Heating and Acceleration in a Solar Flare

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Typical "Hot thermal flare" on 1981 Oct. 12.

near East limb.
X-ray class : M 7.5
no Hα flare
strong Fe XXVI line

$T_e \sim 2.6 \times 10^7$ K
$EM \sim 1.6 \times 10^{49}$ cm^{-3}

Soft and hard components coexist.

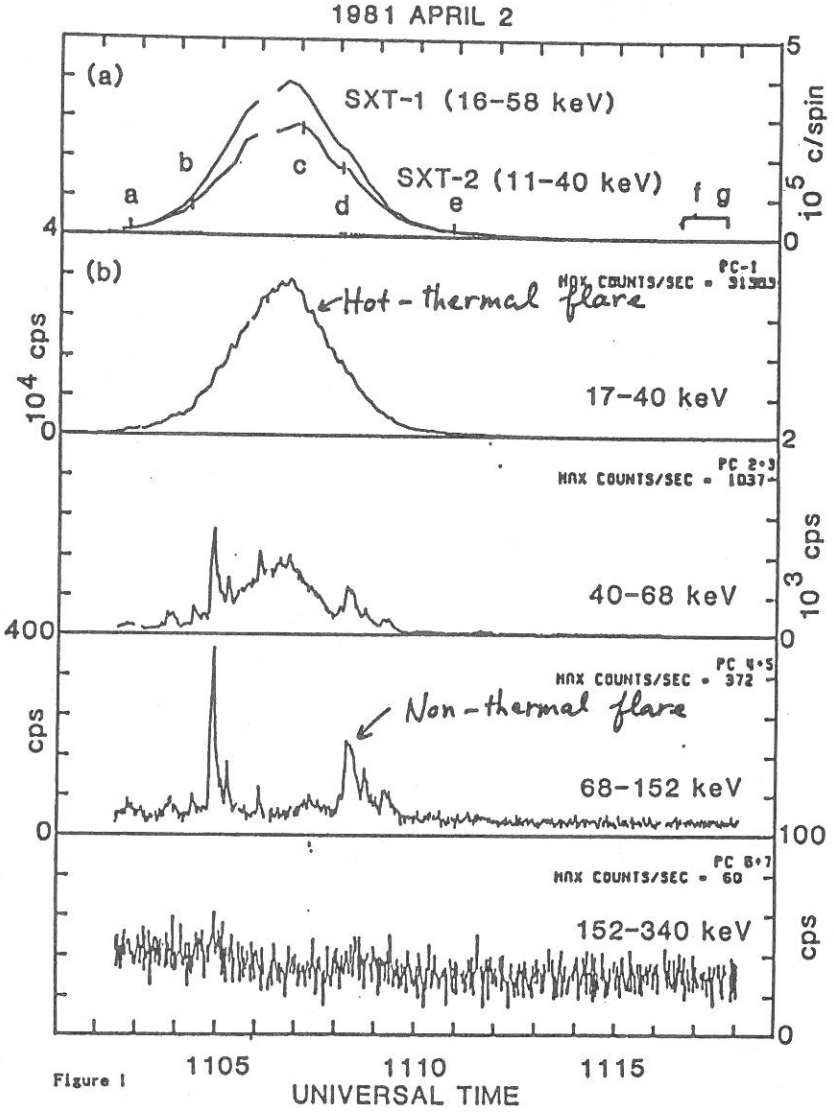
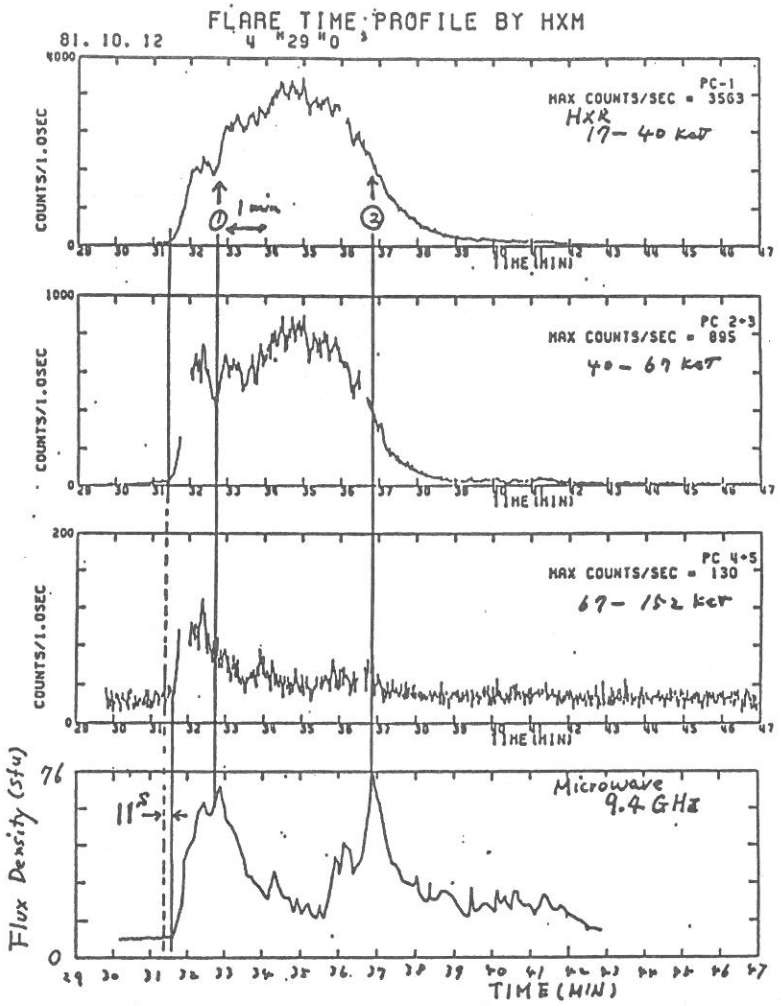
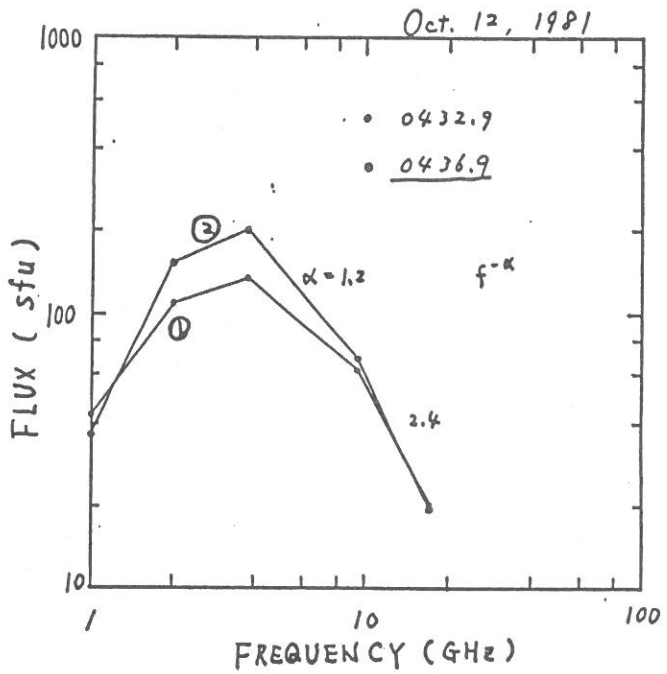


