in the effective temperature–luminosity diagram can be outlined and the period–luminosity relation determined.

It is found that the ionization zone of hydrogen and both ionization zones of helium all contribute to the instability. The mean effective temperature at which maximum instability occurs depends only very weakly on mass and mean luminosity. The instability region is thus an almost vertical strip in the temperature–luminosity diagram. The width of this strip is in good agreement with the width of the observed Cepheid band, but the mean effective temperature at the center of the strip is several hundred degrees lower than that determined from observations (Kraft, R. P., *Astrophys. J.* **134**, 616, 1961). This conclusion appears to be nearly independent of the assumed mass–luminosity law and of the assumed chemical composition. The calculated periods are rather larger than the observed ones, but depend upon the adopted masses. The slope of the period–luminosity relation, $M_v = A - B \log P$, is somewhat larger ($\sim 30\%$) than the observed slope, but this result also depends upon the mass–luminosity law. The period–luminosity relation also depends upon the assumed composition. Detailed results are presented and compared with the observations.

Dense Stars and Problems of Their Detection.

H. Y. CHIU, *Institute for Space Studies, New York*.—Stars with a density approaching nuclear density ($\sim 10^{14}$ g/cm³) are formed during the supernova explosion of a star. Such stars are of great interest. Since the gravitational energy of such stars is of the same order as their rest energy, general relativistic effects will become very important.

In this paper we discuss the formation of such stars, their observable features and their detection. In particular, we shall discuss the value of an orbital astronomical observatory in detecting such stars.

Existence of Symmetric Periodic Orbits in the Restricted Problem of Three Bodies in Three-Dimensional Coordinate System. RAM KISHORE CHOUDHRY, *L. S. College, Muzaffarpur, Bihar, India*.—In this paper $z=0$ has been taken for the intermediate plane. Then, having established the conditions for symmetric periodic orbits, the existence of analytical continuation and its parametric representation in cylindrical coordinates for the circular orbits in the direct and retrograde motion for the two-body problem with respect to the moving axes is proved and these curves are seen to be positively tangential to the orbits in the actual problem. The points of contact of the orbits and the

analytical continuation define a transformation which helps to prove the existence of symmetric periodic orbits of Schwarzschild's type in the three-dimensional restricted problem of three bodies. The above results hold good for the minor planets with the commensurability 3/1, 5/1, 7/1, etc.

A Dynamical Model of SU Draconis. R. F. CHRISTY, *California Institute of Technology*.—The numerical solution of the coupled equations of motion and heat flow in the envelopes of pulsating stars (Christy, R. F., *Astron. J.* **68**, 275, 1963) is being continued with the same technique and boundary conditions. A survey of the pulsation of RR Lyrae models, all with period of $\frac{2}{3}$ day, has been made, aimed at determining the mass, radius, temperature, and composition of SU Draconis. The best fit to the observations of Oke, Giver, and Searle (*Astrophys. J.* **136**, 393, 1962) is obtained with nearly the same parameters that they report. We find $P(\rho/\rho_\odot)^{\frac{1}{2}} = 0.035$. The mass appears to lie between 0.6 and 1.2 $M_\odot$ and the best value for the mean radius is 4.7×10^6 km, corresponding to a mass of 0.9 $M_\odot$. The hydrogen–helium ratio is closely correlated with the mean temperature and the best value is about 45% He by mass with the mean $T_e = 6500^\circ$. This corresponds to a minimum temperature of 6000° and gives a mean absolute bolometric magnitude of $+0.1$. The models in the range 30% He to 70% He are not unreasonable but require mean temperatures ranging from 6200° at 30% He to 6800° at 70% He.

The quantities which appear useful in matching a computed model to the observations, in addition to the period, are the shape of the velocity curve, the magnitude of the radius variation (from the Wesselink method), the area between the luminosity curve and the mean luminosity, and the phase difference of the luminosity and velocity curves. In particular, the information from the velocity curve is important in selecting a radius and a He abundance. Correlations between the above quantities are presented.

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On the Probable Meteorite Origin of the Clearwater Lakes, Quebec. M. R. DENCE, M. J. S. INNES, AND C. S. BEALS, *Dominion Observatory, Ottawa*.—An origin by impact of twin meteorites is suggested for two circular basins 32 and 20 km in diameter forming the Clearwater Lakes (lat. $56^\circ N$, long. $74^\circ 30' W$). The following evidence supports this theory:

(1) The circular form of the basins is unusual in an area dominated by elongated lakes formed by glacial erosion.

