Time reversal of waves and selective spectral hole burning by dissipation pulses.

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Dissipation is usually associated with irreversibility. Here we present a counterintuitive concept to perform time-reversal of waves using a dissipation pulse. A sudden, strong, time-localized change of damping in the propagating medium generates a counter-propagating time-reversed version of the initial wave. In the limit of a high dissipation shock, the wave field is rendered immobile. This amounts to preserving its potential energy while setting its kinetic energy to zero. The initial wave then splits into two waves with identical profiles, but whose directions of propagation are opposite. The present technique produces an exact temporal reversal of the initial wave field compatible with broad-band wave fields. For standing waves where the total wave energy oscillates between kinetic and potential energy, the amplitude of the output wave can be controlled depending on when the damping pulse occurred. Applying two successive dissipation pulses with a controlled delay to a monochromatic wave field propagating in a complex medium can cancel the entire wave field. In the case of a broad band wave, the spectrum can even be tailored by selective “hole burning” of specific wavelengths. We investigate these concepts using numerical simulations and also experimentally implement sudden dissipation pulses on waves propagating in 1D and 2D systems composed of repulsive magnets levitated on an air cushion.