D-Sucrose ($C_{12}H_{22}O_{11}$) Structure: A12B22C11_mP90_4_12a_22a_11a-001

Cite this page as:

- H. Eckert, S. Divilov, M. J. Mehl, D. Hicks, A. C. Zettel, M. Esters, X. Campilongo, and S. Curtarolo, *The AFLOW Library of Crystallographic Prototypes: Part 4*, Comput. Mater. Sci. **240**, 112988 (2024), doi: 10.1016/j.commatsci.2024.112988.
- D. Hicks, M. J. Mehl, M. Esters, C. Oses, O. Levy, G. L. W. Hart, C. Toher, and S. Curtarolo, *The AFLOW Library of Crystallographic Prototypes: Part 3*, Comput. Mater. Sci. **199**, 110450 (2021), doi: 10.1016/j.commatsci.2021.110450.

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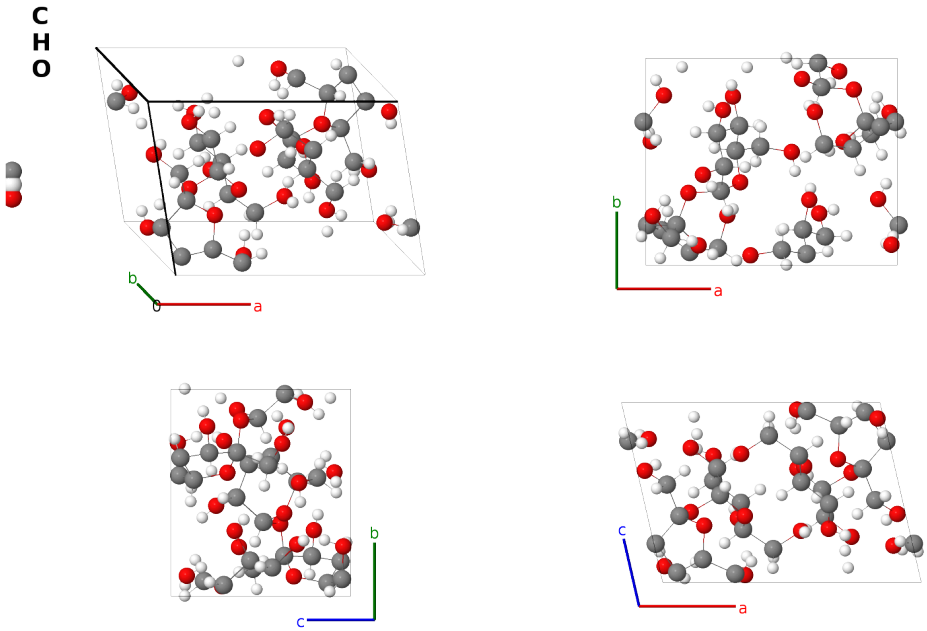
https://aflow.org/prototype-encyclopedia/PFH2

https://aflow.org/prototype-encyclopedia/A12B22C11_mP90_4_12a_22a_11a-001

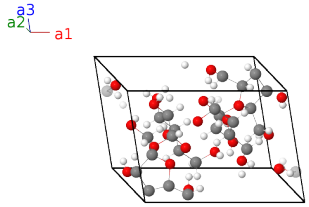


Prototype	$C_{12}H_{22}O_{11}$
AFLOW prototype label	A12B22C11_mP90_4_12a_22a_11a-001
Mineral name	D-sucrose
CCDC	1263571
Pearson symbol	mP90
Space group number	4
Space group symbol	$P2_1$
AFLOW prototype command	`aflow --proto=A12B22C11_mP90_4_12a_22a_11a-001 --params=`$a, b/a, c/a, \beta, x_1, y_1, z_1, x_2, y_2, z_2, x_3, y_3, z_3, x_4, y_4, z_4, x_5, y_5, z_5, x_6, y_6, z_6, x_7, y_7, z_7, x_8, y_8, z_8, x_9, y_9, z_9, x_{10}, y_{10}, z_{10}, x_{11}, y_{11}, z_{11}, x_{12}, y_{12}, z_{12}, x_{13}, y_{13}, z_{13}, x_{14}, y_{14}, z_{14}, x_{15}, y_{15}, z_{15}, x_{16}, y_{16}, z_{16}, x_{17}, y_{17}, z_{17}, x_{18}, y_{18}, z_{18}, x_{19}, y_{19}, z_{19}, x_{20}, y_{20}, z_{20}, x_{21}, y_{21}, z_{21}, x_{22}, y_{22}, z_{22}, x_{23}, y_{23}, z_{23}, x_{24}, y_{24}, z_{24}, x_{25}, y_{25}, z_{25}, x_{26}, y_{26}, z_{26}, x_{27}, y_{27}, z_{27}, x_{28}, y_{28}, z_{28}, x_{29}, y_{29}, z_{29}, x_{30}, y_{30}, z_{30}, x_{31}, y_{31}, z_{31}, x_{32}, y_{32}, z_{32}, x_{33}, y_{33}, z_{33}, x_{34}, y_{34}, z_{34}, x_{35}, y_{35}, z_{35}, x_{36}, y_{36}, z_{36}, x_{37}, y_{37}, z_{37}, x_{38}, y_{38}, z_{38}, x_{39}, y_{39}, z_{39}, x_{40}, y_{40}, z_{40}, x_{41}, y_{41}, z_{41}, x_{42}, y_{42}, z_{42}, x_{43}, y_{43}, z_{43}, x_{44}, y_{44}, z_{44}, x_{45}, y_{45}, z_{45}$

