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Shannon Entropy as a Characterization Tool in Acoustics

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Shannon entropy [1] was introduced as a measure of the uncertainty associated with a random variable and initially it was used to quantify the information contained in a binary message. In this work, a definition of Shannon's information entropy is introduced in acoustics, defined in terms of the displacement field, as a measure of the localization of resonant modes. As an example, it is applied to study the avoided crossing appearing in the resonant Zener-like phenomenon in ultrasonic superlattices made of two different fluidlike metamaterials. It is shown that acoustic Shannon entropy gives a correct physical insight of the localization effects taking place and manifest the informational exchange of the involved acoustic states in the narrow region of parameters where the avoided crossing occurs. Results for ultrasonic structures consisting of alternating layers of polymethyl-methacrylate (Plexiglas) and water cavities, in which the acoustic Zener effect were recently demonstrated [2], are also reported. It is concluded that Shannon entropy is a useful tool to characterize localization effects in acoustical systems.
[1] C.E. Shannon, Bell Sys. Tech. J. 27, 623 (1948). [2] H. Sanchis-Alepuz, Yu.A. Kosevich, and J. Sanchez-Dehesa, Phys. Rev. Lett. 98 134301 (2007).