Table 1

Cycles N	T (in years)	T_R^*	Cycles N	T (in years)	T_R	Cycles N	T (in years)
−12	4·3	4·7	4	3·3	3·3	20	4·1
−11	6·8	7·0	5	6·2	6·2	21	4·6
−10	5·3	5·5	6	5·7	5·8	22	3·5
−9	4·2	4·0	7	6·7	6·6	23	4·7
−8	5·3	5·0	8	3·5	3·5	24	3·3
−7	8·2	8·2	9	4·6	4·7	25	4·6
−6	5·5	5·5	10	4·1	4·2	26	6·0
−5	3·3	3·5	11	3·3	3·3	27	2·9
−4	7·7	7·5	12	5·3	5·3	28	4·3
−3	6·2	6·2	13	4·6	4·6	29	6·2
−2	3·5	4·0	14	5·5	5·8	30	5·3
−1	4·7	4·7	15	4·2	4·2	31	6·7
0	5·3	5·3	16	5·0	4·9	32	5·3
1	6·4	6·3	17	3·8	3·7	33	6·4
2	3·5	3·5	18	3·2	3·2	34	5·5
3	2·9	2·9	19	3·3	3·3	35	3·3

$N = 20$ will occur probably in $1968{\cdot}8 \pm 0{\cdot}1$. According to relations (3), (4) and (5) the values of $[R_m]$, $R_{\max}$ and $R_{\min}$ for this cycle will be respectively

$$[R_m] = 98{\cdot}1 \pm 4{\cdot}0 \quad R_{\max} = 132{\cdot}3 \pm 8{\cdot}0 \quad R_{\min} = 75{\cdot}0 \pm 5{\cdot}0.$$

It should be noted that King-Hele[4] has recently found that the time of rise for the sunspot cycles $N = 20$ and 21 will be equal to $T_R = 3{\cdot}4$ and 3·8 years, respectively. On the other hand, for $T_R = 4{\cdot}1$ years, King-Hele's relation $(R_m - 16)T_R^2 - 10^{-5}\ (R_m - 100)^4 \simeq 1401$ gives two values for R_m of which the smallest (99·3) differs little from the value of $[R_m]$ reported here (98·1) for the sunspot cycle No. 20.

JOHN XANTHAKIS

Research Centre
for Astronomy and Applied Mathematics,
Academy of Athens.

Received May 15; amended July 10, 1967.

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PLANETARY SCIENCE

Rotational Speed of the Upper Atmosphere: an Increase with Height above 200 km

THE average speed of rotation of the upper atmosphere can be determined by analysing small changes in the inclinations of satellite orbits to the equator. Previous studies[1,2] have indicated that, on average, the upper atmosphere at heights of 200–300 km is rotating faster than the Earth: the mean value obtained for the ratio Λ of the rotational speed of the atmosphere to that of the Earth was Λ = 1·27, which corresponds to a mean west-to-east wind speed of 100 m/s in middle latitudes. These previous studies, however, were not accurate enough to allow any definite conclusions to be drawn about the variations of Λ with height, time or latitude.

Recently we completed an analysis of the changes in the orbital inclinations of the following nine satellites: 1962βκ, 1962βτ1, 2, 5 and 6, 1965–95*B*, and 1966–51*A*, *B* and *C*. Their inclinations range between 49° and 90°, and the heights to which the values of Λ apply, taken as half a scale height above the mean perigee height, range between 200 and 260 km.

The values of Λ obtained, which are more accurate than before, are plotted against height in Fig. 1, with their estimated standard deviations and an unweighted least-squares line through the points. Fig. 1 justifies the conclusion that the average angular velocity of the upper atmosphere increases from about 1·1 at a height of 210 km to about 1·4 at 260 km. The corresponding mean west-to-east wind speeds in middle latitudes would be 30 m/s at 210 km, increasing to 130 m/s at 260 km. The values obtained previously[1,2], although less accurate, are also consistent with this conclusion.

For two of the satellites in Fig. 1, 1966–51*B* and *C*, for which the average value of Λ over the whole lifetime is 1·0, it has been possible to obtain values of Λ over a much shorter time interval centred in August 1966 when perigee was near the sunset line, with the local time between 18 and 21 h (ref. 3): over this time interval both satellites yield values of Λ near 1·5, which suggests that the west-to-east motion is greatest in the early evening.

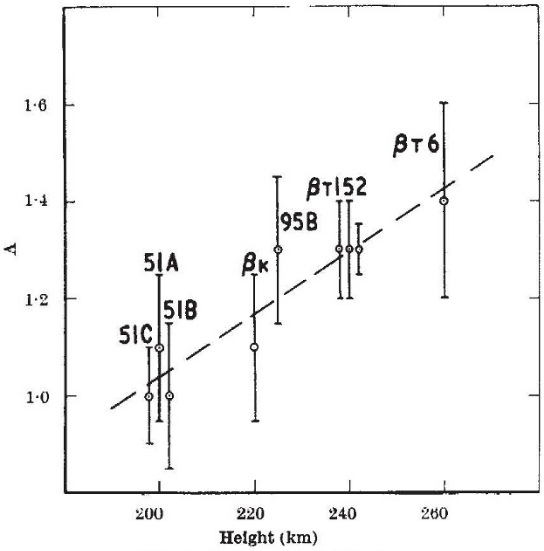

Fig. 1. Values of Λ obtained.

D. G. KING-HELE
DIANA W. SCOTT

Royal Aircraft Establishment,
Farnborough, Hampshire.

Received August 2, 1967.

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Plasma Resonances of the Magnetosphere

THERE have been many investigations of resonance phenomena in geophysics, for example, the Schumann resonances of the Earth-ionosphere cavity which is excited by lightning flashes. Theoretical attempts have been made to determine possible hydromagnetic resonances of the magnetosphere which should be excited by the solar wind. Under conditions of axial symmetry it is possible to obtain uncoupled solutions for poloidal and toroidal modes. Carovillano and Radoski[1] have recently considered a perfectly conducting plasma, magnetized by a dipole field, in which the plasma density function was expressed in a generalized form, thus allowing their model to incorporate some of the observed features of the magnetosphere. Their calculations for the toroidal modes, and also for the poloidal modes, indicate that the eigenperiods for such a model magnetosphere should lie in the geomagnetic micropulsation range, in agreement with the conclusions reached by a number of other workers.

In practice there are considerable departures from axial symmetry in the magnetosphere and so there arises the question of whether it is possible to observe anything which approximates to axially symmetric resonant modes. The vast amount of rather confusing and often contradictory information in the literature on the characteristics of micropulsations recorded at different localities has so far left this question unanswered.

Using techniques similar to that described by Mainstone and McNicol[2,3], daily micropulsation spectra in the form of sonagrams covering the $Pc3$–$Pc4$ range have been produced