Spectra of flares in the range of $\sim 6.7$ keV Fe line emission to be observed by STIX.

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STIX: HXR imaging spectrometer on Solar Orbiter

Borrowed from Sam Krücker

Tungsten grids

Set of tungsten grids separated by 55 cm

Beryllium window

Detector Electronics Module with 32 detectors

CdTe detectors (Caliste SO)

X-ray windows and feed-through in heat shield

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Aim:
Simulate spectra to be collected by STIX in the lower-energy range $3 \div 10$ keV where line emission contributes.

The basis:
- Use of detector response matrix (DRM) calculated using Geant4 (CdTe $10 \times 10 \times 1$ mm & Calliste ASIC readout)
- Use of modern CHIANTI spectral code
- Use of RHESSI heritage
- Support from high-resolution spectra collected by BCS on SMM
Why this is important? STIX can see Fe & Ni line groups atop the continuum.

Observed intensity of these lines & the shape of the continuum should allow for:

• Determination of plasma temperature (differential emission measure, DEM) for the „thermal” plasma component

• Determination of abundance of Fe and Ni in flaring plasmas
Geant4 DRM response model and measurements

The measurements of detector response measurements were performed at CEA-Saclay 2014.

Spectrum of detector response was Monte-Carlo generated (blue) and found to reproduce well the $^{241}$Am spectra measured in France.
DRM matrix: for details see poster by Jaromir

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Simulation of Caliste-SO response

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Simulation of Caliste-SO single pixel response

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"escape peaks"
From Cd and Te

Compton scattering

7th Solar Orbiter Workshop, Granada, Spain, 3 - 7 April 2017
Energy resolution of STIX from Monte-Carlo DRM response calculations

- Cut-off of instrument sensitivity for $E < 4$ keV
- Steady increase of FWHM towards higher energies
Spectra to be observed

Solar spectra in the softer range $E < 10$ keV contain emission lines due to trace elements and the continuum CHIANTI (SolarSoft).
How the telescope record spectra?

Comparison of input (black) and detected spectra. Dashed-just continuum

Only Ca, Fe and Ni line groups Contribute substantially
Components of low-E STIX spectra

Dashed continuum:
Free-free
Free-bound
Two-photon

And the line Contribution on top
Line groups are of great interest- advanced plasma diagnostics

Log of irradiance
Lines & continuum Log of irradiance

10 MK

STIX spectra

25 MK

Log of irradiance
Lines only

7th Solar Orbiter Workshop, Granada, Spain, 3 - 7 April 2017
Spectra as they really look
SMM BCS is a good instrument to consider
Synthetic spectra between 4 and 10 keV from the CHIANTI code, with coronal abundances of Fe and Ni, convolved with respective DRM. For RHESSI a Gaussian filter having FWHM = 0.8 keV was used while for STIX the Geant4-calculated one. Spectra are given in 1 MK intervals from 8 to 33 MK. Fluxes are those at the mean solar distance and for a flare with volume emission measure $N_e^2 V = 10^{49} \text{ cm}^{-3}$.
temperature diagnostics

At the lowest energies, cooler (5 MK) plasma component will dominate the flux.
Conclusions

- STIX is able to detect X-ray spectra according to specifications.
- Line emission related to presence of trace elements in plasma is substantial, contributing up to 10 keV.
- Observations of lower energy part of flare and AR spectra will provide data for study of Fe and possibly Ni abundances of hot coronal plasmas.

Thank you!