

S E M I N A R



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Nicolas is a permanent CNRS researcher at Institut Néel in Grenoble, France, where he leads work in the Quantum Electronic Circuits Alpes (QuantECA).

Date:

Friday, 17 October 2025

Time:

15h00-16h00 SAST

Venues:

- P213, Physics Building, East Campus, WITS
- Online

Who should attend?

All are welcome!

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Evidence of Dual Shapiro Steps in a Josephson Junction Array

ABSTRACT:

The modern primary voltage standard is based on the AC Josephson effect and the resulting Shapiro steps. When a microwave tone is applied to a Josephson junction, it produces a constant voltage of $hf/2e$ (where h is Planck's constant and e is the electron charge), which is determined solely by the microwave frequency f and fundamental constants.

Theoretical arguments regarding current and voltage have long suggested the existence of dual Shapiro steps — indicating that a Josephson junction device could generate current steps with heights determined only by the applied frequency.

In this presentation, I will introduce an experimental platform featuring an ultrasmall Josephson junction embedded in a high-impedance array of larger junctions. Using the latest generation of these devices, we reveal the presence of dual Shapiro steps.

For multiple frequencies, we observe that the AC response of the circuit is synchronized with the microwave tone at frequency f . This synchronization leads to the emergence of flat steps in the DC response with a current of $2ef$, which corresponds to the tunnelling of a Cooper pair for each tone period.

This research sheds new light on phase-charge duality — a concept widely applicable in condensed matter physics — and extends it to Josephson circuits. Looking ahead, it opens up a wide range of possibilities for new experiments in the field of circuit quantum electrodynamics and represents a significant step toward resolving the long-anticipated closure of the quantum metrology electrical triangle.

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