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Measurement of detection efficiency of XRS onboard MUSES-C in low-energy range.

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XRS, X-ray fluorescence Spectrometer, onboard MUSES-C, which will be launched in 2002, will determine elemental composition of surface material on an asteroid. The XRS will observe X-ray fluorescence excited by solar X-rays on the surface of asteroid, with simultaneously monitoring solar X-rays. Spectra and intensities of X-ray fluorescence reflect the surface material, so major elemental composition of the asteroid could be determined quantitatively by analyzing line spectra of each element. In order to quantitatively discuss on elemental composition of the asteroid's materials, accurate information about intensities of X-ray fluorescence is required. It is important to determine the detection efficiency, since it takes effect on the X-ray intensities observed by the XRS.

In this study the efficiency of XRS flight model was measured in terms of the pre-launch performance evaluation and discussion about the precision of quantitative analysis. The measurement was performed in the energy range 1-2 keV, where K-alpha peaks of major components of the rock; Mg, Al and Si, are observed. In laboratory we generated line spectra corresponding to Mg, Al and Si with some relative intensity ratios under the vacuum condition of 10 -6 torr. We measured the spectra with two different X-ray detectors. One is XRS flight model; another is a PIN-photodiode whose response function is adequately understood. Comparing with both of the intensity ratio of X-ray spectra, the detection efficiency of the XRS could be obtained. The characteristics and principle of PIN-photodiode are well investigated, because the structure is easier than that of CCD (Charge Coupled Device), which is adopted as detectors of the XRS. To the contrary the structure of CCD is much complex. Front-illuminated CCD is selected in order to observe in the energy range 1-10 keV. This type of CCD has poly-silicon electrode and silicon dioxide insulator (2 um) in front of silicon detection layer where X-ray is detected. Further more, there are aluminum coating (0.2 um) and beryllium window (5 um) preventing visible light leaking. Their dead layer (electrode and insulator) and filters can absorb soft X-rays before X-ray gets to silicon detection layer. Therefore those factors described above affect the detection efficiency, especially in low-energy range.

Here we report the results of measurements and theoretical estimation of the detection efficiency, and evaluate our methodology of detection efficiency by comparing them. In addition we apply our results to discussion on the precision in quantitative analysis of elemental composition during the planned XRS observation.