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Atomtronics with Ultracold Bose Gases

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Neutral atom systems can exhibit similar transport properties like solid state devices. For instance, a neutral atom current is induced by a difference in chemical potential very much in the same way as a voltage drives an electric current. Employing Bose-Einstein condensed atomic gases allows observing superfluid transport phenomena, thus drawing connections to superconductivity. With help of light fields, the atomic current can additionally be guided in engineered potential landscapes in which one can also incorporate tunneling junctions. Eventually, the different components and elements can be integrated in atomtronic circuits which shed light on fundamental transport properties of many-body quantum systems. In this talk, I will present two fundamental atomtronic devices. The first is the observation of negative differential conductivity, which occurs at a multimode tunneling junction for ultracold atoms [1]. The second is the appearance of a DC Josephson current in a biased tunneling junction [2], which features bistable transport characteristics. I will discuss the prospects of these basic elements for more complex atomtronic circuits. References [1] R. Labouvie, B. Santra, S. Heun, S. Wimberger, and H. Ott "Negative Differential Conductivity in an Interacting Quantum Gas" Phys. Rev. Lett. 115, 050601 (2015). [2] R. Labouvie, B. Santra, Simon Heun, and H. Ott "Nonequilibrium steady states in a driven-dissipative superfluid" arXiv:1507.05007