OSCILLATIONS OF A SOLAR MODEL CONSTRUCTED WITH AN IONIZATION EQUILIBRIUM EQUATION OF STATE WITH SCREENED COULOMB FORMULATION

A. BOURY, A. NOELS, R. SCUFLAIRE, M. GABRIEL
Institut d'Astrophysique, Université de Liège, Belgium

and

C.A. ROUSE
General Atomic Company
San Diego, California, U.S.A.

A solar model was constructed with a screened Coulomb formulation of the ionization equilibrium equation of state (SCIEEOS) (Rouse 1967c, 1968 and 1971a). The SCIEEOS is based on a complete solution to the Saha or ionization equation with density and temperature as the independent thermodynamic variables. Finite electronic partition functions and the corresponding corrections to the ionization potentials are derived from solutions of the Schrödinger equation with a screened Coulomb potential (Rouse 1967a,b). This potential with screening radius equal to the radius of the mean atomic volume is viewed as a model for the first-order interaction of bound electrons with the free electrons and nearest-neighbor atoms of the stellar plasma from low to high densities. (See also Rouse 1971b).

The influence of SCIEEOS compared to the equation of state used in our usual Henyey code (Bodenheimer et al 1965) is felt mostly in the outer layers. This is compensated by the choice of the ratio of the mixing length necessary to fit the solar radius, which is here 2.4 compared to 1.55 in the model studied in Boury et al (1975) and Scuflaire et al (1975). The differences between the values of the eigenvalues $\omega=(2\pi/\text{Period})\ (GM/R^3)^{-1/2}$ of the present model and that of Scuflaire et al (1975) are much smaller than would permit any discrimination in comparing with Hill's observed periods.

REFERENCES

BODENHEIMER, P., FORBES J.E., GOULD L., HENYEY L.G., 1965, Astrophys. J., 141, 1019.

BOURY, A., GABRIEL M, NOELS A.,SCUFLAIRE R., LEDOUX, P. : 1975, Astron. and Astrophys. 41, 279.

ROUSE, C.A. : 1967a, Phys. Rev. 159, 41; 176, 423(E)(1968); 188, 525(A)(1969); 1967b, Phys. Rev. 163, 62; 176, 423(E) (1968); 188, 525(A)(1969); 1967c, Screened Coulomb Formulation of the Ionization Equilibrium Equation of State, NRL Report 6594, dated September 18, 1967; Rev.# 1 Nov. 21, 1968; Rev.#2 March 13, 1969; 1968, Tables of Ionization Equilibrium Equation of

State at Stellar Temperatures and Densities, NRL Report 6756, dated Nov. 22, 1968; 1971a, Calculation of Stellar Structure II, Determination of the Helium Abundance of the Sun by the Theoretical Prediction of Line and Continuum Radiation from Solar-Model Photospheres in Progress in High Temperature Physics and Chemistry, Vol. 4, Ed. C.A. Rouse, Pergamon Press, Oxford, p. 139; 1971b, Phys. Rev. A, 4, 90.

SCUFLAIRE, R., GABRIEL M., NOELS A., and BOURY A.; 1975, Astron. and Astrophys. 45, 15.