TUESDAY, 23 APRIL 1974 GEORGIAN ROOM, 2:00 P.M.

Session K. Underwater Acoustics I: Parametric Arrays, Processing, Noise

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Contributed Papers

2:00

K1. Disk parametric acoustic array. James C. Lockwood (AMETEK/Straza, 790 Greenfield Drive, El Cajon, California 92022)

A parametric acoustic array, the primary field of which is a thin disk of waves spreading cylindrically between two parallel planes, is analyzed. It is shown that the half-power beamwidth of difference-frequency radiation perpendicular to the disk exceeds the beamwidth of the corresponding collimated plane wave parametric array by a factor of 1.316. The radiated intensity is less than in the plane-wave case by a factor of α_0/k, for the same total acoustic power in the primary waves, where α_0 is the absorption coefficient at the mean primary frequency and k is the wavenumber at the difference frequency.

2:15

K2. Surface reflection of an underwater acoustic parametric source. R. C. Khosla and Anthony I. Eller (Naval Postgraduate School, Monterey, California 93940)

An acoustic parametric source was mounted underwater in such a way that its axis could be aimed horizontally or at some angle of elevation, heading upward to the surface above. Free-field measurement of the radiation pattern showed the typical absence of side lobes in the difference-frequency beam. However, reflection of the beam by a calm water—air surface caused severe broadening of the beam and reduction of the sound pressure level at the difference frequency, as compared with the direct path signal from source to hydrophone. Measurements of the received signal as a function of horizontal range and of azimuthal angle are presented. The parametric source was a USRD Type E8 transducer. It and the receiving hydrophone were located at the same depth of 0.47 m. The reflecting surface was located within the nearfield of the parametric source, and the beam disruption is attributed to phase reversal that occurs upon reflection. The results are consistent with results presented by Mellenbruch and Muir at the 86th Meeting of the Acoustical Society of America [J. Acoust. Soc. Am. 55, 429(A) (1974)].

2:30

K3. Performance of a parametric receiving array in the presence of a strong, distributed nearfield interference. Robert E. Kowalczyk (Raytheon Company, Portsmouth, Rhode Island 02871)

A potential problem of a parametric receiving array mounted on a mobile platform is the platform's radiated noise interference. This can severely limit the detection performance of the parametric receiving array and, hence, can possibly limit the parametric receiving array to a quiet (stationary) platform. On the other hand, inspection of the nearfield interference pattern of a distributed set of discrete radiators along the boundaries of typical platform geometries suggests the possibility of nulls in the parametric receiver response over a narrowband range of frequencies. The potential of operating the parametric receiving array through these nulls is explored.

2:45

K4. Saturation effects in a parametric receiving array. James F. Bartram (Raytheon Company, Portsmouth, Rhode Island 02871)

In a joint paper [J. Acoust. Soc. Am. 52, 121(A) (1972)], Westervelt and the author showed a way to account for the effects of saturation due to shock formation in a parametric transmitting array. The same basic method is used here to add the effects of saturation to the Berktay—Shooter treatment of parametric receiving arrays [J. Acoust. Soc. Am. 54, 1056 (1973)]. The result is a simple closed-form solution for the loss due to saturation as a function of the ratio of the shock formation distance to array length.

3:00

K5. Nearfield effects in a parametric transmitting array. James F. Bartram and R. Payson Fugitt (Raytheon Company, Portsmouth, Rhode Island 02871)

Experimental measurements were made of the secondary source level from a parametric transmitting array under the following conditions: relatively short distance from the transducer to the measuring point, low attenuation of the primary and secondary waves, and primary source level too low for shock formation. The resulting source levels were low compared to predictions based on current farfield theories. A purely geometrical theory has been derived, neglecting absorption and saturation due to shock formation. The theory is successful in two respects: it is in good agreement with the data, and it matches the Berktay—Leahy theory when the distance from the transducer to the measuring point is increased to the absorption distance.

3:15

K6. Error analysis of the Doppler correction factor in underwater communications. K.G. Foote (Raytheon Company, Portsmouth, Rhode Island 02871)

One limitation to the attainment of high spectral resolution in underwater communications is the Doppler effect. In principle, this purely geometric, or kinematic, effect can be defined precisely and the attendant Doppler-generated frequency shift can be removed by suitable signal processing. In practice, however, uncertainties in knowledge of instantaneous position and velocity of transmitter and receiver always exist and constitute an instrinsic limitation to spectral resolution. An error analysis is presented here of the Doppler correction factor for underwater communication between the sonar systems of two mobile platforms whose instantaneous positions and velocities, including rotation and other accelerations, are known imprecisely. Doppler errors produced by inhomogeneities in flow structure and sound profile are ignored, but the uncertainty in knowledge of sound speed is recognized. Some simple expressions for rms and worst-case errors are derived for cases which are distinguished by the relative size of transmission time to a characteristic rotational period. An application to spectral resolution by mobile parametric receivers is mentioned.