DOI 10.5162/Ultrasonic2025/PL3.1

PL3.1 - Keynote

Zero group velocity and backward guided elastic waves

Dr. Claire Prada

Institut Langevin, Paris (France)

Abstract:

Guided elastic waves involves the coupling of shear and compression waves at interfaces. Even in the simplest guides, such as homogeneous plates or cylinders, this complex interaction results in the existence of negative phase velocity branches. In the absence of attenuation or leakage, the minimum frequencies of such backward branches correspond to zero-group-velocity (ZGV) modes and are associated with narrow local resonances. These ZGV resonances are very well observed using non-contact laser ultrasonic techniques (LUS) [1] and are useful for assessing the local properties of materials such as thickness, Poisson's ratio [2] in particular at high temperatures [3] and, elastic anisotropy whether intrinsic [4] or induced by stress [5]. This presentation will review the remarkable properties of backward and ZGV resonances. Special attention will be given to anisotropic plates, for which ZGV points exist for some propagation directions at minima and saddle points of modal dispersion surfaces, whereas quasi-resonances with energy propagation perpendicular to the wave vector occur in other directions. These transverse-velocity modes and the associated extreme power flux skewing will be illustrated through measurements conducted on monocrystalline silicon plates [6] and on rolled steel plates.

[1] Prada, Balogun, Murray, Appl. Phys. Lett. (2005)
[2] Clorennec, Prada, Royer, J. Appl. Phys., 101 (3) (2007)
[3] Watzl, Kerschbaummayr,…, Grünsteidl, Acta Materiala 235 (2023).
[4] Prada, Clorennec, Murray, Royer, J. Acoust. Soc. Am. 126, (2009)
[5] Morales, Pathal, Lum, Kube, Murray, Stobbe, Appl. Phys. Lett. 124, 084101 (2024)
[6] Kiefer, Mezil, Prada, Science Advances 9, eadk6846 (2023)