maintained by vaporization of the ices while a stratification of the ices according to vapor pressure at low temperatures is maintained immediately below the meteoric layers.

Because of the time lag in heat transfer such a cometary nucleus rotating in the forward sense with respect to its revolution will emit its vaporized ices with a component towards the antapex of motion. The momentum transfer from the kinetic velocity of the emitted gas will propel the nucleus in the forward sense, reduce the mean motion and increase the eccentricity of the orbit. Such orbital effects occur for Comet D'Arrest; the mean daily motion of Comet Wolf I also appears to be increasing.

Retrograde rotation can produce an acceleration in mean motion and a decrease in eccentricity as observed for Comet Encke. If the decelerating force component is taken as $\frac{1}{4}$ its maximum theoretical value, the maximum observed acceleration in the mean motion, μ , of Comet Encke, $\Delta\mu/\mu = +0.0001$ per revolution, can be produced by a loss of 0.005 of its mass per revolution; the present average rate since 1865 is $\Delta\mu/\mu = +0.00004$ giving a mass loss of only 0.002. The corresponding mass loss for Comet D'Arrest is the same. For both comets the observed changes in eccentricity are obtained if the force acts proportionately to the solar energy flux but is cut off at a solar distance of about 2 astronomical units. For Comet Wolf I the change in eccentricity corresponding to the observed deceleration in mean motion is too small to be observed.

On the basis of this theory Comet Encke might still persist for more than 600 revolutions with an extremely slow diminution in brightness. The observed changes in mean motion lead to a de-

termination of the maximal radius of meteoric spheres ejected by the gas escaping from the cometary nucleus, and to an upper limit to the possible radius of the nucleus. For Comet Encke in recent times spheres of radius about 30 cm and density four might be ejected at perihelion; hence Taurid fireballs could arise in this fashion. The maximum radius of the comet is calculated to be 6 km while the more likely radius of $\frac{1}{2}$ km corresponds to a 10 per cent transfer of solar heat to the icy core.

Loss of meteoric material would be continuous with a maximum rate at perihelion. Velocities of ejection would not exceed 1 km/sec for Comet Encke, although any icy particles ejected might attain higher velocities away from the sun by rocket effects. The spectacular activity of certain comets near perihelion may be produced by collapses of "caves" produced beneath the meteoric material, permitting the heated meteoric material and possibly direct sunlight to act on ices with high vapor pressures at low temperatures.

Photo-dissociation of the postulated gases can, a priori at least, produce the observed non-metallic spectra of comets. The observed mean variation in cometary brightness with solar distance is consistent with the present theory and most of the irregularities are of an expected character.

The "ices" are made of the chemically active elements most common in the universe at large, but the model comet must originate at great solar distances. The present theory is consistent with the maintenance of the supply of periodic comets through capture from long-period orbits by the major planets.

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ABSTRACTS *

Aller, Lawrence H. Proton-proton reactions in red dwarf stars.

The relative role of the carbon cycle and proton-proton reactions in red dwarf stars such as Krueger 60A and 40 Eridani C is studied with the aid of models calculated by Schwarzschild and Keller, in which the heavy stuff is taken as the Russell mixture and oxygen respectively. The proportions of carbon-plus-nitrogen are taken as 0.08 and 0.15 for the RM and O models.

The lifetime of the carbon cycle, adopted from

recent work at the California Institute of Technology, is 10^6 years for $\rho = 80 \text{ g/cm}^3$, $T = 20,000,000^\circ\text{K}$, and hydrogen content $X = 0.35$. The adopted value of the Fermi constant is $1.13 \times 10^{-4} \text{ sec}^{-1}$.

