SATURDAY MORNING AT 9:30

1 Le Conte Hall

(I. PERLMAN presiding)

Invited Papers on Low-Energy Nuclear Physics

P1. Single-Particle States in Deformed Nuclei. F. S. STEPHENS, JR., *Lawrence Radiation Laboratory, Berkeley.* (30 min.)

P2. Pairing Correlation Effects in Deformed Nuclei. S. G. NILSSON, *Lawrence Radiation Laboratory, Berkeley.* (30 min.)

P3. Evaporation of Particles from Rapidly Rotating Nuclei. I. HALPERN, *University of Washington.* (30 min.)

P4. Two-Nucleon Stripping Reactions. N. K. GLENDENNING, *Lawrence Radiation Laboratory, Berkeley.* (30 min.)

SATURDAY MORNING AT 9:30

4 Le Conte Hall

(ROLAND E. MEYEROTT presiding)

Solid State, Shock Waves

Q1. On the Possibility of Detecting Shock Induced Second-Order Phase Transitions in Solids. DONALD R. CURRAN, *Stanford Research Institute* (introduced by G. E. Duvall).—First-order phase changes in shock loaded solids have been previously detected from the formation of multiple wave structures in the solids.[1] It is shown theoretically that a multiple shock structure under shock loading also may be produced by a second-order phase transition. Therefore, the possibility of detecting shock-induced demagnetization of ferromagnetic metals and alloys is discussed, and an experimental attempt to detect such a demagnetization in shock-loaded Invar (64 Fe 36 Ni) is reported. Extrapolation of data by Patrick[2] suggests a Curie point transition in Invar in the neighborhood of 50 kilobars. The Hugoniot equation of state of Invar has been obtained over a pressure range of 40 to 60 kilobars. Although there is evidence of a large compression below 40 kilobars, there is no evidence of a multiple shock structure in the observed pressure range. The possibility that the Curie point transition is a factor in the multiple shock formation in iron also is discussed.

[1] R. E. Duff, and S. Minshall, Phys. Rev. **108**, 5, 1207 (1957).
[2] L. Patrick, Phys. Rev. **93**, 3, 384 (1954).

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Q2. Equation of State of Metals from Shock Data to 4 mb.* DONALD G. DORAN,† *Washington State University* (introduced by G. E. Duvall).—The thermodynamic technique developed by Walsh *et al.*[1,2] for deducing isentropes from shock Hugoniots has been applied to the strong shock data of Al'tshuler, Krupnikov, and Brazhnik[3] which extends to 4 mb. Below 0.5 mb the data of Walsh *et al.* was used. The Slater expression was employed for the volume dependence of the Gruneisen ratio γ. The resulting $\gamma(V)$ curves will be compared with those of Walsh *et al.* and the more recent results of McQueen and Marsh[4] based on the Dugdale-MacDonald expression for γ. Zero degree isotherms and shock temperature estimates will be presented, the latter ranging from 15 000°K for copper to 58 000°K for lead at 4 mb.

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† Now at Poulter Laboratories, Stanford Research Institute.
[1] J. M. Walsh, M. H. Rice, R. G. McQueen, and F. L. Yarger, Phys. Rev. **108**, 196 (1957).
[2] M. H. Rice, R. G. McQueen, and J. M. Walsh, *Solid State Physics* (Academic Press, Inc., New York, 1958), Vol. 6, p. 1.
[3] L. V. Al'tshuler, K. K. Krupnikov, and M. I. Brazhnik, Soviet Phys.—JETP **34**, 614 (1958).
[4] R. G. McQueen and S. P. Marsh, J. Appl. Phys. **31**, 1253 (1960).

Q3. Shock Wave Compression of Hardened and Annealed 2024 Aluminum.* G. RICHARD FOWLES, *Stanford Research Institute* (introduced by G. E. Duvall).—Application of elastic-plastic theory to plane shock waves in metals predicts that the stress normal to the front is larger than the hydrostatic pressure necessary to produce the same compression by an amount equal to two-thirds the yield strength in simple tension. Experiments designed to observe such differences (~1.2 kb) in the Hugoniot equation of state for hardened and annealed 2024 aluminum are described. Oblique shock geometry was employed.[1] Shock and free-surface velocities were recorded with a smear camera by an optical lever technique.[2] This technique provides continuous recording of free surface velocities with time, an essential requirement because of the existence of a double wave system. Observed elastic wave amplitudes (5.4 and ~1.0 kb) agree within experimental precision with predicted values. The shock wave data (20 to 50 kb) yields one-dimensional strain isotherms which agree within experimental precision with semitheoretical curves based on Bridgman's hydrostatic data to 30 kb and simple tension stress-strain data. (No significant strain rate effects are observed.) It is concluded that elastic-plastic theory is valid for the description of plane shock waves in this material.

* Supported by the U. S. Air Force Office of Scientific Research.
[1] S. Katz, D. G. Gordan, and D. R. Curran, J. Appl. Phys. **30**, 568 (1959).
[2] W. Allen, and C. L. McCrary, Rev. Sci. Instr. **24**, 165 (1952).

Q4. Shock-Wave Compression of Quartz.* JERRY WACKERLE, *Los Alamos Scientific Laboratory.*—By means of explosive plane-wave systems shock waves of pressures ranging from 80 to 800 kilobars have been induced into x-cut, y-cut, and z-cut crystalline quartz and in fused quartz. High-speed streak camera observations of shock and free-surface velocities have demonstrated that a two-wave structure is developed in the crystalline samples below 500 kilobars. The first of these waves is associated with the Hugoniot elastic limit in the quartz and the second with the usual plastic flow. Elastic limit pressures and compressions are observed to vary with the axis of wave propagation and, for a given cut, with the strength of the driving shock. Observed Hugoniot elastic limits range from 45 to 90 kilobars in the x-cut crystals, 75 to 100 kilobars in the y-cuts, and 110 to 160 kilobars in the