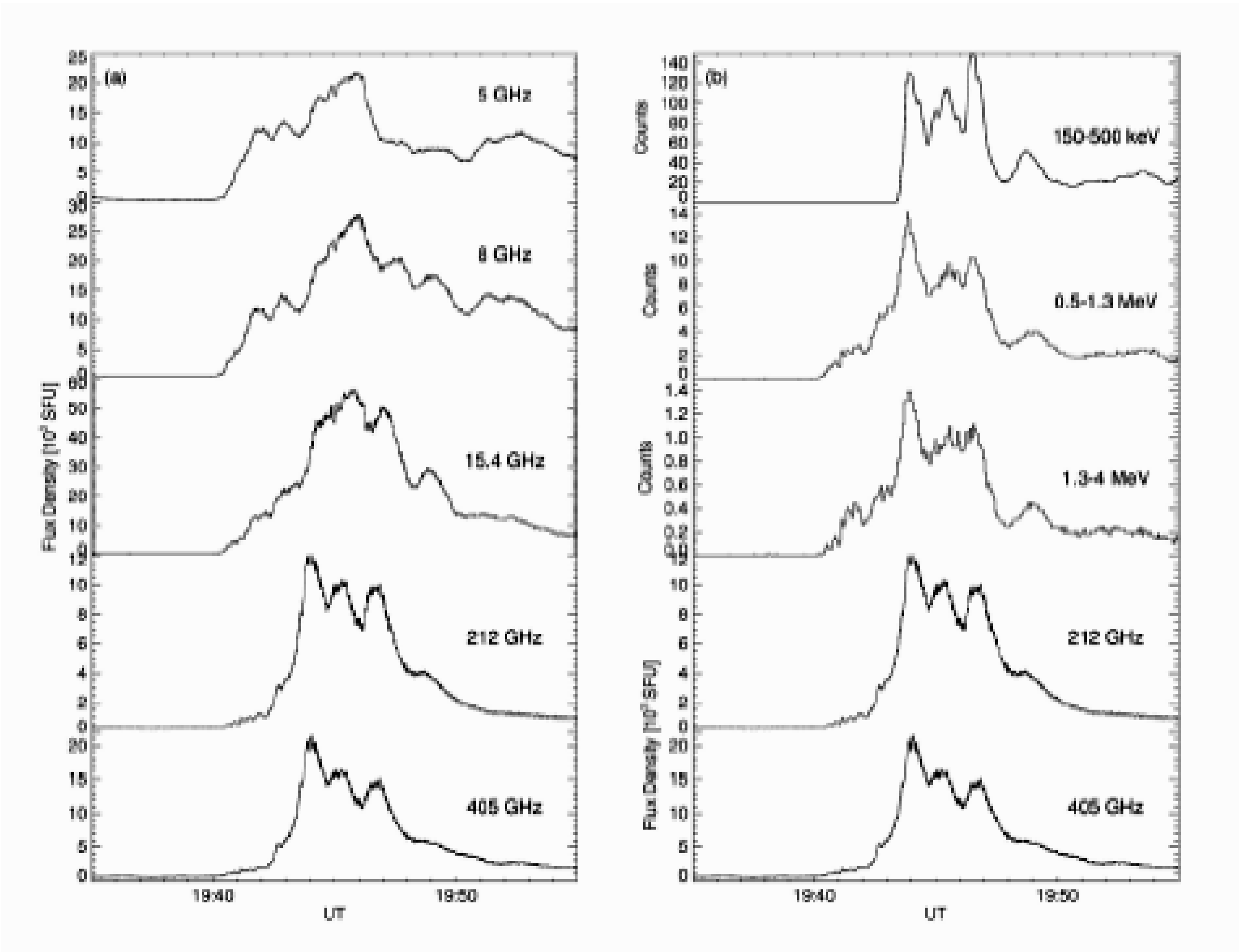
4 November 2003



Kaufmann et al. 2005

Two questions raised by submm-λ observations presented by Kaufmann et al. 2004:

By what mechanism(s) is the emission produced?

- Thermal free-free radiation?
- Synchrotron radiation?
- A coherent mechanism?

What bearing does it have, if any, on γ-ray observations?

- Anomalous widths of the 511 keV emission?
- High energy electrons?