- The full name of this compound is β-D-Fructofuranosyl α-D-glucopyranoside. It is a dextrorotatory compound composed of a fructose molecule and a glucose molecule, both $C_6H_{12}O_6$, which share one oxygen atom and shed two hydrogen atoms, making the stoichiometry $C_{12}H_{22}O_{11}$.
- Since this is a chiral compound, we could invert the structure, taking $(x, y, z) \to (-x, -y, -z)$ and transforming D-sucrose into its enantiomer, L-sucrose (β-L-Fructofuranosyl α-L-glucopyranoside) which would be levorotatory. Only D-sucrose is found in biological systems.
- We use the data in Table 4 of (Hanson, 1973).

Simple Monoclinic primitive vectors

$$\begin{aligned}
\mathbf{a_1} &= a\,\hat{\mathbf{x}} \\
\mathbf{a_2} &= b\,\hat{\mathbf{y}} \\
\mathbf{a_3} &= c\cos\beta\,\hat{\mathbf{x}} + c\sin\beta\,\hat{\mathbf{z}}
\end{aligned}$$



Basis vectors

		Lattice coordinates		Cartesian coordinates	Wyckoff position	Atom type
$\mathbf{B_1}$	=	$x_1\,\mathbf{a}_1 + y_1\,\mathbf{a}_2 + z_1\,\mathbf{a}_3$	=	$(ax_1 + cz_1\cos\beta)\,\hat{\mathbf{x}} + by_1\,\hat{\mathbf{y}} + cz_1\sin\beta\,\hat{\mathbf{z}}$	(2a)	C I
$\mathbf{B_2}$	=	$-x_1\,\mathbf{a}_1 + \left(y_1 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_1\,\mathbf{a}_3$	=	$-\left(ax_1 + cz_1\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_1 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_1\sin\beta\,\hat{\mathbf{z}}$	(2a)	C I
$\mathbf{B_3}$	=	$x_2\,\mathbf{a}_1 + y_2\,\mathbf{a}_2 + z_2\,\mathbf{a}_3$	=	$(ax_2 + cz_2\cos\beta)\,\hat{\mathbf{x}} + by_2\,\hat{\mathbf{y}} + cz_2\sin\beta\,\hat{\mathbf{z}}$	(2a)	C II
$\mathbf{B_4}$	=	$-x_2\,\mathbf{a}_1 + \left(y_2 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_2\,\mathbf{a}_3$	=	$-\left(ax_2 + cz_2\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_2 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_2\sin\beta\,\hat{\mathbf{z}}$	(2a)	C II
$\mathbf{B_5}$	=	$x_3\,\mathbf{a}_1 + y_3\,\mathbf{a}_2 + z_3\,\mathbf{a}_3$	=	$(ax_3 + cz_3\cos\beta)\,\hat{\mathbf{x}} + by_3\,\hat{\mathbf{y}} + cz_3\sin\beta\,\hat{\mathbf{z}}$	(2a)	C III
$\mathbf{B_6}$	=	$-x_3\,\mathbf{a}_1 + \left(y_3 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_3\,\mathbf{a}_3$	=	$-\left(ax_3 + cz_3\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_3 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_3\sin\beta\,\hat{\mathbf{z}}$	(2a)	C III
