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# Observation of Interference Fringes Caused by Only Imaginary Part of X-ray Anomalous Scattering Factor

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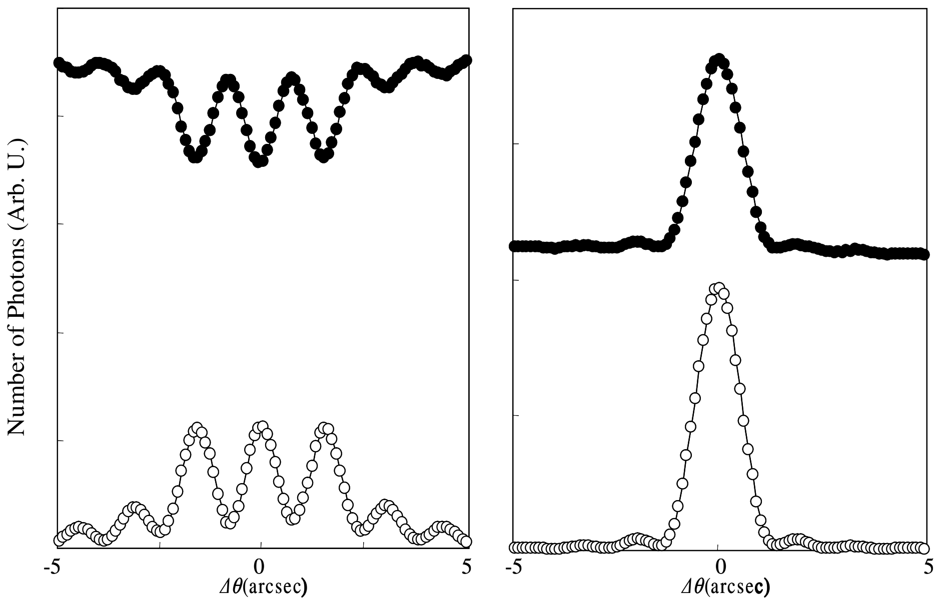
In the two-wave approximation of the dynamical theory of X-ray diffraction by Ewald [1], a diffracted wave and a transmitted wave propagate in the crystal by exchanging energy to each other. The movement of the two waves resembles a 2-body pendulum. Thus such an interference fringe is called a “Pendellösung fringe”. In a the fringe, there is a phase difference of $\pi$ in the fringe period between the diffracted wave and transmitted waves. In this paper, we report on the rocking curves of the diffracted and transmitted waves, which were observed from an absorbing crystal when only the imaginary part of the Fourier transform of X-ray polarizability $\chi_{hi}$ is nonzero.

The experiment was performed at Bl-15C in KEK-PF. The X-ray from synchrotron radiation is monochromated by a Si 111 double-crystal symmetric and a GaAs 200 asymmetric monochromaters. X-rays of $\sigma$-polarization was used. The asymmetric factor $a$ is approximately 10 around the Ga K-absorption edge. The diffraction condition is the symmetric Laue case. The specimen used was GaAs crystal, and 200 reflection was observed.

Fig.1(a) shows the rocking curves when $\omega_k$=10360.5eV i.e. , $\chi_{hi}$ is equal to 0. The diffraction condition of $\chi_{hi}$=0 is confirmed from two facts. One is that the rocking curves are symmetric about $\Delta\theta$, and the other is that the intensity of the transmitted wave is equal to or weaker than the intensity given by the mean absorption coefficient [2]. Since the phase difference in the fringes between the diffracted and transmitted rocking curves is $\pi$ , these interference fringes are Pendellösung fringes. On the other hand, when $\omega_k$ is 11403eV (Fig. 1 (b)), the real part of the Fourier transform $\chi_{hr}$ =0 and the diffraction only by $\chi_{hi}$ is observed. The sharp peaks are observed at the center of the diffracted and transmitted rocking curves. This peak is caused by anomalous transmission but is not the interference fringe [3]. Even though small undulations are observed at the peak tail, there is no phase difference between these two rocking curves. The transmitted intensity is always larger than that given by the mean absorption coefficient.

There are two points to be emphasized here. First, as shown in (a), the diffracted and transmitted rocking curves are observed for $\chi_{hi}$ =0, when there is no anomalous transmission effect even from an absorbing crystal. Secondly, the interference fringes are observed in the rocking curves only caused by $\chi_{hi}$. The phases of the diffracted and transmitted rocking curves are the same in this case. This indicates that the diffracted and transmitted rocking curves observed in this experiment are different from those predicted by Ewald model when the diffraction is caused by $\chi_{hi}$.

These results should be quit useful for deeper understanding of X-ray dynamical diffraction effect with the resonant scattering.




(a) (b)

Fig.1 Observed rocking curves. Open and closed circles are diffracted and transmitted intensities, respectively. (a) $\chi_{hi}$=0 and (b) $\chi_{hr}$=0.

## References

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