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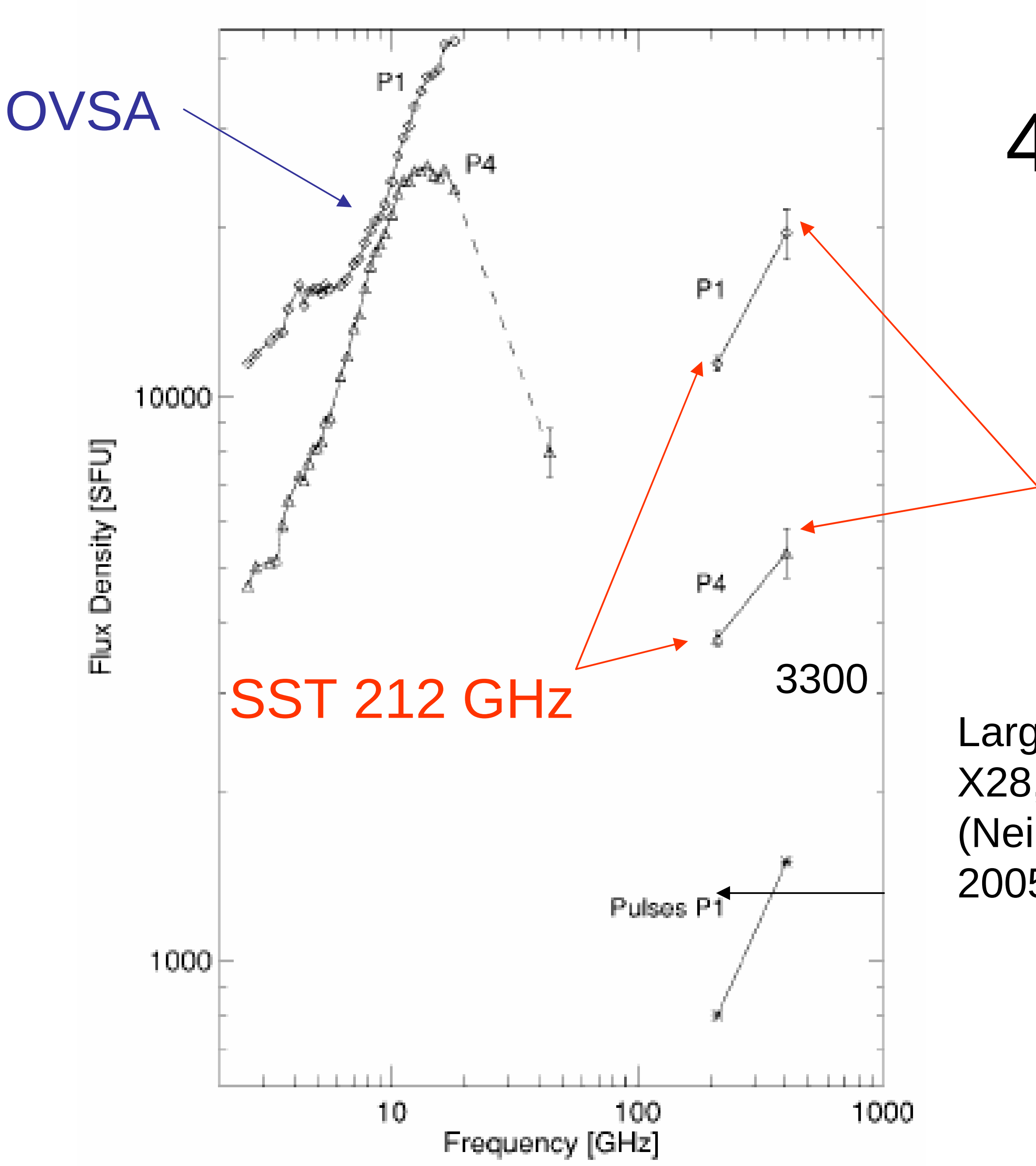


Largest SXR flare recorded: X28, possibly as large as X45 (Neil et al. 2004, Burton et al 2005).

Kaufmann et al. 2004

Kaufmann et al. argue that the submm-λ emission cannot be thermal in origin. Their argument is as follows:

1- Using multi-beam observations, they claim the source size is of order 10” or less.

2- The peak flux at 212 GHz is 12000 SFU and that at 405 GHz is 20000 SFU.

3- The flux is related to brightness temperature via

$$S_\nu = 2k_B T_B \frac{\nu^2}{c^2}\Omega$$

The 212 and 405 GHz observations then imply a brightness temperature 2.5-5 x 10^7 K.

