Climbing the ladders of physics with Thierry

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Quantum ladders are coupled one-dimensional systems and they offer a unique playground to advance our understanding of strongly correlated effects in quantum physics. I have started getting interested in ladder systems thanks to my repeated discussions with Thierry, and with many members of his group, during my four-year stay in Geneva. Quantum ladders are a minimal system to study the effects of interactions on the Hall effect in a conductor, namely the emergence of a finite "Hall" voltage drop perpendicular to the current flow and an applied magnetic field. The reason why measurements of the Hall voltage should bring information about the current carrier density remains still largely mysterious for strongly correlated systems, where even the existence of long-lived quasi-particles is not guaranteed. Our investigations [1,2] led to the discovery of universal Hall phenomena triggered by interactions in quantum ladder systems [3,4], which were also probed in a recent cold-atom experiment [5].

If time permits, I will also review our activity on quantum stochastic systems to enlighten the effects of inelastic processes in quantum transport [6–9].

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[1] M. Filippone, C.-E. Bardyn, and T. Giamarchi, *Controlled parity switch of persistent currents in quantum ladders*, Physical Review B **97**, 201408 (2018).

[2] C.-E. Bardyn, M. Filippone, and T. Giamarchi, *Bulk pumping in two-dimensional topological phases*, Physical Review B **99**, 035150 (2019).

[3] S. Greschner, M. Filippone, and T. Giamarchi, *Universal Hall response in interacting quantum systems*, Physical Review Letters **122**, 083402 (2019).

[4] M. Filippone, C.-E. Bardyn, S. Greschner, and T. Giamarchi, *Vanishing Hall response of charged fermions in a transverse magnetic field,* Physical Review Letters **123**, 086803 (2019).

[5] T.-W. Zhou, G. Cappellini, D. Tusi, L. Franchi, J. Parravicini, C. Repellin, S. Greschner, M. Inguscio, T. Giamarchi, M. Filippone, J. Catani, and L. Fallani, *Observation of universal Hall response in strongly interacting fermions*, Science **38**, 427 (2023).

[6] T. Jin, M. Filippone, and T. Giamarchi, *Generic transport formula for a system driven by Markovian reservoirs*, Physical Review B **102**, 205131 (2020).

[7] T. Jin, J. S. Ferreira, M. Filippone, and T. Giamarchi, *Exact description of quantum stochastic models as quantum resistors*, Physical Review Research **4**, 013109 (2022).

[8] T. Jin, J. Ferreira, M. Bauer, M. Filippone, and T. Giamarchi, *Semiclassical theory of quantum stochastic resistors*, Physical Review Research **5**, 013033 (2023).

[9] J. Ferreira, T. Jin, J. Mannhart, T. Giamarchi, and M. Filippone, *Exact description of transport and non-reciprocity in monitored quantum devices*, arXiv:2306.16452 (2023).