

THE TIME OF THE END OF THE CURRENT SOLAR CYCLE AND THE RELATIONSHIP BETWEEN DURATION OF 11-YEAR CYCLES AND SECULAR CYCLE PHASE

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We show that the duration of the solar 11-year cycles depends on the phase of the secular cycle. It generally grows over the period from the rising phase to the maximum and the descending phase. The likely duration of cycles 23—26 at the descending phase of the secular cycle will be about 11.2 ± 0.4 yr. Therefore, the minimum of the current 11-year cycle should occur in July 2007.

The eleven-year cycles of the solar activity, radius, and integral radiation flux are primarily defined by their duration and the heights of their maxima. These parameters are the important characteristics of the physical processes which are going on deep in the Sun [2]. The duration of the 11-year cycles varies from 9 to 13.4 yr.

General behavior and statistics of the 11-year activity cycles have not thoroughly been studied yet because of a small number of reliably studied cycles (there are only 13 such cycles). We also have no adequate physical model of their development with the secular changes taken into consideration. This hinders any reliable long-term prediction of the duration of the 11-year cycles.

We suppose that the secular cycle is a primary (parent) cycle which governs the whole solar activity [1] (Fig. 1), while the 11-year cycles are filial cycles of this secular cycle. The purpose of this study is to determine some possible common features of the well-studied 11-year cycles, to estimate their statistical parameters, and to reveal some regularities in their duration. The table gives some known data on cycles 1—23, which we took from study [3], and the corresponding phases of the secular cycle. Figure 2 demonstrates the duration of 11-year cycles P as a function of the secular cycle phase. There is a tendency for a general increase of the duration of 11-year cycles over the period from the rise to the maximum and descent in the secular cycle, although there also were several decreasing branches. With the unreliable data on cycles 1—9 excluded from consideration, this tendency is yet more pronounced. The duration of the descending branches of 11-year cycles depends on the secular cycle phase in the same way. So, the 11-year cycles at the descending phase of the secular cycle have a duration of about 11.2 ± 0.4 yr (the table), and they

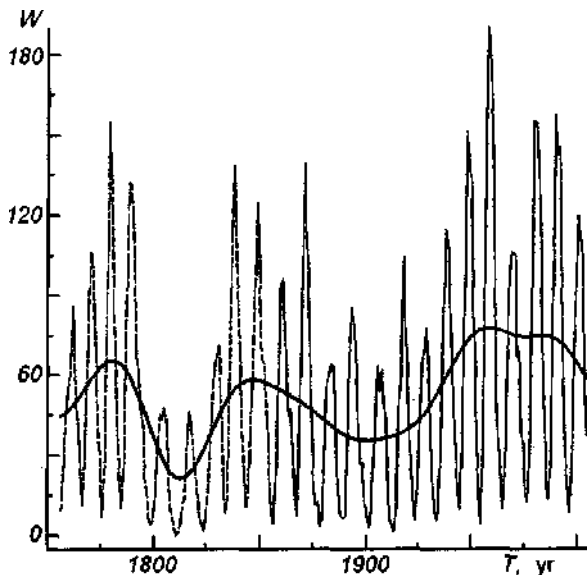


Fig. 1. Variations of the 11-year sunspot activity in cycles 1—23 and its secular changes (W is the Wolf number): solid line) cycles 10—23, for which reliable data are available, dashed line) cycles 1—9, for which only casual observations are available.

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Durations of Cycles 1—23 and Corresponding Phases of the Secular Cycle

Cycle number	Beginning of the cycle (year and month)	Duration		Secular cycle phase			
		of the cycle, yr	of the descending branch, yr	rise	maximum	descent	minimum
1	1755 March	11.25	5.00	0.7			
2	1766 June	9.00	5.75	0.9			
3	1775 June	9.25	6.33		0.4		
4	1784 Sept.	13.67	10.25			0.3	
5	1798 May	12.25	5.50			0.7	
6	1810 Aug.	12.75	7.08	0.2			
7	1823 May	10.50	4.00	0.5			
8	1833 Sept.	9.67	6.33	0.8			
9	1843 July	12.42	7.83		0.7		
10	1855 Dec.	11.25	7.08			0.3	
11	1867 March	11.75	8.33			0.6	
12	1878 Dec.	11.25	6.25			0.8	
13	1890 March	11.83	8.00				0.2
14	1902 Jan.	11.58	7.50				0.7
15	1913 Aug.	10.00	6.00	0.1			
16	1923 Aug.	10.08	5.42	0.3			
17	1933 Sept.	10.42	6.83	0.6			
18	1944 Feb.	10.17	6.92	0.8			
19	1954 Apr.	10.50	6.58		0.2		
20	1964 Oct.	11.67	7.58		0.4		
21	1976 June	10.25	6.75		0.7		
22	1986 Sept.	9.75	6.83		1.0		
23	1996 June	11.2+0.4?				0.3	
Average (cycles 10—22)		10.81	6.93				
Average duration of cycles, yr (cycles 10-22)				10.17	10.54	11.42	11.70
Average duration of descending branches, yr (cycles 10—22)				6.29	6.93	7.22	7.75

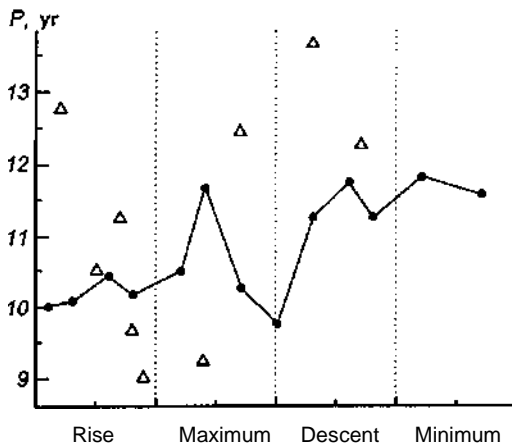


Fig. 2. Duration of 11-year cycles as a function of the secular cycle phase: triangles – cycles 1—9, dots – cycles 10—22.

are ordinarily longer than the cycles at the rising and maximum phases of the secular cycle.

The above data can also explain a tendency for a decrease of the average duration of the last eight cycles 15—22 (which developed at the rising and maximum phases of the secular cycle) down to $P = 10.4$ yr [4] as compared to the average duration $P = 10.81$ yr of the last 13 cycles, for which reliable data are available. The obtained relationship allows us to predict not only the duration of the current cycle but also the durations of the subsequent cycles 24—26, which will be formed during the descent of the current secular cycle. The minimum of the current cycle 23 is most likely to come in July 2007 (or in the period between February 2007 and December 2007). The succeeding cycles 24, 25, 26, and 27 are expected to begin in August 2007, October 2018, November 2029, and December 2040, respectively.

Thus, the duration of 11-year cycles depends on the secular cycle phase and generally grows over the period from the rising phase to the maximum and descending phases of the secular cycle. This fact proves once again that the 11-year cycles are genetically related to the secular cycle and that the secular cycle determines the regularities in the development of the filial 11-year cycles.

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