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EVIDENCE FOR REALITY OF RAPID SOLAR RADIO FLUCTUATION

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INTRODUCTION

Since fast fine structures (FFS) superimposed on microwave bursts were found with high time resolution observations, they have been observed in extensive frequency range (Slottje 1978; Fu, *et al.* 1986; Stähli and Magun 1986; and Stepanov and Yurovsky 1991), and these results make understanding of the emission deepening. But, at the same time, the puzzling problem, these phenomena originate from sun or are only artificial,is often concerned and disputed (Benz and Fürst 1987). As it was pointed out by Benz and Fürst (1987), "the only really reliable way to study solar microwave fluctuation is to use two or more widely separated radio telescopes".

In this paper, some of FFS events superimposed on microwave bursts simultaneously obtained at Beijing Astronomical Observatory (BAO), Crimea Astrophysical Observatory (CAO) and Institute of Applied Physics, University of Bern (IAP), are presented at first time. It is a conclusive evidence of rapid radio fluctuation originating from sun and associated with flare appearance.

OBSERVATIONS

The partial FFS events to be simultaneously observed are as follows:
1. The event of June 4, 1991:
This event associated with a 1N flare (0614-0615-0635 UT) in AR 6652 and a 10 cm burst (0614-0614.8-0634.8 UT). Figure 1a shows the time profile of 2.84GHz flux density of the June 4,1991 event recorded at BAO (compressed from 10 msec data). It can be seen that an obvious pulse at the beginning of impulsive phase. Fig.1b and 1c are extended time profiles of 9-second-section to the pulse indicated with arrow in Fig.1a at 2.84 GHz (BAO) and at 2.85 and 2.5 GHz(CAO), respectively. In Fig.1c (CAO) there appear 3 FFS groups (No.1, 2 and 3). Group No.3 is the largest and a pulse cluster

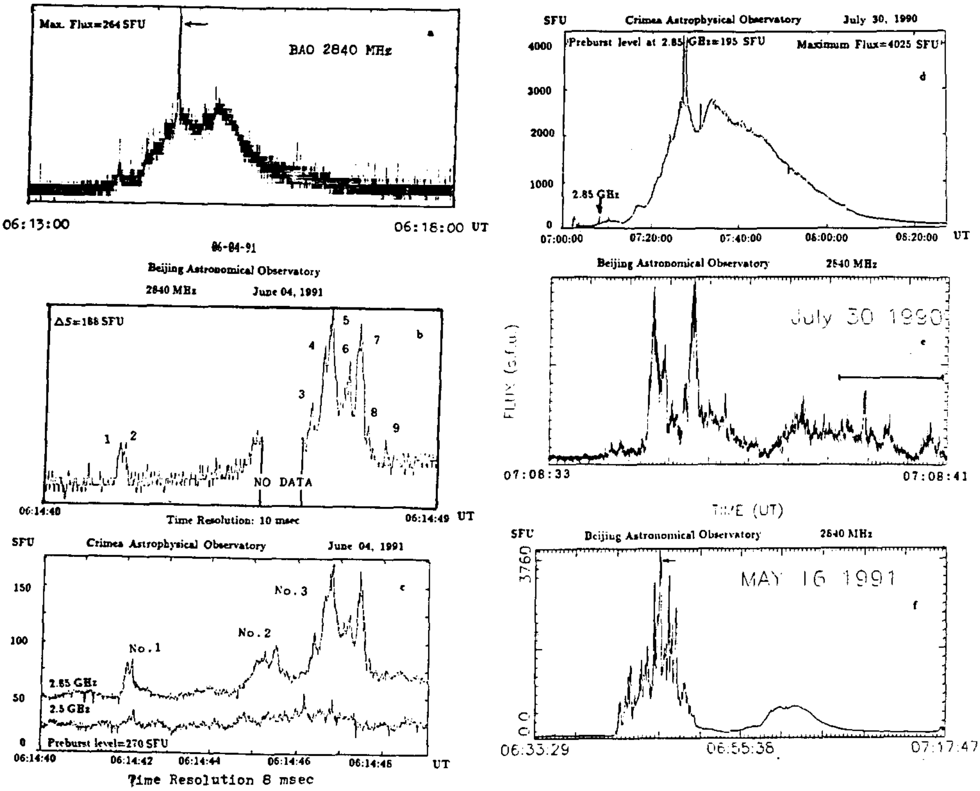

Figure 1. Time profiles of the event: a. compressed time profile of the event; b. extended plot of BAO at 2.84 GHz; c. extended plot of CAO at 2.5 and 2.85 GHz; d. time profiles of July 30, 1990 event; e. extended plot of the part indicated with arrow in Fig.1d; f. time profile of the May 16, 1991 event.

consisting of a number of pulses mutual overlaping. The amplitude of the strongest pulse is about 170 S.F.U. In group No.3 there are nine pulses to be mutually found their counterparts in Fig.1b and 1c. Morphologically, the FFS in Fig.1b and 1c are indeed the same one without any doubt.

2. The event of July 30, 1990 :

This event associated with a 2B/M4.4 flare occurring in AR 6180. The peak flux density at 2.84 GHz is about 4000 S.F.U.(Jin, *et al.* , 1990; Fu, *et al.* , 1992). A wealth of strong FFS groups occurred in the beginning and around peak time of the microwave burst. Fig.2a, 2b, and 2c illustrate a two-second-section time profile (0708 : 39 - 0708 : 41 UT) in the beginning of the event (as indicated with arrow in Fig.1d). Comparing Fig.2b with Fig.2c, at least there are 26 pulses to be mutually found their counterparts in other time profile. A conclusion can be drawn that, morphologically, without doubt, they are the same sun-originating phenomena recorded by two widely separated radiotelescopes.

