

# Transport phenomena with ultracold atomic bosons. Atomtronics

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This series of lectures begins with an introduction of chemical potential and atom flux as the analogs of electric potential and current. These analogs provide the basis for a discussion about atomtomtronic circuits as atom duals to electronic circuits. We discuss at first simple circuits as a means to draw the similarities and differences between the two domains. In particular, as atomtronics operates with ultracold matter, quantum effects play a key role. Fundamentally, atomtronic circuits that involve signals must be treated as many-bodied open quantum systems. We discuss wave techniques such as the impedance method for understanding the behavior of states involving, for example, potential barriers. Of particular interest in atomtronics are atom analogs of the transistor, which we cover using semi-classical kinetic techniques as well as with a quantum many-bodied approach. We draw a connection with heuristic concepts used in electronics such as negative resistance and gain.