

Time reversal and spectral wave engineering using damping pulses

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Dissipation is commonly associated with irreversibility. Here, we present a counterintuitive concept to perform time-reversal of waves using damping pulses. A sudden, strong, time-localized dissipation change in the propagating medium generates a counter-propagating time-reversed version of the initial wave. In the regime of a high damping shock, the wave field is rendered immobile. This preserves its potential energy while setting its kinetic energy to zero. As a result, the initial wave splits into two counter-propagating waves. The present technique produces an exact time-reversal of the initial wave field, with a higher fidelity and enhanced broadband capabilities compared to other methods [1] [2]. Moreover, by controlling the consecutive application of damping pulses we can selectively annihilate a monochromatic wave field. This enables a fine tuning of the wave spectrum in the case of a broadband propagating wave by applying a selective “hole burning” of specific wavelengths. We investigate these concepts numerically and we also perform an experimental proof of concept by time-reversing phonons in a lattice composed of repelling magnets placed on a tunable air cushion.

References

1. V. Bacot, et al. Time reversal and holography with spacetime transformations. *Nature Physics*(2016).
2. Fink, Mathias, et al. Time-reversed waves and super-resolution. *Comptes Rendus Physique* (2009)