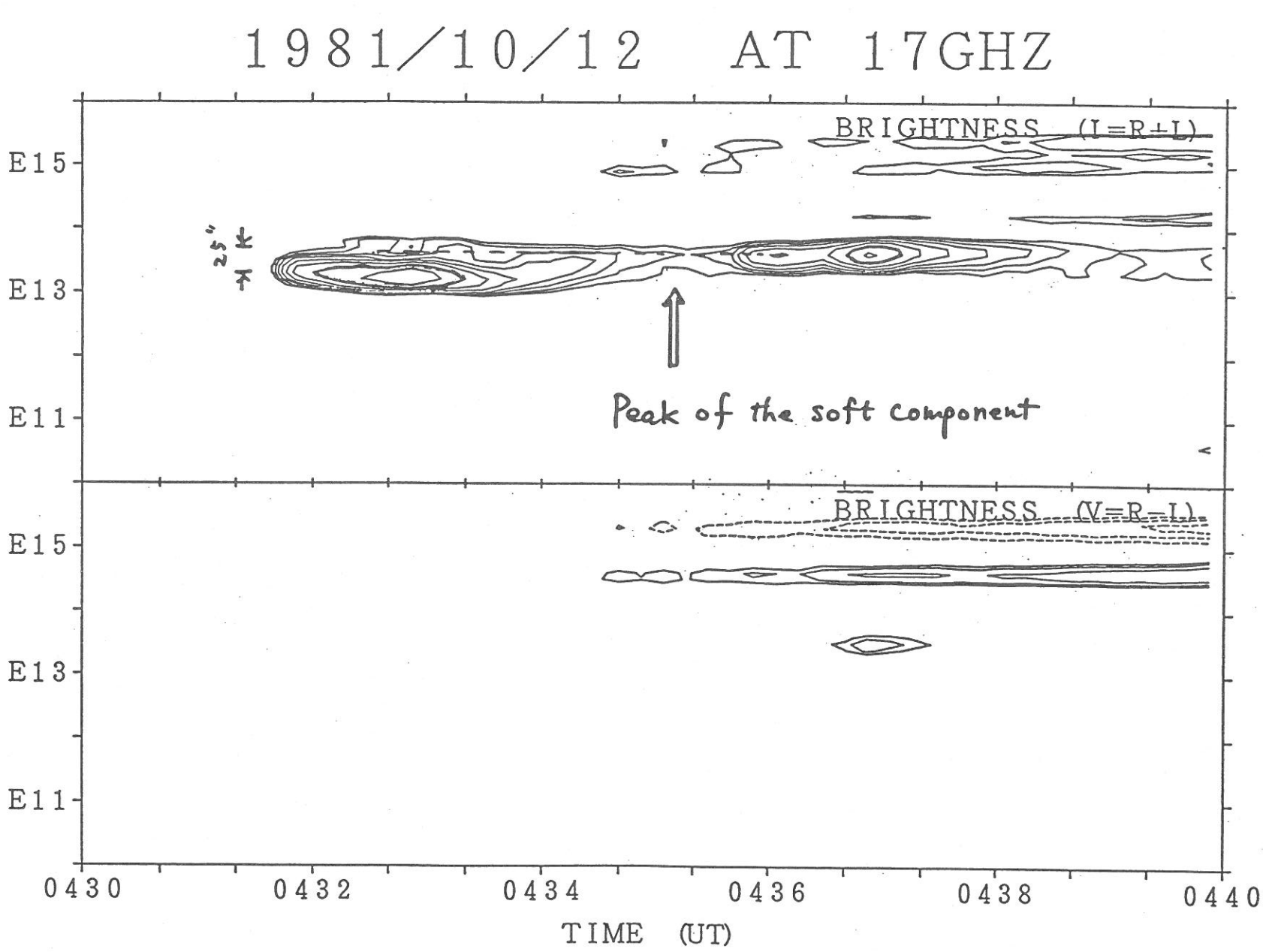
Figure 1



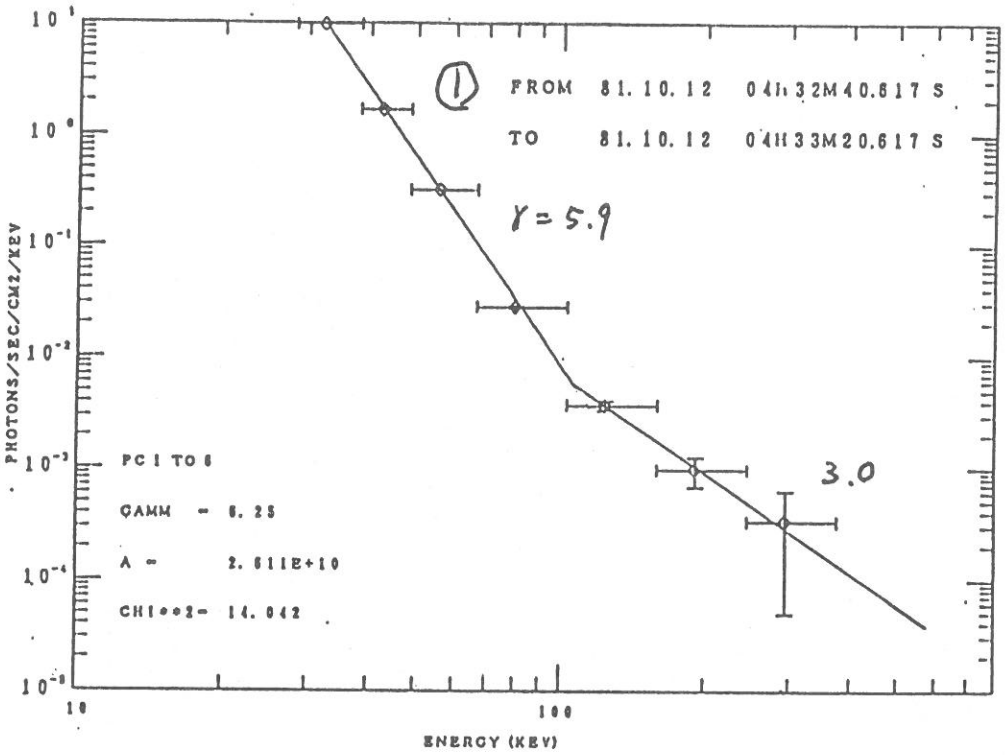
HXR : gradual time profile at energy $\lesssim$ 50 keV
different time profile at energy $\gtrsim$ 60 keV
Microwave : similar to HXR time profile $\gtrsim$ 60 keV
delayed with respect to HXR soft comp. by 11 s.