$\mathbf{B_7}$	=	$x_4\,\mathbf{a}_1 + y_4\,\mathbf{a}_2 + z_4\,\mathbf{a}_3$	=	$(ax_4 + cz_4\cos\beta)\,\hat{\mathbf{x}} + by_4\,\hat{\mathbf{y}} + cz_4\sin\beta\,\hat{\mathbf{z}}$	(2a)	C IV
$\mathbf{B_8}$	=	$-x_4\,\mathbf{a}_1 + \left(y_4 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_4\,\mathbf{a}_3$	=	$-\left(ax_4 + cz_4\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_4 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_4\sin\beta\,\hat{\mathbf{z}}$	(2a)	C IV
$\mathbf{B_9}$	=	$x_5\,\mathbf{a}_1 + y_5\,\mathbf{a}_2 + z_5\,\mathbf{a}_3$	=	$(ax_5 + cz_5\cos\beta)\,\hat{\mathbf{x}} + by_5\,\hat{\mathbf{y}} + cz_5\sin\beta\,\hat{\mathbf{z}}$	(2a)	C V
$\mathbf{B_{10}}$	=	$-x_5\,\mathbf{a}_1 + \left(y_5 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_5\,\mathbf{a}_3$	=	$-\left(ax_5 + cz_5\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_5 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_5\sin\beta\,\hat{\mathbf{z}}$	(2a)	C V
$\mathbf{B_{11}}$	=	$x_6\,\mathbf{a}_1 + y_6\,\mathbf{a}_2 + z_6\,\mathbf{a}_3$	=	$(ax_6 + cz_6\cos\beta)\,\hat{\mathbf{x}} + by_6\,\hat{\mathbf{y}} + cz_6\sin\beta\,\hat{\mathbf{z}}$	(2a)	C VI
$\mathbf{B_{12}}$	=	$-x_6\,\mathbf{a}_1 + \left(y_6 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_6\,\mathbf{a}_3$	=	$-\left(ax_6 + cz_6\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_6 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_6\sin\beta\,\hat{\mathbf{z}}$	(2a)	C VI
$\mathbf{B_{13}}$	=	$x_7\,\mathbf{a}_1 + y_7\,\mathbf{a}_2 + z_7\,\mathbf{a}_3$	=	$(ax_7 + cz_7\cos\beta)\,\hat{\mathbf{x}} + by_7\,\hat{\mathbf{y}} + cz_7\sin\beta\,\hat{\mathbf{z}}$	(2a)	C VII
$\mathbf{B_{14}}$	=	$-x_7\,\mathbf{a}_1 + \left(y_7 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_7\,\mathbf{a}_3$	=	$-\left(ax_7 + cz_7\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_7 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_7\sin\beta\,\hat{\mathbf{z}}$	(2a)	C VII
$\mathbf{B_{15}}$	=	$x_8\,\mathbf{a}_1 + y_8\,\mathbf{a}_2 + z_8\,\mathbf{a}_3$	=	$(ax_8 + cz_8\cos\beta)\,\hat{\mathbf{x}} + by_8\,\hat{\mathbf{y}} + cz_8\sin\beta\,\hat{\mathbf{z}}$	(2a)	C VIII
$\mathbf{B_{16}}$	=	$-x_8\,\mathbf{a}_1 + \left(y_8 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_8\,\mathbf{a}_3$	=	$-\left(ax_8 + cz_8\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_8 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_8\sin\beta\,\hat{\mathbf{z}}$	(2a)	C VIII

