An Attempt to the Explanation and to the Prediction of the Eleven-Year Cycle of Solar Activity

(Preliminary communication)

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Summary – According to the author the reason of the subsistence of the 11 years' sunspot cycle is to be found in the conjunction of the planets. As a result of the investigations it has been stated that from among the nine planets the joint tidal effect of Venus-Jupiter-Earth is a decisive factor in the variations of sunspot activity. The above three planets are every 10.4 years and 12.0 years respectively, in a close conjunction. The mean value (11.2 years) is in an almost full accordance with the average cycle-period. The fluctuations of the period of the cycle come from the fact that the planets' getting into approximately one line takes a different time within each cycle. This time delay is the cause of the stronger or weaker sunspot activity, and of the shorter or longer cycles.

In the present paper, a short description is given of a method for the forecasting of the length of a solar cycle and of the maximum value of sunspot numbers within the cycle. Previous results in this field,—based partly on statistical methods, i.e. on the looking for periodicities and partly on the conjunctions of planets—were not satisfactorily approximating the actual values of sunspot numbers and the times of occurrence of the maxima, especially when the forecasts have been extended to periods of more than 10 or 20 years. Moreover there was lacking a satisfactory answer to the question: why solar cycles are possessing an average length of 11.1 years and why they are able to assume actually longer or shorter periods? In the full version of this paper, we are attempting to eliminate some insufficiencies of the present situation of solar cycle forecasting and to give an explanation for several features in solar activity (such as the length of a solar cycle, the steepness of the ascending branch of the cycle, the ending of a cycle and the beginning of a new one, etc.).

In this work, the conjunction of planets has been adopted as the basis of forecasting solar cycles, a possibility detected by WOLF as early as 1859 [1][2]). In other words, we are starting from the assumption that the planets are capable of exerting an induction effect on the Sun, in a way that at the time of certain conjunctions there is a possibility of the production of a greater number of sunspots, i.e., the sunspot activity is increased. Solar phenomena may be accelerated and enhanced by tidal influences [2].

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[2]) Numbers in brackets refer to References, page 210.

In this short discussion, only the tidal effects from Venus, Jupiter and Earth are considered, and only the main effects of the combined influences of these three planets are presented [3]. In fact, the influences from these three planets may cover more than 80% of the total influences from the 9 planets; this assumption is supported by the results deduced from it.

In table 1, the conjunctions Venus–Earth and Jupiter–Earth are given for a period of 40 years. In the first column, the lower conjunctions of Venus are listed with any nearly coinciding conjunction of Jupiter, while in the second column the upper conjunctions of Venus are figuring with equally any nearly coinciding conjunction of Jupiter. The time difference between the conjunctions Venus–Earth and Jupiter–Earth has been equally noted, as these values are constituting the foundation of our forecasts.

It is readily seen from the table, that small values of time differences—corresponding to close conjunctions of the three planets—are almost coinciding with the years of maximum solar activity. In the second column, the years of close conjunctions are 1960 and 1938 (maxima of solar activity occurred in 1957 and 1937), while in the first column, we have close conjunctions in 1950 and 1927 (with maxima of solar

Table 1

Conjunction of Venus and Jupiter, 1924 to 1963

Lower conjunction of Venus		Time difference, days	Opposition of Jupiter (J. conj.)		Upper conjunction of Venus		Time difference, days	Conjunction of Jupiter (J. opp.)	
1962	12 Nov.	73	1962	31 Aug.	1963	30 Aug.	(– 39)	(1963	8 Oct.)
1961	10 April	(95)	(1961	5 Jan.)	1962	27 Jan.	– 12	1962	8 Febr.
1959	1 Sept.	(– 95)	(1959	5 Dec.)	1960	22 June	(2)	(1960	20 June)
1958	28 Jan.	– 79	1958	17 April	1958	11 Nov.	6	1958	5 Nov.
1956	22 June	(– 74)	(1956	4 Sept.)	1957	14 April	(28)	(1957	17 March)
1954	15 Nov.	– 61	1955	15 Jan.	1955	1 Sept.	28	1955	4 Aug.
1953	13 April	(– 42)	(1953	25 May)	1954	30 Jan.	(48)	(1953	13 Dec.)
1951	3 Sept.	– 30	1951	3 Oct.	1952	24 June	68	1952	17 April
1950	31 Jan.	(– 3)	(1950	3 Febr.)	1950	13 Nov.	(79)	(1950	26 Aug.)
1948	24 June	9	1948	15 June	1949	16 April	105	1949	1 Jan.
1946	17 Nov.	(17)	(1946	31 Oct.)	1947	3 Sept.	– 89	1947	1 Dec.
1945	15 April	33	1945	13 March	1946	1 Febr.	(– 71)	(1946	13 April)
1943	6 Sept.	(38)	(1943	30 July)	1944	27 June	– 65	1944	31 Aug.
1942	2 Febr.	56	1941	8 Dec.	1942	16 Nov.	(– 56)	(1943	11 Jan.)
1940	26 June	(76)	(1940	11 April)	1941	19 April	– 30	1941	19 May
1938	20 Nov.	91	1938	21 Aug.	1939	5 Sept.	(– 22)	(1939	27 Sept.)
1937	18 April	– 88	1937	15 July	1938	4 Febr.	6	1938	29 Jan.
1935	8 Sept.	(– 80)	(1935	27 Nov.)	1936	29 June	(19)	(1936	10 June)
1934	5 Febr.	– 62	1934	8 April	1934	18 Nov.	22	1934	27 Oct.
1932	29 June	(– 58)	(1932	26 Aug.)	1933	21 April	(43)	(1933	9 March)
1930	22 Nov.	– 45	1931	6 Jan.	1931	7 Sept.	44	1931	25 July
1929	20 April	(– 25)	(1929	15 May)	1930	6 Febr.	(65)	(1929	3 Dec.)
1927	10 Sept.	– 12	1927	22 Sept.	1928	1 July	85	1928	7 April
1926	7 Febr.	(13)	(1926	25 Jan.)	1926	20 Nov.	(97)	(1926	15 Aug.)
1924	1 July	26	1924	5 June	1925	23 April	(– 78)	(1925	10 July)

