88/3-6-84 5 ①

I, 13527

DR -2143-1

MLM-3108

**Periods Found in Heat Measurements
Obtained by Calorimetry**

Kenneth C. Jordan

February 28, 1984

**DO NOT MICROFILM
COVER**

MOUND

Miamineburg, Ohio 45342

operated by

MONSANTO RESEARCH CORPORATION

a subsidiary of Monsanto Company

for the

U. S. DEPARTMENT OF ENERGY

Contract No. DE-AC04-76-DP00053

Monsanto

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DO NOT MICROFILM
COVER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Printed in the United States of America
Available from
National Technical Information Service
U. S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed Copy: A02
Microfiche copy: A01

UC-34B

Periods Found in Heat Measurements Obtained by Calorimetry

Kenneth C. Jordan

Issued: February 28, 1984

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MOUND

Miamisburg, Ohio 45342

operated by

MONSANTO RESEARCH CORPORATION

a subsidiary of Monsanto Company

for the

U. S. DEPARTMENT OF ENERGY

Contract No DE-AC04-76-DP00053

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Contents

	<u>Page</u>
ABSTRACT.	3
INTRODUCTION.	3
EXPERIMENTAL.	3
ANALYSIS AND DISCUSSION	4
Short Term Phase Shifts in Voltage Data	
From Calorimeter #127	12
CONCLUSION.	17
ACKNOWLEDGEMENTS.	18
REFERENCE	18
DISTRIBUTION.	19

Abstract

During a span of 640 days, a periodicity of 1.5158 ± 0.0008 days was discovered in successive heater equilibria on Calorimeter #127. Measurements were taken at 12-hr intervals, with occasional changes of exactly 3 or 6 hr in the schedule of measurements. This schedule eliminated all other possible periods except a period of 0.150156 days. Periods of 1.519125 and 1.511283 days were discovered in data on the excess length of day as obtained by the U.S. Naval Observatory over a period of 24 yr. These two periods could equally well represent periods of 0.150189 and 0.150112 days, since measurements were obtained only once every 24 hr. It is suggested that periods observed in sensitive calorimeters and in length of day data may be related.

Introduction

The thermal power of radioisotopes has been used to study and measure radioisotopes for many years. In a typical calorimetric process, the power of a radioisotope is measured alternately with the power of a heater in the sample side of the calorimeter. The heater and the isotope in the sample side have about the same power, and also about the same power as the heater in the reference side of the calorimeter.

A phenomenon observed in Calorimeter #127 is the apparently random voltage variations that occur between the sample and reference sides of the calorimeter when a radioisotope and the built-in heater are alternately used as the source of heat in the sample side. To reduce these voltage variations between the two sides of Calorimeter #127, a fan was placed inside the hermetically sealed calorimeter lid. The fan was installed in October 1981. This fan directed a stream of argon through the tube into the base joining the sample and reference sides of the calorimeter. After installation of the fan, the potentials across the resistance bridge at times of measurement were found to be constant or nearly constant when a radioisotope was in the sample chamber of the calorimeter. But the bridge

potential showed considerable variation between successive heater runs. In other words, radioisotope measurements seemed to be unaffected by the presence of the fan, but heater measurements were still complicated by unexpected, troublesome voltage variations across the resistance bridge of the calorimeter between successive heater runs.

Careful analysis of these voltage variations has shown them not to be random, but to be periodic in nature. It is the purpose of this report to suggest a correlation between this periodicity and a periodicity discovered in length of day data as obtained by the U.S. Naval Observatory.

Experimental

It should be remarked that the radioisotope is located a few inches above the heater during heater runs, and that power measurements with Calorimeter #127 (the calorimeter used in this study) were typically about 1 W. During heater runs the heaters on the sample side and the reference side of the calorimeter were in series, so that the same current passed through each heater coil. No changes were effected in the calorimeter during the experiments other

than lifting the radioisotope out of the sample chamber during heater runs and returning the isotope to the sample chamber during periods of measuring its power. The operations of removing and returning the radioisotope to the sample chamber were done automatically on a schedule.

