

ADVANCED QUANTUM FIELD THEORY IN CONDENSED MATTER

Lecturer: Eran Sela

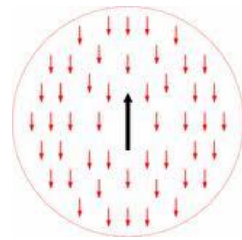
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Lectures: Tuesday 9-11, Thursday 15-16

Tentative Syllabus

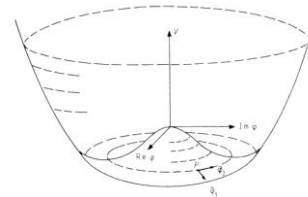
Weeks 1-2 - Kondo effect and the renormalization group: Schrieffer-Wolff transformation, poor man's scaling, strong coupling theory, Local Fermi liquid theory, multichannel Kondo effect.



Week 3 – Quantum Physics in one Dimension: Hydrodynamical approach, orthogonality catastrophe, Bosonization of fermions, Bosonization of bosons, Jordan-Wigner transformation.

Week 4. Exact solution of Luttinger model, Sine-Gordon model, renormalization group analysis, semiclassical interpretation of strong coupling theory.

Week 5 Quantum Magnetism: Jordan-Wigner transformation, spin chains, Lieb-Shultz-Mattis theorem, the Haldane gap.

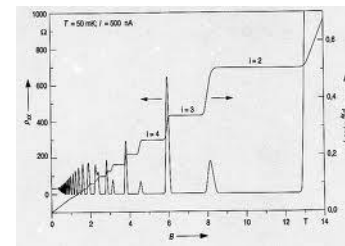


Week 6 – Symmetry breaking, mean field theory, long range order, effective theory and Goldstone modes.

Week 7. Superfluidity versus superconductivity. Anderson-Higgs mechanism.

Week 8 – Low dimensional systems, Mermin-Wagner theorem, the xy model, Kosterlitz-Thouless transition.

Week 9 – Topological phases and Quantum Hall effect: Topological field theory, Chern-Simons theory, Berry phase, topological band insulators, topological superconductors, Majorana fermions



Week 10 – Aharonov-Bohm effect and fractional statistics in 2D, quasiparticle excitations in fractional quantum Hall effect, ground state degeneracy, quantum gauge theories.

Week 11 – From Luttinger liquid theory to fractional quantum Hall effect, ground state degeneracy.

Week 12 – Conformal field theory, and entanglement entropy as an application.

Week 13: Classification of topological quantum matter with symmetries – the ten-fold way

Literature:

- 1.) Xiao-Gang Wen: Quantum Field Theory of many-body systems
- 2.) Tierri Giamarchi: Quantum Physics in one dimension
- 3.) A. Altland and B. Simons: Condensed matter Field theory

Grading: weekly problem sets –10%; final – 90%