activity in 1947 and 1928). In both cases, close conjunctions are separated from each other by a period of 22.4 years. This coincides with the wellknown Hale period of sunspots. It corresponds to a cycle length of 11.2 years. The time difference between immediately subsequent close conjunctions is equal to 10.4 and 12.0 years, respectively; this yields an average of 11.2 years. The fact that the actual average period length is still equal to only 11.1 years, could be explained by the circumstance that in the longer series of conjunctions, the two-fold value of 10.4 years (that is 20.8 years) is appearing with a greater frequency than the two-fold value of 12.0 years (that is 24.0 years). As a consequence of this discrepancy, the exact length of period may be assumed to be 11.067 years. However, this value could be only obtained by computing averages from at least 38 subsequent periods. In this case, we should encounter 11 times the value 20.8 years and 8 times the value 24.0 years. In fact, by studying a series of observations possessing a considerable length (1626.0 to 1957.9) we obtained a value of 11.063 years for the average length of solar cycles. From shorter series of observations, however, values around 10 or 12 years may be found.

Table 1 should be considered also from the view-point of the variation in the time-differences of conjunctions. We are interested not in the absolute magnitudes of these differences, but in the manner in which these values are decreasing in time. The decrease is not taking place linearly with time. This is a consequence of the fact that the orbits of planets are not circular, but elliptical ones. It is found that in cases, in which the differences are very *rapidly* decreasing, solar activity during the corresponding cycle is more pronounced. In the case of a *slow* decrease in the differences, the maximum of solar activity is found to be a weaker one. This circumstance is also determining the shape of the solar cycle. *It is suggested, that the strength of solar activity may be dependent on the rate of the decrease in the above-mentioned time differences.*

By using the principles discussed above, forecasts have been prepared for the years of maximum solar activity in the period 1831 to 1978 (figure 1). It has been found

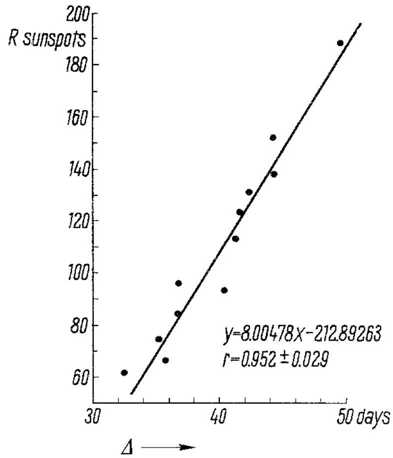

Figure 1
Trend of time differences (days) between conjunctions and the maximum number of sunspots, 1831 to 1960

that a strong correlation exists between the variation of time differences and the number of sunspots ($r = 95\%$).

As the second part of the present short communication, the prediction of cycle length is discussed, based equally on the variation of time differences (table 1). For this purpose, in place of the decrease of time differences, their increase in absolute values from the time of close conjunction is to be taken into account. *It appears that the length of the descending branch of the cycle may be depending on the value of this increase.* By calculating the values of these time differences, it is possible to obtain the times corresponding to the smoothed values of the minima of the given solar cycle. From the variation of time differences, not only the times corresponding to the smoothed values of the sunspot number are obtained, but there is also the possibility of obtaining from the time differences in the first column the time of the ending of the cycle, and from the time differences in the second column the time of the beginning of the new cycle. Results of these calculations are given in table 2. The average deviation between the calculated and the actually observed results is only equal to $\pm$ 0.2 years. There is a strikingly strong deviation in 1913; however, this year is belonging, even from the month of January, to the new cycle of solar activity.