$\mathbf{B_{17}}$	=	$x_9\,\mathbf{a}_1 + y_9\,\mathbf{a}_2 + z_9\,\mathbf{a}_3$	=	$(ax_9 + cz_9\cos\beta)\,\hat{\mathbf{x}} + by_9\,\hat{\mathbf{y}} + cz_9\sin\beta\,\hat{\mathbf{z}}$	(2a)	C IX
$\mathbf{B_{18}}$	=	$-x_9\,\mathbf{a}_1 + \left(y_9 + \frac{1}{2}\right)\,\mathbf{a}_2 - z_9\,\mathbf{a}_3$	=	$-\left(ax_9 + cz_9\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_9 + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_9\sin\beta\,\hat{\mathbf{z}}$	(2a)	C IX
$\mathbf{B_{19}}$	=	$x_{10}\,\mathbf{a}_1 + y_{10}\,\mathbf{a}_2 + z_{10}\,\mathbf{a}_3$	=	$(ax_{10} + cz_{10}\cos\beta)\,\hat{\mathbf{x}} + by_{10}\,\hat{\mathbf{y}} + cz_{10}\sin\beta\,\hat{\mathbf{z}}$	(2a)	C X
$\mathbf{B_{20}}$	=	$-x_{10}\,\mathbf{a}_1 + \left(y_{10} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{10}\,\mathbf{a}_3$	=	$-\left(ax_{10} + cz_{10}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{10} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{10}\sin\beta\,\hat{\mathbf{z}}$	(2a)	C X
$\mathbf{B_{21}}$	=	$x_{11}\,\mathbf{a}_1 + y_{11}\,\mathbf{a}_2 + z_{11}\,\mathbf{a}_3$	=	$(ax_{11} + cz_{11}\cos\beta)\,\hat{\mathbf{x}} + by_{11}\,\hat{\mathbf{y}} + cz_{11}\sin\beta\,\hat{\mathbf{z}}$	(2a)	C XI
$\mathbf{B_{22}}$	=	$-x_{11}\,\mathbf{a}_1 + \left(y_{11} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{11}\,\mathbf{a}_3$	=	$-\left(ax_{11} + cz_{11}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{11} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{11}\sin\beta\,\hat{\mathbf{z}}$	(2a)	C XI
$\mathbf{B_{23}}$	=	$x_{12}\,\mathbf{a}_1 + y_{12}\,\mathbf{a}_2 + z_{12}\,\mathbf{a}_3$	=	$(ax_{12} + cz_{12}\cos\beta)\,\hat{\mathbf{x}} + by_{12}\,\hat{\mathbf{y}} + cz_{12}\sin\beta\,\hat{\mathbf{z}}$	(2a)	C XII
$\mathbf{B_{24}}$	=	$-x_{12}\,\mathbf{a}_1 + \left(y_{12} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{12}\,\mathbf{a}_3$	=	$-\left(ax_{12} + cz_{12}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{12} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{12}\sin\beta\,\hat{\mathbf{z}}$	(2a)	C XII
$\mathbf{B_{25}}$	=	$x_{13}\,\mathbf{a}_1 + y_{13}\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$(ax_{13} + cz_{13}\cos\beta)\,\hat{\mathbf{x}} + by_{13}\,\hat{\mathbf{y}} + cz_{13}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H I
$\mathbf{B_{26}}$	=	$-x_{13}\,\mathbf{a}_1 + \left(y_{13} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{13}\,\mathbf{a}_3$	=	$-\left(ax_{13} + cz_{13}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{13} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{13}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H I
$\mathbf{B_{27}}$	=	$x_{14}\,\mathbf{a}_1 + y_{14}\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3$	=	$(ax_{14} + cz_{14}\cos\beta)\,\hat{\mathbf{x}} + by_{14}\,\hat{\mathbf{y}} + cz_{14}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H II
$\mathbf{B_{28}}$	=	$-x_{14}\,\mathbf{a}_1 + \left(y_{14} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{14}\,\mathbf{a}_3$	=	$-\left(ax_{14} + cz_{14}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{14} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{14}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H II
$\mathbf{B_{29}}$	=	$x_{15}\,\mathbf{a}_1 + y_{15}\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3$	=	$(ax_{15} + cz_{15}\cos\beta)\,\hat{\mathbf{x}} + by_{15}\,\hat{\mathbf{y}} + cz_{15}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H III
$\mathbf{B_{30}}$	=	$-x_{15}\,\mathbf{a}_1 + \left(y_{15} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{15}\,\mathbf{a}_3$	=	$-\left(ax_{15} + cz_{15}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{15} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{15}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H III
$\mathbf{B_{31}}$	=	$x_{16}\,\mathbf{a}_1 + y_{16}\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$(ax_{16} + cz_{16}\cos\beta)\,\hat{\mathbf{x}} + by_{16}\,\hat{\mathbf{y}} + cz_{16}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H IV
