Session S. Physical Acoustics III: Scattering II: Waveguides, Imaging, Flow, and Probes

Joseph A. Clark, Chairman
Mechanical Engineering Department, Catholic University, Washington, DC 20064

Contributed Papers

9:00

S1. Comparison of backscattered and forward scattered fields for objects immersed in a shallow water waveguide. M. F. Werby and Guy Norton (Naval Ocean Research and Development Activity, Numerical Modeling Division, NSTL, MS 39529)

A noise source will form a guided wave in a suitable environment at sufficiently high frequencies. When the guided wave encounters a submerged object, the field scattered from the object will itself form a guided wave when suitably far from the object. The object scatters the field in a fairly complicated manner and depends on the relative direction of measurement from that of the incident field as well as the orientation of the object relative to the guided wave. A recent numerical development at NORDA enables calculations to be simulated for such physical situations. The objective of this study is to assess the relative importance of forward scattered to backscattered fields. Calculations are performed and compared for several frequencies for the two configurations and will be presented. Results indicate that, above a frequency limit, forward scatter is stronger, while, below that frequency, backscatter is favored.

9:15

S2. Acoustic scattering in an ocean environment: III. Scattering in an inhomogeneous layered waveguide. Roger H. Hackman and Gary S. Sammelmann (Naval Coastal Systems Center, Panama City, FL 32407)

Previously, the formal solution to the scattering from an elastic target in a waveguide with an arbitrary number of homogeneous layers was presented [R. H. Hackman and G. S. Sammelmann, J. Acoust. Soc. Am. Suppl. 1 **78**, S76 (1985)]. The solution is valid to all orders of multiple scattering among the target and waveguide boundaries. Here, this scattering formalism is extended to an inhomogeneous layered waveguide with an arbitrary number of layers. As a first application of this formalism, the long-range, low-frequency scattering from an elastic spherical shell in a rangé-independent waveguide with a sound-speed profile of the kind leading to caustic formation is considered. The focus of this study is the extent to which the elastic information in the scattered wave is modified by the propagation of both the incident and scattered signals through a convergence zone. [Work supported by the Office of Naval Research.]

9:30

S3. Acoustic scattering in a range-independent, shallow water waveguide with a penetrable bottom. Gary S. Sammelmann, D. H. Trivett, and Roger H. Hackman (Naval Coastal Systems Center, Panama City, FL 32407)

At a previous meeting of the Acoustical Society of America, the analysis of the low-frequency, acoustic scattering from an elastic spherical shell in a homogeneous, range-independent waveguide with an impenetrable bottom was presented [G. S. Sammelmann and R. H. Hackman, J. Acoust. Soc. Am. Suppl. 1 **79**, S76 (1986)]. This previous investigation centered on elucidating the underlying dynamical picture leading to the observed "fine structure" of the scattering resonances of the sphere in the waveguide and to the occurrence of "superresonances." Here, this analysis was extended to a waveguide with a (liquid) penetrable bottom to more completely explore the dependence of the resonance spectrum of the sphere on the acoustic environment. For a sphere in the sediment layer, the effects of the sediment loading and of the partial "unloading" by the nearby sediment–seawater boundary are discussed. [Work supported, in part, by the Office of Naval Research.]

9:45

S4. Scattering of acoustic waves in a waveguide. Rahul Sen (Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060) and Charles Thompson (Department of Electrical Engineering, University of Lowell, One University Avenue, Lowell, MA 01854)

The problem of scattering from boundary discontinuity in a waveguide is discussed. The relationship between the static and dynamic representations of the scattered pressure field will be investigated for those frequencies falling below the first cross mode of the duct. Special attention is paid to the influence of cutoff cross modes to the solution of the pressure field. It is shown that the method of matched asymptotic expansions can be successfully used to determine globally valid pressure field junction conditions near a boundary discontinuity. The matching of exponentially decaying terms of the inner solution is shown to, in turn, contribute to the junction impedance and extend the frequency range of the solution's validity.

10:00

S5. Experiments on junction inertance. Zili Li and A. H. Benade (Department of Physics, Case Western Reserve University, Cleveland, OH 44106)

The concept of junction inertance at the joint between two axisymmetric waveguides of different tapers arises from the nonaxial rearrangement flow and may be understood in terms of the imaginary wave impedance of the locally excited evanescent modes. The cases considered consist of cylindrical pipes with infinitely long conical terminations of different angles. In these cases, the terminal impedance of the pipe can be written as $Z_t = jwM_j + Z_{\text{cone}}$, where M_j is the junction inertance and Z_{cone} is the parallel combination of M_c, conicity inertance of the cone, and R_0, the characteristic impedance of the pipe. Experiments were performed over a frequency range of 150 Hz–15 kHz and reflection coefficients were measured for cones with half-angle 10, 32, and 90 deg. The results showed that at high frequencies (above 8 kHz for pipe radius $a = 10$ mm), the effect is negligible for all cases. For 10 deg, M_j is $0.03(a/c)R_0$ in a range of 4–6 kHz, where c is the speed of sound. At low frequencies (below 3 kHz), Z_t has the form of $jw(M_j + M_c)$; to separate M_j and M_c becomes more complicated. Several cases will be discussed. [Work supported by NSF.]