Measuring the Solar Soft X-Ray Spectrum

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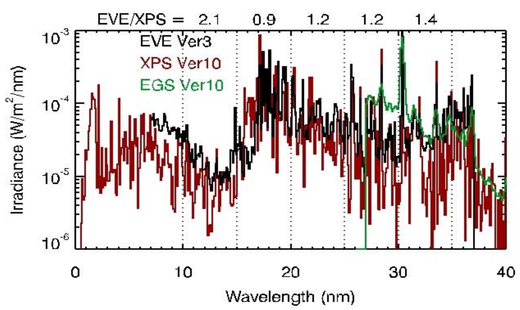
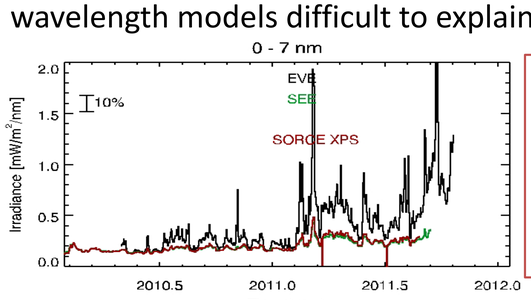
Abstract

The Amptek X123 x-ray spectrometer was used to obtain a spectrum ranging from 0.1-3 nm. This was then compared to models scaled to match the broadband irradiance in the 0.1-7 nm range from the TIMED and SORCE XUV Photometer System (XPS). This XPS-based model, or XPS Level 4 product, overestimates the X123 spectrum by a factor of approximately ten. With the GOES-15 0.1-0.8 nm irradiance in agreement with the X123 result and SDO EUV Variability Experiment (EVE) spectra being more than a factor of two higher than XPS Level 4 in the 7-15 nm range, it appears that the XPS Level 4 model needs major revisions from 0-15 nm. The X123 measurement provides a new reference spectrum for the 0.1-3 nm range.

The Problem



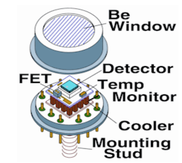
Current solar measurements of soft x-ray (SXR) irradiances are not providing spectra below 6nm, making differences in broader wavelength models difficult to explain.



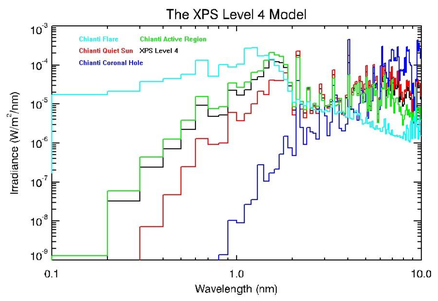
All three are 0.1-7nm broad measurements, but they disagree sometimes by factor of 3.

The Solution

The X123, a photon counter made for low wavelengths, takes data in terms of counts(bin). These counts are turned into an irradiance spectrum in units of W/m²/nm. Once this is done, the spectrum must be compared to current models of the SXR spectrum.



XPS Level 4 uses CHIANTI model spectra. All four model spectra agree with XPS 0-7 nm broad band. Which one, or combination of them, is the REAL solar spectrum?

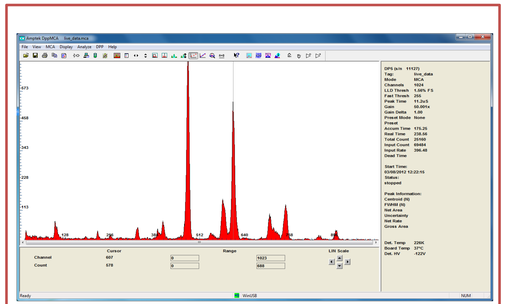


[cts] [J]

[W/m²/nm]

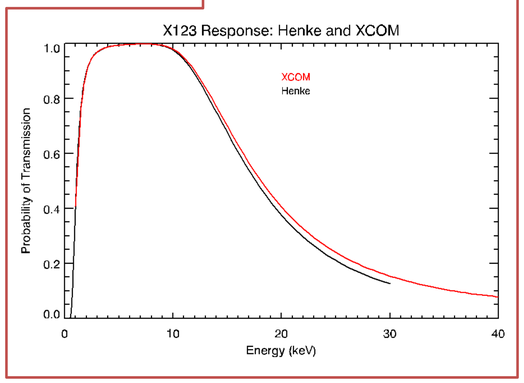
$$Irr(\lambda) = \frac{X123\ counts(\lambda) \times E(\lambda)}{(Resp(E) \times \Delta\lambda(\lambda) \times \Delta T \times Area)}$$

[cts/ph] [nm] [s] [m²]



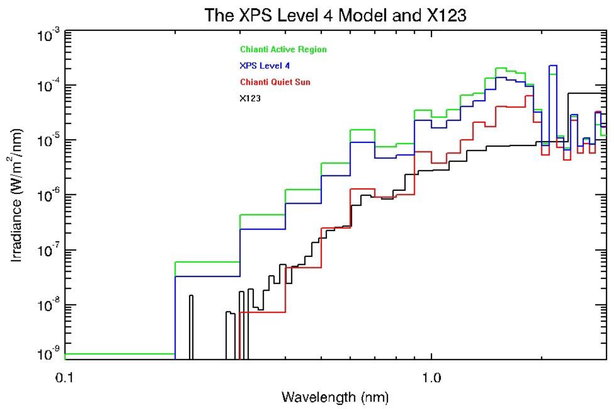
The gain calibration gives energy as a function of bin, allowing counts (initially in terms of bin number) to be graphed against energy and therefore wavelength.

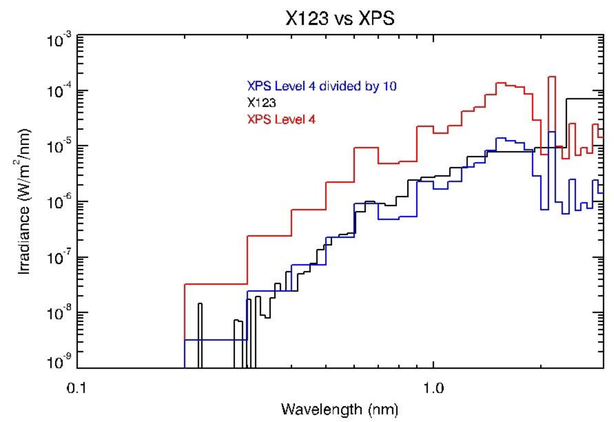
The response gives the probability that a photon of some energy gets counted (i.e. that the photon makes it through the filter AND is absorbed by the detector).



Results

The figures below show comparisons between X123 and the XPS Level 4 and Chianti models.





Total Irradiance from 1-8 A (W/m²)		
XPS Level 4	GOES	X123
1.84×10^{-6}	2.2×10^{-7}	1.84×10^{-7}

Conclusion

- X123 provides a new reference spectrum for the 0.1-3 nm range
- X123 agrees well with GOES-15 0.1-0.8 nm irradiance (NOTE: GOES calibrated value = GOES web value / 0.7)
- X123 can be used to improve solar SXR models, such as CHIANTI, SRPM, FISM, NRLEUV, SIP

References

1. Woods, T. N. et al., XPS L4 Irradiance Algorithm, Solar Phy.,249, 2008.
2. X123 Manual: 'DP5 Programmer's Guide A4', Amptek, Inc., 2012.