DYNAMICS OF LOCAL SOURCES IN CM-WAVE RANGE ACCORDING TO OBSERVATIONS WITH THE RATAN-600 TELESCOPE BY THE "RELAY TECHNIC" (JULY 1981)

O.A. Golubchina
Special Astrophysical Observatory Ac. Sci. USSR,
196140 Leningrad, USSR

ABSTRACT. Solar emission observations on July 24 and 31, 1981, with RATAN-600, have demonstrated the possibility of finding sympathetic bursts. H--alpha flares always displayed as the increase of relative fluxes of local sources nonpolarized emission in cm-wave range. The correlation of solar emission was also recorded in soft X-rays and at wave length 2.3 and 4.5 cm. H-alpha flares as well as the increase of relative fluxes of local sources at wave length 2.3 and 4.5 cm occured by series (July 31, 1981).

ДИНАМИКА ЛОКАЛЬНЫХ ИСТОЧНИКОВ В САНТИМЕТРОВОМ ДИАПАЗОНЕ ДЛИН ВОЛН В ИЮЛЕ 1981 ГОДА ПО НАБЛЮДЕНИЯМ НА РАДИОТЕЛЕСКОПЕ РАТАН-600 МЕТОДОМ "ЭСТАФЕТЫ": Наблюдения радиоизлучения Солнца, 24 и 31 июля 1981 г.,показали возможность обнаружения симпатических всплесков на РАТАН-600. Н-альфа вспышки, обязательно проявлялись в виде повышения относительных потоков неполяризованного излучения локальных источников в см-диапазоне волн. Отмечена корреляция излучения Солнца в мягком рентгене и на волнах 2,3 и 4,5 см. 31 июля 1981 г. как Н-альфа вспышки так и повышение относительных потоков локальных источников на волнах 2,5 и 4,5 см происходили сериями.

DYNAMIKA LOKÁLNYCH ZDROJOV POZOROVANÝCH NA SLNKU V JÚLI 1981, RÁDIOVÝM ĎALEKOHĽADOM RATAN-600, METÓDOU "ŠTAFETY", V INTERVALE CENTIMETROVÝCH VLNOVÝCH DĹŽOK: Pozorovania slnečnej emisie na RATANE-600, 24. a 31. júla 1981, svedčia o existencii "sympatických" (kvazisynchrónnych) impulzov emisie. H--alfa erupcie sa prejavovali ako vzrast relatívneho toku lokálnych zdrojov nepolarizovanej emisie na centimentrových vlnových dĺžkach. Korelácia slnečnej emisie bola zistená pre mäkké röntgenové žiarenie a pre vlnové dĺžky 2,3 a 4,5 cm. H-alfa erupcie podobne ako aj zvýšenie relatívneho toku lokálnych zdrojov pre vlnové dĺžky 2,3 a 4,5 cm sa vyskytovali 31. júla 1981 v sériách.

The study of the local sources (l.s.) development is one of the actual problems in solar radio astronomy which permits to examine rapidly changing solar processes, in particular, such as the burst 1 phenomenon. The introduction of the "Relay technic" to the RATAN-600 permited to obtain scans of solar radio emission often enough (ΔT = 14 min.) within 4-6 hours.

This paper deals with the l.s. dynamics on July 24 and 31. On those days an extremely high solar activity was recorded. We have compared the changes of l.s. relative fluxes (Fi/Fo) with the time of fluxes in H_α bursts recorded in the integral solar radio emission and solar emission at X-rays range (10, 11). Simultaneously according observation changes of July 24 the finding of synchronous changes in the l.s. emission at λ = 2.3 and 4.5 cm was carried out.

A number of papers in optical and radio ranges (1-9) is devoted to the synchronous changes phenomenon of the brightness in active solar regions. Great methodical difficulties in revealing real existing sympathetic flares and bursts in the first place are resulted in scant information of observation data and some contradictions to these events. The first results of finding synchronous changes of l.s. emission intensity identified with different groups of sunspots at the two wave lengths simultaneously (2.3 and 4.5 cm) according to data observations with RATAN-600 by the "Relay technic" are given in our paper.

The spatial resolution of the telescope was ρ = 1!1 x 16!8 at λ = 2.3 cm and ρ = 2'x27!2 at λ = 4.5 cm. The observation programme is aimed at the successive solar radio emission scans obtaining in every 14 minutes. The radiometers sensitivity is ΔT = 1-2 °K at λ = 2.3 and 4.5 cm.