For each model a mass-luminosity curve exists. Our problem is to find a pair of X and Y (helium content) values which fall on the curve and for which observed and calculated energy outputs

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are equal. For the Russell mixture, two solutions are possible. In one, 60–70 per cent of the energy comes from the carbon cycle; in the other all comes from the proton-proton reactions. For Krueger 60A, $X = 0.11$, $Y = 0.64$, $T_c = 15,400,000^\circ\text{K}$ with 60 per cent of the energy supplied by the carbon cycle, or $X = 0.34$, $Y = 0.64$ and $T_c = 10,700,000^\circ\text{K}$ with proton-proton reactions delivering all of the energy. On the oxygen model the stars are always too bright.

No emphasis can be placed on the actual X and Y values since the opacity law assumed for the sun cannot apply in red dwarfs, nor are the models valid when energy generation occurs outside the convective core. If further work shows that the composition approaches that of the oxygen model, it may be necessary to assume a structure consisting of two zones of different molecular weight.

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Aller, Lawrence H. and Marvin L. White. Forbidden lines of ionized nitrogen in the planetary nebulae.

The relative intensities of the auroral-type and nebular-type transitions in a planetary nebula depend on the Einstein A-values, the target areas for collisional excitation, the electron density N_e , and electron temperature T_e . Menzel and his colleagues employed the ratio of $\lambda 4363$ to $\lambda 4959 + 5007$ $[O\text{ III}]$, and N_e estimates from the Balmer continuum to evaluate T_e .

We have calculated the target areas for the collisional excitation of the 1S and 1D levels in $N\text{ II}$ from wave functions kindly supplied by Prof. D. R. Hartree. Thus a second relation between the observable auroral-nebular line ratio, N_e , and T_e is obtained. Although the target areas for $N\text{ II}$ are about half as large as those for the corresponding transitions in $O\text{ III}$, the A-values for the nebular $[N\text{ II}]$ lines are about one-seventh the corresponding values for the $[O\text{ III}]$ lines. Hence the line-ratio, $N_e - T_e$ relationships for $O\text{ III}$ and $N\text{ II}$ differ sufficiently to permit a unique determination of both N_e and T_e provided the radiations originate in the same strata. We have calculated both N_e and T_e values for a number of objects observed by Wyse. The temperatures fall in the same range as before, but the N_e values indicate that in the radiating strata the electron densities may be higher by factors ranging from one to seven. Future studies must emphasize the filamentary character of the planetary nebulae.

From the lines of $[O\text{ II}]$ and $[O\text{ III}]$ and estimated target areas for $N\text{ I}$, we have estimated the nitrogen/oxygen abundance ratio to be about 0.3.

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Anneer, Paul. An investigation of galactic structure in a region of Cygnus.

This investigation was carried out with the 24-inch Burrell Schmidt-type telescope at the Warner and Swasey Observatory. It is a part of a general program dealing with the luminosity function in the plane of the galaxy in process at that observatory.

The field investigated has its center about three degrees south of P Cygni, and includes parts of the Cygnus Cloud, Great Rift, and a prominent parabolic area of obscuration. It also includes part of an area where a well-known clustering of B stars exists.

The spectral types and photographic magnitudes of all (1281) stars to 12.0 photographic magnitude were obtained within an area of 12.5 square degrees. Photo-red magnitudes were obtained for all stars of spectral type A0 and earlier (608), and for 111 stars of later spectral types. Star-counts were made to photographic magnitude 17.6 as an aid in determining absorption features over the plate.

In spite of the fact that the region involves absorption which is definitely non-uniform, it was divided into two areas approximately homogeneous in absorption. In one area, which includes part of the Great Rift, the absorption begins at about 500 parsecs and increases rapidly to about two and one-half magnitudes at 1500 parsecs. In the other area, it increases more slowly to about two magnitudes at 3000 parsecs.

Using these absorptions, a density analysis was made for various spectral groups in each area. The B-type stars show clustering tendencies at various distances, whereas the other spectral groups in general show a rapid decrease in density with increasing distance from the sun. A comparison with the standard luminosity function reveals an excess of luminous stars (M between -4 and $+1$) in this region, and a deficiency of less luminous stars (M between $+1$ and $+4$), a result in agreement with conclusions reached in two other fields included in this general program.

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