β-monoclinic Sulfur Structure: A_mP64_14_16e-002

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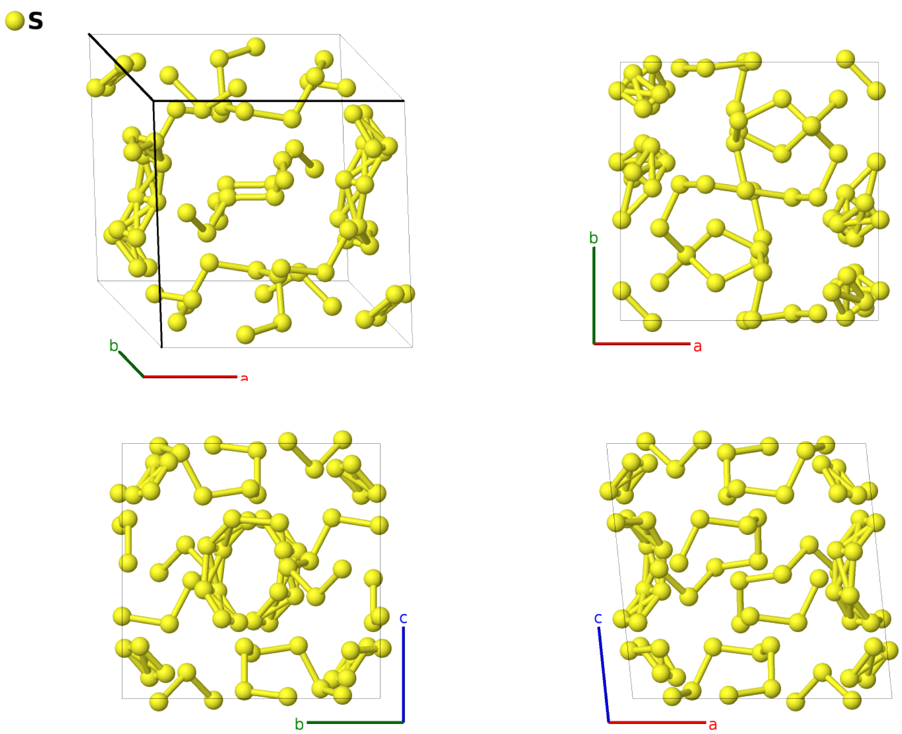
https://aflow.org/p/AYZW

https://aflow.org/p/A_mP64_14_16e-002



Prototype	S
AFLOW prototype label	A_mP64_14_16e-002
ICSD	870
Pearson symbol	mP64
Space group number	14
Space group symbol	$P2_1/c$
AFLOW prototype command	`aflow --proto=A_mP64_14_16e-002` `--params=`$a, b/a, c/a, \beta, x_1, y_1, z_1, x_2, y_2, z_2, x_3, y_3, z_3, x_4, y_4, z_4, x_5, y_5, z_5, x_6, y_6, z_6, x_7, y_7, z_7, x_8, y_8, z_8, x_9, y_9, z_9, x_{10}, y_{10}, z_{10}, x_{11}, y_{11}, z_{11}, x_{12}, y_{12}, z_{12}, x_{13}, y_{13}, z_{13}, x_{14}, y_{14}, z_{14}, x_{15}, y_{15}, z_{15}, x_{16}, y_{16}, z_{16}$

- We take the name of this structure from (Donohue, 1976). This is the high temperature phase of sulfur, stable from 95°C to the melting point at 115°C, although it can be kept at room temperatures for some time. (Templeton, 1976)
- This is a refinement of the original structure found by (Sands, 1965). There are two types of sulfur atoms in this sample:

- atoms S-I through S-VIII form stable sulfur rings with all the sites fully occupied, just as in the ground state α-S ($A16$).
- Atoms S-IX through S-XVI form a ring with one of two orientations, randomly chosen.