The Fi/Fo curve was drawn to revealing l.s. synchronous bursts. On July 24 one observation seance of 13 solar radio emission scans was carried out. The observation interval was 03:20 = 06:50 UT. Within that period the Sun was characterised by high activity: radio bursts and flares in H_α and intensity changes in X-ray emission were observed.

Solar radio recording process technic for revealing synchronous changes in the l.s. non-polarized intensivity is as follows:

1. the antenna setting quality fixed in the observation journal for obtaining every examining scan is defined;
2. the solar disc picture for the elimination of "confusion" effect is analysed;
3. the procedure of the "quiet" Sun revealing is carried out;
4. the l.s. identification with sunspots groups is carried out;
5. the areas under the l.s. curves proportional to emission fluxes from l.s. and the areas under the "quiet" Sun curves proportional to the emission flux from the "quiet" Sun (Fi an Fo respectively) are measured;
6. time dependence of Fi/Fo curve is drawn;
7. the comparison of the moments increasing of relative fluxes with maximum flare moments in H_α, radio bursts and the emission behaviour of the X-ray (10, 11) is carried out.

The absence of the obligatory performance of every enumirated processing points may result in the appearence of false increasings or depressions in the l.s. emission.

Let us consider a short list of processing technic points:

1. the setting antenna quality control is necessary as the antenna temperature of a discrete source is $T_A \sim N^2$ (N - number of reflecting elements of the antenna working part and for the "quiet" Sun $T_{A0} \sim N$. Therefore the decreasing of N of the antenna working part will tell differently on the antenna temperature of l.s. and "quiet" Sun, that, in its turn, may result in false increasing or decreasing in l.s. emission. The antenna stability was checked according to the Crab Nebulae with help of high sensitivity radiometers $\Delta T = 0.015$ ^oK, $\tau = 1$ sec., $\lambda = 3.9$ cm in the four nearest azimuths: A = 255°, 257°, 259°, 262°. The repeatability is of some hundredths degree fractions of the antenna temperature (Tab. 1).

Table 1

The antenna temperatures of the Crab Nebulae in four nearest azimuths. (K_λ Fi(λ)).

A	U. T.	T_A, °K	K_λ
255°	$23^h41^m.5$	4.63	0.341
257°	$23^h54^m.0$	4.62	0.345
259°	$00^h06^m.5$	4.57	0.355
262°	$00^h25^m.0$	4.61	0.346
		4.61 ± 0.02	0.346 ± 0.006

2. The aereal directivity diagram (a.d.d.) is of a knife form, which in the observation process is turned to the diurnal parallel (Fig. 1, 2). The directivity diagram turn may result in the "confusion" effect. i.e. the simulteneous entry in the a.d.d. of different local sources. To eliminate this factor it is necessary to control the identity of every following scan with the preveous one.

3. The revealing of the "quiet" Sun is the most vulnerable processing procedure as the conpution of the "quiet" Sun is not quite determined itself. In the given observation series the "quiet" Sun level revealed along solar parts free from any active formations according to photoheliograms for a given observation day. Under these circumstances we tried to preserve the similarity of the "quiet" Sun form in all records using the proportionally coefficient for every scan concerning the base scan. At $\lambda = 4.5$ cm this procedure has been success for all the scans, at $\lambda = 2.3$ cm the two forms of the "quiet" Sun were used successively which is marked by a dotted line (Fig. 3). The accuracy of the definition of the area under the "quiet" Sun curve is of 1-2 %. The area definition accuracy under the l.s. curve is of 2 %.

On Fig. 3 synchronous increasing or relative fluxes are seen at one or at the both waves in one or in the both A and B l.s. identified with the groups No. 323 + 325 and 329 correspondently. Thus the observation No 10 has

