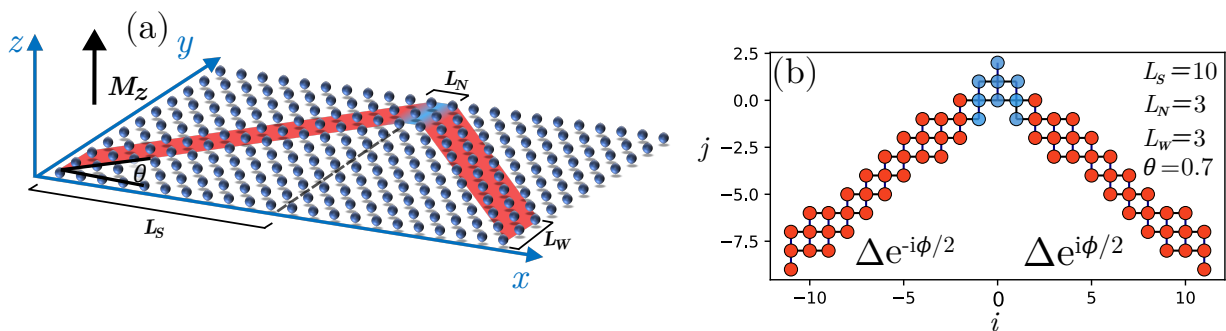




Unconventional Josephson signatures and diode effects in oxide nanojunctions

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Josephson junctions based on oxide nanochannels provide a versatile platform in which spin-orbit coupling, geometric confinement, and external fields can combine to generate unconventional superconducting transport phenomena. In this talk, I will discuss a line of research devoted to understanding how these ingredients can be exploited to engineer and probe anomalous Josephson effects in oxide nanojunctions [1–3].

I will first present signatures of unconventional superconducting transport linked to the interplay of Rashba spin-orbit coupling and device geometry, including anomalous critical-current behavior and the emergence of orbital-flavored Majorana states [1]. I will then discuss how fractional Shapiro steps under AC driving can be used as a dynamical probe of topological superconductivity in these systems [2]. Finally, I will show how suitably engineered kinked Rashba nanochannels can exhibit both anomalous Josephson effects and a controllable Josephson diode effect [3].

Altogether, these results highlight the richness of oxide-based Josephson nanostructures as a platform where topology, non-equilibrium dynamics, and device design can be combined to realize and control novel superconducting functionalities.

- [1] A. Maiellaro, J. Settino, C. Guarcello, F. Romeo, and R. Citro, Phys. Rev. B 107, L201405 (2023)
- [2] C. Guarcello, A. Maiellaro, J. Settino, I. Gaiardoni, M. Trama, F. Romeo, and R. Citro, Chaos, Solitons & Fractals 189, 115596 (2024)
- [3] A. Maiellaro, M. Trama, J. Settino, C. Guarcello, F. Romeo, and R. Citro, SciPost Phys. 17, 101 (2024)