Dissipative dark solitons in acoustic waveguides loaded with an array of side holes

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In this work, we study analytically and numerically solitons in an one-dimensional (1D) weakly lossy nonlinear acoustic metamaterial, composed of a waveguide periodically loaded by side holes. Based on the transmission line approach, we develop a lossy nonlinear dispersive lattice model which, in the continuum approximation, leads to a nonlinear, dispersive and dissipative wave equation. Applying the multiple scales perturbation method, we derive an effective lossy defocusing nonlinear Schrödinger equation which supports dark soliton solutions. Using these solutions we obtain approximate analytical envelope dark solitons of the lattice model under conditions based on the relationship between dispersion and nonlinearity. We perform direct simulations to study the dissipation-induced dynamics of the dark solitons. The limits of the three relevant parameters, i.e., nonlinear, dispersion and dissipation lengths, playing a role in the generation of the dark soliton are discussed in this work. Our results provide opportunity for the development of new acoustic metamaterials combined simultaneously with dissipative, dispersive and nonlinear effects.