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STATISTICAL ANALYSIS OF FAST HARD X-RAY BURSTS BY SMM OBSERVATIONS AND MICROWAVE BURSTS BY GROUND-BASED OBSERVATIONS

Li Chun-sheng and Jiang Shu-ying

Astronomy Department
Nanjing University
Nanjing, China

1. Data and Method of Analysis

In order to understand the relationship between fast hard X-ray bursts (HXRB) and microwave bursts (NWB), we have used the data published in the following publications.

1. NASA Technical Memorandum 84998.
   The Hard X-Ray Burst Spectrometer Event Listing 1980, 1981 and 1982.

2. Solar Geophysical Data (1980-1983). Academia Sinica

3. Monthly report of Solar Radio Emission. Toyokawa Observatory, Nagoya University (1980-1983).

4. NASA and NSF: Solar Geophysical Data (1980-1983).

We get the data of fast HXRB detected with time resolutions of 10 ms, 5 ms, and 1 ms and corresponding data of MWB observed (with a time constant of 1 s) at frequencies of 17GHz, 9.4 GHz, 2.75 GHz, and 2.8 GHz during the same flare-burst event.

For analyzing individual events, the criterion of the same event for HXRB and MWB is determined by the peak time difference.

$$T = |Tmw - Thx| < 20 \text{ seconds}$$

The regression relation between the physical parameters of MWB and HXRB may be written as:

$$Y = A + BX$$

where X indicates the logarithm of the following parameters: peak flux density Sp, total flux density St, and duration T'mw of MWB. Y indicates the logarithm of the corresponding parameters: peak rate Cp, total counts Ct, and duration T'hx of HXRB.

B is the regression coefficient
A is the regression constant
Sp is in s.f.u.
St = $\bar{S}$.T'mw, $\bar{S}$ = the mean flux density
T'mw in seconds
Cp in counts per second
Ct in counts
Thx in seconds

2. Results and Conclusions

With the method of data analysis mentioned above, we obtain the results presented in Table 1 and Figures 1 to 4.

In Table 1, the parameters have the following meanings:

R is the correlation coefficient between X and Y for the energy range of channels 1 to 15 (i.e. 25-500 keV)
R1 is the correlation coefficient for the energy range of channels 1 to 5 (i.e. 25-140 keV)
R2 is the correlation coefficient for the energy range of channels 6 to 15 (i.e. 145-500 keV).

The statistical analysis run so far and the comparisons of correlation parameters with one another allow us to draw the following conclusions:

1. There is a good linear correlation between the physical parameters of MWB and fast HXRB.

2. Comparison of R, R1 and R2 at different frequencies for MWB show the best correlation coefficients occur at 9.4 GHz.

3. R2 is larger than R1 at any frequency. This means that the correlation between X and Y is closer in the higher energy range of 145-550 keV than that in the energy range of 25-140 keV at the same frequency.

4. Correlation coefficients between T'mw and T'hx are not as good as the others, but they increase as the frequency decreases.

Table 1. The parameters of the linear relation between X and Y.

Considered Parameters	Number of Events	Correlation Coefficient R	R1	R2	Regression Constant A	Regression Coefficient B
f1 = 17 GHz						
Sp and Cp	162	0.781	0.46	0.81	1.168	0.960
St and Ct	/	/	/	/	/	/
T'_{mw} and T'_{hx}	158	0.511			1.412	0.423
f2 = 9.4 GHz						
Sp and Cp	190	0.856	0.65	0.76	1.463	0.778
St and Ct	190	0.857	0.73	0.86	1.179	0.878
T'_{mw} and T'_{hx}	191	0.613			0.831	0.631
f = 3.75 GHz						
Sp and Cp	153	0.797	0.055	0.79	1.515	0.848
St and Ct	160	0.733	0.76	0.82	1.258	0.859
T'_{mw} and T'_{hx}	161	0.686			0.748	0.639
f = 2.8 GHz						
Sp and Cp	206	0.743	0.52	0.71	1.663	0.675
St and Ct	209	0.722	0.58	0.84	1.819	0.703
T'_{mw} and T'_{hx}	201	0.695			0.735	0.702

