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Performance Verification of An Imaging Polarimeter with a Transmission Multi Layer

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Introduction

By X-ray observation of the celestial objects, we can have information of their X-ray energy spectra, images and time variations. A polarization is another important information, which relate to the emission mechanism and to the geometry of the emission region. However, the observation of the X-ray polarization is not established. The main reason might be a technical difficulty to have a high sensitivity. So far only one object, Crab Nebula, had been detected a significant polarization degree with 20%. Since we do not know an actual polarization degree of the other celestial objects, the satellite mission for the polarization measurement has a high risk to get scientific products.

Recently several technologies as a polarimeter were developed and achieved high sensitivity. Each of them has its merit and demerit. In this work, we propose an imaging polarimeter with a transmission multi-layer and a CCD. It is well known that a reflectivity and a transmission of multi layers have different values for the different polarization position angle if we use it with an incident angle of 45 deg. Also the CCD is now a standard imaging detector for soft X-ray observations with a moderate energy resolution. We employ a multi layer, tilted by 45 degree, as a transmission filter in front of a CCD. The multi layer can be rotate around the optical axis keeping the incident angle to be 45 deg. Thus we can image celestial objects by X-rays with a selected position angle.

Test Camera System

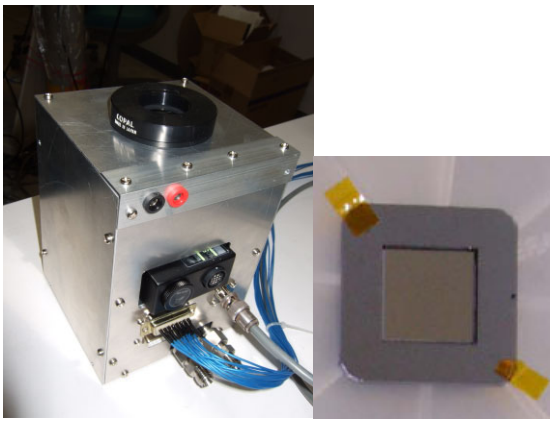

Figure1. (a: left) The over view of the test camera system. (b: right) the Mo/Si multi layers, which is installed in the camera.

We constructed a test camera system, which is shown in figure 1(a). A Mo/Si multi layers was fabricated by NTT-AT. The thicknesses of Si and Mo are 6 nm and 4 nm, respectively and the number of the layer pair is 7. The size is ~10mm square. The picture of the multi layer is shown in figure 1(b). This multilayer is installed on a rotational stage, the axis of which is aligned with the x-ray beam. The incident angle is set to be 45 deg. Since the rotation of the small filter is easy, the size of the system is small. The CCD is always on the optical axis of the optics, we can perform a normal spectroscopic imaging observation by removing the filter [1].

Experiment and Results

The camera is installed in a vacuum chamber, which was connected the output gate valve of BL12A. CCD output was measured at various EUV energies and at various rotational angles of the multi layer. Figure 2 shows the detected signal intensity as a function of an EUV energy from 70 eV to 120 eV. The rotational angle is selected as 0 deg, 45 deg and 90 deg, where 0 deg means S-polarization for the multi layer. Expected transmission properties were detected. The calculated modulation factor is roughly 40 % and this is consistent to a theoretical calculation.

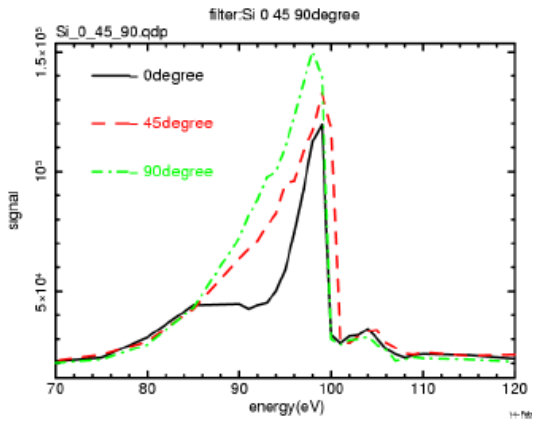

Figure 2. Obtained signal intensity of the transmitted EUVs from 70eV to 120 eV. Three lines are obtained at 0, 45, and 90 degree rotational angle.

Reference

[1] S. Kitamoto et al., Proc of SPIE 6266-104 (2006).

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