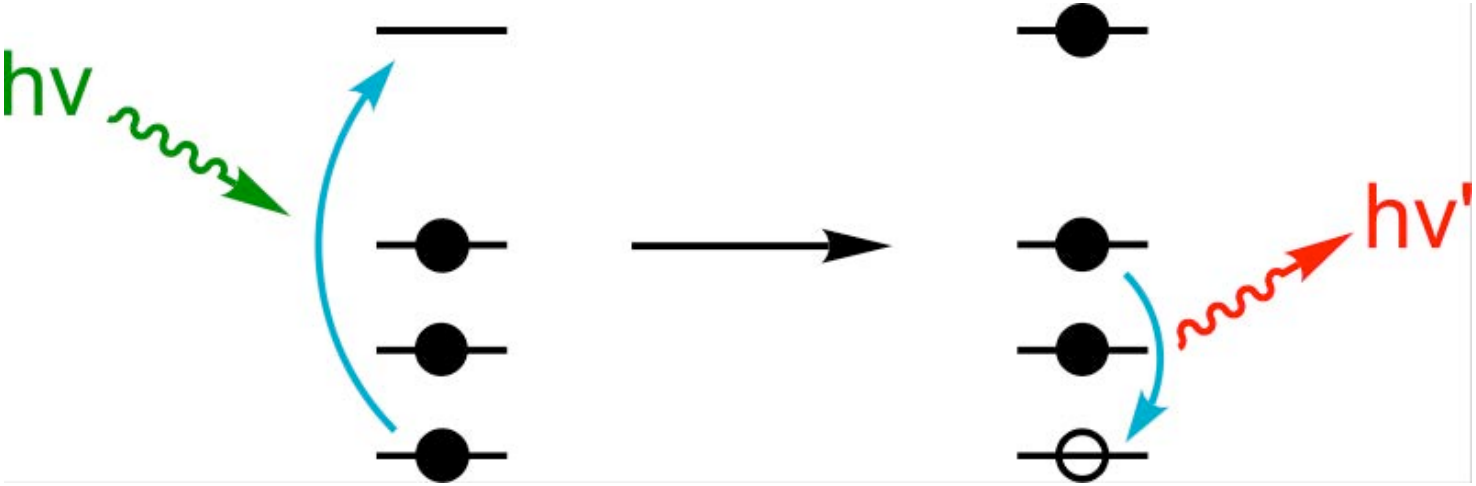
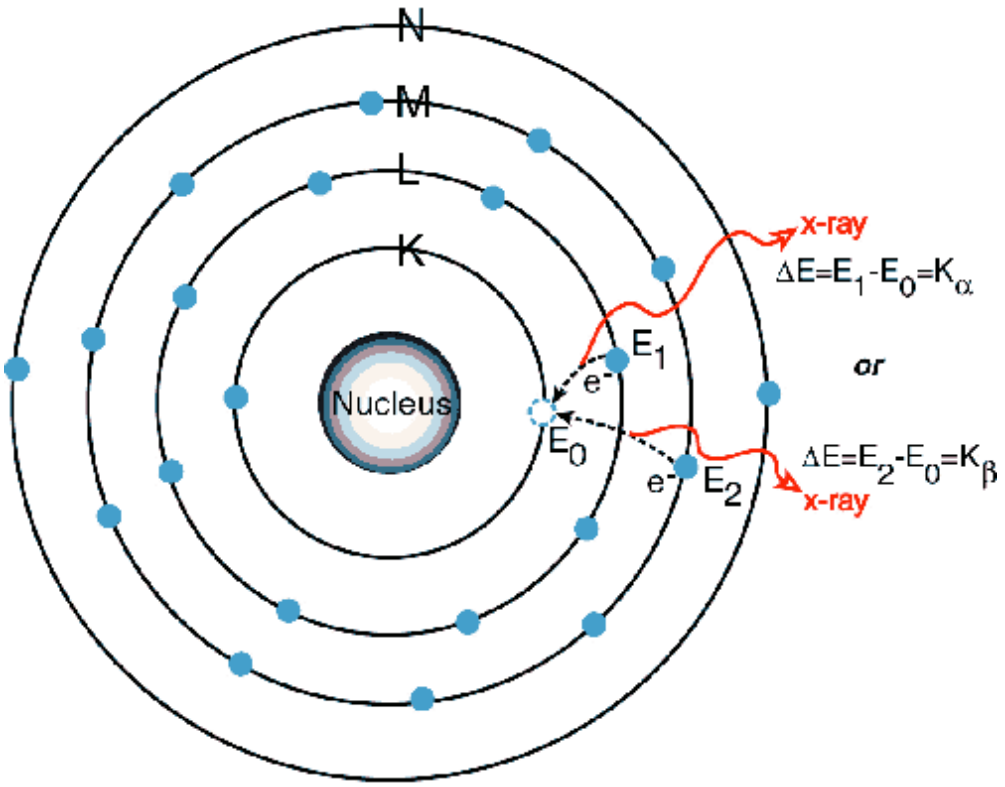
X-ray Fluorescence Spectroscopy