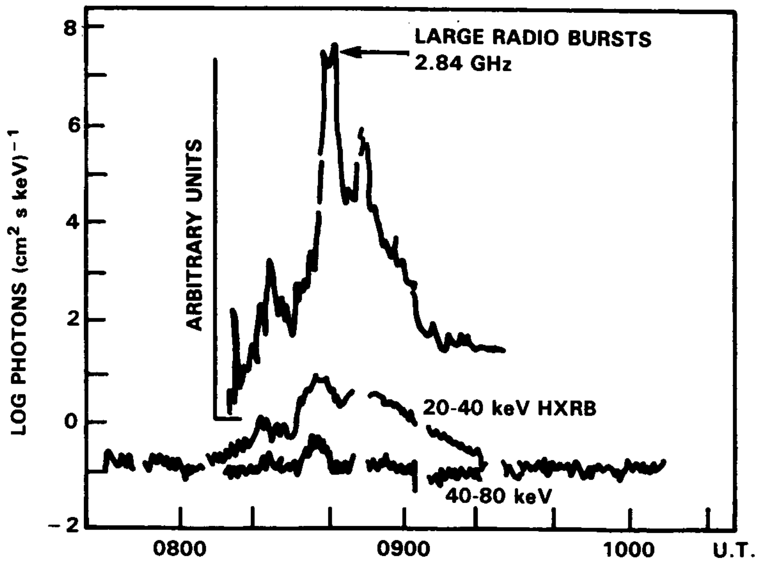

Figure 1: Time profiles of radio bursts at 2.84 GHz and hard X-ray bursts during the large solar flare of May 16, 1981.

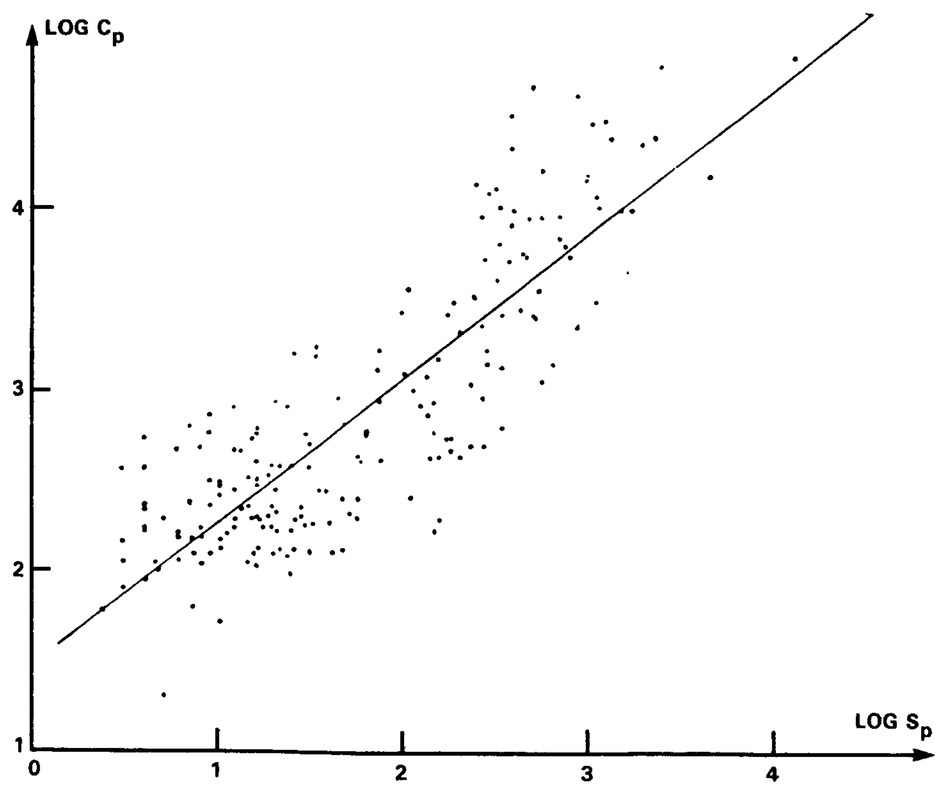

Figure 2: Correlation diagram between peak flux Sp at 9.4 GHz and hard X-ray intensity Cp (in counts/s) in the energy range of 25-500 keV.

