Parity-time symmetric wave tunneling and teleportation using dispersive negative impedance converters

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The last decade has witnessed a considerable surge of interest in Parity-Time (PT)-symmetric structures, as evidenced by the booming literature in this field. PT-symmetric structures belong to a category of non-Hermitian systems with real eigenvalues whose Hamiltonians obey PT symmetry, meaning that the Hamiltonian is commutative to the product of space reversal operator and time reversal operator. One of the fascinating phenomena based on PT-symmetry is wave tunneling and teleportation in microwave network, in which waves with arbitrary amplitude and phase is fully absorbed in one end of the network, while being perfectly replicated at the other end. However, this balanced gain and loss design is inherently constrained by dispersion and stability issues in practical implementations. In this paper, we demonstrate a robust and stable PT-symmetric tunneling and teleportation circuit with parametrically engineered negative impedance converter (NIC). The utilized NIC is based on a noninverting feedback configuration presenting a purely effective negative impedance at the designed frequency. Our detailed analysis indicates that whole circuit remains stable within 5% perturbation of the design parameters and provides acceptable scattering properties within this perturbation threshold. The scattering properties and robustness of PT-symmetric tunneling and teleportation circuit are further confirmed with impulse and monochromatic responses in time domain. Both ideal one-pole NIC and realistic NIC with commercial amplifier are employed in the above study and they show excellent agreement within 3-dB bandwidth region. This design strategy and stability analysis not only provides an empirical paradigm for future realizations of PT-symmetric systems in microwaves and optics, but also sheds new light into the innovation of PT-symmetric functionalities in other physical systems, extending from optics to acoustics and mechanics.