§35. Development of High-Resolution Vacuum Crystal Spectrometer for Doppler Broadening Measurement in CHS

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High-resolution vacuum crystal spectrometer (Johan type, 2R=3m, Crystal:RAP, 2d=26.12Å) has been designed and developed to measure ion temperature , electron temperature and plasma rotation using OVII (He-like) and OVIII (H-like) emitted in the soft x-ray region around 20Å. The information from the central column of the plasma can be obtained in the temperature range of T_e<1keV.

The spectral resolving power of the spectrometer was calculated as a function of the FWHM ε_H in the rocking curve of the RAP crystal using computer simulation code with a ray tracing method [1]. Here, the rocking curve function W(ε) of RAP is given by

$$W(\varepsilon)=2^{1/2}\,G\exp(-2\pi G^2\varepsilon^2),$$

where G is a constant which represents the characteristics of the crystal. The calculated results are shown in Fig.1. It is understood that the resolving power of the crystal spectrometer largely depends on the quality of the RAP crystal itself. In case of the ε_H=0.02 (0.04) the resolving power $\lambda/\Delta\lambda$ corresponds to 3500 (2100) and equals to Doppler broadening of the OVII line with T_i=200eV (400eV).

Figure 1 shows TiK$\alpha_{1,2}$ characteristic X-ray lines from a solid target using quartz(2020) crystal (2d=4.246Å). A photodiode array with 2-stage MCP is used as a detector. The spectrum indicates high spectral resolving power ($\lambda/\Delta\lambda$=3400) at a Bragg angle of 40.4deg. In contrast to it, FeL$\alpha_{1,2}$ characteristic lines obtained with the RAP crystal has no high spectral resolving power ($\lambda/\Delta\lambda$=199) as shown in Fig.2.

The OVII resonance line (21.6Å) has been observed from CHS plasmas using the RAP crystal (see Fig.4). The spectral resolving power ($\lambda/\Delta\lambda$=222) obtained was roughly the same as the FeL$\alpha_{1,2}$ case. The resolving power of the RAP crystal before bending was near 2000. Another bending technique is needed.

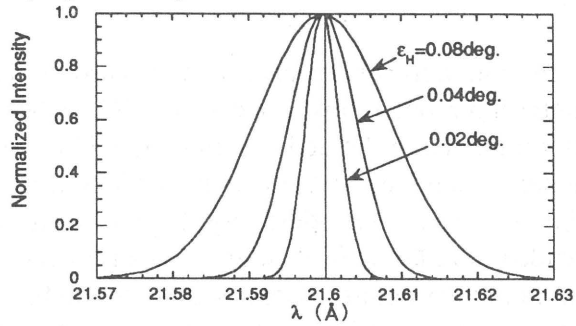

Fig.1 Computed result of ray tracing.

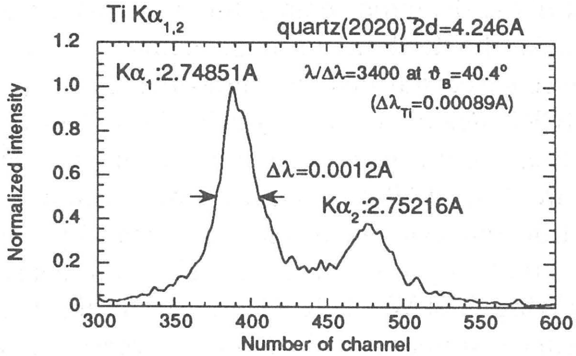

Fig.2 TiK$\alpha_{1,2}$ from solid target.

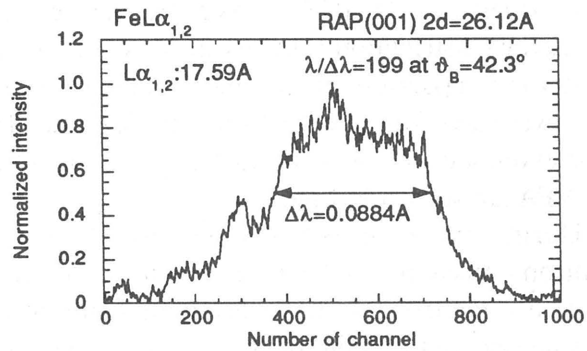

Fig.3 FeL$\alpha_{1,2}$ from solid target.

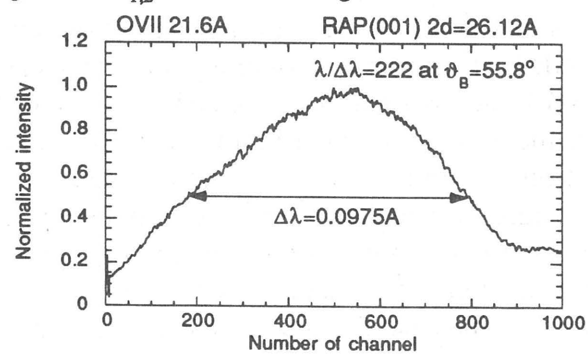

Fig.4 OVII resonance line from CHS plasmas.

Reference

1)Morita,S., Jpn.J.Appl.Phys. 22 (1983) 1030.