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Observation of Shapiro Steps in an Atomic Superfluid

Tuesday 3 September 2024 15:00 (20 minutes)

Shapiro steps occur in the reverse AC Josephson effect, which is one of the three fundamental effects in superconducting Josephson junctions. When a DC and an AC current are applied simultaneously to a Josephson junction, finite voltage steps are generated across the junction. The voltage is directly linked to the applied frequency via V= h/(2e) x f, where f is the frequency of the alternating current. The series connection of several such junctions in one device corresponds to the current voltage standard.
We have observed Shapiro steps in a Bose-Einstein condensate of rubidium atoms. Following the protocol proposed by Singh et al [1], we move a narrow barrier through the superfluid at a constant velocity, which corresponds to a DC particle current through the barrier. At the same time, we perform a sinusoidal modulation of the barrier velocity with frequency f, which corresponds to an additional AC current through the barrier. When the instantaneous velocity of the barrier exceeds the critical velocity of the superfluid, a finite particle imbalance occurs between the two sides of the barrier. We find that the corresponding chemical potential difference takes on discrete values corresponding to Shapiro steps. We characterize the Shapiro steps and investigate their microscopic dynamics.

[1] V. P. Singh, J. Polo, L. Mathey, and L. Amico. arXiv:2307.08743 (2023)

References

[1] V. P. Singh, J. Polo, L. Mathey, and L. Amico. arXiv:2307.08743 (2023)

Short bio (50 words) or link to website

https://physik.rptu.de/ags/ott

Relevant publications (optional)

Career stage

Professor

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