$$0 = \frac{\partial}{\partial y}\left(\frac{1}{R} + T_{22}\,\overline{v'^2}\right)\frac{\partial \bar{E}}{\partial y} + 2\bar{\varepsilon}\overline{w'^2}\,S_{33}/\lambda_{333}^2$$

where T_{22} and S_{33} are Lagrangian integral time scales which are determined from quantitative analysis of motion picture data. The other terms are Eulerian quantities measured in a turbulent channel flow.

SESSION AC: GENERAL FLUID DYNAMICS I
Sunday afternoon, 19 November 1978
Room 221 at 2:30 P.M.
A. Acrivos, presiding

AC1 A General Class of Motions with Explicit Stress Pattern for Simple Materials. J. D. GODDARD, U. of So. Calif. - For deformation gradients which, up to a change of frame, are always commutative (or "Abelian") it is shown that the stress in a Noll simple material can be rendered explicit. All such deformations are specified here and are shown to include most of the commonly studied deformations, such as steady, unsteady and superposed simple shears, steady and unsteady extensions and, more generally, motions of constant stretch history together with certain unsteady analogues. Explicit and irreducible representations are given for isotropic materials, thereby completing the earlier works on simple fluids by the present author (1971), and by Zahorski (1972), who has called such motions "superposed proportional stretch histories".

AC2 Immiscible Fluid Displacement in Slots and Tubes.* L. E. SCRIVEN and W. J. SILLIMAN, Univ. of Minnesota -- Steady displacement of inviscid, tenuous fluid by incompressible, Newtonian liquid is analyzed, taking account of 1) the essential role of surface tension in maintaining a translating meniscus of permanent shape, 2) dynamic contact angle at the moving line of meniscus contact with the wall, and 3) slip of liquid along the wall, in accordance with Navier's hypothesis. The Navier-Stokes system is solved by computer-aided finite mathematics employing subdomain basis functions and the Galerkin weighted-residual method in the finite element mode. The dependences are found of velocity and stress distributions, meniscus profile and apparent contact angle on capillary number, Reynolds number, slip parameter, and local dynamic contact angle. The validity of Washburn's approximate formula for capillary displacement is assessed.

*Work supported by the National Science Foundation and University of Minnesota Computer Center.

AC3 Inviscid Theory of Unsteady Confluent Flows. H. Atas University of Notre Dame.--The interpenetration of two st with a small unsteady disturbance is analyzed. The mixin boundary of the two streams is approximated by a slip lin along which the flow velocity is discontinuous and a vort shedding phenomenon takes place. The two streams are the treated as incompressible inviscid flows and the jump con ditions along the slip line are derived. The problem is then formulated in terms of sectionally analytic function by extending the classical analysis of steady inviscid in penetrating streams with a small difference in total pres sure to the unsteady case. The theory is illustrated by examples of a jet penetrating a stream while attached to downstream wall, and a jet penetrating a stream with a stagnation region on its down side.

AC4 Compressible Fluid Flow in a Cylinder of Varying Cross-Sectional Area. J. E. WHALEN, ORI, Inc., and D. D. MORAN, David W. Taylor Naval Ship Research and Development Center. --The pressure and fluid velocity variation associated with subsonic, compressible fluid flow in a cylinder with spatially and temporally varying cross-sectional area is examined. A set of partial differential equations for the pressure, fluid velocity and density are derived using a standard control volume approach and appropriate conservation laws. The resulting differential equations are solved numerically using the method of characteristics. Results for sinusoidally varying cross-sectional areas of different wavelengths are presented. The results indicate that the relationship between the pressure, velocity, or density of fluid in the cylinder and the cross-sectional area is strongly nonlinear as the wavelength approaches the length of the cylinder.

AC5 Relativistic Fluid Dynamics in a Steadily Rotating Star: A Nonlinear Problem Exhibiting Conformal Invariance. C.M. PEREIRA, 9737 Mt. Pisgah,Apt. 604 Silver Spring, Md.--G. E. Tauber and J. W. Weinberg[1] have pointed out the advantages of using comoving coordinates in the analysis of the pressure, density, and streamlines inside a star in the ideal fluid case. This suggests that efforts to solve Einstein's field equations in the interior of a steadily rotating axially symmetric star can be aided by a formulation of these equations which uses comoving coordinates and also includes all the nonzero components of the spatial metric tensor among the four unknown functions of two variables. A new formulation of this type and having $g_{\phi r} = g_{\phi z} = g_{rt} = g_{zt} = g_{rz} = g_{rr} - g_{zz} = 0$ is presented.

[1]G.E. Tauber, J.W. Weinberg,Phys. Rev. 122,1342 (1961). As helpful examples of results related to the exterior equations, see R.P. Kerr, Phys. Rev. Lett. 11,237(1963) J.N. Goldberg, R.K. Sachs, Acta Phys. Polon. 22, 13 (1962); I. Robinson, A. Trautman, Proc. Roy. Soc. A265, 463 (1961); and also R.A. Matzner,C.W. Misner, Phys. Rev. 154, 1229 (1967); R. Geroch, J. Math. Phys. 6, 956 (1972); K. S. Thorne, J. Math. Phys. 16, 1860 (1975).

AC6 Flying-Hot-Wire Study of Two-Dimensional Mean Flow Past an NACA 4412 Airfoil at Maximum Lift.* D. COLES and A. J. WADCOCK, Calif. Inst. of Tech. -- Hot-wire measurements have been made in the boundary layer, the separated region, and the near wake for flow past an NACA 4412 airfoil at maximum lift. The Reynolds number based on chord was about 1,500,000. Special care was taken to achieve a two-dimensional mean flow. The main instrumentation was a hot-wire probe mounted on the end of a rotating arm. An unexpected effect of rotor interference was identified and brought under control. A digital computer was used to control synchronized sampling at closely spaced points along the probe arc. Ensembles of data were obtained at several thousand locations in the flow field. The data include intermittency, two components of mean velocity, and twelve mean values for double, triple, and quadruple products of two velocity fluctuations. The data are available on punched cards in raw form and also after use of smoothing and interpolation routines to obtain values on a fine rectangular grid aligned with the airfoil chord.
*Research supported by NASA Ames Research Center under Grants NGL 05-002-229 and NSG-2319.

AC7 Experiments on Modal Oscillations in Isochronous Containers. P.D. WEIDMAN and A. MAMROL*, Univ. So Calif.- A low frequency (1 - 10 Hz) shaker table was constructed to experimentally test the prediction of Troesch and Weidman[1] of the existence of isochronous containers--containers with the special property that the natural frequency of fluid oscillation within the container is independent of the fluid depth. Measurements with a hot-film probe of the planar oscillations for both the mode 1 and mode 3 isochronous containers give good confirmation of the theory.

*National Science Foundation Student.

[1]Troesch, B.A. and Weidman, P.D. (1972) "Containers with isochronous fluid oscillations", SIAM J. Appl. Math., 23, 477-489.

*Work is supported by ONR Contract N00014-76-C-0211.

AC8 The Effects of a Linear Shear Flow with Varying Intensity Past a Bluff Body*. C. FISCINA and A.A. SZEWCZYK, U. of Notre Dame.**--A comparison of