Particle and x-ray bombardment (from Sun, or a radioactive source) leads to ionization and subsequent electron cascade, causing fluorescence at wavelengths specific to each element

X-ray Fluorescence



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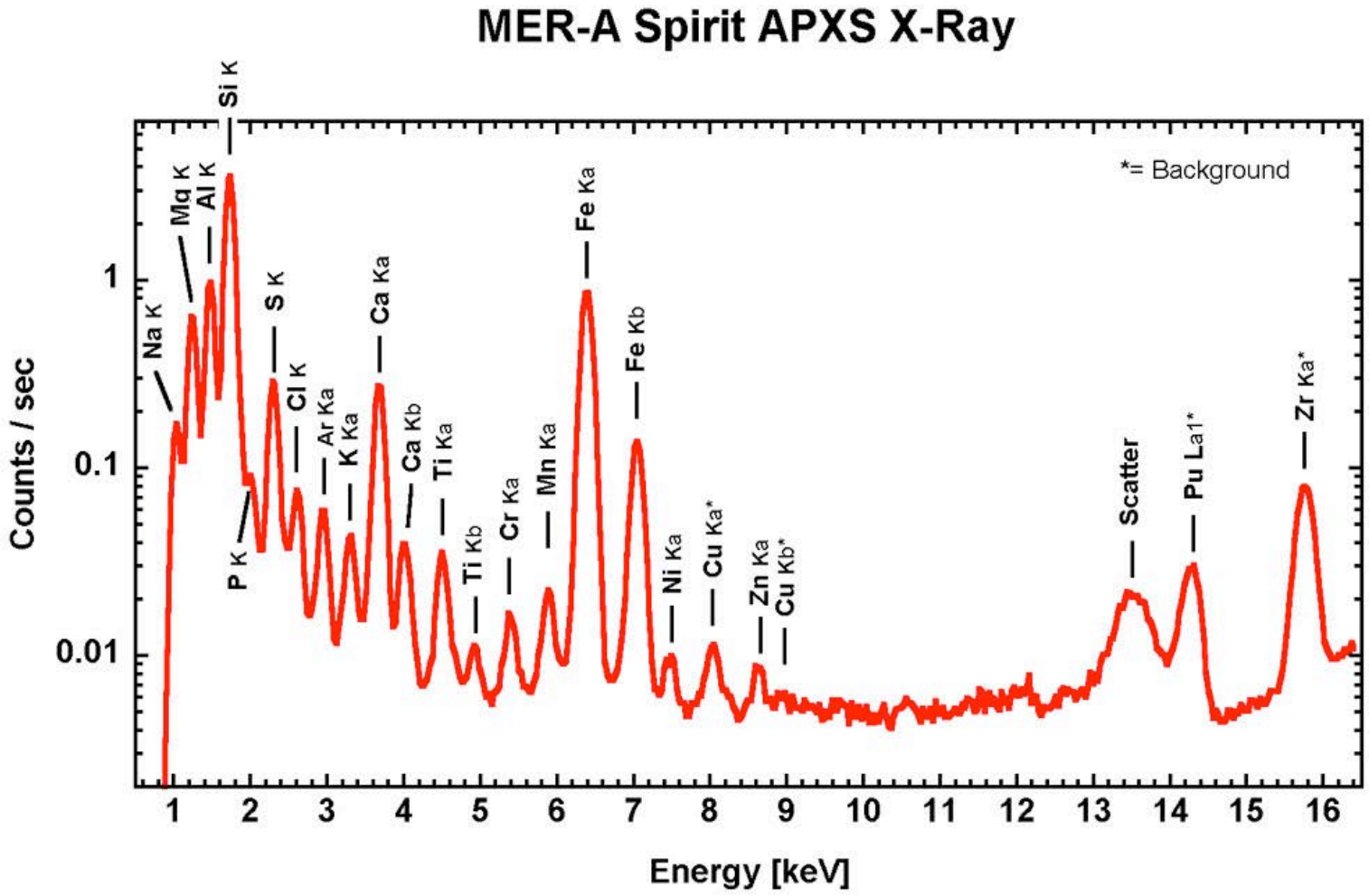
X-ray Fluorescence (and ^{244}Cm α-PIXE)