The troublesome and puzzling voltage variations observed in Calorimeter #127 were observed only during runs when the heater in the sample side of the calorimeter was in operation. These voltage variations did not take the form of unpredictable and unsteady irregularities such as might result from background noise. During heater runs, the voltage across the bridge of the calorimeter appeared to reach its equilibrium value in the ordinary way. When equilibrium had been obtained, the voltage across the bridge was steady and showed no more noise than was observed during sample runs. But the voltage observed across the calorimeter bridge reached different equilibrium values during successive heater runs. The heater measurements were made at intervals of 12 hr and were interspersed, at regular intervals, with measurements of the power of the radioisotope.

A typical heater run begins at noon. At 6:00 PM this run has been completed and the radioisotope is automatically lowered into the sample chamber. At midnight, measurements on the power of the isotope have been completed, and it is automatically lifted out of the sample chamber. Then another heater run begins. This heater run is finished at 6:00 AM the morning of the following day, when the radioisotope is again automatically lowered into the sample chamber. The puzzling voltage variations occur only during successive heater runs. The voltage variations are observed as

differing positions of equilibrium during these successive heater experiments.

Analysis and discussion

A plot was made of successive equilibrium voltages across the resistance bridge for a succession of heater runs. The heater runs were made at intervals of 12 hr and were interspersed, at periods of 6 hr, with measurements of a radioisotope. A typical portion of this plot is shown in Figure 1. The peaks, or maxima, in observed voltages were as large as 4 μ V. This corresponds to 52 μ W, or 0.0052% of heater power. The periodicity of these peaks proved to be ~ 1.512 days, based on 8 mo of observations.

A search for natural periods of ~ 1.512 days was begun. This search included examination of various geological periods, such as those which are associated with natural electrical currents in the earth and with the earth's magnetic field. A period of appropriate duration was finally discovered in unsmoothed data on the length of day obtained by the U.S. Naval Observatory (NOTSS) at Richmond, Florida. A sample of this data is shown in Table 1.

The left-hand column of Table 1 shows the calendar year (1982) and the calendar dates of the measurements. Proceeding from left to right in the table, the next entry represents the Modified Julian Day (MJD) of the measurement. The Modified Julian Day begins at noon the day before the indicated calendar date, whereas the calendar day begins at midnight. The third column lists unsmoothed, cumulative time measurements; blanks in the table represent no measurements that night. (The reason for lack of measurements is probably weather unsuitable for observing the passage of the stars, since length of day is determined by analyzing data from as many as 70 star passages

FIGURE 1 - Voltage variations in Calorimeter #127 as shown from readings taken at midnight and noon over several typical weeks.

Table 1 - SPECIMEN OF DATA ON LENGTH OF DAY FROM U.S. NAVAL OBSERVATORY^a

III. OBSERVATIONS (TIME)									
		USNO			NOTSS			ADOPTED	
1982		A.1-UT1	SIGMA		A.1-UT1	SIGMA		A.1-UT1	
	MJD	S	MS	N	S	MS	N	S	
FEB	13	45013			20.1182	13.4	13	20.1072	
	14	45014	20.1272	20.5				20.1104	
	15	45015	20.1088	13.8				20.1137	
	16	45016			20.1055	8.9	46	20.1166	
	17	45017			20.1102	9.3	57	20.1192	
	18	45018						20.1213	
	19	45019			20.1203	13.2	67	20.1231	
	20	45020	20.1313	17.3				20.1249	
	21	45021						20.1269	
	22	45022						20.1289	
	23	45023	20.1432	16.1	20.1266	12.9	69	20.1309	
	24	45024	20.1499	22.8	20.1361	18.9	69	20.1325	
	25	45025	20.1258	19.3	20.1374	16.6	53	20.1343	
	26	45026	20.1500	16.2	20.1325	20.8	61	20.1363	
	27	45027			20.1279	23.6	57	20.1383	
	28	45028			20.1387	14.7	57	20.1403	
MAR	1	45029	20.1551	19.6				20.1425	
	2	45030			20.1422	7.5	29	20.1452	
	3	45031			20.1484	11.5	16	20.1476	
	4	45032			20.1450	4.6	6	20.1498	
	5	45033			20.1455	14.9	17	20.1523	
	6	45034	20.1730	11.1	20.1544	14.0	10	20.1546	
	7	45035			20.1504	20.9	4	20.1568	
	8	45036			20.1613	6.5	8	20.1590	

