Kinetic Inductance Parametric Up-Converter

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We describe a novel class of devices based on the nonlinearity of the kinetic inductance of a superconducting thin film. By placing a current-dependent inductance in a microwave resonator, small currents can be measured through their effect on the resonator's frequency. By using the high-resistivity material TiN for the superconducting film, and nanowires as low-volume kinetic inductors, it is possible to achieve a large coefficient of nonlinearity to improve device sensitivity. Ultimately this type of device could reach a current sensitivity of 0.1 pA/Hz1/2, which would make it useful for many applications including readout of transition edge sensors. A natural advantage of these devices over existing technologies is their ability to be multiplexed in the microwave frequency domain, enabling high-density detector arrays for next-generation TES-based instruments. A traveling-wave version of the device, consisting of a microwave-frequency, thin-film transmission line, is also sensitive to small currents, as they change the phase length of the line due to their effect on its inductance. This version of the device has the advantage of multi-GHz bandwidth and greater dynamic range, offering a different approach compared to the resonator for similar current-detection applications.