$\mathbf{B_{32}}$	=	$-x_{16}\,\mathbf{a}_1 + \left(y_{16} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{16}\,\mathbf{a}_3$	=	$-\left(ax_{16} + cz_{16}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{16} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{16}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H IV
$\mathbf{B_{33}}$	=	$x_{17}\,\mathbf{a}_1 + y_{17}\,\mathbf{a}_2 + z_{17}\,\mathbf{a}_3$	=	$(ax_{17} + cz_{17}\cos\beta)\,\hat{\mathbf{x}} + by_{17}\,\hat{\mathbf{y}} + cz_{17}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H V
$\mathbf{B_{34}}$	=	$-x_{17}\,\mathbf{a}_1 + \left(y_{17} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{17}\,\mathbf{a}_3$	=	$-\left(ax_{17} + cz_{17}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{17} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{17}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H V
$\mathbf{B_{35}}$	=	$x_{18}\,\mathbf{a}_1 + y_{18}\,\mathbf{a}_2 + z_{18}\,\mathbf{a}_3$	=	$(ax_{18} + cz_{18}\cos\beta)\,\hat{\mathbf{x}} + by_{18}\,\hat{\mathbf{y}} + cz_{18}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H VI
$\mathbf{B_{36}}$	=	$-x_{18}\,\mathbf{a}_1 + \left(y_{18} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{18}\,\mathbf{a}_3$	=	$-\left(ax_{18} + cz_{18}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{18} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{18}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H VI
$\mathbf{B_{37}}$	=	$x_{19}\,\mathbf{a}_1 + y_{19}\,\mathbf{a}_2 + z_{19}\,\mathbf{a}_3$	=	$(ax_{19} + cz_{19}\cos\beta)\,\hat{\mathbf{x}} + by_{19}\,\hat{\mathbf{y}} + cz_{19}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H VII
$\mathbf{B_{38}}$	=	$-x_{19}\,\mathbf{a}_1 + \left(y_{19} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{19}\,\mathbf{a}_3$	=	$-\left(ax_{19} + cz_{19}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{19} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{19}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H VII
$\mathbf{B_{39}}$	=	$x_{20}\,\mathbf{a}_1 + y_{20}\,\mathbf{a}_2 + z_{20}\,\mathbf{a}_3$	=	$(ax_{20} + cz_{20}\cos\beta)\,\hat{\mathbf{x}} + by_{20}\,\hat{\mathbf{y}} + cz_{20}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H VIII
$\mathbf{B_{40}}$	=	$-x_{20}\,\mathbf{a}_1 + \left(y_{20} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{20}\,\mathbf{a}_3$	=	$-\left(ax_{20} + cz_{20}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{20} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{20}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H VIII
$\mathbf{B_{41}}$	=	$x_{21}\,\mathbf{a}_1 + y_{21}\,\mathbf{a}_2 + z_{21}\,\mathbf{a}_3$	=	$(ax_{21} + cz_{21}\cos\beta)\,\hat{\mathbf{x}} + by_{21}\,\hat{\mathbf{y}} + cz_{21}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H IX
$\mathbf{B_{42}}$	=	$-x_{21}\,\mathbf{a}_1 + \left(y_{21} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{21}\,\mathbf{a}_3$	=	$-\left(ax_{21} + cz_{21}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{21} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{21}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H IX
$\mathbf{B_{43}}$	=	$x_{22}\,\mathbf{a}_1 + y_{22}\,\mathbf{a}_2 + z_{22}\,\mathbf{a}_3$	=	$(ax_{22} + cz_{22}\cos\beta)\,\hat{\mathbf{x}} + by_{22}\,\hat{\mathbf{y}} + cz_{22}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H X
$\mathbf{B_{44}}$	=	$-x_{22}\,\mathbf{a}_1 + \left(y_{22} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{22}\,\mathbf{a}_3$	=	$-\left(ax_{22} + cz_{22}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{22} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{22}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H X
$\mathbf{B_{45}}$	=	$x_{23}\,\mathbf{a}_1 + y_{23}\,\mathbf{a}_2 + z_{23}\,\mathbf{a}_3$	=	$(ax_{23} + cz_{23}\cos\beta)\,\hat{\mathbf{x}} + by_{23}\,\hat{\mathbf{y}} + cz_{23}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H XI
$\mathbf{B_{46}}$	=	$-x_{23}\,\mathbf{a}_1 + \left(y_{23} + \frac{1}{2}\right)\,\mathbf{a}_2 - z_{23}\,\mathbf{a}_3$	=	$-\left(ax_{23} + cz_{23}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{23} + \frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{23}\sin\beta\,\hat{\mathbf{z}}$	(2a)	H XI