^aA.1-UT1 data, Series 6, U.S. Naval Observatory, Washington, D.C.
(Series 6 has been discontinued).

per night.) The numbers in this third column are the accumulated seconds, which represent the cumulative "lateness" of the earth in its rotation since January 1, 1956. ("Lateness" is determined by comparison to a cesium atomic clock, which accurately measures a period of 24 hr.) These numbers were obtained at USNO, the United States Naval Observatory in Washington, D.C. The column labeled sigma represents the standard deviation (in milliseconds) for a single observation on the number of stars observed that night. The number of observed stars is indicated in the column headed by the letter N. The next three columns represent similar information as obtained by the Observatory at Richmond, Florida. The last column on the right in Table 1 represents a smoothed combination of the data obtained from the two

naval observatories and is the "adopted" cumulative time in seconds of the "lateness" of the earth in its rotation as measured since January 1, 1956.

The difference between any two numbers in the "adopted" column represents the daily smoothed discrepancy between the cesium atomic clock and the actual rotation time on the indicated date. These data suggest that the measured rotation of the earth takes longer than 24 hr as defined by the atomic clock. This discrepancy amounted to 2 ms between February 20 and February 21, 1982, for example. Smoothed data, such as is shown in the "adopted" column, are satisfactory for estimating the lengths of long periods, but not for studying short periods such as 1.5 days. Raw, unsmoothed data in the column labeled NOTSS (Richmond,

Florida station) obtained over a period of years show that the length of day was greater than 24 hr by at least 10 ms on 1004 days during the period from January 1, 1956 to March 8, 1980.

Let the term "aspect" be defined as the decimal part, PQ, of the ratio defined in Equation (1).

$$\frac{\text{Julian Day} - 39127}{1.511296} = N.PQ \quad (1)$$

Here, PQ is the aspect, or fractional part of a period of 1.511296 days. Noon (E.S.T.) of January 1, 1966 is the epoch of all calorimetry data at Mound and is equivalent to Julian Day 39127 as shown in Equation (1).

A frequency plot of the aspects of those days that were at least 10 ms longer than 24 hr revealed that there were 119 days with aspect between 0.400 and 0.499 (a range hereafter denoted as aspect 0.450), 115 days with aspect between 0.300 and 0.399 (hereafter denoted as aspect 0.350), 95 days at aspect 0.950, and 89 days at aspect 0.050. The frequency diagram for all aspects from 0.050 to 0.950 is shown in the lower portion of Figure 2 using 1.511296 days as the working period.

Voltage peaks on the bridge of Calorimeter #127 occurred 50 times on aspect 0.450, but never on aspect 0.050, even though data were recorded 89 times at aspect 0.050. A frequency diagram of number of voltage peaks vs. aspect of peak is shown in the upper portion of Figure 2.

Examination of both parts of Figure 2 reveals certain similarities, but these similarities could be due to chance. To test the probability that the similarities are due to chance, 1000 sequential digits were

FIGURE 2 - Number of days ≥ 24 hr + 10 ms in length (lower graph) and number of peaks in Calorimeter #127 (heater vs. heater), October 1981 to January 1983 (upper graph), both plotted against the aspect of day at a 1.511296-day period.

selected from randomly chosen numbers generated by a computer. A frequency table of these digits was prepared. A second set of 1000 digits was selected by again randomly choosing sets of sequential digits from randomly chosen numbers generated by a computer, and a third set was similarly developed. Frequency tables for these latter two sets of 1000 digits were also prepared. It was observed in these three sets of digits that the ratio of the number of appearances of the most frequently encountered digit to the number of appearances of the least frequently encountered digit never exceeded 1.33. Yet the number of appearances of aspect 0.450 divided by the number

of appearances of aspect 0.550 was about 1.45. This test is judged sufficient evidence to prove that the similarities between the upper and lower portions of Figure 2 are not due merely to chance.