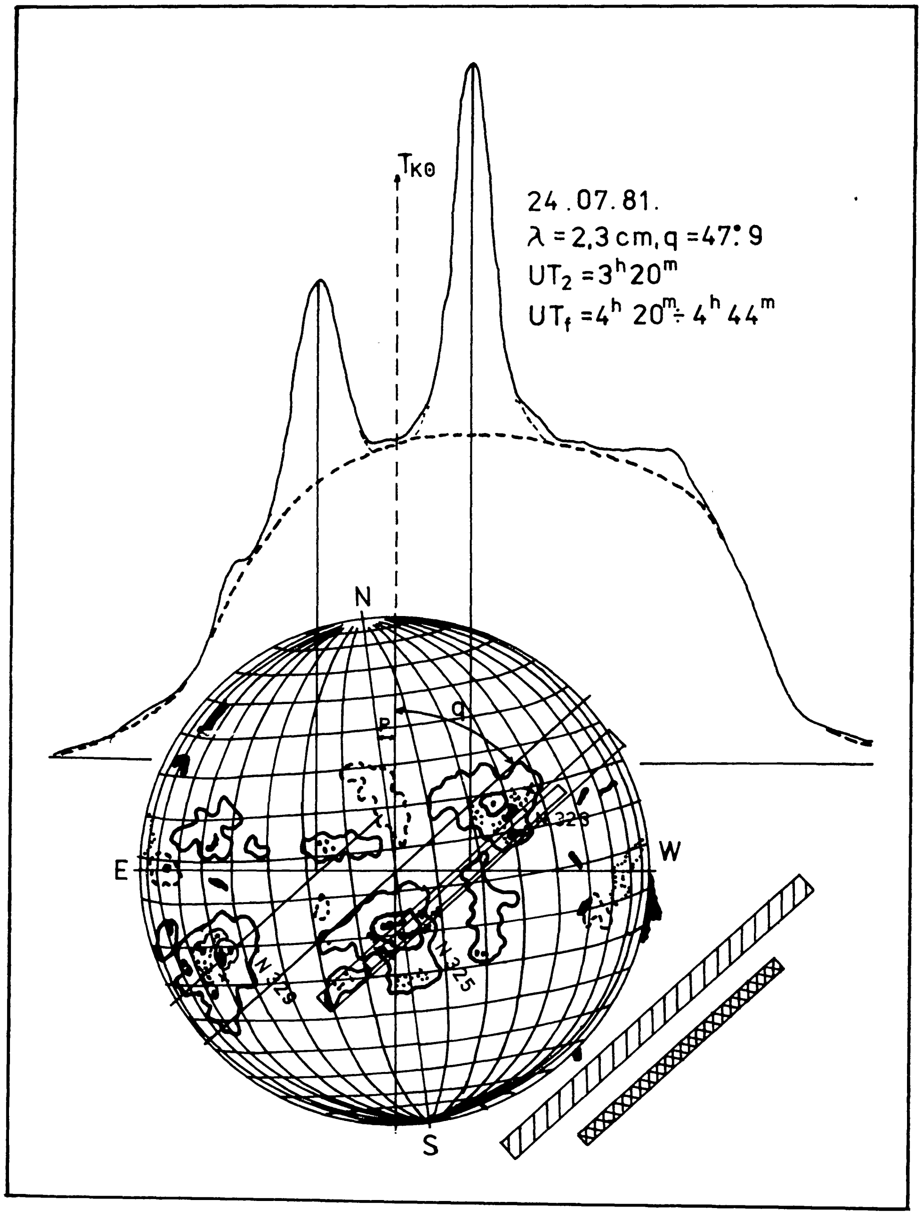

Fig. 1: The scan of the Sun at $\lambda = 2.3$ cm and the photoheliogram 24.07.81

/////// - the diagram of the antenna at $\lambda = 4.5$ cm;

XXXXXXX - the diagram of the antenna at $\lambda = 2.3$ cm;

UT_2 - the time of the radio observation,

UTf - the time of the optical observation.