$$\mathbf{B_{47}} = x_{24}\,\mathbf{a}_1 + y_{24}\,\mathbf{a}_2 + z_{24}\,\mathbf{a}_3 = (ax_{24} + cz_{24}\cos\beta)\,\hat{\mathbf{x}} + by_{24}\,\hat{\mathbf{y}} + cz_{24}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XII}$$

$$\mathbf{B_{48}} = -x_{24}\,\mathbf{a}_1 + \left(y_{24} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{24}\,\mathbf{a}_3 = -\left(ax_{24} + cz_{24}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{24} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{24}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XII}$$

$$\mathbf{B_{49}} = x_{25}\,\mathbf{a}_1 + y_{25}\,\mathbf{a}_2 + z_{25}\,\mathbf{a}_3 = (ax_{25} + cz_{25}\cos\beta)\,\hat{\mathbf{x}} + by_{25}\,\hat{\mathbf{y}} + cz_{25}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XIII}$$

$$\mathbf{B_{50}} = -x_{25}\,\mathbf{a}_1 + \left(y_{25} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{25}\,\mathbf{a}_3 = -\left(ax_{25} + cz_{25}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{25} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{25}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XIII}$$

$$\mathbf{B_{51}} = x_{26}\,\mathbf{a}_1 + y_{26}\,\mathbf{a}_2 + z_{26}\,\mathbf{a}_3 = (ax_{26} + cz_{26}\cos\beta)\,\hat{\mathbf{x}} + by_{26}\,\hat{\mathbf{y}} + cz_{26}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XIV}$$

$$\mathbf{B_{52}} = -x_{26}\,\mathbf{a}_1 + \left(y_{26} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{26}\,\mathbf{a}_3 = -\left(ax_{26} + cz_{26}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{26} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{26}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XIV}$$

$$\mathbf{B_{53}} = x_{27}\,\mathbf{a}_1 + y_{27}\,\mathbf{a}_2 + z_{27}\,\mathbf{a}_3 = (ax_{27} + cz_{27}\cos\beta)\,\hat{\mathbf{x}} + by_{27}\,\hat{\mathbf{y}} + cz_{27}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XV}$$

$$\mathbf{B_{54}} = -x_{27}\,\mathbf{a}_1 + \left(y_{27} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{27}\,\mathbf{a}_3 = -\left(ax_{27} + cz_{27}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{27} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{27}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XV}$$

$$\mathbf{B_{55}} = x_{28}\,\mathbf{a}_1 + y_{28}\,\mathbf{a}_2 + z_{28}\,\mathbf{a}_3 = (ax_{28} + cz_{28}\cos\beta)\,\hat{\mathbf{x}} + by_{28}\,\hat{\mathbf{y}} + cz_{28}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XVI}$$

$$\mathbf{B_{56}} = -x_{28}\,\mathbf{a}_1 + \left(y_{28} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{28}\,\mathbf{a}_3 = -\left(ax_{28} + cz_{28}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{28} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{28}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XVI}$$

$$\mathbf{B_{57}} = x_{29}\,\mathbf{a}_1 + y_{29}\,\mathbf{a}_2 + z_{29}\,\mathbf{a}_3 = (ax_{29} + cz_{29}\cos\beta)\,\hat{\mathbf{x}} + by_{29}\,\hat{\mathbf{y}} + cz_{29}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XVII}$$

$$\mathbf{B_{58}} = -x_{29}\,\mathbf{a}_1 + \left(y_{29} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{29}\,\mathbf{a}_3 = -\left(ax_{29} + cz_{29}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{29} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{29}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XVII}$$

$$\mathbf{B_{59}} = x_{30}\,\mathbf{a}_1 + y_{30}\,\mathbf{a}_2 + z_{30}\,\mathbf{a}_3 = (ax_{30} + cz_{30}\cos\beta)\,\hat{\mathbf{x}} + by_{30}\,\hat{\mathbf{y}} + cz_{30}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XVIII}$$

$$\mathbf{B_{60}} = -x_{30}\,\mathbf{a}_1 + \left(y_{30} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{30}\,\mathbf{a}_3 = -\left(ax_{30} + cz_{30}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{30} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{30}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XVIII}$$

$$\mathbf{B_{61}} = x_{31}\,\mathbf{a}_1 + y_{31}\,\mathbf{a}_2 + z_{31}\,\mathbf{a}_3 = (ax_{31} + cz_{31}\cos\beta)\,\hat{\mathbf{x}} + by_{31}\,\hat{\mathbf{y}} + cz_{31}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XIX}$$