It was not an easy task to determine the length of the aspect period as 1.511283 days from the approximate value 1.512 days. That the period was about 1.5 days is apparent from inspecting data such as that graphically displayed in Figure 1. Careful analysis of data taken over a period of about 8 mo allowed the approximate number 1.5 days to be refined to 1.512 days, but further refinement of the calorimetric voltage data was not attempted.

Using measurements on the rotation of the earth, which are available back to January 1, 1956, the aspects of all days that were longer than 24 hr by at least 10 ms were calculated using the best period available: 1.512 days. The number of days that fell into a given aspect range was entered into

a table such as Table 2. For each year there is a maximum number of days in a particular aspect range, and it can be seen that these maximum numbers (circled) can be connected by a dashed line. But if the period 1.512 days were exact, these maximum numbers would lie on a horizontal line, not on a line with a slope different from zero. So the period 1.512 days is inexact. The slope of the line in Table 2 is positive and is equal to the quantity (Δ aspect/time in days). Because the slope is positive, the original period of 1.512 days must be too long. The reciprocal of the time period is therefore about

$$\left(\frac{1}{1.512} + \text{slope of line/day}\right)$$

This sum is inverted and yields a better approximation of the true period. Another table similar to Table 2 is prepared with this new period, and the process is repeated, if necessary, until the slope of the line connecting circled entries is

Table 2 - USING THE NUMBER OF DAYS IN A GIVEN ASPECT RANGE TO REFINES THE WORKING PERIOD OF 1.512 DAYS: ILLUSTRATIVE CASE^a

Aspect Range	Number of Days				
	Year 1	Year 2	Year 3	Year 4	Year 5
0.05	04	39	35	44	28
0.15	40	44	38	45	29
0.25	45	31	40	39	90
0.35	32	36	44	70	18
0.45	32	43	85	22	30
0.55	32	78	23	28	35
0.65	80	12	25	17	29
0.75	44	46	26	33	32
0.85	28	25	27	33	73
0.95	28	21	22	34	71

^aData are contrived to illustrate working technique.

close to zero. The period that results when this process is applied to NOTSS data on days longer than 24 hr by at least 10 ms (Figure 2) is 1.511296 ± 0.000033 days. This period was adjusted to 1.51133 days,* which was then used as the working period for all of the data collected by NOTSS between 1956 and 1963.5.

Unsmoothed time differences for consecutive days during the period 1956 to 1963.5 were calculated by taking the difference between consecutive entries in NOTSS data. Thus, for each Julian Day from January 1, 1956, through 1963.5 there is an aspect and a time. The time is the difference between consecutive entries in NOTSS data. The dimension of this time is milliseconds, and it is the time in excess of 24 hr for rotation of the earth as of noon of the calendar date of the first entry used for computing time differences. Of course, these times were not available where blank spaces occur in the NOTSS data. (About 1700 days out of a possible 2700 days are accounted for.) The times were divided into ten groups, each group representing one of the previously described aspect ranges. For example, if 27.5 ms was the rotation time in excess of 24 hr for a calendar day with aspect 0.45, then 27.5 ms was entered into the column for aspect 0.45. All such millisecond times for the years 1956 to 1963.5 were thus entered into the ten aspect groups. There were ~170 entries under each aspect. Then the times, which could be positive or negative, in each aspect group were averaged. These averages were plotted vs. aspect of calendar day, as shown in

*The adjustment was incorrectly calculated, but was nevertheless used as the working period.

Figure 3. As can be seen from Figure 3, aspect 0.45 has the highest average milliseconds per day. Aspects were computed relative to a period of 1.51133 days, the working period for these years.

The midpoint of the period selected (1956 to 1963.5) is 1959.75, or 2281 days before the calorimetry epoch at Mound. Because it is before the calorimetry epoch, it is considered a negative number: -2281 days. By trial and error, -2292 days (2292 days before the calorimeter epoch at Mound) was found to have an aspect of exactly 0.45 relative to the working period of 1.51133 days. The positive aspect 0.45 of this day is found by Equations 2 and 3:

$$\frac{-2292}{1.51133} = -1516.55 \quad (2)$$

$$-1516.55 + 1517 = 0.45 \quad (3)$$

Thus, day -2292, with aspect exactly 0.45, occurs in the midpoint of aspect range 0.400 to 0.499, and may be counted among the days with longest average length of day. Day -2292 is assigned as a reference day for refining the working period of 1.51133 days.