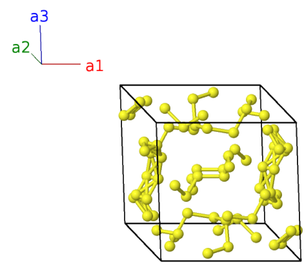
- The S-IX through S-XVI sites are thus half occupied, so there are only 48 atoms and six sulfur rings in any unit cell. Contrast this with A_k selenium, which has eight complete rings in the unit cell.
- Both A_k selenium and β-monoclinic sulfur have the same AFLOW prototype label, A_mP64_14_16e. They are generated by the same symmetry operations with different sets of parameters (`--params`) specified in their corresponding CIF files.

Simple Monoclinic primitive vectors

$$\mathbf{a_1} = a\,\mathbf{\hat{x}}$$

$$\mathbf{a_2} = b\,\mathbf{\hat{y}}$$

$$\mathbf{a_3} = c\cos\beta\,\mathbf{\hat{x}} + c\sin\beta\,\mathbf{\hat{z}}$$



Basis vectors

		Lattice coordinates		Cartesian coordinates	Wyckoff position	Atom type
$\mathbf{B_1}$	=	$x_1\,\mathbf{a}_1 + y_1\,\mathbf{a}_2 + z_1\,\mathbf{a}_3$	=	$(ax_1 + cz_1\cos\beta)\,\mathbf{\hat{x}} + by_1\,\mathbf{\hat{y}} + cz_1\sin\beta\,\mathbf{\hat{z}}$	(4e)	S I
$\mathbf{B_2}$	=	$-x_1\,\mathbf{a}_1 + \left(y_1 + \frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_1 - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_1 + c\left(z_1 - \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_1 + \frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_1 - \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S I
$\mathbf{B_3}$	=	$-x_1\,\mathbf{a}_1 - y_1\,\mathbf{a}_2 - z_1\,\mathbf{a}_3$	=	$-(ax_1 + cz_1\cos\beta)\,\mathbf{\hat{x}} - by_1\,\mathbf{\hat{y}} - cz_1\sin\beta\,\mathbf{\hat{z}}$	(4e)	S I
$\mathbf{B_4}$	=	$x_1\,\mathbf{a}_1 - \left(y_1 - \frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_1 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_1 + c\left(z_1 + \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_1 - \frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_1 + \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S I
$\mathbf{B_5}$	=	$x_2\,\mathbf{a}_1 + y_2\,\mathbf{a}_2 + z_2\,\mathbf{a}_3$	=	$(ax_2 + cz_2\cos\beta)\,\mathbf{\hat{x}} + by_2\,\mathbf{\hat{y}} + cz_2\sin\beta\,\mathbf{\hat{z}}$	(4e)	S II
$\mathbf{B_6}$	=	$-x_2\,\mathbf{a}_1 + \left(y_2 + \frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_2 - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_2 + c\left(z_2 - \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_2 + \frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_2 - \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S II
$\mathbf{B_7}$	=	$-x_2\,\mathbf{a}_1 - y_2\,\mathbf{a}_2 - z_2\,\mathbf{a}_3$	=	$-(ax_2 + cz_2\cos\beta)\,\mathbf{\hat{x}} - by_2\,\mathbf{\hat{y}} - cz_2\sin\beta\,\mathbf{\hat{z}}$	(4e)	S II
$\mathbf{B_8}$	=	$x_2\,\mathbf{a}_1 - \left(y_2 - \frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_2 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_2 + c\left(z_2 + \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_2 - \frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_2 + \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S II
$\mathbf{B_9}$	=	$x_3\,\mathbf{a}_1 + y_3\,\mathbf{a}_2 + z_3\,\mathbf{a}_3$	=	$(ax_3 + cz_3\cos\beta)\,\mathbf{\hat{x}} + by_3\,\mathbf{\hat{y}} + cz_3\sin\beta\,\mathbf{\hat{z}}$	(4e)	S III
$\mathbf{B_{10}}$	=	$-x_3\,\mathbf{a}_1 + \left(y_3 + \frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_3 - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_3 + c\left(z_3 - \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_3 + \frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_3 - \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S III
$\mathbf{B_{11}}$	=	$-x_3\,\mathbf{a}_1 - y_3\,\mathbf{a}_2 - z_3\,\mathbf{a}_3$	=	$-(ax_3 + cz_3\cos\beta)\,\mathbf{\hat{x}} - by_3\,\mathbf{\hat{y}} - cz_3\sin\beta\,\mathbf{\hat{z}}$	(4e)	S III
$\mathbf{B_{12}}$	=	$x_3\,\mathbf{a}_1 - \left(y_3 - \frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_3 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_3 + c\left(z_3 + \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_3 - \frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_3 + \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S III
$\mathbf{B_{13}}$	=	$x_4\,\mathbf{a}_1 + y_4\,\mathbf{a}_2 + z_4\,\mathbf{a}_3$	=	$(ax_4 + cz_4\cos\beta)\,\mathbf{\hat{x}} + by_4\,\mathbf{\hat{y}} + cz_4\sin\beta\,\mathbf{\hat{z}}$	(4e)	S IV
$\mathbf{B_{14}}$	=	$-x_4\,\mathbf{a}_1 + \left(y_4 + \frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_4 - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_4 + c\left(z_4 - \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_4 + \frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_4 - \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S IV
$\mathbf{B_{15}}$	=	$-x_4\,\mathbf{a}_1 - y_4\,\mathbf{a}_2 - z_4\,\mathbf{a}_3$	=	$-(ax_4 + cz_4\cos\beta)\,\mathbf{\hat{x}} - by_4\,\mathbf{\hat{y}} - cz_4\sin\beta\,\mathbf{\hat{z}}$	(4e)	S IV
$\mathbf{B_{16}}$	=	$x_4\,\mathbf{a}_1 - \left(y_4 - \frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_4 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_4 + c\left(z_4 + \frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_4 - \frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_4 + \frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S IV