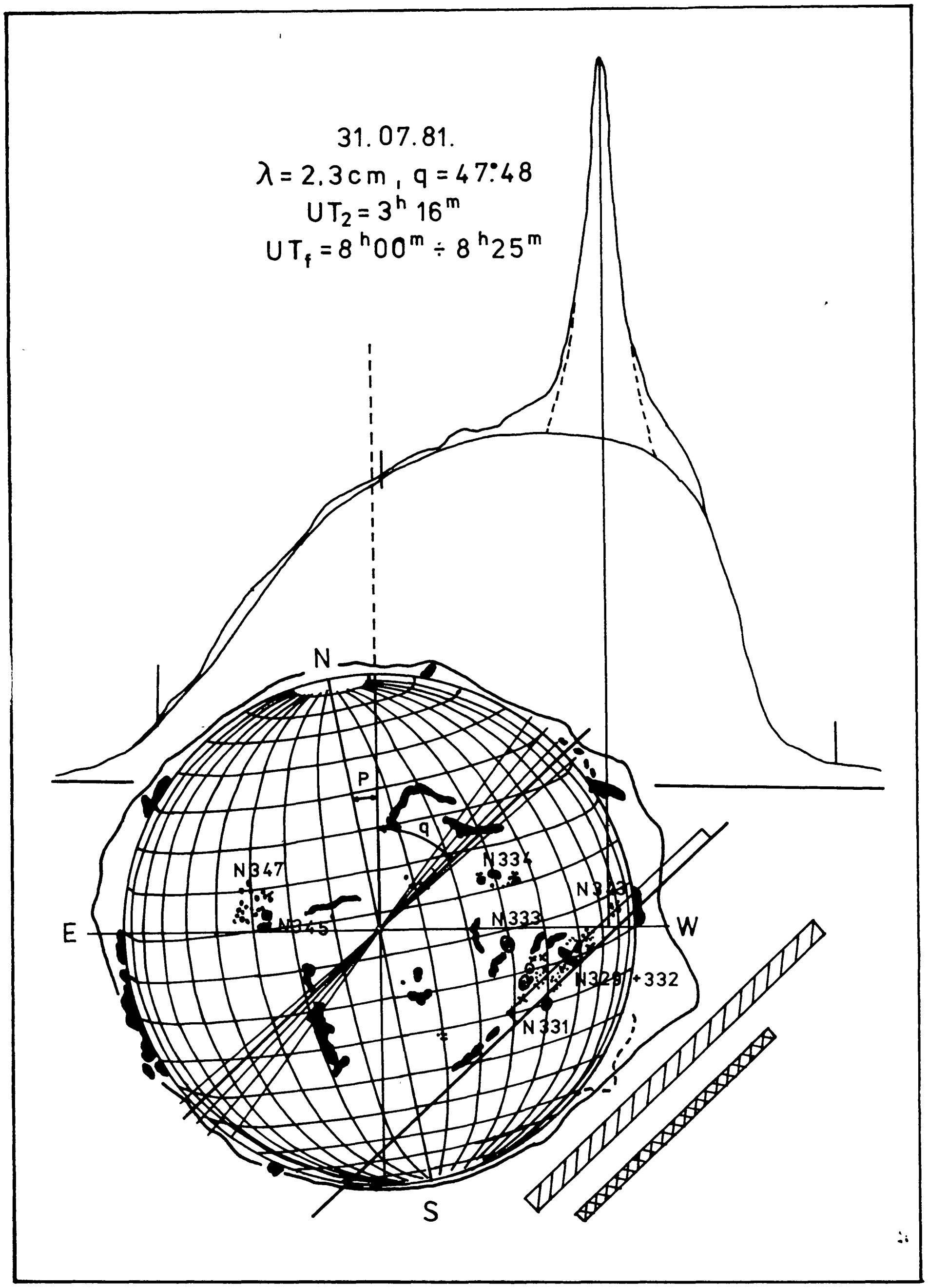

Fig. 2: The scan of the Sun at λ = 2.3 cm and the photoheliogram 31.07.81

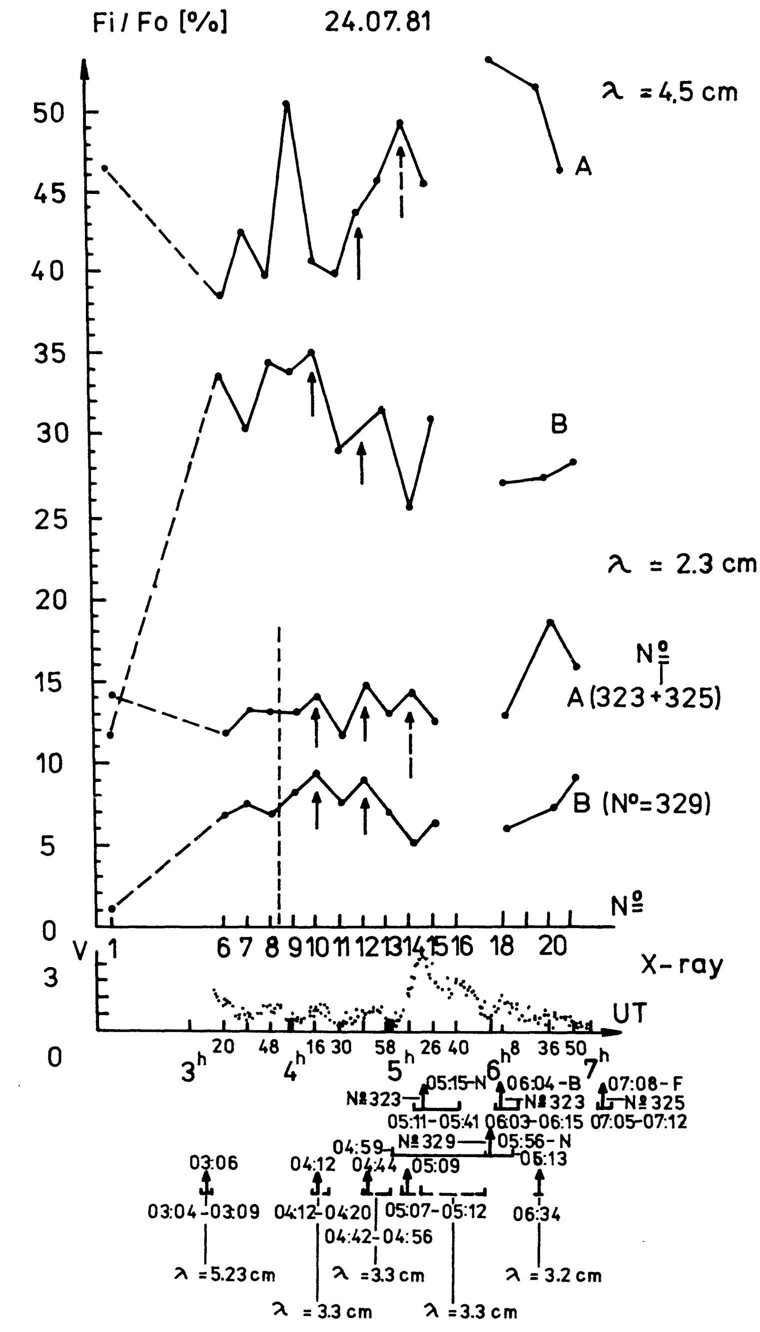

Fig. 3: The dependence of relative fluxes of l.s. (A,B) with the time at λ = 2.3 cm, λ = 4.5 cm (24.07.81). - the time interval of the H_α -flare (SGD); - the time interval of the bursts (SGD); ..... - X-ray (Prognoz Data-8).

revealed the synchronous increasing of relative fluxes of l.s. A and B at λ = 2.3 cm and in B source only at λ = 4.5 cm.

We want to note that the intensive increase of the relative flux is ~10% (N = 9) in A source accured 14 minutes earlier and was no displayed neither in flares observations in H_α nor in X-ray range. The increase of the relative flux in the observation No 12 displayed on the both wave lengths and in the both l.s. It should be noted that theseboth synchronous phenomena may be regarded as sympathetic bursts. The bursts at λ = 2.3 cm (10) were recorded in the integral solar radio emission in the time close to our observation No 10 and No 12. According to Tab. 2 it is seen that the closer the observation time to the moment of the burst maximum recorded by the solar radio emission service, the more relative flux increasing that is evidence to the reality of relative flux increasing.

Table 2

The difference (ΔT) between the time of our observation and T_{max} of the burst or the H_α-flare and the change of relative fluxes at that time (Δ(Fi/Fo)).

No	λ = 2.3 cm			λ = 4.5 cm		
		Δ(Fi/Fo)%			Δ(Fi/Fo)%	
	ΔT	(A)	(B)	ΔT	(A)	(B)
10	4^m00^s0	1.2	1.2	3^m55^s3	1	1.2
12	0^m14^s4	3.4	1.8	0^m16^s8	4	1.3
14	2^m30^s0	1.5		2^m34^s7	3.6	
	3^m30^s0			3^m25^s3		

Near the observation No 14 flares in H in 323 and a burst at λ = 3.3 cm were recorded. According to our data relative fluxes increase was observed on the both waves of λ = 2.3 and 4.5 cm, but just in a l.s., identified with Nos 323 + 325 groups.