A similar analysis of aspect data from 1976 to 1980, inclusive, showed that days in aspect range 0.400 to 0.499 were also the days of longest average length of day. These aspects were calculated relative to another working period: 1.511262 days. (The fact that these days of longest average length of day also occurred at aspect 0.45 may be fortuitous.) Trial and error revealed that day 4539, a day close to day 4535, or 1978.5, had an aspect of exactly 0.45. Thus, it too occurs at the midpoint of the range of aspects of days with longest average length of day in these latter years. Days -2292 and 4539 both occur at

FIGURE 3 - Rotation time of the earth in excess of 24 hr plotted against the aspect of day at a 1.51133-day period. The numbers on the graph show the number of occurrences in each aspect range (not available for 0.55 and 0.65 aspects). Data are from the NOTSS unsmoothed length of days from 1956 to 1963.5.

the midpoint of the aspect range of the days with longest average length of day. The period of time between them, 6831 days, should, therefore, contain an integral number of periods whose approximate length is equal to that of the working periods. A period that exactly fits the total length of time of 6831 days is 1.511283 days. In this way, the two working periods were discarded in favor of a more statistically reliable period: 1.511283 days.

Observations on voltage variations in heater vs. heater runs were made twice a day. The voltage peaks, now believed to occur at intervals of 1.511283 days, could be produced equally well by any of the periods represented by

$$\frac{1}{P(N)} = \frac{1}{P_0} \pm 2N \quad (4)$$

where

N = an integer

P(N) = all other periods with the same aspect at noon and at midnight as P₀

P₀ = period of 1.511283 days.

Shifting the time of heater measurements, first by 3 hr and then by 6 hr, allowed data on voltage variations to follow a new schedule. Analysis of voltage peaks obtained on the new schedule fit one other period predicted by Equation 4 besides the original period P₀ = 1.511283 days, and that was a period of 0.1501206 days (equivalent to taking N=3).

Table 3 shows typical times of peak voltage measurements and the aspect of these measurements for a period of 1.511283 days. It can be seen that the aspects of these measurements fall predominantly into aspect range 0.45, although this is not always the case.

Table 3 - TIME OF VOLTAGE PEAKS AND ASPECT OF DAY FOR PERIOD OF 1.511283 DAYS

<u>Day of Voltage Peak^a</u>	<u>Aspect of Day</u>
6115.375	0.48
6117.375	0.80
6118.375	0.46
6119.875	0.46
6121.375	0.45
6122.875	0.44
6124.375	0.43
6125.875	0.43
6127.375	0.42
6128.875	0.41
6130.375	0.40
6132.375	0.73

^aExpressed as days after calorimetry epoch.

A working period from length of day data was then used for comparison. Figure 4 shows the number of days of length equal to or exceeding 24 hr and 10 ms vs. the aspect for a working period of 0.644320 days. The data shown in Figure 4 are broken into two periods: the 13-yr period between 1956 and 1968, and the 11-yr period from 1969 to 1979. It can be seen that the number of days on aspects 0.55, 0.65, 0.75, 0.85, and 0.95 can be almost perfectly superimposed. Data at other aspects do not correlate quite so well. But Figure 4 shows that the shifting of either set of data by one-tenth of the period would cause detectably poor correspondence of the data from aspects 0.55 to 0.95, inclusive. This phenomenon also is found in the data revealing the period of 1.511283 days. Hence the accuracy of this latter period can be taken as not worse than

$$\frac{(0.1)(1.511283)}{4380} = 0.000034 \text{ days} \quad (5)$$

That is to say that the calorimetric period is equal to 1.511283 ± 0.000034 days. The period of 0.644320 days is significant in NOTSS data, but is too weak to be detected

FIGURE 4 - Number of days > 24 hr + 10 ms in length plotted against the aspect of day at a 0.644320-day period. Data are from the NOTSS unsmoothed length of days.

in calorimetric data, where only the period 1.511283 days, as well as a few other periods, could be detected with certainty.