$$\mathbf{B_{17}} = x_5\,\mathbf{a}_1 + y_5\,\mathbf{a}_2 + z_5\,\mathbf{a}_3 = \left(a x_5 + c z_5 \cos\beta\right)\,\mathbf{\hat{x}} + b y_5\,\mathbf{\hat{y}} + c z_5 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S V}$$

$$\mathbf{B_{18}} = -x_5\,\mathbf{a}_1 + \left(y_5 + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_5 - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_5 + c\left(z_5 - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_5 + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_5 - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S V}$$

$$\mathbf{B_{19}} = -x_5\,\mathbf{a}_1 - y_5\,\mathbf{a}_2 - z_5\,\mathbf{a}_3 = -\left(a x_5 + c z_5 \cos\beta\right)\,\mathbf{\hat{x}} - b y_5\,\mathbf{\hat{y}} - c z_5 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S V}$$

$$\mathbf{B_{20}} = x_5\,\mathbf{a}_1 - \left(y_5 - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_5 + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_5 + c\left(z_5 + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_5 - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_5 + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S V}$$

$$\mathbf{B_{21}} = x_6\,\mathbf{a}_1 + y_6\,\mathbf{a}_2 + z_6\,\mathbf{a}_3 = \left(a x_6 + c z_6 \cos\beta\right)\,\mathbf{\hat{x}} + b y_6\,\mathbf{\hat{y}} + c z_6 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VI}$$

$$\mathbf{B_{22}} = -x_6\,\mathbf{a}_1 + \left(y_6 + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_6 - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_6 + c\left(z_6 - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_6 + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_6 - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VI}$$

$$\mathbf{B_{23}} = -x_6\,\mathbf{a}_1 - y_6\,\mathbf{a}_2 - z_6\,\mathbf{a}_3 = -\left(a x_6 + c z_6 \cos\beta\right)\,\mathbf{\hat{x}} - b y_6\,\mathbf{\hat{y}} - c z_6 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VI}$$

$$\mathbf{B_{24}} = x_6\,\mathbf{a}_1 - \left(y_6 - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_6 + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_6 + c\left(z_6 + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_6 - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_6 + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VI}$$