Similar instruments on Mars Pathfinder, Curiosity, Rosetta/Philae

For solar X-ray source, must monitor it simultaneously with your target

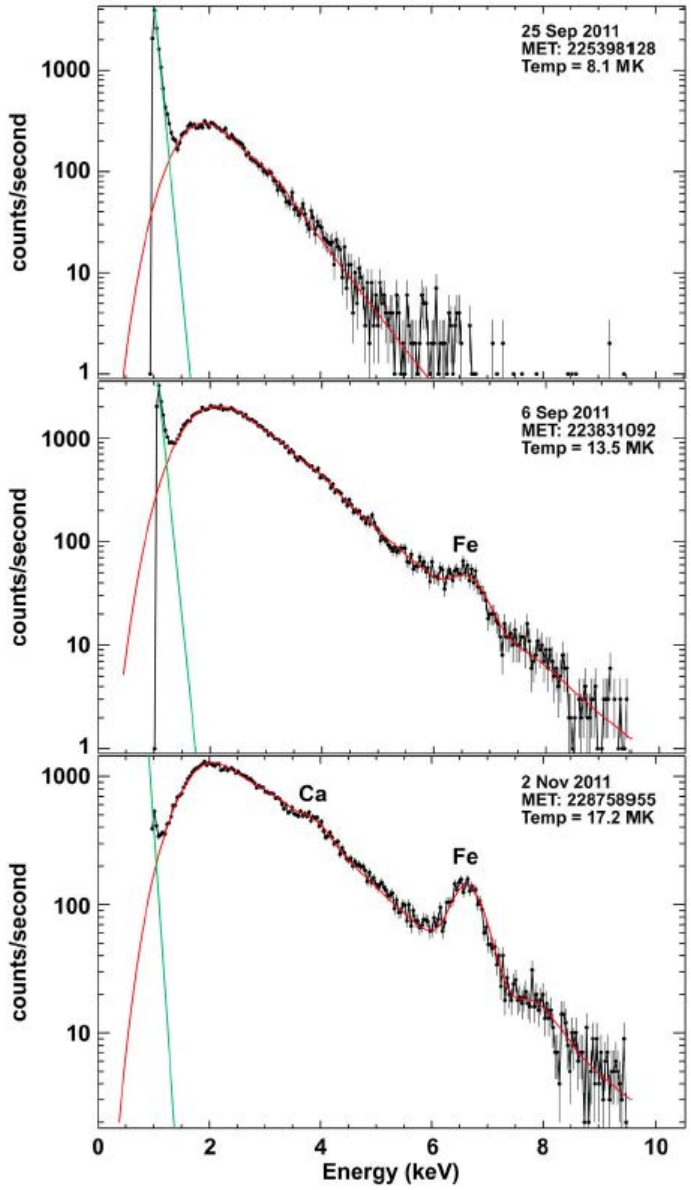


Figure 1. Three examples of fits to solar flare X-ray spectra measured by the SAX. The steeply inclined green line depicts the electronic background in the detector; the red line is the best fit solar spectrum (for the plasma temperature given in each case) convolved with the instrument response. The Ca and Fe line complexes (at ~3.6 keV and ~6.4 keV, respectively) increase in magnitude with temperature. MET = mission elapsed time, in s.

