estimate that the column number density of potassium atoms on January 27, 1973, was 9×10^{11} m^{-2}. This density is consistent with twilight photometric data[12-14].

Figure 1 shows the resonance scattering profile for the heights 75 to 100 km. There is a broad potassium layer with appreciable density over the whole of the 24 km region studied. The height is consistent with twilight data[12-14], but the large fraction of potassium that is below 84 km is different from that of sodium in the profiles obtained at 51° N (ref. 15) or at 23° S (ref. 6). This may be a consequence of differences in the chemical and diffusive equilibria of sodium and potassium or it may be that sodium was also at a lower height at Jamaica (18° N) on this occasion compared with that measured previously at other latitudes.

It is hoped to extend these measurements to provide a greater height coverage and finer resolution. Comparison with nearly simultaneous sodium profiles will also be attempted.

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Tidal Friction

IT seems worth while to compare various estimates of the secular accelerations of the Moon's mean motion ($\dot{n}$) and the Earth's rate of rotation ($\dot{\omega}$), and also of the dissipation (dE/dt) in the M_2 oceanic tide. I have recalculated the values given in chapter 8 of ref. 1, and I indicate the consequences of various other estimates in Table 1.

Van der Waerden's value[2] from ancient observations (back to the ancient Greeks) was found by classifying the data into four intervals. The number of degrees of freedom is therefore small, and a considerable error was more likely than the apparent uncertainty would suggest. In ref. 1 I made some adjustments, which have been further modified to give the result in Table 1. Newton's and Stephenson's values (refs 3 and 4 respectively) are based on much work, but differ rather seriously, particularly in the results that they give for the apparent secular acceleration ν ($=\dot{n}-\dot{\omega}/27.3$).

Under 'modern observations' the value of n from van der Waerden is essentially that of Spencer Jones, which eliminates variation of $\dot{\omega}$ in the past 250 yr. I have calculated $\dot{\omega}$ and dE/dt from it on the supposition that the angular momentum in the Earth–Moon system and the Earth's moment of inertia are constant. Spencer Jones's uncertainties may have been underestimated (see ref. 10, page 400). Newton's satellite value[5] is based on perturbations of artificial satellites by the potential due to the tides; he gives the lunar contribution to $\dot{\omega}/\omega$ and I have calculated $\dot{n}$ and dE/dt above from it. The value of $\dot{\omega}$ calculated from $\dot{n}$ would be increased numerically by allowance for the solar tide and reduced by the thermal atmospheric tide. It seems clear that $\dot{\omega}$ varies, and only an average value means much, but there is no apparent reason why $\dot{n}$ should have varied appreciably in the past 2,000 yr.

Table 1 Consequences of Other Estimates

Author	$-\dot{n}$ (1″ cy^{-2})	$-\dot{\omega}$ (1″ cy^{-2})	$-dE/dt$ (10^{19} erg s^{-1})
Ancient observations			
Van der Waerden[2]	17.9 ± 1.1		
Newton[3]	42 ± 4	$1,180\pm140$	
Stephenson[4]	34.2 ± 1.9	$1,213\pm57$	5.1
Modern observations			
Van der Waerden[2]	22.4 ± 1.8	$1,198\pm96$	2.76 ± 2.2
Newton (satellites)[5]	23.5 to 17.5		2.88 to 2.16
Van Flandern[6]	52 ± 16		
Tidal theory			
Munk and MacDonald[7]			3.2
Pekeris and Accad[8]			6.3
Hendershott[9]			2.7

Van Flandern[6] studied occultations, using an atomic standard of time, and consequently his result does not depend on the rotation of the Earth. It covers, however, only a short interval of time and will probably be improved. Pekeris and Accad[8] made a numerical solution for the M_2 tide, using the actual form of the oceans. They did not allow for the elastic yielding of the solid Earth, and their dissipation should probably be halved. Hendershott's solution[9] allows for it. It seems probable therefore that the rate of dissipation in the lunar semidiurnal tide is about 2.7×10^{19} erg s^{-1}, and this is consistent with Spencer Jones's $\dot{n}$ and Newton's value from artificial satellites. It seems to me that these are the least likely to be affected by disturbances not yet considered. This is substantially greater than my estimate for the dissipation in ref. 1. To find these I started with a wholly provisional estimate (page 308) of the apparent secular acceleration of the Moon, and neglected tidal dissipation along the open coasts, which is probably much larger than was thought (page 313).

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