Analiza dwóch wybranych mikro-rozbłysków obserwowanych za pomocą przyrządu SphinX

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SphinX observations

The largest SphinX flare:
5th July 2009
C 2.7 GOES class flare
Analysed flares

18 July 2009 (A9 class)
17 October 2009 (A7 class)

18 July 2009  A9 class
17 October 2009  A7 class
18 July 2009 flare  A9 class

SphinX

http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html
18 July 2009 flare  A9 class

http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html
18 July 2009 flare A9 class

SphinX, XRT/Hinode and GOES Observations

SphinX

Be_thin

C_poly

Start Time (18-Jul-09 00:00:00)
18 July 2009 flare

STEREO_A Observations
EUVI 171
18 July 2009 flare

**STEREO A Observations**

**EUVI Extreme Ultraviolet Imager**

- 195 1.4 MK
- 284 2.2 MK
18 July 2009 flare

EUVI Extreme Ultraviolet Imager
- 171: 1.0 MK
- 304: 80000 K

Loop explosion ~ 01:40 UT
18 July 2009 flare

Loop explosion

maximum

02:01:00 UT

STEREO_A SECCHI EUVI 171 18-Jul-2009 02:01:00.006 UT

SphinX D1 countrate [c/s]
18 July 2009 flare

Time flares parameters:
- Start time: 01:33:57.72
- Peak time: 02:00:15.72
- End time: 04:17:11.72
- Duration: 163.23 [min]

Peak countrate: 3231.24
Peak incremental countrate: 3080.53

Flaring plasma diagnostics with SphinX data
- Background subtracted method
- Isothermal approximation
Elementary soft X-ray flare profile

Convolution of two functions
Gauss function:
\[ f(t) = Ae^{-(t-B)^2/C^2} \]
Exponential function:
\[ f(t) = e^{-Dt} \]

**FLARE PROFILE FORMULA:**

\[
\text{EFP}(t) = 0.5 \sqrt{\pi} AC \exp(D(B-t)+(C^2 D^2)/4). \\
\frac{\text{erf}((2B+C^2D)/2C) - \text{erf}((2(B-t)+C^2D)/2C)}{2C} + Et + F
\]

Linear background
\[ f_{bg}(t) = Et + F \]

4 parameters (flare) +
2 parameters (linear background-attributable) = 6 PARAMETERS
Elementary soft X-ray flare profile

FLARE AFTER BACKGROUND SUBTRACTION

PARAMETERS:
T\_\text{start} \quad \text{time of start}
T\_\text{end} \quad \text{time of end}
T\_\text{max} \quad \text{time of maximum}
Flare magnitude

**FLARE PROFILE FORMULA:**

\[
f(t) = 0.5 \sqrt{\pi} \ A \ C \ \exp(D(B-t) + (C^2 D^2)/4) \cdot \\
\left[ \text{erf}((2B + C^2 D)/2C) - \text{erf}((2(B-t) + C^2 D)/2C) \right]+ \\
Et + F
\]
Evolution of flaring plasma

RESULTS:
max T 6.09 [MK]
max EM 1.9 x 10^{47} [cm^{-3}]

The straight lines:
Quasi steady state
Switch-off heating

REFERENCE:
Jakimiec et al., (1992)
SphinX lightcurves in two channels:

Low (red curve): countrates of photons within energy range 1.16 - 1.5 keV.
High (blue curve): countrates of photons within energy range 1.5 - 15.07 keV.

\[
\text{Low/high} = f (T, EM)
\]
17 October 2009 flares  A7 class

LONG DURATION EVENT

LDE, Hybrid flare ?
Svestka, Solar Phys. 1989, 121, 399

Interball  RF15I
11-Jan-96 LDE

http://156.17.94.1/sphinx_l1_catalogue/SphinX_cat_main.html
Hybrid flares (confined & dynamic)

Fig. 9. The X-ray counting rate versus time profiles (above) and results of fitting procedure for one-temperature and two-temperature fit (below) for a tentatively confined (left) and dynamic (right) flare. (Examples taken from Lin, Lin, and Kane, 1985.)

Svestka, Solar Phys. 1989, 121, 399
17 October 2009 flares  A7 class

GOES Observations

17-Oct-09  ~A7 flare 19:16 UT

15 hours

SphinX  1-8 Å

GOES 10

flux [W/m²]

10⁻⁷

10⁻⁸

18:00  21:00  00:00  03:00  06:00  09:00
time
17 October 2009 flares

Be_thin filter

XRT Be_thin

Flux [W/m²]

17-Oct-2009

15:00 20:00 04:00 08:00 12:00

10⁻⁷ 10⁻⁶ 10⁻⁵ 10⁶
17 October 2009 flares
17 October 2009 flares – complex view
17 October 2009 flares

Elementary flare time profile optimal fits
RESULTS:
max T  5.48 [MK]
max EM  1.23 x 10^{47} [cm^{-3}]

unusual case

The straight lines:
Quasi steady state
Switch-off heating

REFERENCE:
Jakimiec et al., (1992)
**RESULTS:**

- max $T$ 4.57 [MK]
- max $EM$ $1.17 \times 10^{47}$ [cm$^{-3}$]

REFERENCE: Jakimiec et al., (1992)
Flares Background determination

BACKGROUND LEVEL SUBTRACTION ESPECIALLY CRITICAL FOR SMALL EVENTS!


FLARING PLASMA EMISSION
17 October 2009 flares
17 October 2009 flares & CME associated with

**CME event**

‘Very Poor Event; Partial Halo’ (SOHO LASCO CME CATALOGUE)

Determinations based on **LASCO data**

~ 18:47

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**Linear Fit**

20091017.205837.w145p.v0220.p226g.

**Height** (R/sun)

**Feature = All**

**Position Angle = 226.**

**Velocity = 220.4 km/s**
Conclusions

Analysed flares:
18 July 2009   A9 class
17 October 2009  A7 class

- Small flares differ from large ones only on scales (of size, Te, EM etc.)
- Morphology of small flare can be as complicated as larger ones
- Even small flares can be associated with ejection phenomena (CME) - flares lightcurves deconvolution allow for determination of exact start and end times of event
Thank You for your kind attention