$$\mathbf{B_{25}} = x_7\,\mathbf{a}_1 + y_7\,\mathbf{a}_2 + z_7\,\mathbf{a}_3 = \left(a x_7 + c z_7 \cos\beta\right)\,\mathbf{\hat{x}} + b y_7\,\mathbf{\hat{y}} + c z_7 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VII}$$

$$\mathbf{B_{26}} = -x_7\,\mathbf{a}_1 + \left(y_7 + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_7 - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_7 + c\left(z_7 - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_7 + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_7 - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VII}$$

$$\mathbf{B_{27}} = -x_7\,\mathbf{a}_1 - y_7\,\mathbf{a}_2 - z_7\,\mathbf{a}_3 = -\left(a x_7 + c z_7 \cos\beta\right)\,\mathbf{\hat{x}} - b y_7\,\mathbf{\hat{y}} - c z_7 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VII}$$

$$\mathbf{B_{28}} = x_7\,\mathbf{a}_1 - \left(y_7 - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_7 + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_7 + c\left(z_7 + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_7 - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_7 + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VII}$$

$$\mathbf{B_{29}} = x_8\,\mathbf{a}_1 + y_8\,\mathbf{a}_2 + z_8\,\mathbf{a}_3 = \left(a x_8 + c z_8 \cos\beta\right)\,\mathbf{\hat{x}} + b y_8\,\mathbf{\hat{y}} + c z_8 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VIII}$$

$$\mathbf{B_{30}} = -x_8\,\mathbf{a}_1 + \left(y_8 + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_8 - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_8 + c\left(z_8 - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_8 + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_8 - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VIII}$$

$$\mathbf{B_{31}} = -x_8\,\mathbf{a}_1 - y_8\,\mathbf{a}_2 - z_8\,\mathbf{a}_3 = -\left(a x_8 + c z_8 \cos\beta\right)\,\mathbf{\hat{x}} - b y_8\,\mathbf{\hat{y}} - c z_8 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VIII}$$

$$\mathbf{B_{32}} = x_8\,\mathbf{a}_1 - \left(y_8 - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_8 + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_8 + c\left(z_8 + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_8 - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_8 + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S VIII}$$

$$\mathbf{B_{33}} = x_9\,\mathbf{a}_1 + y_9\,\mathbf{a}_2 + z_9\,\mathbf{a}_3 = \left(a x_9 + c z_9 \cos\beta\right)\,\mathbf{\hat{x}} + b y_9\,\mathbf{\hat{y}} + c z_9 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S IX}$$

$$\mathbf{B_{34}} = -x_9\,\mathbf{a}_1 + \left(y_9 + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_9 - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_9 + c\left(z_9 - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_9 + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_9 - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S IX}$$

$$\mathbf{B_{35}} = -x_9\,\mathbf{a}_1 - y_9\,\mathbf{a}_2 - z_9\,\mathbf{a}_3 = -\left(a x_9 + c z_9 \cos\beta\right)\,\mathbf{\hat{x}} - b y_9\,\mathbf{\hat{y}} - c z_9 \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S IX}$$

$$\mathbf{B_{36}} = x_9\,\mathbf{a}_1 - \left(y_9 - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_9 + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_9 + c\left(z_9 + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_9 - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_9 + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S IX}$$

$$\mathbf{B_{37}} = x_{10}\,\mathbf{a}_1 + y_{10}\,\mathbf{a}_2 + z_{10}\,\mathbf{a}_3 = \left(a x_{10} + c z_{10} \cos\beta\right)\,\mathbf{\hat{x}} + b y_{10}\,\mathbf{\hat{y}} + c z_{10} \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S X}$$

$$\mathbf{B_{38}} = -x_{10}\,\mathbf{a}_1 + \left(y_{10} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{10} - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_{10} + c\left(z_{10} - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{10} + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{10} - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S X}$$

$$\mathbf{B_{39}} = -x_{10}\,\mathbf{a}_1 - y_{10}\,\mathbf{a}_2 - z_{10}\,\mathbf{a}_3 = -\left(a x_{10} + c z_{10} \cos\beta\right)\,\mathbf{\hat{x}} - b y_{10}\,\mathbf{\hat{y}} - c z_{10} \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S X}$$

