Coupled Scholte Modes in Plastic Plates Underwater

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Pressure fluctuations in turbulent flow create unwanted near-field noise detected by Sonar devices, used for underwater navigation, communication, and surveillance. Although these fluctuations are picked up by the detectors, they remain localised, and do not form propagating sound waves[1]. Many efforts have already been made to reduce the amount of turbulent noise generated around the Sonar devices. This study, however, aims to reduce the amount of this noise that is detected, by investigating the nature of its transmission from the water, through the detector housing.

Near-field pressure fluctuations may excite a trapped surface acoustic wave at the interface between a liquid and a solid, called the Scholte wave[2]. In a thin plate, the surface waves that exist on each interface can couple to form a symmetric and antisymmetric pair[3]. Previous studies have explored sound hard metal plates underwater, where the Scholte wave velocity is approximately equal to the speed of sound in water[4]. They find the only interesting behaviour is at low frequency where the antisymmetric couple mode has a speed which deviates significantly from the water sound speed[3][5].

In practice most sonar devices are surrounded by plastic materials which are 'soft' acoustically for which the transverse sound speed is less than the speed in water. Consequentially the speed of the Scholte interface wave is notably less than the speed of sound in the water. Under these conditions, for plates of such soft materials, both the symmetric and antisymmetric coupled Scholte waves exhibit dispersive behaviour with group and wave speeds that deviate from the Scholte speed (high frequency limit) at low frequencies. This is demonstrated, and experimentally verified using Acrylic plates underwater.

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