Table 2
Maxima and minima of solar activity 1831 to 1978

Minimum			Maximum		
Observed	Calculated	Deviation	Observed	Calculated	Deviation
1833.9	1834.1	− 0.2	1837.2	1837.5	− 0.3
1843.5	1843.5	0.0	1848.1	1847.8	0.3
1856.0	1855.7	0.3	1860.1	1860.0	0.1
1867.2	1867.3	− 0.1	1870.6	1870.7	− 0.1
1878.9	1878.5	0.4	1883.9	1883.7	0.2
1889.6	1889.8	− 0.2	1894.1	1894.1	0.0
1901.7	1901.5	0.2	1906.4	1906.7	− 0.3
1913.6	1912.9	0.7	1917.6	1917.2	0.4
1923.6	1923.5	0.1	1928.4	1928.7	− 0.3
1933.8	1933.8	0.0	1937.4	1937.2	0.2
1944.2	1944.4	− 0.2	1947.5	1947.8	− 0.3
1954.3	1954.3	0.0	1957.9	1957.7	0.2
(1964.9)	1965.0	− 0.1		1968.4	
	1976.7				

Finally, an explanation could be offered for the fact that there is often a deviation of $\pm$ 2 or even $\pm$ 3 years between the time of close conjunction and the year of maximum solar activity. By considering the conjunctions of Venus and Jupiter (table 1), it is seen that, as a consequence of interference between the periods of 20.8 and 24.0 years, a discrepancy of 1.6 years might occur between the two columns of the table in the 11 year period. A further cause of the modification of cycle length resides in the differences in solar activity, this later factor being a function of the trend of time differences. When from the variation of time differences between the days of conjunction we are, according to the adopted method, obtaining higher values of sunspot numbers, the year of maximum solar activity is occurring earlier. When, on the contrary, the decrease in time differences is slower, then the occurrence of the year of maximum solar activity is delayed. As a consequence of these deviations, during the period 1831 to 1960 the lengths of solar cycles, counted from a maximum to the subsequent maximum of solar activity, include values between 8.9 and 12.7 years. This represents an amplitude of 3.8 years. On the other hand, if the cycle length is counted from minimum to minimum, we are obtaining values between 9.8 and 12.2 years. In this case, the amplitude is equal to 2.4 years. This means that the time differences between minima are of a more stationary behaviour. The same feature is valid for the cycle length when defined on the basis of minima of solar activity.

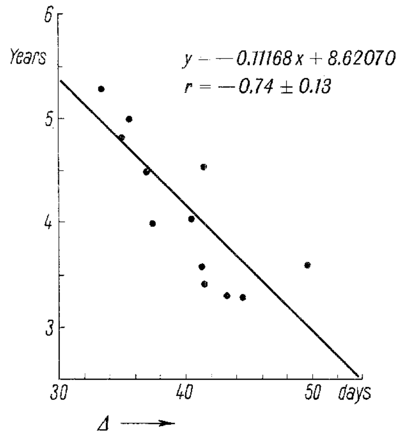

Figure 2
Relation between time difference (days) of conjunctions and the length of the ascending branch of the solar cycle, 1831 to 1960

As it appears that the maximum value of sunspot numbers could be calculated from the variation of time differences between conjunctions, it is concluded that this variation is related to the ascending branch of the solar cycle, too (figure 2).

In the present communication only the correlation concerning the maximum sunspot number and the length of the solar cycle is discussed. Of course, there exist, beside the main periods of 11 and 22 years, also other periods of greater or shorter lengths, respectively, *and they equally could be explained on the basis of planet conjunctions*. In calculating shorter periods, several other factors must be taken into account. This investigation and its preliminary results will be included in the full version of the present paper.

As the occurrence of planetary conjunctions can be calculated, with great precision, for hundreds and even thousands of years of the past, the possibility arises that sunspot observations from very remote periods could be compared [4]. From the conjunctions Venus–Jupiter–Earth, the existence of periods of cca 80, 200 and 400 years in solar activity could be expected. In centuries for which the close conjunctions, according the representation adopted in table 1, are showing in both columns two immediate successions of the time interval of 20.8 years, solar activity could be expected to be of great strength during several successive cycles, and at the same time, solar cycles should be expected to be shorter than 11 years. On the other hand, when time intervals of 20.8 and 24.0 years are occurring in an alternating way in both columns of the table, sunspot numbers should be lower, and the solar cycles should be longer. Thus, this method provides, by using theoretical calculations based on planet conjunctions, not only the possibility of making forecasts on the maximum and minimum numbers of sunspots, but also on the occurrence of the years of lowest and highest solar activity. Accordingly, the average number of sunspots for the year of maximum solar activity may vary within the limits of 30 and 200.

References

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