Coupled Scholte Modes in “Soft” Elastic Plates Underwater

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The Scholte mode is a localised, trapped surface acoustic wave that exists at the boundary between a fluid and a solid. It evanescently decays away from the interface, and propagates along it with a velocity that is less than the bulk speeds of sound in both the fluid and the solid[1]. In a thin plate, the surface waves that exist on each interface can couple to form a symmetric and antisymmetric pair[2].

For “metal-fluid”, or hard-solid interfaces, the Scholte phase velocity is approximately equal to the speed of sound in the fluid. This is because the speed of sound in the fluid is less than both bulk speeds of sound in the metal[3]. In this case, the energy of the Scholte wave is largely localised within the fluid, and its character is dictated primarily by the fluid properties. Because of this previous studies, which explored the modes of metal plates underwater, have examined only the antisymmetric coupled Scholte mode. Since for a ‘hard’ solid the symmetric coupled Scholte is almost non-dispersive and almost sits on the water sound line at all frequencies some studies neglect its existence entirely[4]. This has unfortunately been then taken as a general property of the Scholte mode in numerous studies, rather than being exclusive to ‘hard’ solid-water interfaces. This present study examines "plastic-solid", or ‘soft’ solid-water interfaces. For ‘soft’ solids, the transverse speed of sound is less than the speed of sound in the surrounding fluid. This results in the velocity of the Scholte interface wave being notably less than the speed of sound in the liquid with much of the energy of the Scholte wave now localised within the ‘soft’ solid[5]. Under these conditions, the symmetric coupled Scholte exhibits dispersive behaviour, and deviates from the Scholte velocity at low frequencies. This behaviour is demonstrated, and experimentally verified using Acrylic plates underwater.

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