# Seminar

# Renormalization: combinatorics, physics, probability

## Sabine Jansen & Jan von Delft

Seminar for M.Sc.-level students in Theoretical and Mathematical Physics (TMP), Mathematics, and Physics. 3 ECTS.

**Time slot** Thursday 16-18. Topics will be distributed on the first date.

**Teaching modalities** (online etc.) to be announced.

**Registration** Places are distributed on a first-come, first-serve basis.

If you are interested, please write an email to `jansen@math.lmu.de` including name and immatriculation number, your course of study (TMP, physics, mathematics...), in which semester you are, whether you need a grade, and if applicable and if you already know, under which module number the seminar should be booked.

### Description

Renormalization is a blanket term for a host of powerful techniques in physics and mathematics; it originated in quantum field theory but has applications in areas as diverse as statistical physics, stochastic partial differential equations, or even mathematical population genetics. Feynman diagrams are also of interest in combinatorics.

The seminar deals with selected aspects of renormalization, in particular a mathematically rigorous introduction to Feynman diagrams, random fields ("Euclidean quantum field theory"), and perturbation theory.

The initial focus is on probabilistic and combinatorial aspects. Preliminary knowledge in quantum field theory or quantum mechanics is not required.

### Prerequisites

Familiarity with analysis and basic probability. Open-mindedness for switching perspectives and unfamiliar language—the seminar is intended for a mixed group of physicists and mathematicians.

**References**

The main reference, chosen for the selection of topics covered, is:

- Razvan Gurau, Vincent Rivasseau, Alessandro Sfondrini:
  *Renormalization: an advanced overview*,
  `https://arxiv.org/abs/1401.5003`

The reference is not easy to read, especially for mathematicians, it will be supplemented by additional references, including:

- William G. Faris:
  *Combinatorial species and Feynman diagrams*
  Sém. Lothar. Combin. 61A (2009/11), Art. B61An, 37 pp.
  `https://www.emis.de/journals/SLC/wpapers/s61Afaris.html`

- Giovanni Jona-Lasinio:
  *Renormalization group and probability theory.*
  Renormalization group theory in the new millennium, III.
  Phys. Rep. 352 (2001), no. 4-6, 439-458.
  `https://doi.org/10.1016/S0370-1573(01)00042-4`
  See also: `https://arxiv.org/abs/cond-mat/0009219`

- Giovanni Peccati and Murad S. Taqqu:
  *Wiener chaos: moments, cumulants, and diagrams. A survey with computer implementation.*
  Bocconi & Springer Series, Springer, Milano (2011)
  `https://doi.org/10.1007/978-88-470-1679-8`
  See also: `https://arxiv.org/abs/0811.1726`