Doctoral Course Program

Course title: Conformal field theory and bootstrap

Duration: 3 ECTS (24 hours)

Target audience: PhD students in Theoretical Physics, possibly advanced MSc students

Instructors: Prof. Xi Yin (Harvard U.) for 2 ECTS, Dr. Alessandro Sfondrini (Padova U.) for 1 ECTS

Abstract:
Conformal field theories (CFTs) are ubiquitous in Physics, from high-energy to condensed-matter systems, as they emerge as fixed points of the renormalisation group flow. Conformal symmetries pose strict requirements on the theory's observables. These become even more stringent in two dimensions, where the algebra of conformal symmetries is enhanced to an infinite-dimensional algebra. We will show how this, together with the existence of an "operator product expansion", allows us to determine many features of a large class of CFTs, and may make it possible to characterise the space of such theories as a whole, and compute their observables quantitatively. This is the "Conformal bootstrap" program, whose roots date from the 1970s and which saw a spectacular development over the last few years. We will also discuss deformations of CFTs in two dimensions, and the related "Integrable bootstrap" program.

Topics will include:

- Conformal Symmetry in various dimensions
- D=2 and the Virasoro Algebra
- Virasoro Conformal Blocks
- The Operator Product Expansion
- The Crossing Equation and Conformal Bootstrap
- Examples (Liouville theory, Ising model, Wess-Zumino-Witten models)
- Marginal Deformations
- Relevant and Irrelevant Deformations and Integrable Bootstrap

Reference literature

- EPFL Lectures on Conformal Field Theory in D>= 3 Dimensions
  By Slava Rychkov.
  arXiv:1601.05000 [hep-th]
  DOI: 10.1007/978-3-319-43626-5.

- Conformal Field Theory
  By P. Di Francesco, P. Mathieu, D. Senechal.
  Graduate Texts in Contemporary Physics, Springer-Verlag New York (1997)
  10.1007/978-1-4612-2256-9

- Introduction to two-dimensional conformal field theory
  By Sylvain Ribault
  Lecture notes for the 2019 Young Researchers School, ESI Wien
  https://conf.itp.phys.ethz.ch/esi-school/Lecture_notes/intro_with_solutions.pdf

- Wess-Zumino-Witten Models
  By Lorenz Eberhardt
  Lecture notes for the 2019 Young Researchers School, ESI Wien
  https://conf.itp.phys.ethz.ch/esi-school/Lecture_notes/WZW%20models.pdf

- Aspects of Two-Dimensional Conformal Field Theories
  By Xi Yin.
  Proceedings of the Theoretical Advanced Study Institute Summer School 2017 "Physics at the Fundamental Frontier" (TASI2017)
  PoS TASI2017 (2017) 003, https://doi.org/10.22323/1.305.0003

- An integrability primer for the gauge-gravity correspondence
  By F. Levkovich-Maslyuk, F. Loebbert, S. Negro, S. van Tongeren, A. Torrielli
  Editors D. Bombardelli, A. Cagnazzo, R. Frassek, I.M. Szécsényi, A. Sfondrini, S. van Tongeren
  10.1088/1751-8113/49/32/320301.
  J.Phys. A49 (2016) no.32, 320301.