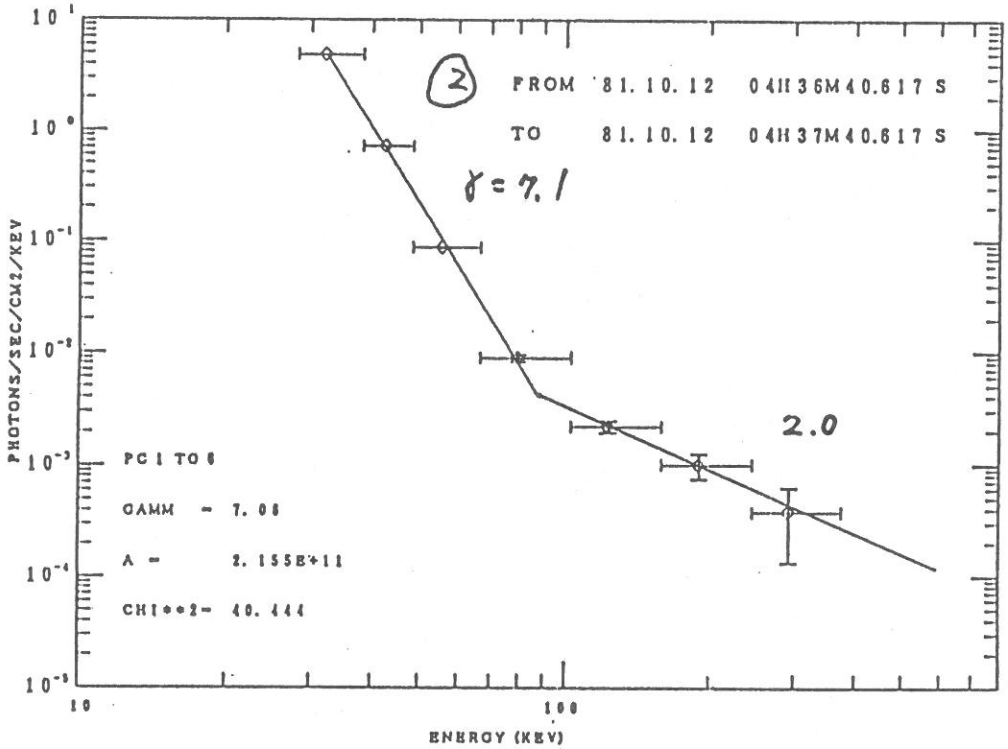


Hard X-ray and microwave spectra :
H = 80 Gauss
$E_{max} \gtrsim 3$ MeV
$N_{amb} = 2.6 \times 10^{10}$ cm^{-3}