Table 4 shows some typical calorimeter voltage data beginning at midnight January 24/25, 1982, and at noon May 27, 1982. The two voltage readings in the first line of the table were taken at these specified times and the next two readings were taken on the same dates 12 hr later. The third and fourth data readings were taken the following day (day 2 is January 25/26, and May 28, respectively). The last two columns of this table show the sums (Σ) and differences (Δ) of corresponding data. If the voltage measurements were truly random, both the averages and the standard deviations per observation of the latter two columns should be approximately the same. But this is not the case, as can be seen graphically in Figure 5. Many different working periods were investigated; 122.5 days was the only real match. And the period of 122.5 days is consistent with the

period 1.511283 days. There probably are other periods that divide evenly into 122.5 days, as does 1.511283 (~ 81.057 times). This longer period was not further investigated, however. Still other periods may exist within the voltage data; some of these are indicated in Table 5 as "Other Unidentified Periods".

Figure 6 shows a plot of the average length of day greater than 24 hr (in ms) vs. the aspect of day using a period of 1.51128 days. The diagram is a composite of all NOTSS data from 1956 to 1980, inclusive. The highest peak in the diagram is 2.19 standard deviations above the average. There is a 1 in 33 chance that this could be the result of random noise effects. About 619 determinations of average length of day are in each peak and trough. The standard deviation per observation is 9.33, and the standard deviation of each aspect range is $9.33/\sqrt{619} \approx 0.38$. The average value of all the points is 2.183 ms/day. The fact that peaks and troughs occur in this diagram associated with rather small probabilities of occurrence by chance is considered evidence in support of the period 1.51128 days in NOTSS data.

Short term phase shifts in voltage data from calorimeter #127

In late December 1981, the voltage peaks observed in Calorimeter #127 began to appear ~ 0.33 aspect less than the usual aspect of ~ 0.45 . In other words, voltage peaks began to occur at ~ 0.12 aspect. It is to be noted that the time of maximum negative declination of the plane of the

Table 4 - CALORIMETER #127 VOLTAGE IMBALANCES:
TWO MEASUREMENTS PER DAY AT 122.5 DAY INTERVALS

Day No. ^a	Units of Imbalance (1 unit = 0.4 μ V)		Sum, Σ	Difference, Δ
	Initial Readings	122.5 Days Later		
1	3.0	-0.35	2.65	3.35
	-5.3	-3.05	-8.35	-2.25
2	-5.8	-8.75	-14.55	2.95
	1.8	3.3	5.10	-1.5
3	-5.1	-3.6	-8.7	-1.5
	-5.2	-4.9	-10.1	-0.30
4	3.2	4.6	7.8	-1.40
	-6.75	-4.5	-11.25	-2.25
5	-8.1	-9.5	-17.6	1.40
	-0.8	3.7	2.9	-4.5
6	-6.0	-0.5	-6.5	-5.5
	-4.25	1.3	-2.95	-5.55
7	-3.0	2.1	-0.9	-5.1
	-1.75	-3.35	-5.1	1.6
8	-3.70	-0.75	-4.45	-2.95
	-0.4	3.8	3.40	-4.20
9	-4.8	-1.2	-6.0	-3.6
	-4.35	-5.75	-10.1	1.40
10	2.45	4.9	7.35	-2.45
	-3.85	-0.9	-4.75	-2.95
11	-3.45	-5.9	-9.35	2.45
	5.4	4.05	9.45	1.35
12	2.0	1.8	3.8	0.2
	-9.0	-6.5	-15.5	-2.5
13	4.1	-0.1	4.0	4.2
	-3.35	-1.2	-4.55	-2.15
14	0.75	-5.4	-4.65	6.15
	5.7	1.4	7.10	4.30
15	-1.55	-0.2	-1.75	-1.35
	-4.65	-4.35	-9.0	-0.30
16	1.2	0.45	1.65	0.75
	-5.6	0.4	-5.20	-6.0
17	-7.7	-3.9	-11.60	-3.8
	-1.5	3.45	1.95	-4.95
18	2.0	-1.25	0.75	3.25
	-3.3	-6.6	-9.9	3.30
19	-5.3	1.2	-4.10	-6.50
	2.8	-0.5	2.3	3.3
20	-10.0	-6.35	-16.35	-3.65
	-2.3	5.95	3.65	2.30