$$\mathbf{B_{62}} = -x_{31}\,\mathbf{a}_1 + \left(y_{31} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{31}\,\mathbf{a}_3 = -\left(ax_{31} + cz_{31}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{31} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{31}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XIX}$$

$$\mathbf{B_{63}} = x_{32}\,\mathbf{a}_1 + y_{32}\,\mathbf{a}_2 + z_{32}\,\mathbf{a}_3 = (ax_{32} + cz_{32}\cos\beta)\,\hat{\mathbf{x}} + by_{32}\,\hat{\mathbf{y}} + cz_{32}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XX}$$

$$\mathbf{B_{64}} = -x_{32}\,\mathbf{a}_1 + \left(y_{32} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{32}\,\mathbf{a}_3 = -\left(ax_{32} + cz_{32}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{32} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{32}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XX}$$

$$\mathbf{B_{65}} = x_{33}\,\mathbf{a}_1 + y_{33}\,\mathbf{a}_2 + z_{33}\,\mathbf{a}_3 = (ax_{33} + cz_{33}\cos\beta)\,\hat{\mathbf{x}} + by_{33}\,\hat{\mathbf{y}} + cz_{33}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XXI}$$

$$\mathbf{B_{66}} = -x_{33}\,\mathbf{a}_1 + \left(y_{33} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{33}\,\mathbf{a}_3 = -\left(ax_{33} + cz_{33}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{33} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{33}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XXI}$$

$$\mathbf{B_{67}} = x_{34}\,\mathbf{a}_1 + y_{34}\,\mathbf{a}_2 + z_{34}\,\mathbf{a}_3 = (ax_{34} + cz_{34}\cos\beta)\,\hat{\mathbf{x}} + by_{34}\,\hat{\mathbf{y}} + cz_{34}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XXII}$$

$$\mathbf{B_{68}} = -x_{34}\,\mathbf{a}_1 + \left(y_{34} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{34}\,\mathbf{a}_3 = -\left(ax_{34} + cz_{34}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{34} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{34}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{H XXII}$$

$$\mathbf{B_{69}} = x_{35}\,\mathbf{a}_1 + y_{35}\,\mathbf{a}_2 + z_{35}\,\mathbf{a}_3 = (ax_{35} + cz_{35}\cos\beta)\,\hat{\mathbf{x}} + by_{35}\,\hat{\mathbf{y}} + cz_{35}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O I}$$

$$\mathbf{B_{70}} = -x_{35}\,\mathbf{a}_1 + \left(y_{35} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{35}\,\mathbf{a}_3 = -\left(ax_{35} + cz_{35}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{35} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{35}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O I}$$

$$\mathbf{B_{71}} = x_{36}\,\mathbf{a}_1 + y_{36}\,\mathbf{a}_2 + z_{36}\,\mathbf{a}_3 = (ax_{36} + cz_{36}\cos\beta)\,\hat{\mathbf{x}} + by_{36}\,\hat{\mathbf{y}} + cz_{36}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O II}$$

$$\mathbf{B_{72}} = -x_{36}\,\mathbf{a}_1 + \left(y_{36} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{36}\,\mathbf{a}_3 = -\left(ax_{36} + cz_{36}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{36} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{36}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O II}$$

$$\mathbf{B_{73}} = x_{37}\,\mathbf{a}_1 + y_{37}\,\mathbf{a}_2 + z_{37}\,\mathbf{a}_3 = (ax_{37} + cz_{37}\cos\beta)\,\hat{\mathbf{x}} + by_{37}\,\hat{\mathbf{y}} + cz_{37}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O III}$$

$$\mathbf{B_{74}} = -x_{37}\,\mathbf{a}_1 + \left(y_{37} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{37}\,\mathbf{a}_3 = -\left(ax_{37} + cz_{37}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{37} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{37}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O III}$$

$$\mathbf{B_{75}} = x_{38}\,\mathbf{a}_1 + y_{38}\,\mathbf{a}_2 + z_{38}\,\mathbf{a}_3 = (ax_{38} + cz_{38}\cos\beta)\,\hat{\mathbf{x}} + by_{38}\,\hat{\mathbf{y}} + cz_{38}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O IV}$$

$$\mathbf{B_{76}} = -x_{38}\,\mathbf{a}_1 + \left(y_{38} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{38}\,\mathbf{a}_3 = -\left(ax_{38} + cz_{38}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{38} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{38}\sin\beta\,\hat{\mathbf{z}} \quad (2a) \quad \text{O IV}$$

