radius 0.02 a.u. around the sun appears to be a region of avoidance for meteor particles which is consistent with the implications of other physical considerations.

Theoretical Evaluation of Atmospheric Drag Effects in the Motion of an Artificial Satellite. DIRK BROUWER AND GEN-ICHIRO HORI, *Yale University Observatory*. If the atmospheric density above perigee height is represented by $\rho = A \exp(-\alpha r)$, the well-known expressions for the drag accelerations are

$$X_j = -C_D A (\dot{x}_j + \delta_j) V \exp(-\alpha r),$$

$$V^2 = \mu \left[\frac{2}{r} - \frac{1}{a} \right] - 2\omega(x_1 \dot{x}_2 - x_2 \dot{x}_1) + \omega^2(x_1^2 + x_2^2),$$

x_j ($j=1, 2, 3$) being the Cartesian coordinates; $\delta_1 = +\omega x_2$, $\delta_2 = -\omega x_1$, $\delta_3 = 0$.

In the Delaunay variables L_k, l_k (for L, G, H, l, g, h), the equations become

$$\frac{dL_k}{dt} = \frac{\partial F}{\partial l_k} + P_k, \quad \frac{dl_k}{dt} = -\frac{\partial F}{\partial L_k} - Q_k,$$

$$P_k = \sum_j l_j \frac{\partial x_j}{\partial l_k}, \quad Q_k = \sum_j X_j \frac{\partial x_j}{\partial L_k}.$$

Similarly, the equations after the elimination of the periodic terms, both short and long, become

$$\frac{dL_k''}{dt} = P_k'', \quad \frac{dl_k''}{dt} = -\frac{\partial F^{**}}{\partial L_k''} - Q_k'',$$

$$P_k'' = \sum_j P_j \frac{\partial l_j}{\partial l_k''} + \sum_j Q_j \frac{\partial L_j}{\partial l_k''},$$

$$Q_k'' = \sum_j P_j \frac{\partial l_j}{\partial L_k''} + \sum_j Q_j \frac{\partial L_j}{\partial L_k''}.$$

By ignoring the rotation of the atmosphere (i.e., putting $\omega=0$), let p_k, q_k, p_k'', q_k'' be the functions obtained by replacing X_j by $\dot{x}_j$. Then it is easily found that

$$p_1 = L_1 \left(\frac{2a}{r} - 1 \right) \quad q_1 = 2e \sin E + \frac{2}{e} \frac{L_2}{L_1} \sin f$$

$$p_2 = L_2 \quad q_2 = -\frac{2}{e} \sin f$$

$$p_3 = L_3 \quad q_3 = 0.$$

The solution of the problem with $\omega=0$ is therefore reduced to that of the equations

$$\frac{dL_k''}{dt} = -C_D A V p_k'' \exp(-\alpha r),$$

$$\frac{dl_k''}{dt} = -\frac{\partial F^{**}}{\partial L_k''} + C_D A V q_k'' \exp(-\alpha r).$$

The quantities p_k'', q_k'' have been obtained from the theory (Brouwer, 1959, *Astron. J.* **64**, 378) to the first power of k_2 (or J) in the periodic terms, to the second power in the secular terms. No infinite series appear in these expressions. In the development of $V \exp(-\alpha r)$ infinite series expressions in e are unavoidable. A development to the fourth power of e has been made.

The final differential equations are solved by iteration. The investigation has not been completed, but it appears that the procedure adopted is a powerful method for dealing with the simultaneous analytic solution of the effects of oblateness and drag in the motion of an artificial satellite.

Perturbations in Perigee Height of Vanguard I.

R. BRYANT, A. BAILIE, AND P. MUSEN, *Theoretical Division, Goddard Space Flight Center*.—The effect of solar radiation pressure on the perigee height of Satellite 1958 β_2 (Vanguard I) has been considered.

A previous perturbation theory of this satellite contained the second, third, and fourth harmonics in the development of the earth's potential and lunar and solar gravitational effects. Comparison between the observed and calculated perigee heights left an unexplained discrepancy of 1 to 3 km.

The inclusion of solar radiation pressure leads to close agreement between the orbit data and the theoretical results except for a short period oscillation which becomes noticeable in the second year of observation.

The Barred Spiral Galaxy NGC 7479.

E. M. BURBIDGE, G. R. BURBIDGE, AND K. H. PRENDERGAST, *Yerkes Observatory and Enrico Fermi Institute for Nuclear Studies, University of Chicago, and McDonald Observatory, University of Texas*.—The galaxy NGC 7479 has been classified SBb in Hubble's original scheme, and fB2 by Morgan. As compared with the essentially stellar bars of many barred spirals, the bar in NGC 7479 appears to have many HII regions along it, making it a promising object for a study of rotation by means of the H α emission line. Velocities along the bar and at a few points outside have been measured with the prime-focus spectrograph of the 82-inch telescope, by