LTCC Proposed Course

Title: Random-matrix methods in statistical mechanics

Basic Details:

- Core Audience: all years, applied
- Course Format: 5 x 2hr lectures

Course Description:

- Keywords: random matrix theory, concentration of measure, quantum mechanics, statistical physics

- Syllabus:
  We introduce selected concepts from random matrix theory and explore how they can be applied in statistical physics to connect the microscopic laws of quantum mechanics with the macroscopic phenomenology of thermodynamics and statistical mechanics.

  The tentative schedule is as follows:

  Lecture 1: Introduction to quantum statistical mechanics
  Lecture 2: Concentration of measure and canonical typicality
  Lecture 3: Circular Unitary Ensemble and reproducibility of macroscopic experiments
  Lecture 4: Wigner matrices and eigenstate thermalization
  Lecture 5: Further applications (time permitting)

- Recommended reading:

Textbooks covering foundations of what is going to be discussed in the course (and a lot more):

- D. J. Griffiths & D. F. Schroeter, *Introduction to quantum mechanics*, 3rd edition (Cambridge University Press, 2018)
- F. Haake, *Quantum signatures of chaos*, 3rd edition (Springer, 2010)
- M. L. Mehta, *Random matrices*, 3rd edition (Academic Press, 2004)
- P. K. Pathria & P. D. Beale, *Statistical mechanics*, 3rd edition (Elsevier, 2011)
- J. J. Sakurai, *Modern quantum mechanics*, revised edition (Addison-Wesley, 1994)

Reviews covering topics from the lectures:

- C. Gogolin & J. Eisert, *Equilibration, thermalisation, and the emergence of statistical mechanics in closed quantum systems*, Rep. Prog. Phys. 79, 056001 (2016)

- T. Mori, T. N. Ikeda, E. Kaminishi, & M. Ueda, *Thermalization and prethermalization in isolated quantum systems: a theoretical overview*, J. Phys. B: At. Mol. Opt. Phys. 51, 112001 (2018)
- P. Reimann & J. Gemmer, *Why are macroscopic experiments reproducible? Imitating the behavior of an ensemble by single pure states*, Physica A 552, 121840 (2020)
- M. Talagrand, *A new look at independence*, Ann. Prob. 24, 1 (1996)

- Prerequisites: Linear algebra, probability theory; some familiarity with basic concepts of quantum mechanics and/or statistical physics will be helpful (but not essential) since the introduction in the first lecture will only be a brief summary of key concepts.

Format:

- No of discussion/problem sheets: 4
- Electronic lecture notes: will be provided

Lecturer Details:

- Lecturer: Lennart Dabelow
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