The optical depth to free-free absorption is given by:

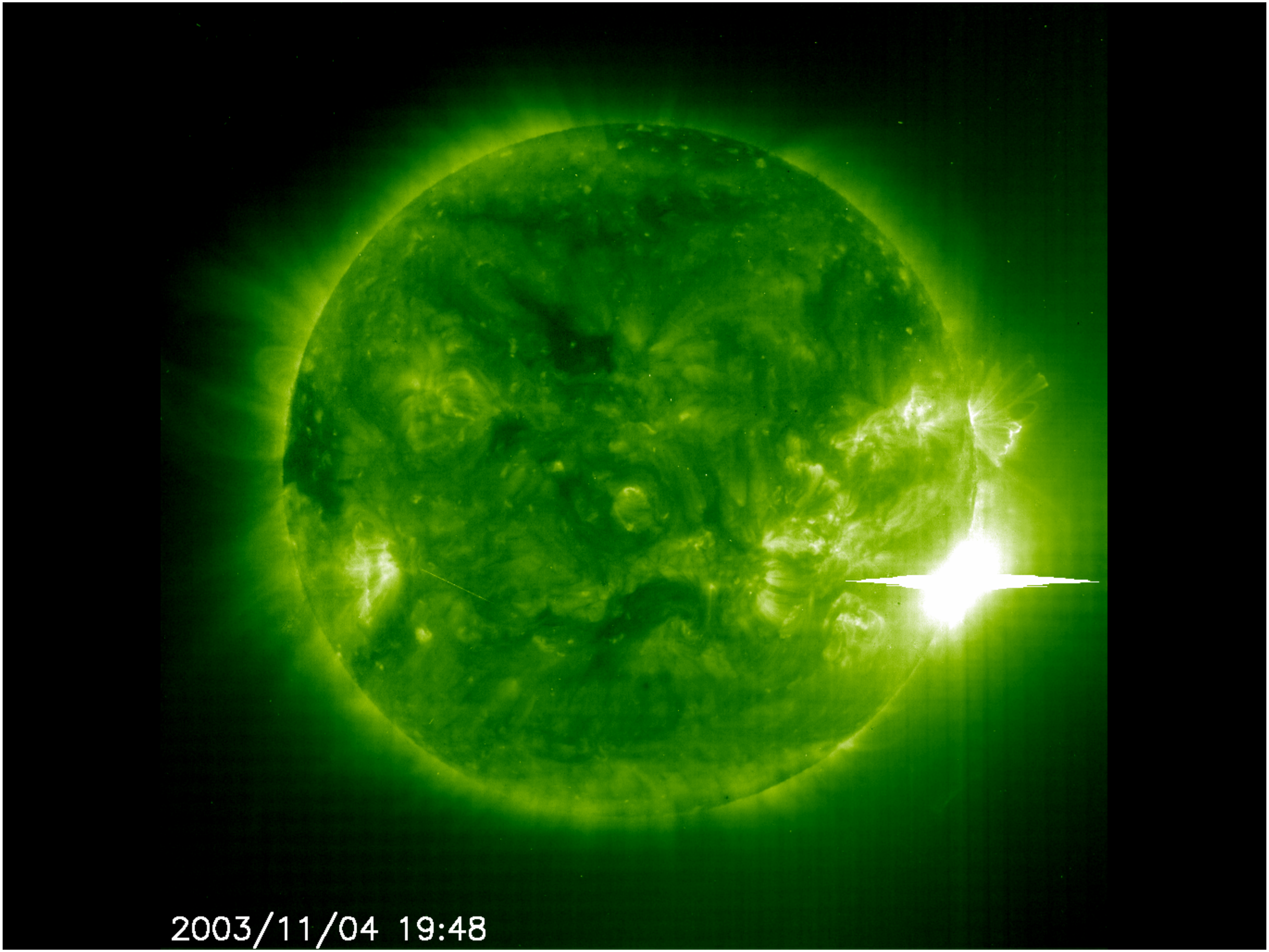
$$\tau_\nu \approx 0.2\Phi\,\nu^{-2}T^{-3/2}L^{-2}$$

where Φ is the volume emission measure. Using a dimension L corresponding to 10", T_B=T~2-5 x 10^7 K, and τ~3, one finds $\Phi \sim 0.3\text{-}2 \times 10^{53}$ (Kaufmann et al. use 10^{53}), much larger than observed: $\Phi = 6.5 \times 10^{50}$.

If Φ were in fact this large, an SXR flare >X1000 is implied!

Kaufmann et al. therefore argue that the 212 and 405 GHz emission must be due to a non-thermal emission mechanism.

