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Acoustic Attraction

ERIC OVIATT, KONSTANTINOS PATSIAOURIS, BRUCE DENARDO, Physics Department, Naval Postgraduate School — A sound source of finite size produces a diverging traveling wave in an unbounded fluid. A rigid body that is small compared to the wavelength experiences an attractive radiation force (toward the source). An attractive force is also exerted on the fluid itself. The effect can be demonstrated with a styrofoam ball suspended near a loudspeaker that is producing sound of high amplitude and low frequency (for example, 100 Hz). The behavior can be understood and roughly calculated as a time-averaged Bernoulli effect. A rigorous scattering calculation yields a radiation force that is within a factor of two of the Bernoulli result. For a spherical wave, the force decreases as the inverse fifth power of the distance from the source. Applications of the phenomenon include ultrasonic filtration of liquids and the growth of supermassive black holes that emit sound waves in a surrounding plasma. An experiment is being conducted in an anechoic chamber with a 1-inch diameter aluminum ball that is suspended from an analytical balance. Directly below the ball is a baffled loudspeaker that exerts an attractive force that is measured by the balance.

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