3. The event of 1991, May 16 :

This event associated with a 2B/M8.9 flare in AR 6619. Fig.2d shows a 8-second-section time profile with a time resolution of 10 msec, as indicated with arrow in Fig.1f,

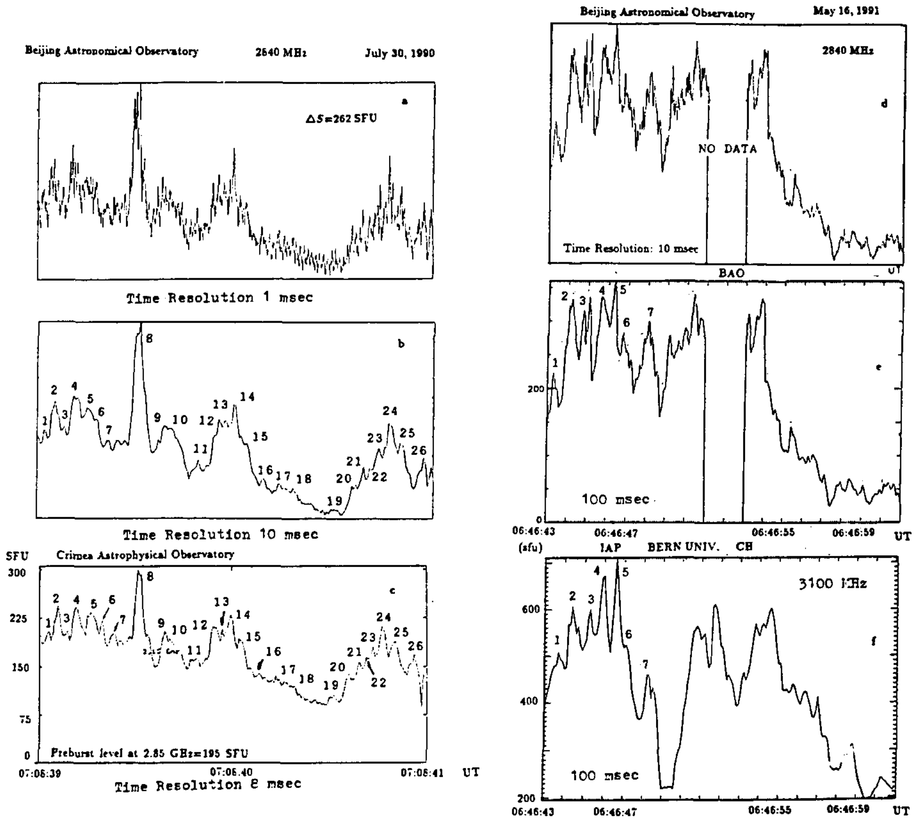

Figure 2. Extended time profiles of the July 30, 1990 and the May 16, 1991 (d,e,f) events: a. the plot of time interval indicated with a bar in Fig.1e with 1 msec time resolution; b. 10 msec time resolution; c. the plot of CAO with 8 msec time resolution; d. the plot of BAO with 10 msec time resolution; e. the plot of BAO with 100 msec resolution; f. the plot of IAP with 100 time resolution at 3.1 GHz.

recorded at 2.84 GHz at BAO. Fig.2e shows Fig.2d's smoothed plot after 100 msec lowpass filtering. Fig.2f shows the 100 msec time profile in the same time interval recorded at 3.1 GHz at IAP. Comparing Fig.2e with Fig.2f, at least seven pulses labelled 1, 2.... 7 are identical (with a constant time delay). Although the difference between both frequencies is 260 MHz,the sub-second FS are still similar.

DISCUSSION

In the June 4, 1991 event (Fig.1b), the average duration of the 12 pulses is 118 msec. In the July 30, 1990 event (Fig.2b and 2c), the average duration of the 28 pulses is 28 msec. The decay time is plotted in Fig.3 (from Stähil and Benz 1987) as a function of observing frequency. The dashed line is the empirical relation found by Alvarez and

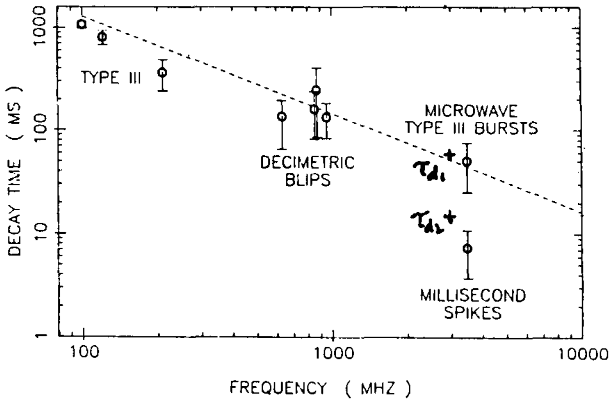

Figure 3. Decay time vs frequency for metric type III bursts, decimentric blips, microwave type III bursts, microwave milliseconds, and our results ("+"). (from Figure 3 of Stähli and Benz 1987)

Haddock (1973). The crossed labels, "+" representing our results τ_{d1} and τ_{d2} (assuming $\tau = 2\tau_d$) show that our results of the June 4, 1991 and the July 30, 1990 events fit well with those at lower frequencies, those of Benz *et al.* , 1983; Stähli and Magun 1986; and Stähli and Benz (1987) in microwave wavelengths. From Fig.3 it can be distinctly seen, that FFS of the July 30, 1990 (τ_2) are a cluster of msec spikes and FFS of the June 4, 1991 event (τ_1) are a cluster of microwave type III bursts with the starting frequency between 2.5 GHz and 2.84 GHz and positive frequency shift rate. The microwave type III burst group occurred just at the edge between rising phase and impulsive phase of the microwave burst (Fig.1a), when particles were accelerated in flash phase of the flare.

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