Is the above argument compelling?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The submm-λ source is manifestly composed of contributions from several sources:

- The SXR-emitting plasma must contribute at least 2000 sfu to each of 212 and 405 GHz
- There is clearly a nonthermal component, estimated to be of order 3300 sfu at 212 GHz and perhaps 1500 sfu at 405 GHz
- The bulk of the remainder could be accounted for by the sum of optically thick and optically thin contributions of material at temperatures from TR to SXR-emitting values.

$$S_\nu = 2k_B \frac{\nu^2}{c^2} \int_{source} d\Omega \int_0^\infty T_{eff} e^{-\tau} d\tau \rightarrow 2k_B \frac{\nu^2}{c^2} \sum_i T_i (1 - e^{-\tau_i}) \Omega_i$$

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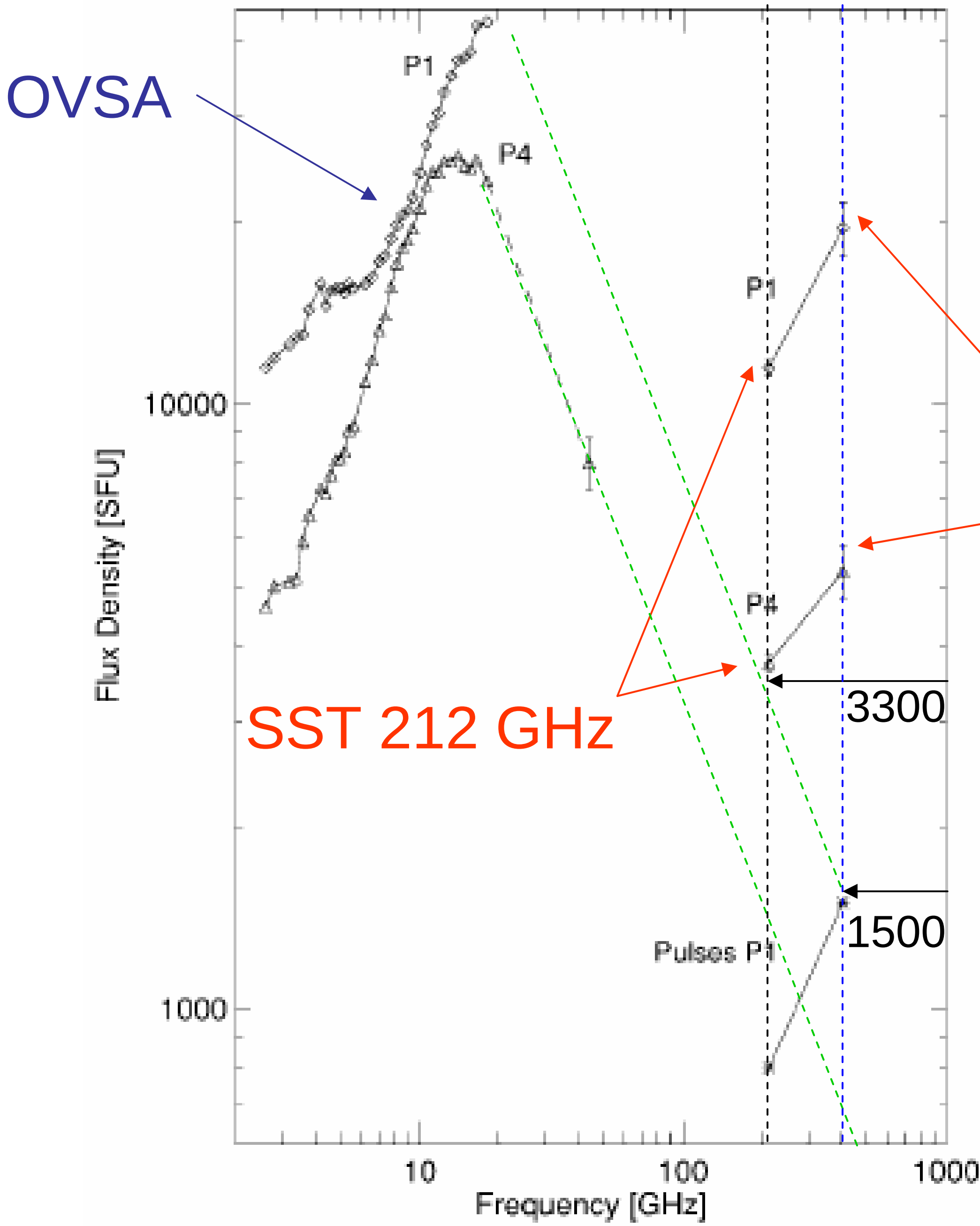

Largest SXR flare recorded: X28, possibly as large as X45 (Neil et al. 2004, Burton et al 2005).

