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Theory of Dispersion Engineering in Traveling-Wave Kinetic Inductance Amplifiers[1] ROBERT ERICKSON, MICHAEL VISSERS, DAVID PAPPAS, National Institute of Standards and Technology — Coplanar-waveguide parametric amplifiers of length extending to the order of a meter have been patterned from superconducting materials using long meandering geometries fabricated on cm^2 chips [B. H. Eom, et al., Nat. Phys. 8, 623 (2012)]. These waveguides have highly reactive impedance and operate below the critical current by leveraging the low-temperature nonlinear kinetic inductance $L(x,t)$ of the underlying superconductor, where $L(x,t) = L_o(x)\left\{1 + \left[I(x,t)/I_*\right]^2\right\}$ at point x along the waveguide and time t. Here, $L_o(x)$ is the linear kinetic inductance at x, I_* is a scaling constant, and $I(x,t)$ is the total microwave current within the waveguide. As a consequence of the nonlinear kinetic inductance, degenerate four-wave mixing between a pump and signal can result in an idler product as well as significant signal gain as the pump transfers energy to these two side features. Frequency stops and other periodic loadings may be engineered to mitigate effects of higher pump harmonics as well as enhance signal gain, via alteration of phase mismatch. We describe here a simple band theory applicable to the waveguide frequency spectrum that allows us to optimize stop gaps and nonlinear signal gain.

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