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HOMOLOGOUS AND HOMOLOGOUS LIKE MICROWAVE SOLAR RADIO BURST

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RESUMO. Foram feitas observações solares em rádio frequência de 1.6 GHz, no mês de julho de 1985, usando-se a antena de 13,7 m de diâmetro de Itapetinga, com resolução de 3 ms. Bursts Homólogos com duração total de dois segundos, repetindo-se por alguns segundos, foram observados, associados com Flares Homólogos em H- . Estes flares em H-α possuem periodicidades de aproximadamente 40 min. Periodicidades longas têm sido atribuídas à oscilações de proeminências, e pequenos períodos podem ser atribuídos à remoção de plasma da zona de interação de campo. Foram observados também eventos Homólogos-Like. Estes eventos possuem pico - duplo com alguns perfis temporais repetindo-se no tempo. Em adição a isto, a razão da duração total do evento para a diferença do tempo entre os picos, permanesce constante.

ABSTRACT. Solar radio observations at 1.6 GHz were carried out in the month of July, 1985 by using 13.7 m diameter Itapetinga antenna with time resolution of 3 ms. Homologous Bursts, with total duration of about couple of seconds and repeated by some seconds were observed associated with Homologous H-α flares. These H- flares were having periodicities of about 40 min. Observed long periodicities were attributed to oscillation of prominences, and small periods were attributed to removal of plasma from the field interaction zone. Also observed are "Homologous-Like" bursts. These bursts are double peak bursts with same time profile repeating in time. In addition to this, the ratio of the total duration of the bursts to time difference in the peaks of bursts remain constant. Morphological studies of these bursts have been presented.

Key words: SUN-BURSTS — SUN-FLARE

I. INTRODUCTION

Homologous flares in H-α and multiwavelength observations have been investigated and reviewed in detail recently by Marters (1989). In fact there are very few joint studies of H-α and associated microwave homologous flares. Very scanty microwave homologous bursts have been reported (Urpo, 1983 Nakajima et al. 1985). We are for the first time reporting observations of extremely weak homologous microwave (1,6 GHz) activity observed so far and discuss their interpretation in terms of conventional suggestion viz. exciter reaching same level to produce repeated homologous bursts. Here we try to explain long and short repetition rate of homologous microwave flare by the model suggested for decrease of prominence oscillations in relation to occurrence of H-α flares.

II. OBSERVATIONS

Solar microwave observations at 1,6 GHz have been carried out in the month of July, 1985, by using Itapetinga 13,7 m diameter antenna. Preliminary observations including instrumentation have been reported elsewhere (Sawant et al., 1987). Here mainly we are reporting the observations of July 9, 1985.

Burst activity was started around 15:42:00 UT associated with H-α flare and this activity lasted for about four minutes and maximum flux of recorded burst was 4 s.f.u. (Figure 1). The observed burst at 1,6 GHz shows oscillatory trend with increasing period up to 5 sec. Associated with this also were weak hard X-ray bursts.

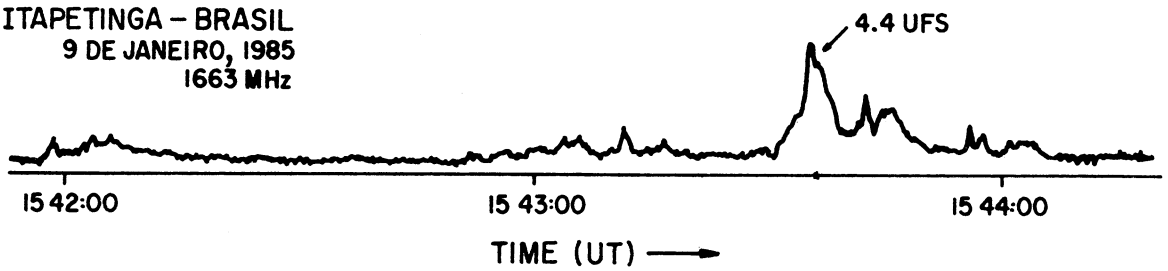

Fig. 1. Burst activity around 15:43 UT. Note oscillatory trend in the bursts.

After about one hour i.e. associated with homologous flare at 1646 UT, another burst activity started and lasted up to 1653 UT. Extremely weak bursts of various types were observed during this time interval. Maximum flux of one of the recorded bursts was 9 s.f.u. (Sawant et al., 1987). Figure 2 shows 5 examples of the observed homologous bursts with nearly total duration of each of them of 2 sec. exhibiting two peaks. Intensities of these bursts ranged between 0,5-1,3 s.f.u. and they were mostly unpolarized.

