Measurement of the universal gas constant *R* using a spherical acoustic resonator

M. R. Moldover, J. P. M. Trusler, T. J. Edwards, et al.

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11:50

JJ9. Acoustic wave interactions at a mean-flow stagnation point. Charles Thompson and Martin Manley (Department of Electrical Engineering, University of Lowell, One University Avenue, Lowell, MA 01854)

The interaction between acoustic disturbances and the mean-flow near the stagnation point of a bluff body will be examined. The stability of such flows will be investigated. It will be shown that streamwise vorticity generated by the Stokes layer can enhance the receptivity of the mean-flow boundary layer to free-stream disturbances. The downstream evolution of the vortical motion of the fluid will also be modeled and the results will be presented. [Work supported by Analog Devices Professorship.]

THURSDAY MORNING, 19 NOVEMBER 1987 TUTTLE SOUTH ROOM, 9:00 TO 11:35 A.M.

Session KK. Physical Acoustics VI: General Topics in Physical Acoustics

Michael E. Haran, Chairman
IBM Federal Systems Division, Manassas, Virginia 22110

Chairman's Introduction—9:00

Contributed Papers

9:05

KK1. Measurement of the universal gas constant R using a spherical acoustic resonator. M. R. Moldover, J. P. M. Trusler, T. J. Edwards, J. B. Mehl, and R. S. Davis (Thermophysics Division, Center for Chemical Engineering, National Bureau of Standards, Gaithersburg, MD 20899)

A spherical acoustic resonator has been used to redetermine the universal gas constant R with an uncertainty of 1.8 ppm (standard deviation). To accomplish this, three subtasks were completed. (1) The volume of a spherical shell was determined by weighing the mercury required to exactly fill it at the temperature of the triple point of water, 273.16 K. (2) With the resonator filled with commercially supplied argon, the resonance frequencies of the radial modes were measured as a function of pressure. Using our theoretical model for the cavity, the frequency measurements were combined with the mean resonator radius determined in subtask (1) to obtain the speed of sound in commercially supplied argon. (3) Finally, the speed of sound in the commerically supplied argon was compared to the speed of sound in a "standard" sample whose chemical and isotopic composition was accurately established.

9:20

KK2. Effects of carbon dioxide and humidity on some acoustic and thermodynamic properties of air. George S. K. Wong (Division of Physics, National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada)

The theoretical data on the combined effects of humidity and carbon dioxide content on some physical properties of air, such as the characteristic impedance ρc and the sound speed c, the specific heats C_p and C_v, and their ratio γ, and the density ρ, have been studied. In general, over the temperature range 0°–30 °C, the normalized values $C_p/(C_p)_0$, $C_v/(C_v)_0$, and c/c_0, become larger with the inclusion of humidity and rising temperature; and they are also inversely proportional to the CO_2 content. Similarly, ρ/ρ_0 and $\rho c/(\rho c)_0$ are proportional to the CO_2 content, but they are inversely proportional to humidity and temperature. However, the normalized value γ/γ_0 becomes smaller with the increase of humidity, temperature, and CO_2 content. The above reference values, which are indicated with a zero suffix, such as $(C_p)_0$ and ρ_0, refer to dry standard air (314 ppm CO_2 content) at 0 °C and at a pressure of 101.325 kPa.

9:35

KK3. Eigenmodes of quasicrystals. J. D. Maynard and Shanjin He (Department of Physics, The Pennsylvania State University, University Park, PA 16802)

Recently, a new state of matter, referred to as quasicrystalline, was discovered. Previously, solids could be classified as crystalline, with periodic lattice spacing, or as glassy, with random site spacing. The new quasicrystal structures appear to have long-range order, showing sharp peaks in the Fourier transform space as in a periodic system, but they also have properties that are impossible for any periodic structure, such as fivefold rotational symmetry. For periodic systems, Bloch's theorem may be used to understand physical properties such as wave transmission, and it is of current interest to learn if any such symmetry theorems apply to quasiperiodic systems. Rigorous theorems for one-dimensional quasiperiodic patterns based on a Fibonacci sequence suggest that such a pattern may be useful in control of vibration transmission in rib-stiffened plates. However, in two and higher dimensions, little is known about the consequences of quasiperiodic structure. Recently, acoustic measurements have been made on a two-dimensional quasiperiodic system and the frequency spectrum, density of states, and eigenmode patterns, showing some features unique to the quasiperiodic pattern, have been determined. [Work supported, in part, by NSF DMR 8701682 and the Office of Naval Research.]

9:50

KK4. Interaction of a sound beam with a two-fluid interface. Jacqueline Naze Tjøtta (Department of Mathematics, The University of Bergen, 5007 Bergen, Norway, and Applied Research Laboratories, The University of Texas at Austin, Austin, TX 78713-8029), Hanne Sagen (Department of Mathematics, The University of Bergen, 5007 Bergen, Norway), and Sigve Tjøtta (Department of Mathematics, The University of Bergen, 5007 Bergen, Norway, and Applied Research Laboratories, The University of Texas at Austin, Austin, TX 78713-8029)

The reflection and transmission of a real sound beam at the interface between two homogeneous and dissipative fluid layers are considered. Numerical results are obtained by using a fast Fourier transform algorithm. For the transmitted field, they show that, at a given incident angle, the direction and displacement of the beam depend critically on the absorption coefficient, and on the distance between the source and the interface. Various asymptotic formulas are also presented, which allow for a physical interpretation of the numerical results.

10:05

KK5. The role of cutoff modes in waveguides with boundary discontinuities. R. Sen (Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060) and Charles Thompson (Department of Electrical Engineering, The University of Lowell, Lowell, MA 01854)

When a waveguide with a boundary discontinuity is excited by a low-frequency plane wave, cutoff cross modes are induced by the discontin-