Plan of the course: (Some) aspects of quantum transport in low dimensions

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I. LECTURE I: LINEAR RESPONSE THEORY AND GREEN-KUBO FORMULA

General setup of linear response theory. The Green-Kubo formula for the transport coefficients. Singular part of the DC conductivity, Drude weight and ballistic transport.
References

- *Theory of Thermal Transport Coefficients, J. M. Luttinger Phys. Rev. 135, A1505 (1964).* (Derivation of the Green Kubo formula we did in class was based on this paper by Luttinger)

Complementary references

- *Transport in one dimensional quantum systems, X. Zotos, P. Prelovsek, arXiv:cond-mat/0304630 (2003)* (A review with a focus on transport in one-dimensional quantum systems and a detailed discussion of the Drude weight in integrable models).
- *Quasilocal charges in integrable lattice systems, E. Ilievski, M. Medenjak, T. Prosen and L. Zadnik. arXiv:1603.00440 (2016).* (Last section describes recent developments including interacting theories.)

II. LECTURE II: THE DW QUENCH AND TRACY WIDOM DISTRIBUTION

The domain wall quench. The emergence of hydrodynamics and separation of scales. Analysis of the front structure, Airy Kernel and Tracy Widom distribution.
References

- *Transport in the XX chain at zero temperature: Emergence of flat magnetization profiles, T. Antal, Z. Racz, A. Rakos and G. M. Schutz, Phys. Rev. E59, 4912 (1999)* (The paper that popularized the DW quench)
- *Inhomogeneous quenches in a fermionic chain: exact results, J. Viti, J-M. Stéphan, J. Dubail and M. Haque, EPL 115 (2016) 40011.* (My lecture was essentially based on this paper)
- *Full counting statistics in a propagating quantum front and random matrix spectra, V. Eisler and Z. Racz, Phys. Rev. Lett. 110, 060602 (2013).* (First to-my-knowledge paper pointing out the emergence of Tracy Widom in the DW quench.)

Complementary references

- *Quantum quenches in 1+1 dimensional conformal field theories, P. Calabrese and J. Cardy, J. Stat. Mech. (2016) 064003).* (Last section includes a discussion of a field theory attempt to describe the hydrodynamical regime).
- *T. Tao, Topics in Random Matrix Theory, https://terrytao.files.wordpress.com/2011/02/matrix-book.pdf* (Last chapter for applications of WKB approximation in random matrices).

III. LECTURE III: THERMAL TRANSPORT AND FEW WORDS ABOUT GENERALIZED HYDRODYNAMICS

Form of the stationary state in a free theory. The energy current and universality at low energies. The large deviation function of the energy flow and Poisson statistics. Few words about interacting theories and generalized hydrodynamics.
References

- *Conformal field theory out of equilibrium: a review, D. Bernard and B. Doyon, J. Stat. Mech. 2016, 064005 (2016)* (A complete overview with many insights and specic emphasis on the low temperature limit).
- *Energy flow in non-equilibrium conformal field theory, D. Bernard and B. Doyon, J. Phys. A: Math. Theor. 45 362001 (2012).* (Introducing the partitioning protocol to analyse transport in 1d).
- *Non-equilibrium thermal transport in the quantum Ising chain, A. De Luca, J. Viti, D. Bernard and B. Doyon, Phys. Rev. B 88, 134301 (2013).* (Application of these ideas to the quantum Ising chain, large overlap with the lecture).

Complementary references

- *Emergent hydrodynamics in integrable quantum systems out of equilibrium, O. A. Castro-Alvaredo, B. Doyon and T. Yoshimura , Phys. Rev. X 6, 041065 (2016).* (Introducing generalized hydrodynamics for interacting integrable field theories).
- *Transport in Out-of-Equilibrium XXZ Chains: Exact Profiles of Charges and Currents, B. Bertini, M. Collura, J. De Nardis and M. Fagotti, Phys. Rev. Lett. 117, 207201 (2016).* (Introducing generalized hydrodynamics for interacting integrable lattice models).