$$\mathbf{B_{77}} = x_{39}\,\mathbf{a}_1 + y_{39}\,\mathbf{a}_2 + z_{39}\,\mathbf{a}_3 = (ax_{39} + cz_{39}\cos\beta)\,\hat{\mathbf{x}} + by_{39}\,\hat{\mathbf{y}} + cz_{39}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O V}$$

$$\mathbf{B_{78}} = -x_{39}\,\mathbf{a}_1 + \left(y_{39} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{39}\,\mathbf{a}_3 = -\left(ax_{39} + cz_{39}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{39} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{39}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O V}$$

$$\mathbf{B_{79}} = x_{40}\,\mathbf{a}_1 + y_{40}\,\mathbf{a}_2 + z_{40}\,\mathbf{a}_3 = (ax_{40} + cz_{40}\cos\beta)\,\hat{\mathbf{x}} + by_{40}\,\hat{\mathbf{y}} + cz_{40}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O VI}$$

$$\mathbf{B_{80}} = -x_{40}\,\mathbf{a}_1 + \left(y_{40} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{40}\,\mathbf{a}_3 = -\left(ax_{40} + cz_{40}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{40} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{40}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O VI}$$

$$\mathbf{B_{81}} = x_{41}\,\mathbf{a}_1 + y_{41}\,\mathbf{a}_2 + z_{41}\,\mathbf{a}_3 = (ax_{41} + cz_{41}\cos\beta)\,\hat{\mathbf{x}} + by_{41}\,\hat{\mathbf{y}} + cz_{41}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O VII}$$

$$\mathbf{B_{82}} = -x_{41}\,\mathbf{a}_1 + \left(y_{41} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{41}\,\mathbf{a}_3 = -\left(ax_{41} + cz_{41}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{41} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{41}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O VII}$$

$$\mathbf{B_{83}} = x_{42}\,\mathbf{a}_1 + y_{42}\,\mathbf{a}_2 + z_{42}\,\mathbf{a}_3 = (ax_{42} + cz_{42}\cos\beta)\,\hat{\mathbf{x}} + by_{42}\,\hat{\mathbf{y}} + cz_{42}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O VIII}$$

$$\mathbf{B_{84}} = -x_{42}\,\mathbf{a}_1 + \left(y_{42} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{42}\,\mathbf{a}_3 = -\left(ax_{42} + cz_{42}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{42} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{42}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O VIII}$$

$$\mathbf{B_{85}} = x_{43}\,\mathbf{a}_1 + y_{43}\,\mathbf{a}_2 + z_{43}\,\mathbf{a}_3 = (ax_{43} + cz_{43}\cos\beta)\,\hat{\mathbf{x}} + by_{43}\,\hat{\mathbf{y}} + cz_{43}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O IX}$$

$$\mathbf{B_{86}} = -x_{43}\,\mathbf{a}_1 + \left(y_{43} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{43}\,\mathbf{a}_3 = -\left(ax_{43} + cz_{43}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{43} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{43}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O IX}$$

$$\mathbf{B_{87}} = x_{44}\,\mathbf{a}_1 + y_{44}\,\mathbf{a}_2 + z_{44}\,\mathbf{a}_3 = (ax_{44} + cz_{44}\cos\beta)\,\hat{\mathbf{x}} + by_{44}\,\hat{\mathbf{y}} + cz_{44}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O X}$$

$$\mathbf{B_{88}} = -x_{44}\,\mathbf{a}_1 + \left(y_{44} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{44}\,\mathbf{a}_3 = -\left(ax_{44} + cz_{44}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{44} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{44}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O X}$$

$$\mathbf{B_{89}} = x_{45}\,\mathbf{a}_1 + y_{45}\,\mathbf{a}_2 + z_{45}\,\mathbf{a}_3 = (ax_{45} + cz_{45}\cos\beta)\,\hat{\mathbf{x}} + by_{45}\,\hat{\mathbf{y}} + cz_{45}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O XI}$$

$$\mathbf{B_{90}} = -x_{45}\,\mathbf{a}_1 + \left(y_{45} + \tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{45}\,\mathbf{a}_3 = -\left(ax_{45} + cz_{45}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{45} + \tfrac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{45}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O XI}$$

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First cited in

N. Anderson, M. J. Mehl, H. Eckert, S. Divilov, X. Campilongo, and S. Curtarolo, *The AFLOW Library of Crystallographic Prototypes: Part 5.* Submitted to Computational Materials Science (2026).