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Resonant wavepackets and shock waves in an atomtronic SQUID

YI-HSIEH WANG, A. KUMAR, Joint Quantum Institute, F. JENDRZEJEWSKI, Ruprecht-Karls-Universität, RYAN M. WILSON, The United States Naval Academy, MARK EDWARDS, Georgia Southern University, S. ECKEL, G. K. CAMPBELL, CHARLES W. CLARK, Joint Quantum Institute — The fundamental dynamics of ultracold atomtronic devices are reflected in their phonon modes of excitation. We probe such a spectrum by applying a harmonically driven potential barrier to a ^{23}Na Bose-Einstein condensate in a ring-shaped trap. This perturbation excites phonon wavepackets. When excited resonantly, these wavepackets display a regular periodic structure. The resonant frequencies depend upon the particular configuration of the barrier, but are commensurate with the orbital frequency of a Bogoliubov sound wave traveling around the ring. Energy transfer to the condensate over many cycles of the periodic wavepacket motion causes enhanced atom loss from the trap at resonant frequencies. Solutions of the time-dependent Gross-Pitaevskii equation exhibit quantitative agreement with the experimental data. We also observe the generation of supersonic shock waves under conditions of strong excitation, and collisions of two shock wavepackets.

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