H. W. Schnopper, Chlorine K Absorption Edge in Single Crystal KClO$_3$
in Röntgenspektren und Chemische Bindung
Physikalisch-Chemisches Institut der Karl-Marx-Universität Leipzig, 1966, pp 303 - 313
POLARIZATION BY BRAGG REFLECTION

\[ I_y = I_x + I_x \]
\[ I_x = I_x + 2P_x I_x \sin^2 2B \]
\[ I_z = I_x + 2P_x I_x \cos^2 2B \]
\[ P_x = \frac{(I_y - I_x)}{(I_y + I_x)} \]

If absorption is neglected,

\[ I_x N = I_x \cos^2 2B \]
\[ I_z N = I_z \]

In practice, \( N \) and \( I_x \) are unknown, but if \( 2B = 45 \) deg then \( I_x N \approx 0 \). If the crystal is rotated about the axis of the incoming beam with an angular frequency \( \nu \), then the \( I_z N \) signal will have a component that has a modulation frequency \( 2\nu \) and an amplitude \( 2P_x I_x \).
BRAGG REFLECTIONS IN A MOSAIC CRYSTAL

- Perfect Crystal
- Mosaic Crystal
- First Order
- Second Order
- Intensity vs. Bragg Angle
- Nominal d-spacing
MINIMUM DETECTABLE POLARIZATION: \((P_x)_{\text{min}}\)

**EFFECTIVE AREA:** \(A \text{ cm}^2 \) (including efficiencies)

**ENERGY RANGE:** \(E \text{ keV @ } E_0\)

**SOURCE FLUX:** \(F(E) \text{ kev cm}^{-2} \text{ sec}^{-1} \text{ keV}^{-1}\)

**INCIDENT COUNT RATE:** \(I_x + I_z = F(E)(E/E_0) \text{ cm}^2 \text{ sec}^{-1}\)

If \(I_x\) is small then \(I_x \approx I_z\) and the integrated signal recorded after an observing time \(t\) is the sum of the following terms:

- **Unmodulated signal:** \(0.5(I_x + I_z)At = 0.5I_xAt\)
- **Modulated signal:** \(0.5P_x(I_x + I_z)At = 0.5P_xI_xAt\)
- **Detector noise:** \(I_D A D t\)
- **\(I^N_2\) leakage (\(2\beta \neq 45\) deg):** \(I_2 \cos^2 2\beta At\)
- **Instrument modulation:**

![Graph showing intensity after reflection as a function of rotation angle.](Image)
**MINIMUM DETECTABLE POLARIZATION: \((P_x)_\text{min}\)**

The raw data is divided into \(N\) bins, the \(k^{th}\) bin containing \(A(k)\) events. The total number of events detected is

\[ N_T = \sum_{k=1}^{N} A(k) \]

The \(A(k)\) are distributed randomly with a mean value \(M(k)\) which is composed of 2 parts:

\[ M(k) = M + m(k), \]

where \(M\) is the unmodulated part of the signal (source and background) and \(m(k)\) is the polarization modulation. In most observations \(M \gg m(k)\).

For a random variable distributed according to Gaussian statistics, a minimum acceptable test is that the result of a measurement exceeds the one expected from chance alone by 3 \(\mathcal{F}\), i.e., the probability of a chance result giving the measured result is only 0.26%. Thus,

\[ 0.0026 = \exp \left( -\frac{(A_{\text{min}})^2}{2 \mathcal{F}} \right) \quad \text{and,} \]

\[ A_{\text{min}} = 3.45(NM/2)^{1/2} \]

In terms of the parameters of the experiment,

\[ NM = I_T A_n t/2 + I_D A_D t \quad \text{and,} \]

\[ 2A_{\text{min}} = (P_x)_{\text{min}} I_T At \quad \text{which results in} \]

\[ (P_x)_{\text{min}} = 6.9(I_T At + 2I_D A_D t)^{1/2}/ I_T At \]

\[ . \quad 6.9(I_T At)^{-1/2} \quad \text{for small detector noise} \]
BRAGG CRYSTAL
X-RAY POLARIZATION PAYLOADS

H. W. SCHNAPPER AND K. KALATA
ASTROPHYSICAL JOURNAL 74, 854 - 858, 1969

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ROXSAN PROPOSAL TO ESA 1984