Entropy transport through a superfluid quantum point contact: A Keldysh field-theory approach

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We study the matter and entropy transport between two ultra-cold neutral Fermi-gas reservoirs linked by a quantum point contact under a chemical-potential gradient. We describe the two leads with a BCS mean-field model and derive the current-bias characteristics for both particle and entropy transport. We compute the out of equilibrium steady-state currents by using the Keldysh formalism. In accordance with previous works in the literature, we confirm the well-known behavior for the particle current and extend the computation to the entropy current in the BCS regime. The entropy current shows an oscillatory behavior at low voltage in the ballistic junction limit. We analyze the results for a wide range of values of the junction's transparency. We also compare our findings with experimental results in cold atomic gases in the unitary regime.