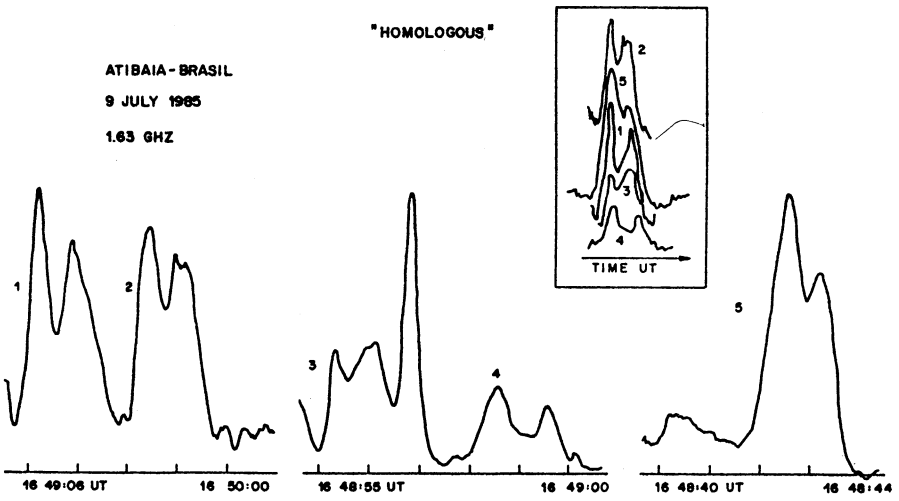

Fig. 2. Examples of homologous bursts. In the upper right inset, observed 5 bursts are put together to show similarity of time intensity plots.

III. HOMOLOGOUS LIKE BURSTS:

These are double peak bursts and are variants of homologous bursts. In case of homologous like bursts, ratio of total duration to time difference in the peak remains almost constant. Fig. 3(a,b) shows examples of these bursts and table 1 sumarizes principal characteristics of these bursts.

Table 1. "Homologous" Like Bursts

Time UT	Total Time (Tt)	Peak-Peak time (TPP)	Tt/TPP	
15 43:03	4800	2640	1,81	0,08
16 48:58	1800	1000	1,80	0,20
16 48:30	2300	1150	2,00	0,17
16 48:54	1600	800	2,10	0,23

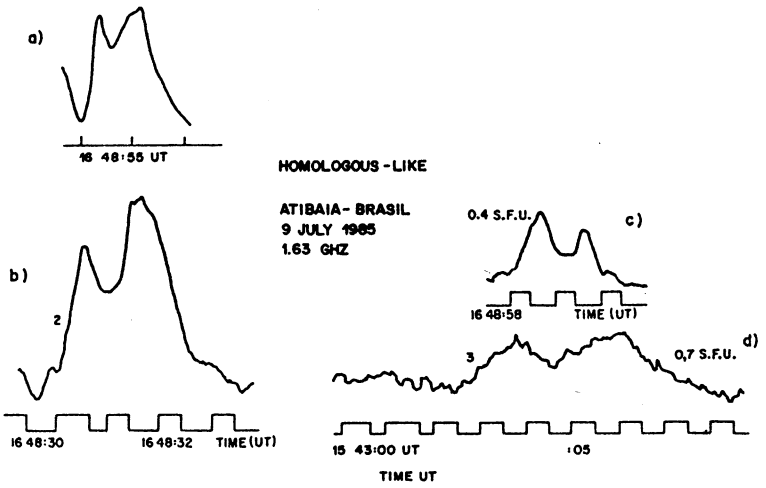

Fig. 3. Examples of "homologous like" bursts described in table I.

I. ASSOCIATED H-α OBSERVATIONS:

Flares were observed mostly associated with sunspot (4671) located around S19 W35. Fig. 4 shows sunspot observation. The sunspot group of 9th July consists of an old spot in north following part, a north-south chain of new spots in the preceeding part and some spots in the south-following parts. Magnetic field of old spot is of south polarity of 2700 gauss.

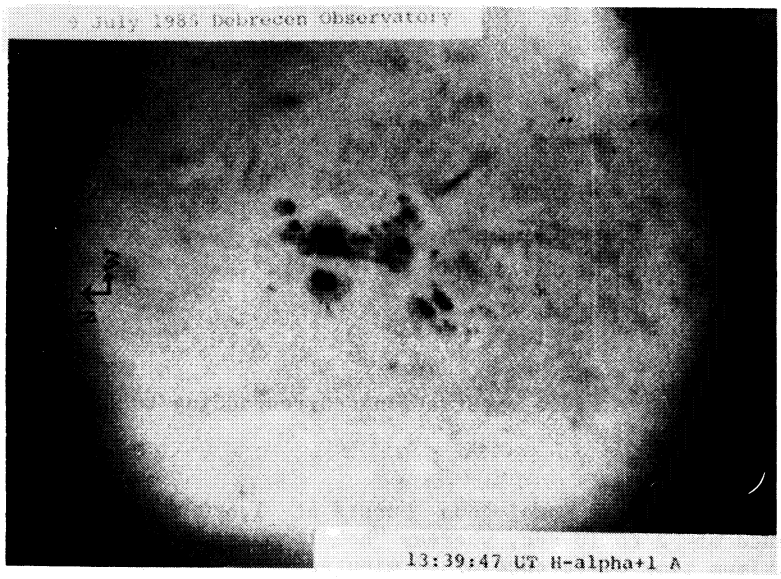

Fig. 4. Sunspot group.

