The coordinate system and the conventions for the orientation used in the Bruker EBSD system

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1 Unit cell axes

We are using the c-axis convention, i.e. the c-axis is aligned with the crystal-z-axis and b is aligned with the crystal-yz-plane. The volume of the unit cell is

$$V = abc\,v \tag{1}$$

with the reduced volume

$$v = \sqrt{1 - \cos^2\alpha - \cos^2\beta - \cos^2\gamma + 2\cos\alpha\cos\beta\cos\gamma} \tag{2}$$

The axis are

$$\mathbf{a} = a \begin{pmatrix} \dfrac{v}{\sin\alpha} \\ \dfrac{\cos\gamma - \cos\alpha\cos\beta}{\sin\alpha} \\ \cos\beta \end{pmatrix} \tag{3}$$

$$\mathbf{b} = b \begin{pmatrix} 0 \\ \sin\alpha \\ \cos\alpha \end{pmatrix} \tag{4}$$

$$\mathbf{c} = c \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \tag{5}$$

2 Meaning of orientations/Coordinate systems

2.1 Camera

The axes of the camera coordinate system are oriented (relative to the pattern image) as follows:

x : points to the right

y : points down

z : points away from the camera (i.e. if the pattern is displayed on the monitor, z points into the monitor)

2.2 Sample

The sample coordinate system is derived from the camera system by rotating around x to account for the sample and detector tilt. The rotation angle α is

$$\alpha = 90^\circ + \vartheta_{\text{sample}} - \vartheta_{\text{detector}} \tag{6}$$

The x-axis stays the same, the sample-y-axis is parallel to the sample and points up (as seen from the camera), the sample-z-axis points perpendicular to the sample surface out of the sample.

3 Meaning of orientations

As a result of the indexing we obtain a rotation matrix $\hat{A}$ which describes the rotation of a plane normal in the ideal unit cell (with axes as described by eqns (3)-(5)) to the detected plane normal. The rotation matrix can be parametrized by Euler angles as follows:

$$\hat{A}=\begin{pmatrix} \cos\varphi_2\cos\varphi_1-\sin\varphi_2\cos\Phi\sin\varphi_1 & \cos\varphi_2\sin\varphi_1+\sin\varphi_2\cos\Phi\cos\varphi_1 & \sin\varphi_2\sin\Phi \\ -\sin\varphi_2\cos\varphi_1-\cos\varphi_2\cos\Phi\sin\varphi_1 & -\sin\varphi_2\sin\varphi_1+\cos\varphi_2\cos\Phi\cos\varphi_1 & \cos\varphi_2\sin\Phi \\ \sin\Phi\sin\varphi_1 & -\sin\Phi\cos\varphi_1 & \cos\Phi \end{pmatrix} \tag{7}$$

Since there seems to be a consensus in the field to report passive rotations (rotations of the coordinate system) instead of rotations of vectors (as described above), all angles displayed on the user interface or plain text data files are inverted, i.e. instead of reporting $(\varphi_1, \Phi, \varphi_2)$ we report $(\pi - \varphi_2, \Phi, \pi - \varphi_1)$.