Kaufmann et al. 2004

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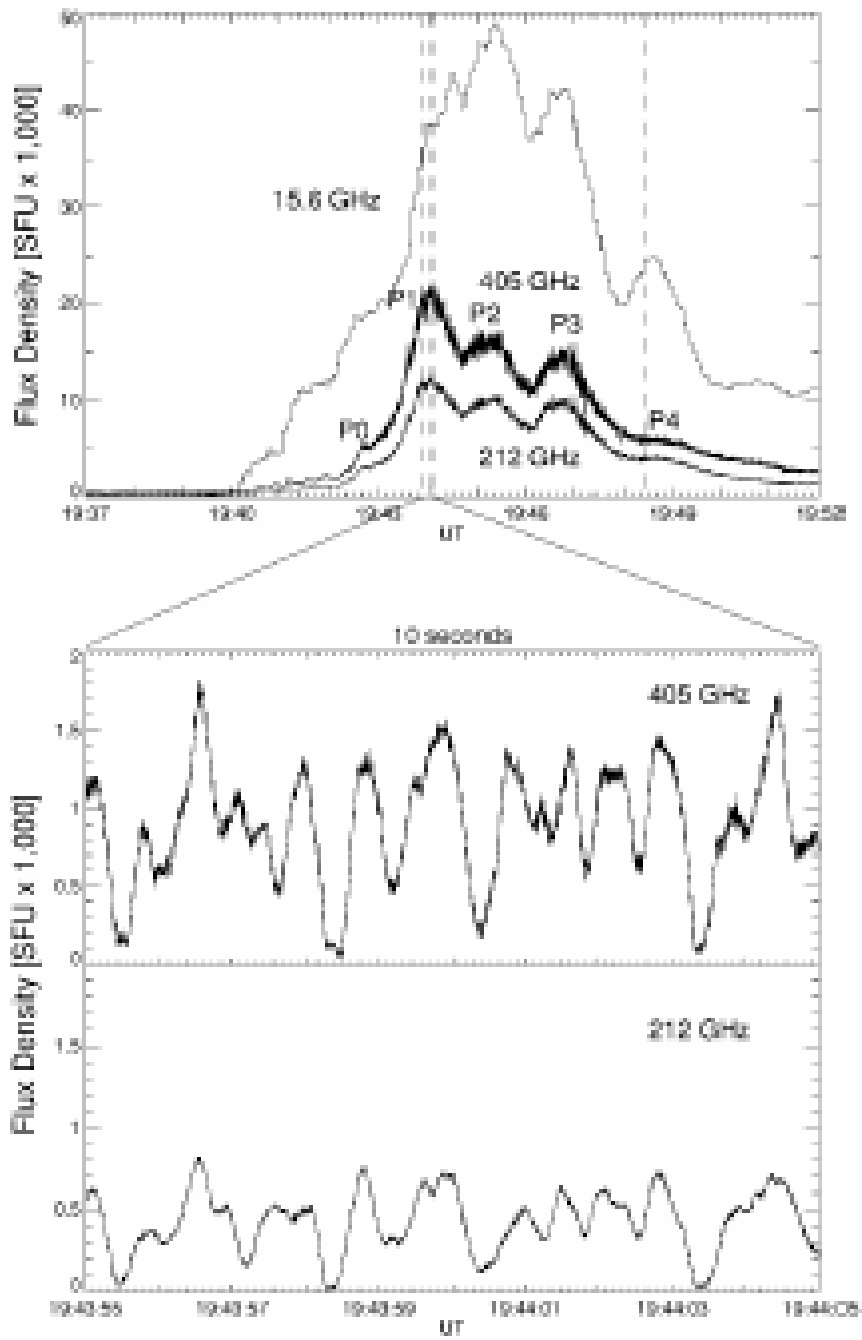

Flux Density [SFU x 1,000]
15.6 GHz
405 GHz
212 GHz
P1
P2
P3
P4
P0
UT
19:37
19:40
19:43
19:46
19:49
19:52
10 seconds
405 GHz
212 GHz
Flux Density [SFU x 1,000]
19:43:55
19:43:57
19:43:59
19:44:01
19:44:03
19:44:05
UT