18. Using CBED

Problems

18.1. A CBED pattern is acquired from a sample of thickness $T = 108$ nm, using a two-beam condition for reflection *g*, where $\xi_g = 125$ nm. Is the central ($s = 0$) portion of the CBED disk for *g* a local intensity minimum, or a maximum?

18.2. A CBED pattern acquired at 200. KeV shows a FOLZ ring ($n = 1$) with diameter $2G_1 = 36.8$ nm^{-1}. Find:

a) The zone separation *H*;

b) The diameter $2G_2$ of the SOLZ ($n = 2$).

18.3. In a strong two-beam condition, the Bloch waves in a crystal have eigenfunctions:

$$\left|\psi^{(1)}\right\rangle = \begin{pmatrix} C_0^{(1)} \\ C_g^{(1)} \end{pmatrix} = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ -1 \end{pmatrix},\ \left|\psi^{(2)}\right\rangle = \begin{pmatrix} C_0^{(2)} \\ C_g^{(2)} \end{pmatrix} = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

The eigenvalues are

$$\gamma^{(1)} = -\frac{1}{2\xi_g} \text{ and } \gamma^{(2)} = \frac{1}{2\xi_g}$$

Assume the operator for the imaginary part of the potential is:

$$\hat{\mathrm{A}}' = \frac{\alpha}{2}\cdot\begin{pmatrix} \frac{1}{\xi_0} & \frac{1}{\xi_g} \\ \frac{1}{\xi_g} & \frac{1}{\xi_0} \end{pmatrix}$$

where α is a small, dimensionless coefficient.

a) Find expressions for the imaginary components of the eigenvalues $\gamma'^{(1)}$ and $\gamma'^{(2)}$ using:

$$\gamma'^{(1,2)} = \left\langle \psi^{(1,2)} \middle| \hat{\mathrm{A}}' \middle| \psi^{(1,2)} \right\rangle$$

b) Evaluate $\gamma^{(1,2)}$ and $\gamma'^{(1,2)}$, assuming $\xi_0 = 48$ nm, $\xi_g = 96$ nm, and $\alpha = 0.10$.