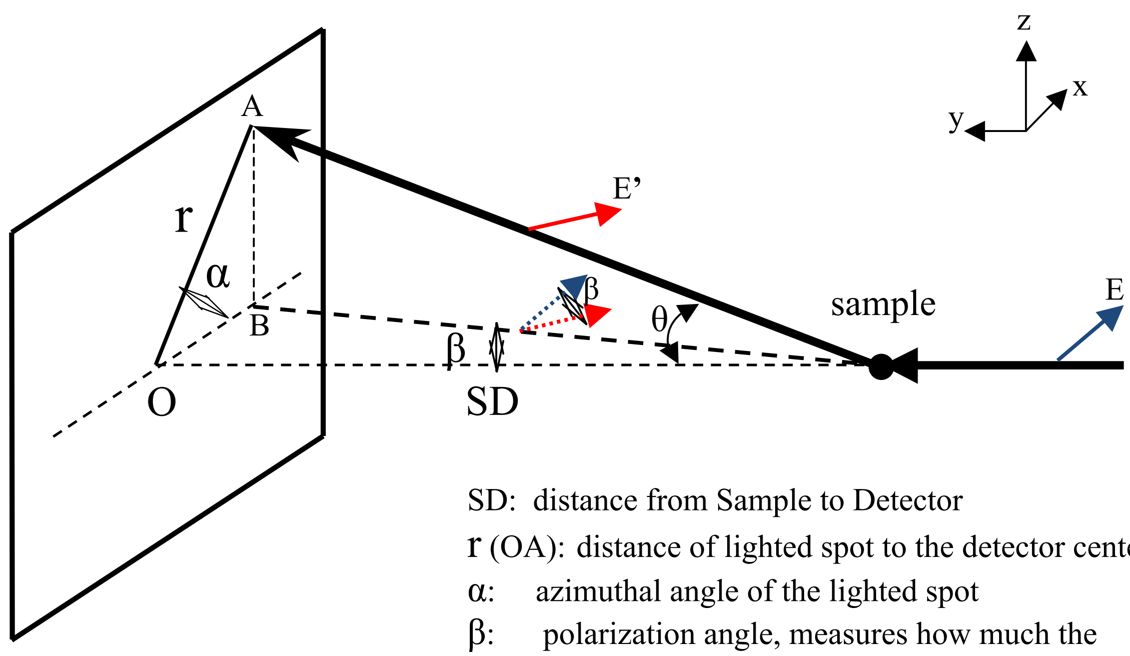
Polarization Correction for Area Detector



SD: distance from Sample to Detector

r (OA): distance of lighted spot to the detector center

α: azimuthal angle of the lighted spot

β: polarization angle, measures how much the scattered beam moves along the x axis

Diagram: X-ray scattering with linearly polarized incident beam and area detector

Configuration and Argument:

Incident beam comes from right (y direction), with polarization E at x direction, as diagram shows. After it is scattered by the sample, the beam reaches area detector on the lighted spot A. As a result, the beam shifted in the x direction by a distance of OB, or an angle of β. Thus the polarization direction also shifts an angle of β, to E**'.** Notice here that E and E' are both in the xy plane. In this circumstance, if the scattered beam intensity is Is, the detector actually measures only Is * $\cos^2\beta$. Hence, to get the correct Is, the measured intensity must be divided by $\cos^2\beta$.

Calculation:

$$q = \frac{4\pi \sin\theta}{\lambda} \quad \Rightarrow \quad \sin\theta = \frac{q\lambda}{4\pi} \qquad \text{.......................} \quad (1)$$

$$\sin 2\theta = \frac{r}{\sqrt{SD^2 + r^2}} \qquad \text{.......................} \quad (2)$$

$$\sin\beta = \frac{r\cos\alpha}{\sqrt{r^2\cos^2 + SD^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (3)$$

$$\cos\beta = \frac{SD}{\sqrt{r^2\cos^2 + SD^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (4)$$

From Eq (4), we know that in order to get cosβ, we need to find out r, which is determined by θ and hence q of each point.

From Eq (2), we have $r^2 = \frac{SD^2\sin^2 2\theta}{\cos^2 2\theta}$, plugging this result back into Eq (4), we have

$$\cos^2\beta = \frac{SD^2}{r^2\cos^2\alpha + SD^2} = \frac{SD^2}{\frac{\sin^2 2\theta\cos^2\alpha}{\cos^2 2\theta}SD^2 + SD^2} = \frac{1}{\frac{\sin^2 2\theta}{\cos^2 2\theta}\cos^2\alpha + 1} = \frac{1}{\frac{4\sin^2\theta\cos^2\theta}{1-4\sin^2\theta\cos^2\theta}\cos^2\alpha +}$$

Or $Is = Is\_measured * \left(\frac{4\sin^2\theta\cos^2\theta}{1-4\sin^2\theta\cos^2\theta}\cos^2\alpha + 1\right) = Is\_measured * \left(\frac{\sin^2 2\theta}{\cos^2 2\theta}\cos^2\alpha + 1\right)$