contour : $\pm.V\ \sqrt{2}$
71%, 50, -- , 9, 6, $(\frac{1}{\sqrt{2}})$

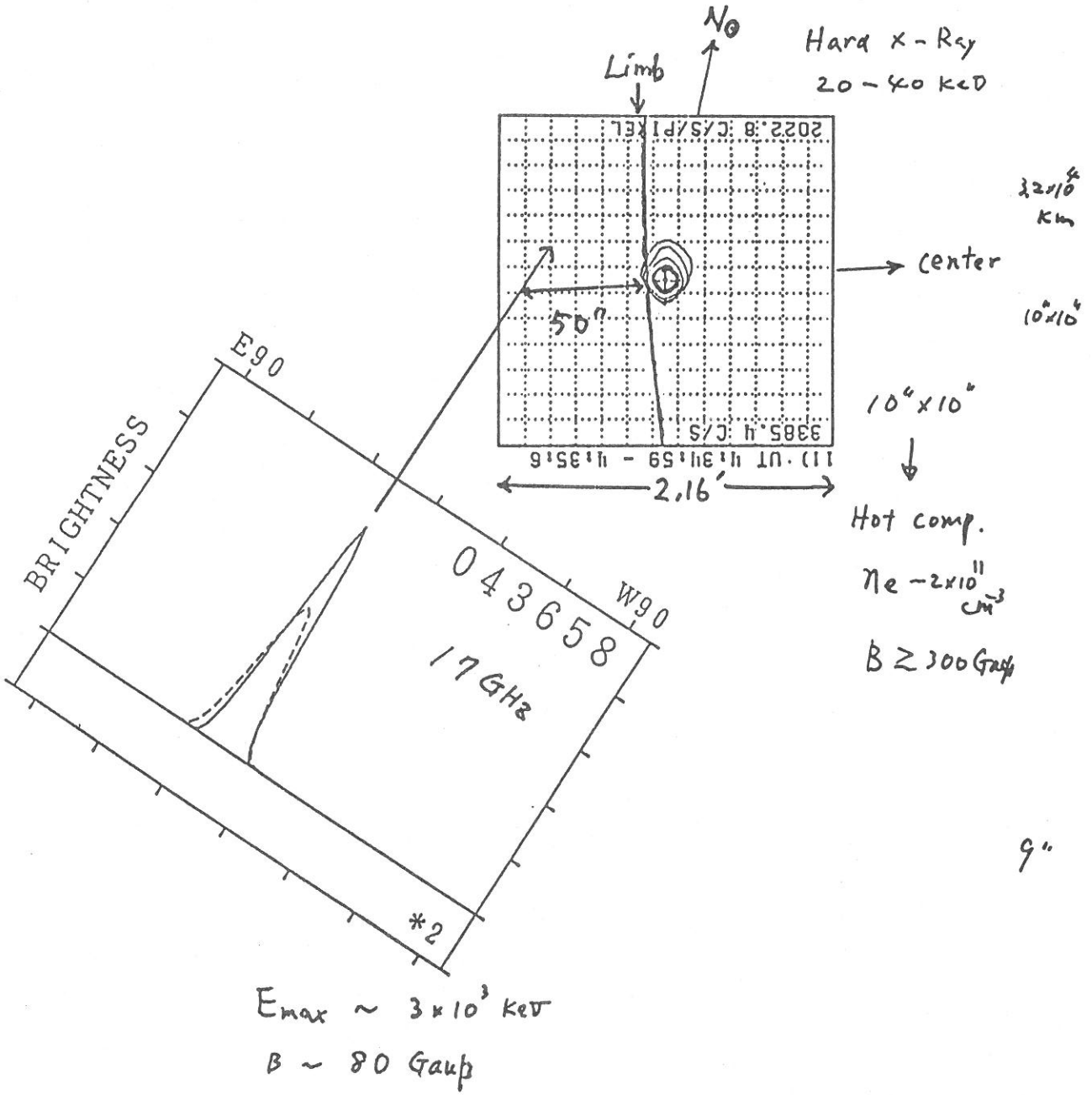




X-ray spectrum : 2 comp.

Soft comp. : $\gamma = 6 \rightarrow 8$, with time (softening)

Hard comp. : $\gamma = 3.5 \rightarrow 1.0$ (hardening) $\leftrightarrow$ Gradual Hard

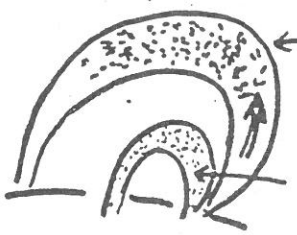

N
Limb
Hard X-Ray
20 - 40 keV
center
50"
2.16'
E90
W90
BRIGHTNESS
043658
17 GHz
*2
10" x 10"
Hot comp.
ne ~ 2x10^11 cm^-3
B ≥ 300 Gauss
Emax ~ 3x10^3 keV
B ~ 80 Gauss

Conclusion

1) Soft and hard components coexist in this flare.

The soft component : hot-thermal flare
The hard component : gradual-hard flare

2) The soft component is confined in a small, dense loop where plasma heating is efficient, while the hard component is trapped in a large, thin loop where electrons are accelerated up to 3 MeV.



← hard component ($E_{max} \geq 3$ MeV, $N \sim 2.6 \times 10^{10}$ cm^{-3}, $H \sim 80$ Gauss)

soft component ($T \sim 3.6 \times 10^7$ K, $N \sim 2 \times 10^{11}$ cm^{-3}, $H \geq 300$ Gauss)

(and the soft component)

3) The hard component are clearly related to each other, that is.

The hard component can be seen in the rising phase and in the decay phase of the soft component, but becomes weaker at its peak.

It suggests that acceleration of high energy electrons in the large loop is depressed by increasing of plasma heating in the low-lying small loop.

4) The onset time of the hard component is delayed with respect to that of the soft component. It suggests that high energy electrons in the hard (of electrons) loop are generated as a result of reacceleration heated or accelerated up to several tens of keV in the small loop.