Driven Atomic Josephson Junctions

Luigi Amico

Quantum Research Centre, Technology Innovation Institute, Abu Dhabi, UAE and

Dipartimento di Fisica e Astronomia,

Via S. Sofia 64, 95127 Catania, Italy

Atomic Josephson junctions can be realized by coupling two atomic clouds. I will report on the experimental work to realize and study atom Junctions both in the cases the system is quasi-2d and 3d, and from weak link to tunneling barrier regimes. In particular, I will consider a driven atomtronic circuit in which the position of the junction is periodically modulated. I will discuss the theory and the experiments that has led led to the observation of the Shapiro steps in the system. By periodically modulating also the barrier height, I will demonstrate that the circuit realizes an atomic Josephson amplifier. This works provide a pathway toward tunable atomtronic circuits with potential applications in quantum sensing.

---

[1] V.P. Singh, J. Polo, L. Mathey, L .Amico, Shapiro steps in driven atomic Josephson junctions, Phys. Rev. Lett. 133, 093401 (2024).

[2] G. Del Pace, D. Hernández-Rajkov, V. P. Singh, N. Grani, M. Frómeta Fernández, G. Nesti, J. A. Seman, M. Inguscio, L. Amico, G. Roati, Shapiro steps in strongly-interacting Fermi gases, Science 390, 1125 (2025), arXiv:2409.03448.

[3] E. Bernhart, M. Röhrle, V. P. Singh, L. Mathey, L. Amico, H. Ott, Observation of Shapiro steps in an ultracold atomic Josephson junction, Science 390,1130 (2025), arXiv:2409.03340

[4] V.P. Singh, L Amico, L Mathey, Atomic Josephson Parametric Amplifier, arXiv preprint arXiv:2503.20890

[5] V.P. Singh, E Bernhart, M Röhrle, H Ott, L Mathey, L Amico, Weak-link to tunneling regime in a 3D atomic Josephson junction, arXiv preprint arXiv:2509.03591