The increase of relative l.s. fluxes in the observations 10, 12 in which sympathetic bursts dispays were probably recorded are 1,2 + 3,4 % at λ = 2.3 cm and 1 - 4 % at λ = 4.5 cm. The relative fluxes of A and B l.s. emissions are 30 - 40 % from F_0 at λ = 4.5 cm and 7 - 12 % from F_0 at λ = 2.3 cm respectively (F_0 = 260 s.u., λ = 2.3 cm; F_0 = 145 s.u., λ = 4.5 cm) The l.s. amplitude change with the time in connection with regarding the possibility of sympathetic bursts finding with radio telescope RATAN-600 can be seen in Fig. 4 at λ = 2.3 cm for three moments of observation time (the records are reduced to the scan N = 10 scale).

The comparison of the flares moments in H_α and those of l.s. relative fluxes in cm range are also carried out for the observation on July 31, on the day of solar eclipse extremely high solar activity was observed. The dependence of relative fluxes of l.s. nonpolarized emission with the time obtained during observations at λ = 2.3 and 4.5 cm are given in Fig. 5. Here we can also

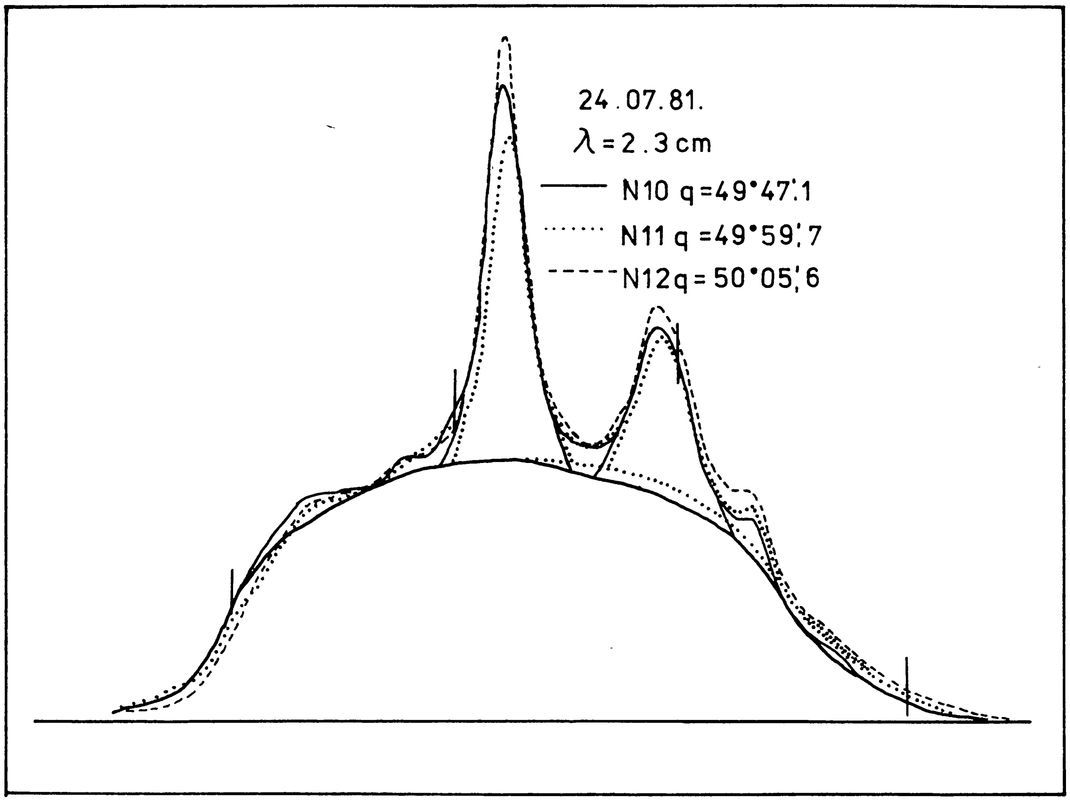

Fig. 4: The scans of the Sun at λ = 2.3 cm (24.07.81)

—— the scan of the observation No 10,

..... the scan of the observation No 11,

----- the scan of the observation No 12.

see time intervals of the flares in H_α (10) and the dependence of the emission intensity in X-ray range can be traced (11).

As it is seen in Fig. 3, 5 the correlation of flares in H_α and the increases of l.s. relative fluxes at cm-range are observed. The correspondence of relative emission fluxes and X-ray emission behaviour shoul be noted. Solar flare activity displaying on July 31 occured ununiformly or occasionally but by series. The same was noted in the behaviour of Fi/Fo of l.s. at cm-range.

