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In-phase Interference Fringe in Laue case and its Dispersion Surface

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We have found interference fringes in the transmitted (I_t) and diffracted (I_h) rocking curves which are in-phase with each other [1]. We measured GaAs 200 rocking curves in Laue case for X-ray energies at which either the real (χ_{hr}) or the imaginary (χ_{hi}) part of Fourier transform of X-ray polarizability is zero. The results are shown in Fig. 1. For χ_{hr}=0 (a), the two rocking curves show in-phase interference fringes with the intensity maxima and minima at the same angle. The intensity of I_t is always higher than the background (dotted line). For χ_{hi}=0 (b), I_t shows maxima at the angle where I_h shows minima and vice versa, i.e., the two curves are anti-phase which is well known as a Pendellösumg fringe. The intensity of I_t is always lower than the background.

The corresponding complex dispersion surfaces are shown in Fig.2 when χ_{hr}=0 (a) and χ_{hi}=0 (b). When $\chi_{hi}=0$ (b), the imaginary parts of the two branches (dashed line) become a single line and the anomalous absorption (Borrmann effect) does not occur even when the crystal is absorbing. When χ_{hr}=0 (a), the real part of the dispersion surface looks like that in Bragg case without absorption. The real parts of the two branches are degenerate in the center. As a result, the central peaks of I_h and I_t are not interference fringes but are produced by anomalous transmission, because the imaginary part of one of the branches becomes zero in the center. The small ripples in I_h and I_t beside the peaks are the interference fringes, because there are two branches in the real part.

By computing the electric fields in the crystal, we are able to analyze why the interference fringe becomes in-phase when χ_{hr}=0.

Reference

[1] R.Negishi et al., J. Phys. Soc. Jpn., **77**, 023709(2008).

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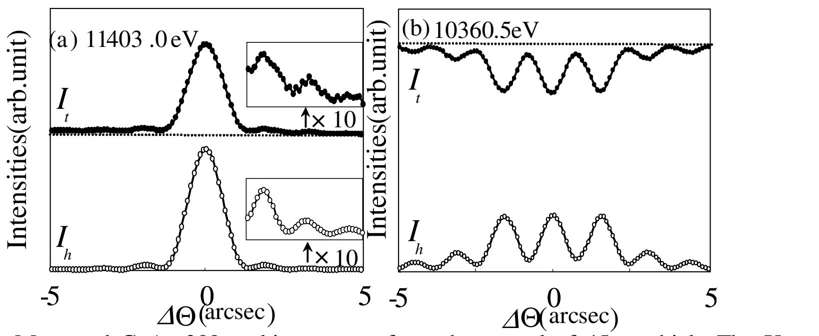

Fig.1. Measured GaAs 200 rocking curves from the crystal of 45μm thick. The X-ray energy is (a) 11403.0eV and (b) 10360.5eV.

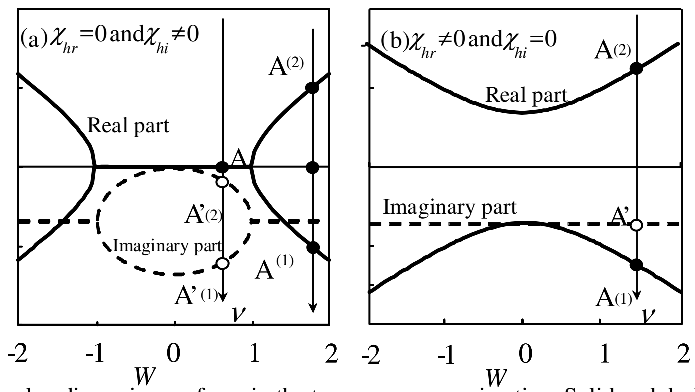

Fig.2 Complex dispersion surfaces in the two-wave approximation. Solid and dashed lines are the real and imaginary parts, respectively. (a) $\chi_{hr}=0$ and $\chi_{hi}\neq0$. (b) $\chi_{hr}\neq0$ and $\chi_{hi}=0$.