$$\mathbf{B_{40}} = x_{10}\,\mathbf{a}_1 - \left(y_{10} - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{10} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_{10} + c\left(z_{10} + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{10} - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{10} + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S X}$$

$$\mathbf{B_{41}} = x_{11}\,\mathbf{a}_1 + y_{11}\,\mathbf{a}_2 + z_{11}\,\mathbf{a}_3 = \left(a x_{11} + c z_{11} \cos\beta\right)\,\mathbf{\hat{x}} + b y_{11}\,\mathbf{\hat{y}} + c z_{11} \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S XI}$$

$$\mathbf{B_{42}} = -x_{11}\,\mathbf{a}_1 + \left(y_{11} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{11} - \tfrac{1}{2}\right)\,\mathbf{a}_3 = -\left(a x_{11} + c\left(z_{11} - \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{11} + \tfrac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{11} - \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S XI}$$

$$\mathbf{B_{43}} = -x_{11}\,\mathbf{a}_1 - y_{11}\,\mathbf{a}_2 - z_{11}\,\mathbf{a}_3 = -\left(a x_{11} + c z_{11} \cos\beta\right)\,\mathbf{\hat{x}} - b y_{11}\,\mathbf{\hat{y}} - c z_{11} \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S XI}$$

$$\mathbf{B_{44}} = x_{11}\,\mathbf{a}_1 - \left(y_{11} - \tfrac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{11} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = \left(a x_{11} + c\left(z_{11} + \tfrac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{11} - \tfrac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{11} + \tfrac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S XI}$$

$$\mathbf{B_{45}} = x_{12}\,\mathbf{a}_1 + y_{12}\,\mathbf{a}_2 + z_{12}\,\mathbf{a}_3 = \left(a x_{12} + c z_{12} \cos\beta\right)\,\mathbf{\hat{x}} + b y_{12}\,\mathbf{\hat{y}} + c z_{12} \sin\beta\,\mathbf{\hat{z}} \quad \text{(4e)} \quad \text{S XII}$$