MESSENGER XRS
(at Mercury)

[Weider et al., 2012]

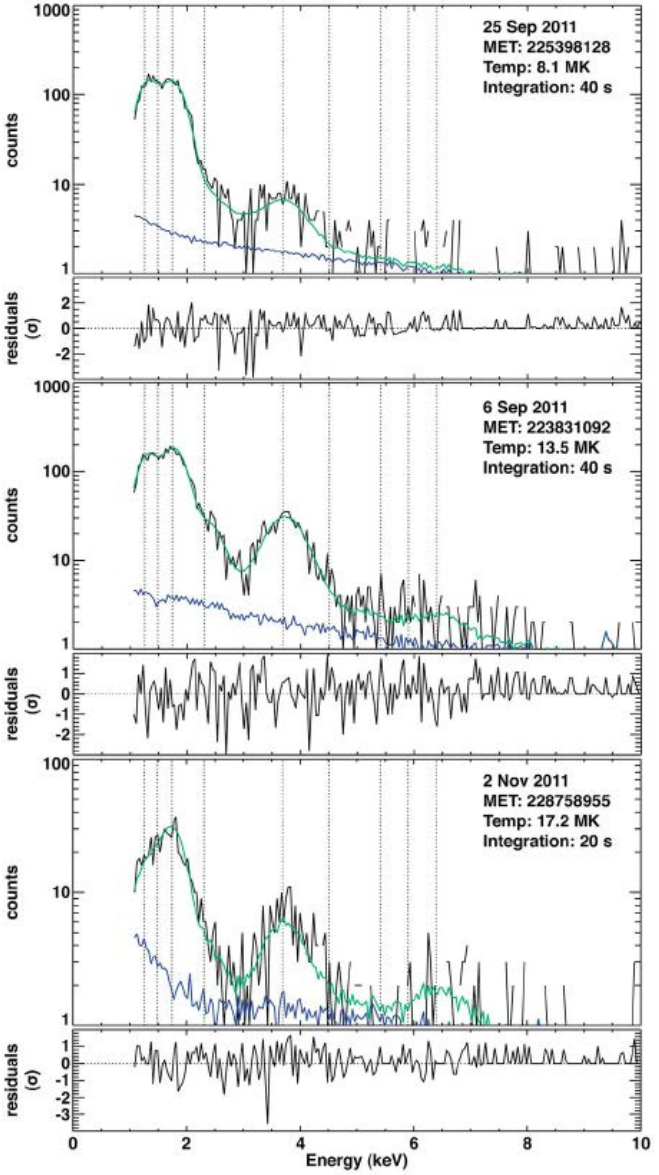


Figure 2. XRF spectra (black, primary signal) for the three time intervals for which solar spectra are shown in Figure 1. These spectra are the sum of the three separate GPC detector spectra. The best fit model (smooth curve) is shown in green, and the background level (lower signal) is shown in blue. Residuals between the best fit model and data are also shown in units of the counting-statistical error (σ) in each channel. Vertical dashed lines indicate the energy of K_α X-ray emission lines from (left to right) Mg, Al, Si, S, Ca, Ti, Cr, Mn, and Fe.

MESSENGER GRNS: Na heterogeneity

Table 1
Observed latitudinal variability of Na over the northern hemisphere of Mercury.

Latitude range	Average altitude (km)	Approximate spatial resolution[a] (km)	Na/Si abundance ratio	Na abundance (wt%)[b]
0–15°N	977	1500	0.115 ± 0.015	2.8 ± 0.4
15–30°N	646	1000	0.098 ± 0.016	2.4 ± 0.4
30–45°N	447	700	0.123 ± 0.019	3.0 ± 0.4
45–60°N	343	500	0.103 ± 0.018	2.5 ± 0.4
60–75°N	351	500	0.129 ± 0.019	3.2 ± 0.4
75–90°N	456	700	0.172 ± 0.020	4.2 ± 0.5
0–60°N			0.107 ± 0.008	2.6 ± 0.2
80–90°N			0.198 ± 0.030	4.9 ± 0.7

[a] The spatial resolution for an omnidirectional Gamma-Ray Spectrometer is approximated as 1.5 times the orbital altitude.
[b] Na abundance is calculated under the assumption of a constant Si abundance of 25 wt% across the surface (see Evans et al., 2012).

High Na abundances around Mercury's north polar region ➔ alkali feldspar-rich volcanic plains?