

COMPREHENSIVE SOLAR FLARE INDICES AND DURATION OF H-ALPHA FLARES

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ABSTRACT. Table 1 gives the mean values of the duration of H-alpha flares as a function of their importance and subdivision by comprehensive flare index. The results were computed using data on 460 flares, observed in the years 1970-1974, and 561 flares, observed in the years 1975-1979. The flare data were selected from extensive records of large flares, published by Dodson et al. (1975, 1980). Flares accompanied by a type IV radio burst produce electrons of higher velocities than flares accompanied by type II radio bursts. Table 1 indicates that the mean duration (D) of the same importance class of flares related to type II radio bursts is shorter and has a smaller standard deviation (S.D.) than the flares related to type IV radio bursts.

ОБЩИЕ ПОКАЗАТЕЛИ СОЛНЕЧНЫХ ВСПЫШЕК И ДЛИТЕЛЬНОСТЬ СВЕЧЕНИЯ ВСПЫШЕК В Н-АЛЬФА. В таб. 1 приведены данные о средней длительности свечения вспышек в Н-альфа, для подраспределения вспышек по их мощности и общему показателю. Результаты были получены на основе исследования 460 вспышек наблюдаемых в 1970-1974 гг. и 561 вспышек наблюдаемых в 1975-1979 гг. Данные о больших вспышках были приведены в списках Додсон и др. (1975, 1980). Вспышки сопровождающиеся радиовсплесками IV типа, являются источниками электронов с более высокой скоростью по сравнению со вспышками связанными с радиовсплесками II типа. Результаты приведенные в таб. 1 показывают, что для вспышек не отличающихся по мощности, получается средняя длительность свечения в Н-альфа (столбец D) и ее дисперсия в случае II типа ниже, чем в случае IV типа. Результат показывает на связь между степенью ускорения электронов и длительностью свечения вспышки в Н-альфа.

CELKOVÉ INDEXY ERUPCIÍ A DĚŽKA TRVANIA H-ALFA ERUPCIÍ. V tab. 1 sú uvedené stredné hodnoty dĚžky trvania H-alfa erupcií ako funkcia ich importancií a podrozdelenia podľa celkového indexu. Výsledky boli vypočítané z údajov pre 460 erupcií, pozorovaných v rokoch 1970-1974 a 561 erupcií z rokov 1975-1979. Údaje o erupciách boli vybrané z rozsiahlych zoznamov veľkých erupcií, publikovaných Dodson et al. (1975, 1980). Erupcie sprevádzané rádiovým zábleskom typu IV produkujú elektróny vyšších rýchlostí, v porovnaní s erupciami sprevádzanými rádiovými zábleskami typu II. Z tab. 1 plynie, že stredná dĚžka trvania H-alfa erupcií (D) má menšiu hodnotu i rozptyl (S.D.), ak erupcie tej istej importancie sú sprevádzané rádiovým zábleskom typu II, v porovnaní s typom IV. Výsledok naznačuje súvislosť medzi dĚžkou trvania H-alfa erupcií a mierou urýchlenia elektrónov.

1. INTRODUCTION

The individual flares differ from one another considerably in many parameters. The relations between the individual parameters are still not quite clear. The magnetic field, its configuration and the conditions for generating current layers at various levels of the solar atmosphere probably play an important part. The variability in the spectral abundance of emissions, generated during a flare, led to the introduction of profiles and comprehensive flare indices (Dodson et al., 1975).

The duration of H-alpha flares reflects the quantitative as well as the altitude variation of the gradual phase of the flare. Observations of flares in the H-alpha are not suitable for determining the time and place of the primary energy release, the so-called impulsive phase of the flare. The emission most suitable for studying the impulsive phase is the hard X-radiation. Transformation processes take place after the energy has been released in the course of the gradual phase and can be analysed not only using the H-alpha, but also other emissions, e.g. soft X-rays.

