Acoustic ring solitons in a periodic network

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We model nonlinear and dispersive effects in air-filled acoustic networks composed of simply connected waveguides, such as the square network depicted in Figure 1 (a). In the longwavelength regime the dispersion of the square network varies along the azimouthial angle θ and vanishes on the diagonal direction.

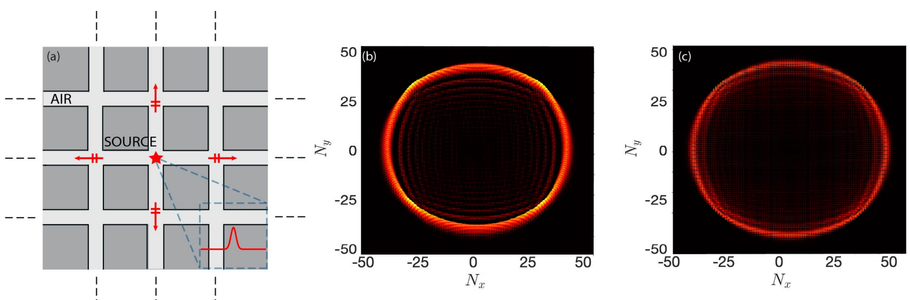

Figure 1. (a) Sketch of the acoustic network composed of air-filled waveguides. The red star indicates the gaussian source. (b) Linear propagation of a radial pulse in the network. (c) Nonlinear propagation of a radial pulse in the network.

In this work we focus on the propagation of cylindrical shaped pressure pulses, which we find that can be effectively modeled by a cylindrical Korteweg de Vries equation (CKdV),

$$p_R + \underline{p}p_T + \beta(\theta)p_{TTT} + \frac{1}{2R}p = 0 \qquad (1)$$

where the coefficient of the dispersive term $\beta(\theta)$ varies with θ. To validate our analytical findings we study numerically pulse propagation in the square network using the longwavelength numerical scheme proposed in [1]. We use a time dependent source condition in the form of a gaussian pulse (illustrated in Fig. 1(a)) at the center of a N_x xN_y=101x101 lattice. In Figure (1) (b),(c) we demonstrate the results in the linear and nonlinear regime respectively. In the linear regime we confirm that the amplitude decay of longwavelength radial pulses can be approximated by the Airy self-similar solutions of the CKdV equation. Finally, in the nonlinear regime we find that the amplitude decay of longwavelength nonlinear pulses is captured by the amplitude decay of the CKdV soliton solutions provided by Ku et al [2].

References

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2. K. Ku & HH Kuehl, Cylindrical and spherical Korteweg–deVries solitary waves *The Physics of Fluids*, **22**, 1343–1348 (1979).