*Lunch*	*Lunch*	*Lunch*	*Lunch*
14:00 - 15:00 : CENATIEMPO (talk) 15:30 - 16:30 : RIVASSEAU (Lecture 1)	14:00 - 15:00 : HENKEL (talk) 15:30 - 16:30 : RIVASSEAU (Lecture 2)		14:00 - 15:00 : FELDER (talk) 15:30 - 16:30 : CARROZZA (talk)	14:00 - 15:00 : TÄUBER (talk)

- **Lecture series by Vincent Rivasseau** - *Constructive Renormalization via Loop Vertex Expansion*

  The loop vertex expansion repacks Feynman perturbative expansion as an absolutely convergent series. However until recently it was not clear how to implement renormalization in this formalism. We shall review in some detail the multiscale loop vertex expansion (arXiv:1312.7226) which allows to do this at least for simple toy models.

- **Lecture series by Gordon Slade** - *Renormalisation group and 4-dimensional critical phenomema*

  We describe recent progress in the development of a mathematically rigorous renormalisation group method and its application to the study of critical phenomena in dimension 4. Specific applications are to the multi-component phi^4 spin model, and to the weakly self-avoiding walk (which we can interpret as a zero-component spin model using fermions). The main results centre on the computation of logarithmic corrections to mean-field critical scaling. The lectures are based on joint work with Roland Bauerschmidt, David Brydges and Alexandre Tomberg, and are intended to be introductory.

- **Lectures series by Uwe Täuber** - *Field theory approach to equilibrium critical phenomena*

  In my lectures, I plan to provide an introduction into applications of field theory methods and the renormalization group to phase transitions and critical phenomena in thermal equilibrium.

  Lecture 1: Critical phenomena: Landau theory; scaling theory; real-space RG; Landau-Ginzburg-Wilson Hamiltonian; importance of fluctuations.

Lecture 2: Renormalization group program: Wilson's momentum shell RG; perturbation expansion and RG recursions; dimensional expansion and critical exponents.

Lecture 3: Field theory approach critical phenomena: perturbation expansion; UV and IR singularities and renormalization; RG equation and critical exponents.

- **Talk by Sylvain Carrozza** - *Renormalization of Tensorial Field Theories*

I will review recent results about the renormalization of tensorial field theories, which are generalizations of matrix and tensor models aiming at a better understanding of random geometry and quantum gravity in dimension higher than three. Even though such theories have non-local interactions, they are of a very specific type which allow most standard renormalization group methods to be incorporated in the formalism. More specifically, I will focus on so-called tensorial group field theories, which can be thought of as generating functionals for loop quantum gravity amplitudes.

- **Talk by Serena Cenatiempo** - *Critical phases for non-relativistic two dimensional interacting bosons: Renormalization group results*

Non-relativistic interacting bosons at zero temperature exhibit two interesting critical phases: the celebrated condensate phase and the critical theory at zero density, known as quantum critical point. From a theoretical point of view these theories are particularly challenging in dimension two, which is in both cases critical in the sense of Renormalization Group. In collaboration with A. Giuliani we proved renormalizability of the quantum critical point and of the condensed phase in two dimensions, both in the ultraviolet and in the infrared, and developed a theory valid at all orders in renormalized perturbation theory, with explicit bounds on the generic order. In this talk I will present these results and compare them with the existing literature. While the results we obtained for the quantum critical case match with previous ones and extend them to all orders, we think that our findings call into question the stability of the two dimensional condensate at zero temperature.

- **Talk by Pierre Clavier** - *Alien calculus and transseries for a Schwinger-Dyson equation*

I will present some recent developments in the study of a Schwinger-Dyson equation. First, I will show that a naive study brings divergent series, which suggest to perform a Borel transform. In the Borel plane, these divergent series are linked to singularities on the real line of the Borel transform. This singularities prevent to perform the usual ressumation procedure, but the so-called median ressumation allows to reconstruct the solution of the Schwinger-Dyson equation in the form of a transseries.

- **Talk by Giovanni Felder** - *Discrete factorization algebras*

Factorization algebras, in the form introduced by Costello and Gwilliam, based on work of Beilinson and Drinfeld, encode the structure of observables in quantum field theory. Discrete factorization algebras are a variant suitable for lattice models. I will introduce them and explain what it means for a sequence of discrete factorization algebras to converge to a factorization

algebra in the continuum limit. These notions will be illustrated by the example of lattice Yang-Mills theory in two dimensions. This talk is based on work in progress with Damien Calaque.

- **Talk by Malte Henkel** - *Non-relativistic variants of conformal invariance and physical ageing*

TBA

- **Talk by Uwe Täuber** - *Critical dynamics in driven-dissipative Bose-Einstein condensation*

The universal critical behavior of the driven-dissipative non-equilibrium Bose condensation transition is investigated employing the field-theoretic renormalization group method. Such criticality may be realized in broad ranges of driven open systems on the interface of quantum optics and many-body physics, from exciton-polariton condensates to cold atomic gases. The starting point is a noisy and dissipative Gross-Pitaevski equation corresponding to a complex valued Landau-Ginzburg functional, which captures the near critical non-equilibrium dynamics, and generalizes Model A for classical relaxational dynamics with non-conserved order parameter. We confirm and further develop the physical picture previously established by means of a functional renormalization group study of this system. Complementing this earlier numerical analysis, we analytically compute the static and dynamical critical exponents at the condensation transition to lowest non-trivial order in the dimensional epsilon expansion about the upper critical dimension d_c = 4, and establish the emergence of a novel universal scaling exponent associated with the non-equilibrium drive.

Ref.: U.C.T. and S. Diehl, Phys. Rev. X 4, 021010 (2014) [arXiv:1312.5182].