Table 4 - continued

Day No. ^a	Units of Imbalance (1 unit = 0.4 μ V)		Sum, Σ	Difference, Δ
	Initial Readings	122.5 Days Later		
21	-3.2 -6.8	0.0 ---	-3.2 ---	3.2 ---
22	-0.25 -2.95	--- -3.2	--- -6.15	--- 5.25
23	-7.0 2.0	-0.6 -3.9	-7.6 -1.9	-6.4 5.9
24	6.3 -6.4	3.7 -1.4	10.0 -7.8	2.6 -5.0
25	6.1 -1.0	2.4 1.7	8.5 0.7	3.7 -2.7
26	-2.2 1.3	-4.8 1.9	-7.0 3.2	2.7 -0.6
27	-3.2 -8.2	-1.25 -4.3	-4.45 -12.5	-1.95 -3.9
28	5.9 2.85	-1.05 -1.20	4.85 1.65	6.95 4.05
29	-1.55 -0.5	-2.20 -1.0	-3.75 -1.5	0.65 0.50
30	-2.9 -6.85	1.0 -1.6	-1.9 -8.45	-3.9 -5.25
31	2.1 -0.3	0.2 3.25	2.30 2.95	1.9 -3.55
32	-5.6 2.6	-5.05 -1.95	-10.65 0.65	-0.55 4.55
Average Value =			-2.927	-0.513
σ per observation =			6.784	3.535

^aDay No. 1 is January 24.5, i.e., midnight, January 24/25, 1982.
Day No. 1 plus 122.5 days is noon on May 27, 1982.

FIGURE 5 - Plots of the sums (Σ) and differences (Δ) of the voltage measurements for Calorimeter #127 heater equilibria. These data, presented in tabular form in Table 4, are plotted here to emphasize that they are not random measurements.

Table 5 - PERIODS COMMON TO VARIATIONS IN CALORIMETER
DATA AND IN ROTATION OF THE EARTH

Period (days)	Aspect ^a 1-1-83	Δ Aspect Per Day	Aspect at Peaks	P-P (ms/day)	Most Prominent Effects
Yearly and Lunar Periods					
365.2422	.0000	0.0027379	.243	1.25	Earth
365.2422	.0000	0.0027379	.858	1.10	Earth
27.554551 (An.P.)	.3348	0.0362916	.397	0.23	Both
29.530589 (Ph.)	.2566	0.033863	.898	0.145	Both
29.530589 (Ph.)	.2566	0.033863	.357	0.100	Both
27.32158 (Sid.P.)	.2563	0.036601	.173	0.090	Earth
Other Unidentified Periods					
1.515759	.2976	0.659735	.85	?	Calorimeter
0.3015184 or	.4415	3.316547	.90	2.2	Earth
0.7595626	.4415	1.316547	.90	2.2	
1.9090909	.3333	0.523810	.10	2.3	Both
19.7263	.7575	0.050694	.10	0.10	Calorimeter
19.7263	.7575	0.050694	.40	0.10	Calorimeter
176.3333 ^b	.2117	0.0056711	.185	0.28	Both
176.3333	.2117	0.0056711	.353	0.24	Both
176.3333	.2117	0.0056711	.483	0.19	Both
413.000 ^b	.0339	0.0024213	.82	0.65	Both
413.000	.0339	0.0024213	.28	0.65	Both
0.64432 ^b	.5160	1.552023	.05	?	{ Earth Calorimeter Perigees of Moon Weather
0.64432	.5160	1.552023	.55	?	
0.305249 ^b	.771		.65	?	
0.58005 ^b	.250		.35	?	