In the new spot chain, field polarity is also south and values of the magnetic field ranged between 2000-2200 gauss. However, in the south-follower, largest spot field is of opposite polarity i.e. north and is 2300 gauss. Values of the magnetic fields have been obtained from Soviet Solar Data Bulletin.

The dimensions of the filaments are following. The main zero filament running north-south in the group is 42.000 km long. There is a curved filament at the north of the group having length of 84.000 km and there was activity between this active region and the active region to the northwest, situated nearly at a distance of 12.500 km.

As seen from Fig. 5, main homologous subflare activity was concentrated in the southern part of the middle of group, where new magnetic flux was emerging. Also on 9th July, the beginning of the interaction of the old spot with new spot has deformed the penumbra of these old spot, as seen from H-α pictures even though both parts are of same polarity. Four sub homologous flares, with time separtation of 40 to 50 minutes, were reported. The flares at 1342, 1425 and 1534 UT have been shown in fig. 4. Flare at 1646 UT is reported in solar geophysical data from the same region.

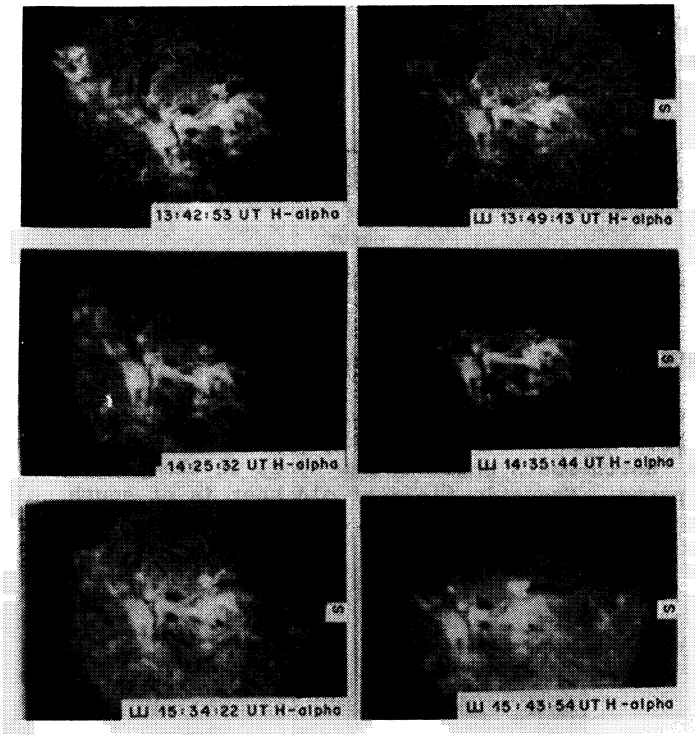

Fig. 5(a,b,c). Homologous flares as observed in the from top to bottom, at 1342; 1425 and 1534UT.

We have radio observations corresponding to 1543 and 1640 UT of H-α flares.

V. DISCUSSIONS

Microwave homologous bursts at 1,6 GHz were observed to be repeated with time difference of 2 to 10 sec, whereas "homologous-like" bursts associated with homologous flares have maximum time difference of 40 minutes.

Convensionally, radio homologous bursts are explained assuming that eletron exciter travelling along the magnetic field lines with the velocity 0,3C reaches same plasma level and generates radio emission at 2nd harmonic. In our cases, radio emission at 2nd harmonic should be generated at density corresponding to $7{,}9 \times 10^9$ cm^{-3} at an altitude of 10^4 km above the photospher according to ten times Bombach Allen Density Height model. In that case, distance along the loop corresponding 2 to 10 sec will be of the order of 10^5 to 10^6 km. If the exciter was a shock travelling with the velocity of 1000 km/s, the distance along the loop will be of the order of 10^3 to 10^4 km for the same time interval. However this suggestion fails to explain longer time delays, of the order of minutes.

Recently, Zaitsev and Stepamov (1988) have suggested that oscillations of prominenses can heat the active regions and as a consequence, flares can be triggered. They have shown period of oscillations 40-50 minutes suficient to trigger flares. This is what we are observing, in case of H-α homologous and radio flares the period of occurence was nearly of 40 minutes.

Repetition of small periods of the order of seconds have been attributed to removal of plasma from interaction zone (Zaitsev and Stepanov, 1988). We observed this in case of one homologous bursts as described above. In that case, $t = d/VA$, t is period of repetition in sec, d is the diameter of proeminence and VA Alfven velocity. Thus, for t=2 to 10 sec, $VA=10^3$ km/s, $d=10^3$ to 10^4 km.

Thus, we feel that the suggestion of oscillation of prominences and removal of plasma from interaction zone, can explain H- homologous flare as well short duration radio homologous flares in radio frequencies. Similarity in intensity time profile due to permenance of same magnetic topology, in the active regions.

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