$\mathbf{B_{46}}$	=	$-x_{12}\,\mathbf{a}_1 + \left(y_{12}+\frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{12}-\frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_{12} + c\left(z_{12}-\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{12}+\frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{12}-\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XII
$\mathbf{B_{47}}$	=	$-x_{12}\,\mathbf{a}_1 - y_{12}\,\mathbf{a}_2 - z_{12}\,\mathbf{a}_3$	=	$-\left(ax_{12} + cz_{12}\cos\beta\right)\,\mathbf{\hat{x}} - by_{12}\,\mathbf{\hat{y}} - cz_{12}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XII
$\mathbf{B_{48}}$	=	$x_{12}\,\mathbf{a}_1 - \left(y_{12}-\frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{12}+\frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_{12} + c\left(z_{12}+\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{12}-\frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{12}+\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XII
$\mathbf{B_{49}}$	=	$x_{13}\,\mathbf{a}_1 + y_{13}\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$\left(ax_{13} + cz_{13}\cos\beta\right)\,\mathbf{\hat{x}} + by_{13}\,\mathbf{\hat{y}} + cz_{13}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIII
$\mathbf{B_{50}}$	=	$-x_{13}\,\mathbf{a}_1 + \left(y_{13}+\frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{13}-\frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_{13} + c\left(z_{13}-\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{13}+\frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{13}-\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIII
$\mathbf{B_{51}}$	=	$-x_{13}\,\mathbf{a}_1 - y_{13}\,\mathbf{a}_2 - z_{13}\,\mathbf{a}_3$	=	$-\left(ax_{13} + cz_{13}\cos\beta\right)\,\mathbf{\hat{x}} - by_{13}\,\mathbf{\hat{y}} - cz_{13}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIII
$\mathbf{B_{52}}$	=	$x_{13}\,\mathbf{a}_1 - \left(y_{13}-\frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{13}+\frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_{13} + c\left(z_{13}+\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{13}-\frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{13}+\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIII
$\mathbf{B_{53}}$	=	$x_{14}\,\mathbf{a}_1 + y_{14}\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3$	=	$\left(ax_{14} + cz_{14}\cos\beta\right)\,\mathbf{\hat{x}} + by_{14}\,\mathbf{\hat{y}} + cz_{14}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIV
$\mathbf{B_{54}}$	=	$-x_{14}\,\mathbf{a}_1 + \left(y_{14}+\frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{14}-\frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_{14} + c\left(z_{14}-\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{14}+\frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{14}-\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIV
$\mathbf{B_{55}}$	=	$-x_{14}\,\mathbf{a}_1 - y_{14}\,\mathbf{a}_2 - z_{14}\,\mathbf{a}_3$	=	$-\left(ax_{14} + cz_{14}\cos\beta\right)\,\mathbf{\hat{x}} - by_{14}\,\mathbf{\hat{y}} - cz_{14}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIV
$\mathbf{B_{56}}$	=	$x_{14}\,\mathbf{a}_1 - \left(y_{14}-\frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{14}+\frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_{14} + c\left(z_{14}+\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{14}-\frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{14}+\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XIV
$\mathbf{B_{57}}$	=	$x_{15}\,\mathbf{a}_1 + y_{15}\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3$	=	$\left(ax_{15} + cz_{15}\cos\beta\right)\,\mathbf{\hat{x}} + by_{15}\,\mathbf{\hat{y}} + cz_{15}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XV
$\mathbf{B_{58}}$	=	$-x_{15}\,\mathbf{a}_1 + \left(y_{15}+\frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{15}-\frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_{15} + c\left(z_{15}-\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{15}+\frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{15}-\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XV
$\mathbf{B_{59}}$	=	$-x_{15}\,\mathbf{a}_1 - y_{15}\,\mathbf{a}_2 - z_{15}\,\mathbf{a}_3$	=	$-\left(ax_{15} + cz_{15}\cos\beta\right)\,\mathbf{\hat{x}} - by_{15}\,\mathbf{\hat{y}} - cz_{15}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XV
$\mathbf{B_{60}}$	=	$x_{15}\,\mathbf{a}_1 - \left(y_{15}-\frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{15}+\frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_{15} + c\left(z_{15}+\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{15}-\frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{15}+\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XV
$\mathbf{B_{61}}$	=	$x_{16}\,\mathbf{a}_1 + y_{16}\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$\left(ax_{16} + cz_{16}\cos\beta\right)\,\mathbf{\hat{x}} + by_{16}\,\mathbf{\hat{y}} + cz_{16}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XVI
$\mathbf{B_{62}}$	=	$-x_{16}\,\mathbf{a}_1 + \left(y_{16}+\frac{1}{2}\right)\,\mathbf{a}_2 - \left(z_{16}-\frac{1}{2}\right)\,\mathbf{a}_3$	=	$-\left(ax_{16} + c\left(z_{16}-\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{16}+\frac{1}{2}\right)\,\mathbf{\hat{y}} - c\left(z_{16}-\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XVI
$\mathbf{B_{63}}$	=	$-x_{16}\,\mathbf{a}_1 - y_{16}\,\mathbf{a}_2 - z_{16}\,\mathbf{a}_3$	=	$-\left(ax_{16} + cz_{16}\cos\beta\right)\,\mathbf{\hat{x}} - by_{16}\,\mathbf{\hat{y}} - cz_{16}\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XVI
$\mathbf{B_{64}}$	=	$x_{16}\,\mathbf{a}_1 - \left(y_{16}-\frac{1}{2}\right)\,\mathbf{a}_2 + \left(z_{16}+\frac{1}{2}\right)\,\mathbf{a}_3$	=	$\left(ax_{16} + c\left(z_{16}+\frac{1}{2}\right)\cos\beta\right)\,\mathbf{\hat{x}} - b\left(y_{16}-\frac{1}{2}\right)\,\mathbf{\hat{y}} + c\left(z_{16}+\frac{1}{2}\right)\sin\beta\,\mathbf{\hat{z}}$	(4e)	S XVI

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