Thus the given solar observations on July 24 showed the possibility of sympathetic burst displaying with RATAN-600 and the reality of finding such phenomenon simulteneously at two cm- wave lengths.

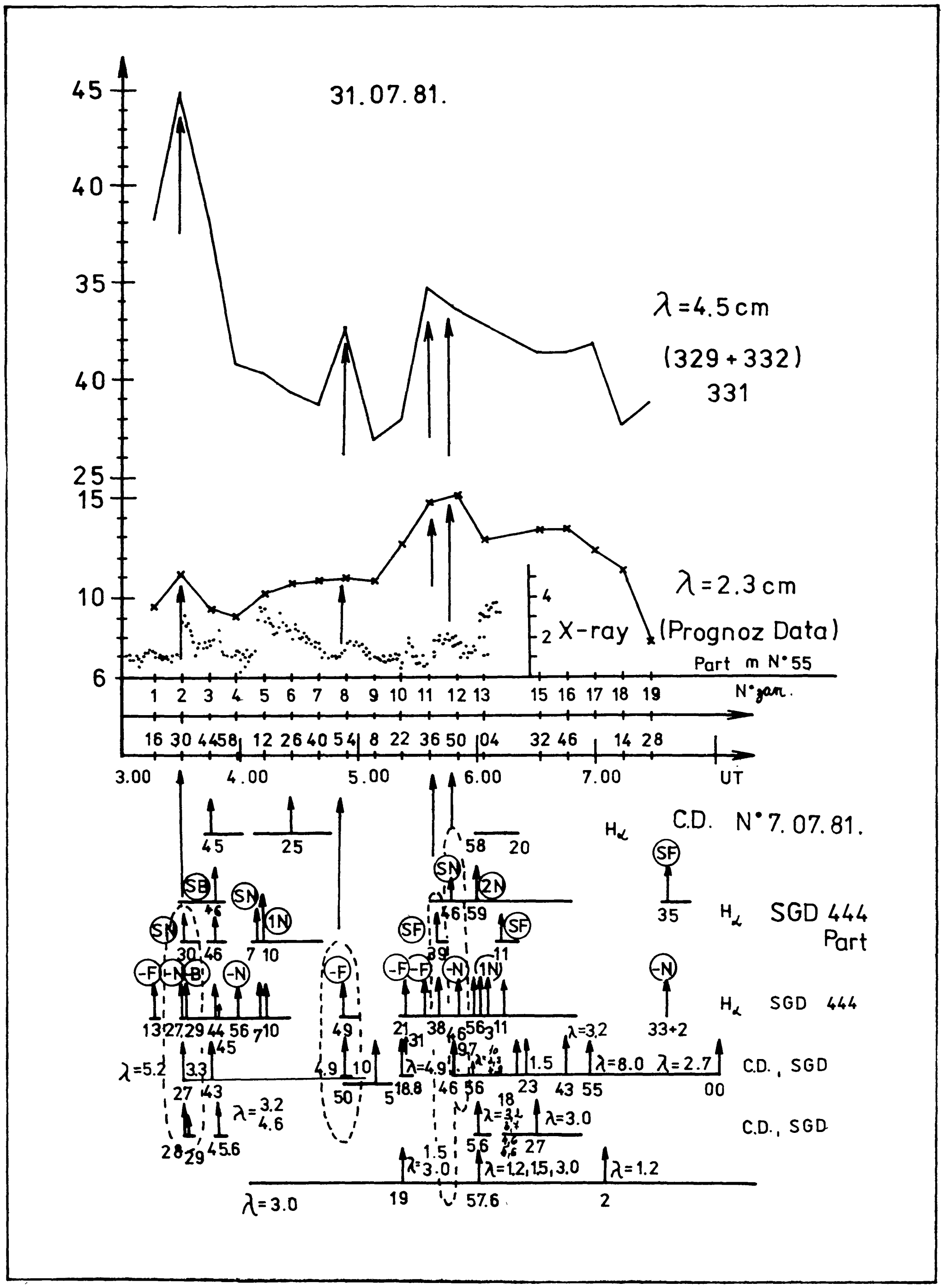

Fig. 5: The dependence of relative fluxes of l.s. with the time at $\lambda = 2.3$ cm, $\lambda = 4.5$ cm (31.07.81)

____ - the time interval of the H_α-flare (SGD)

---- - the time interval of the burst (SGD)

.... - X-ray (Prognoz Data-8)

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