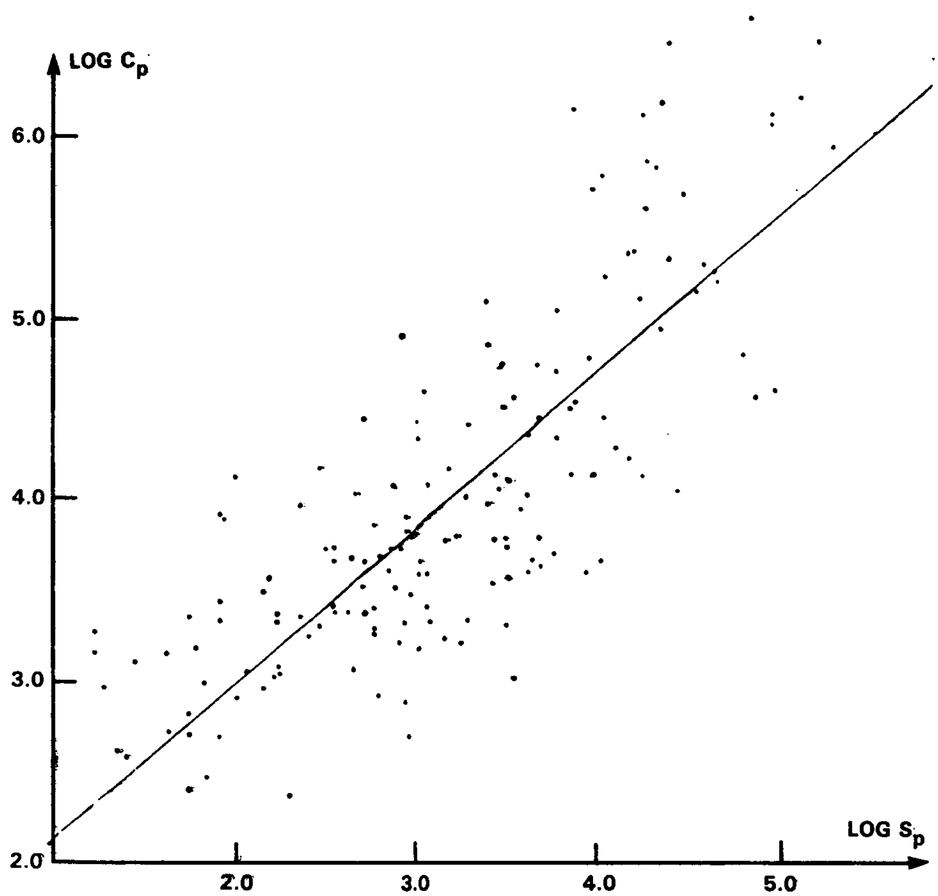

Figure 3: Correlation diagram between peak flux Sp at 3.75 GHz and hard X-ray intensity Cp (in counts/s) in the energy of 25-500 keV.

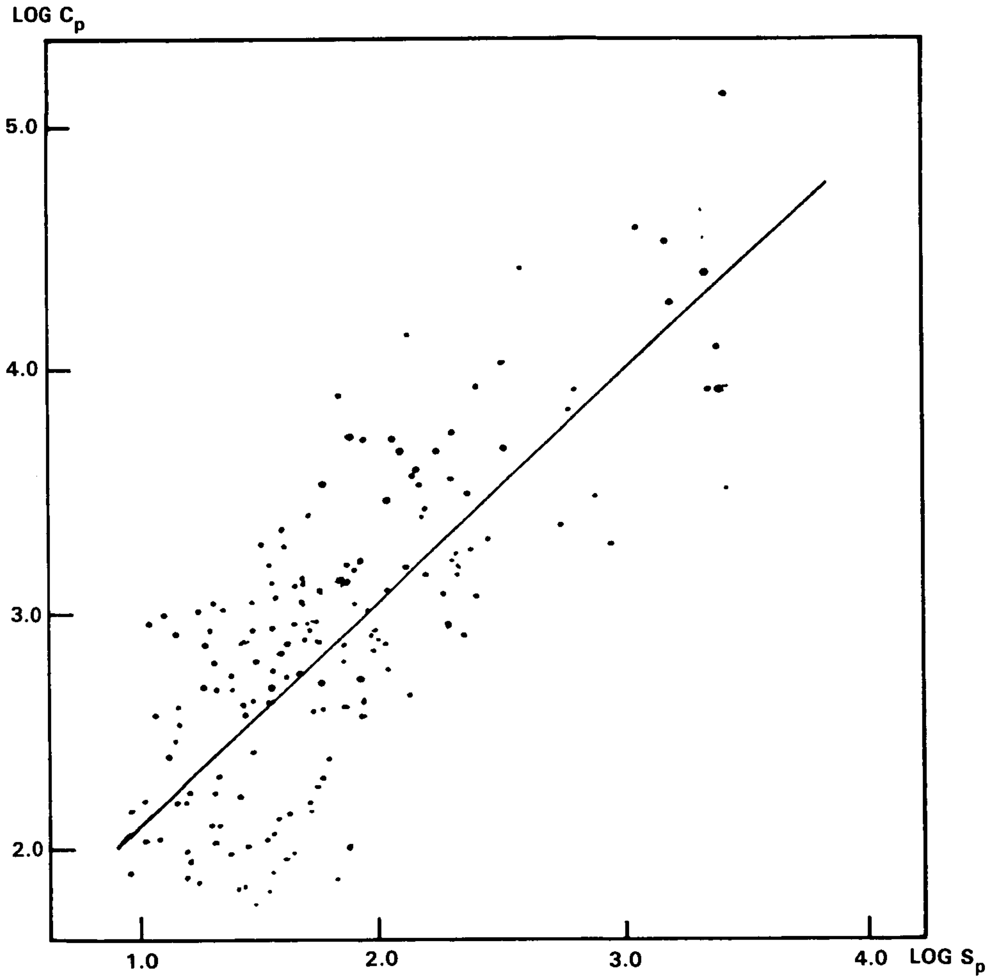

Figure 4: Correlation diagram between peak flux Sp at 17 GHz and hard X-ray intensity Cp (in counts/s) in the energy of 25-500 keV.