(2) In the larger western basin, on a ring of islands 16 km in diameter, strongly fractured basement rocks are covered by up to 100 m of rock breccia, consisting of altered, partly glassy fragments of the country rock. The character of the breccia is not easily explained on the basis of volcanic activity.

(3) Diamond drilling of several holes near the center of the western basin demonstrates that the basement rocks there are heavily fractured with zones up to 8 m thick of intense brecciation and flowage. There are no indications of igneous intrusions.

(4) In the eastern crater, diamond drilling in 87 m of water passed through 45 m of glacial debris and 150 m of calcareous and gritty sediments with ill-defined fossils, before penetrating some 50 m into an unknown thickness of vesicular breccia closely resembling breccia from the well-authenticated Brent meteorite crater.

(5) The gravity pattern for both craters suggests that the brecciated and fractured rocks extend to depths of several kilometers.

A great age for the craters is suggested by the removal of their rims and by an apparent general erosion of the Pre-Cambrian country rock in the vicinity to the extent of about 1000 m. The western crater shows indications of a central uplift, while the two craters may also have undergone differential isostatic adjustment.

D-Line Intensities in the Spectra of Galaxies.

ARMIN J. DEUTSCH, *Mount Wilson and Palomar Observatories, Carnegie Institution of Washington, California Institute of Technology, Pasadena, California*.—Spinrad has estimated the intensities of the absorption lines at D in the spectra of nine galaxies in the Virgo cluster (*Astrophys. J.*, **135**, 715, 1962). These intensities show a significant positive correlation with redshift. The airglow emission lines at D are undoubtedly responsible for this effect. At the scale of Spinrad's apparatus, they are able to obliterate absorption lines with equivalent widths as large as 10 Å in the brighter Virgo galaxies, when the galaxy redshifts are small; and they will appreciably weaken the galaxian D lines for redshifts of 1000 km/sec or more. Observations at more favorable scale, and with due allowance for the effects of airglow emission, indicate that the D lines are intrinsically very strong absorption features in all the galaxies so far examined in the Virgo cluster.

Although the airglow emission lines have systematically affected the observations of D-line strengths in the fainter galaxies with small redshifts, Spinrad's proposal may nevertheless prove

to be correct, that the lines are systematically weak in galaxies of low luminosity. Thus, a recent spectrogram of NGC 205 shows D lines that are much weaker than those of M31, and the difference can probably not be wholly attributed to airglow emission.

Hill's Boundary Curves for a Special Case of the Restricted Four-Body Problem and Different Values of the Finite Masses. MARTIN C. ECKSTEIN (introduced by A. J. Deutsch), *Douglas-Aircraft Company, Inc.*—For the special case of the restricted four-body problem, where the three finite masses are located at the angle points of an equilateral triangle, the values of the Jacobian constant were calculated by means of a suitable computational schedule. The trace of Hill's boundary curves was determined in the xy plane in the neighborhood of the mass triangle. The procedure was applied to 21 different combinations of values of the three finite masses, the sum of which was always 1.

The possibilities of motion of the infinitesimal mass and its dependency upon the values of the finite masses have been discussed. It turns out that the possibilities of motion may be completely different even if the initial conditions (or the Jacobian constant) are the same.

The regions of the xy plane, inside of which the motion of the infinitesimal mass is possible according to its Jacobian constant, were regarded and discussed with respect to their dependency on the combination of the three values of the finite masses.

A separate discussion has been made for Hill's boundary curves in the vicinity of a finite, but very small mass (0.00001); and of Hill's boundary curves in the vicinity of the libration points.

The connection between the stability of motion of the infinitesimal mass around the libration points and the shape of Hill's boundary curves in their vicinity has been discussed.

Galactic Scale Discretization. DOMINIC G. B. EDELEN (introduced by A. G. Wilson), *The RAND Corporation*.—If it is assumed that (1) a galaxy has a definite physical boundary, (2) this boundary is stable with respect to the Einstein gravitational field, (3) as a consequence of an invariant averaging process the macroscopic Einstein field equations contain terms exhibiting small deviations from oblate spheroidal symmetry, (4) the deviations are time-independent, and (5) the physical parameter denoted by ξ is independent of the particular galaxy under consideration, then the length of the semi-major axes of E-series galaxies can assume only discrete values that are proportional to uniquely determined functions of the eccentricity. For small