The analysis of observational data indicates that the duration of H-alpha flares varies considerably. Smith (1962) gives the mean duration of H-alpha flares as a function of importance:

Importance	1	25 mins
	2	55 mins
	3 - 4	120 mins

The purpose of this study is to determine the mean values of the duration of H-alpha flares in dependence on the flare profile. Flares with a high comprehensive index play an important part in the overall production of the short-wave, radio, as well as corpuscular emission.

2. OBSERVATIONAL DATA AND THEIR ANALYSIS

The basic observational data on the flare parameters were adopted from

records of "large" flares (Dodson et al., 1975, 1980). The only criterion for selecting and processing a flare was the condition that the beginning and end of the H-alpha flare had to be known precisely. In the lists, these flares are distinguished from those with less accurate data by the times of the beginning and end of the flare being underlined. For each "large" flare, Dodson et al. (1975, 1980) constructed a flare profile which contains data on the X-ray, H-alpha and dynamic radio spectrum of the flare in terms of five numbers.

On the whole, 460 flares observed in 1970-1974 and 561 flares observed in 1975-1979 were selected and processed. The results are given in Tab. 1. Column 4 of this table contains the mean durations of the H-alpha flares by their importance. Column 5 gives the standard deviation of the mean value. Columns 6 - 8 contain flare data related to type IV radio bursts. Columns 9 - 11 contain the flare data related to type II radio bursts.

Table 1
The mean duration (D) of the H-alpha flares

Years	Imp	All flares			with type IV			with type II		
		N	D	S.D.	N	D	S.D.	N	D	S.D.
1970-74	SF	29	20	12	14	23	15	13	15	6
1975-79	SF	71	27	18	11	19	14	24	33	22
1970-74	SN	128	28	16	62	29	19	44	25	12
1975-79	SN	134	30	21	17	35	17	29	27	26
1970-74	SB	47	27	17	15	30	23	19	19	7
1975-79	SB	59	33	29	8	43	35	29	27	24
1970-74	1N	91	55	31	30	64	40	35	50	23
1975-79	1N	105	49	27	26	61	32	23	36	22
1970-74	1B	93	55	32	40	66	34	14	40	19
1975-79	1B	87	54	39	18	59	54	16	35	21
1970-74	2N	32	71	36	7	64	30	3	67	4
1975-79	2N	44	63	29	11	92	27	2	66	8
1970-74	2B	40	83	45	18	96	51	5	73	30
1975-79	2B	52	92	67	21	139	79	9	64	40
1975-79	3B	9	201	151						

Remarks:

N - Numbers of selected flares

D - The mean duration of flares in minutes

S.D. - Standard deviation of the mean duration D, in minutes

Type II metre radio bursts, frequently observed to accompany large fla-

res, indicate the occurrence of shock waves in the corona and the acceleration of electrons to non-relativistic velocities. Type IV radio emissions indicate electron acceleration to relativistic velocities (Chupp et al., 1982, Mullan, 1983). Flares which produce solar cosmic radiation (E in excess of 20 MeV) display a high degree of correlation with type IV radio bursts (Kahler, 1982). Subgroups of flares associated with type II and IV radio bursts were established, using the observational material, with respect to the different final velocities of the electrons accelerated during the flares. It should be pointed out that the type IV burst may lag a few minutes behind the type II burst (Kahler, 1982); this would be evidence of the prolongation of the mechanism of electron acceleration in flares as compared to the cases in which only type II bursts were recorded.

3. RESULTS

Apart from the expected direct dependence of the flare importance on its duration, one should notice the large scatter in all the calculated values. The accuracy in determining the mean duration of H-alpha flares could possibly be increased by stricter determination of the burst importances.

The most significant result of this study is the finding that the mean duration of the H-alpha flares, associated with type II radio bursts, is shorter than of the flares of the same importance which are accompanied by type IV bursts. The results indicate a relation between the duration of the H-alpha flare and the degree of electron acceleration.

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