^aAspect = decimal cycles of

$$\frac{\text{Julian Days} - 39127}{\text{Period}} = N. \text{ Aspect}$$

$$\text{b} \quad \frac{1}{0.305249} - \frac{1}{0.58005} = \frac{1}{0.64432} \quad \text{and} \quad \frac{176.3333}{0.58005} = 304.00$$

Related to H.H. Clayton's weather periods [1] of 3, 3.6, 4.6, 5.45, 6.14, 7.24, 9.1, 11, 18, 22, 29, 44, 58, etc. days.

An.P. = Anomalistic period of moon; Ph. = Phases of moon;
Sid.P. = Sidereal period of moon.

FIGURE 6 - Average length of day plotted against aspect of day at a 1.51128-day period. Data are from the NOTSS for 1956 to 1980.

earth's equator to the plane of the ecliptic occurs on or about December 22, while perihelion is on or about January 3. Whether this is connected to the change in phase of the voltage maxima is not known, but it suggested that periods of other extremes in the earth's orbit about the sun be examined to see whether the most frequent aspect of voltage peaks would similarly be changed. The time of maximum positive declination of the plane of the earth's equator to the plane of the ecliptic occurs on or about June 20, while aphelion occurs on or about July 2. Measurements of voltage across the bridge of the calorimeter during this period in 1982 showed that the aspect of voltage maxima shifted upward ~ 0.33 aspect to ~ 0.78 aspect. Careful measurements 6 mo later,

at the end of 1982, again showed a negative phase shift in the aspect of voltage maxima from ~ 0.45 to ~ 0.12 . Subsequently, voltage measurements around the time of the earth's aphelion in 1983 were made, but they failed to substantiate the theory that aspect changes are correlated with the earth's perihelion and aphelion.

Incorporating these new data into previously obtained voltage measurements modified the period of "best fit" to 1.515759 days (or 0.1501562 days, obtained by making $N = 3$ in Equation 4.) These periods are the result of 640 days of calorimeter heater measurements. Unfortunately, these exact periods do not seem to be present in length of day.

Conclusion

A period of 1.5158 days was discovered in calorimetry data and was subsequently refined to 1.5158 ± 0.0008 (or the shorter period of 0.150156 days) by various statistical methods that included comparison to other natural periods. The most significant short period found in length of day data was 0.7595626 days (or 0.3015184 days - see Equation 4), obtained as shown in Table 2. The difference between the maximum and minimum length of day during 24 yr of measurements is equivalent to eight standard deviations. (The peak to peak period was originally taken to be 1.519125 days, but since the plot of length of day vs. aspect had two extremes, this period was divided by 2 to obtain 0.7595626 days.) For $N = 6$ in Equation 4 (with the factor 2 removed because length of day measurements are obtained only once each day), the period 1.519125 days yields a period of 0.1501891 days. This differs from the period 0.1501562 days, found by calorimetry, by the factor 1.000219. If this small difference could be reconciled, then the period found in calorimeter data would correlate

exactly with the strongest short period found in length of day data. Otherwise, the two periods come into resonance every 684 days and are probably not identical.

Acknowledgements

The author wishes to express his gratitude to Gary L. Silver for his assistance in preparing this manuscript; to George W. Otto for many valuable discussions; and to his

wife, Paulette H. Jordan, who spent months averaging data on the lunar and solar periods as well as many other unidentified periods.

Reference

1. H. H. Clayton, World Weather Records, Washington, D.C., Smithsonian Institution (Smithsonian Miscellaneous Collections, Vols. 79, 90, and 105), 1927, 1934, and 1947.

Distribution

EXTERNAL

TIC, UC-34B (86)

R. C. Ritter, University of Virginia

H. N Hill, DOE/Dayton Area Office

H. A. Schneiderman, Monsanto, St. Louis

Monsanto Reports Library, R2C, St. Louis

INTERNAL

A. R. Burke

W. B. Hogeman

C. W. Huntington

K. C. Jordan (3)

B. R. Kokenge

J. F. Lemming

G. W. Otto

G. L. Silver

W. Smith

R. E. Vallee

Document Control

Publications

Library (15)

Published by Information Services:
Patricia A. Fitzharris, Editor