Orthorhombic Co_4Al_{13} Structure (Approximate Quasicrystal): A13B4_oP102_31_17a11b_8a2b-001

This structure originally had the label `A13B4_oP102_31_17a11b_8a2b`. Calls to that address will be redirected here.

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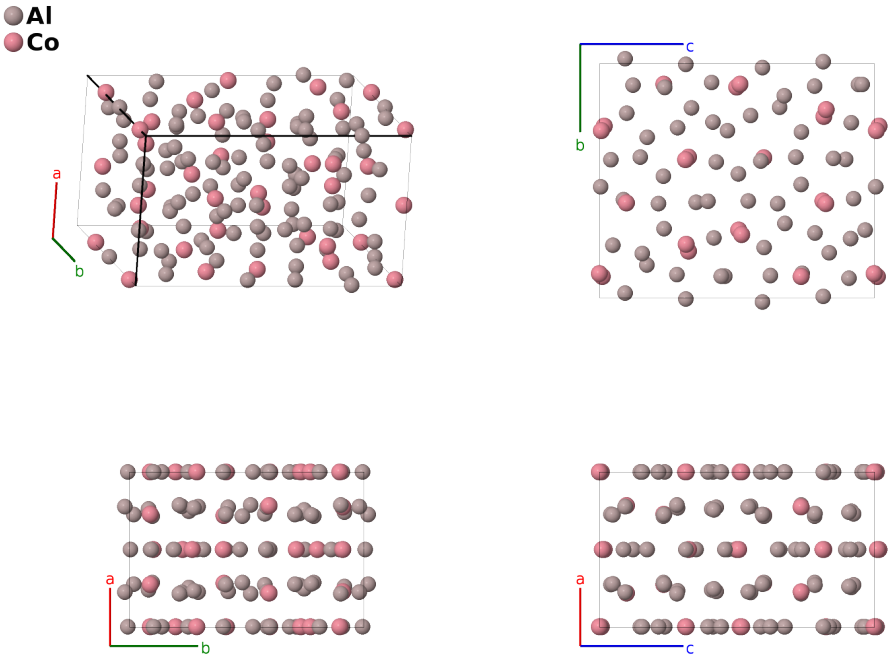
https://aflow.org/p/DHFF

https://aflow.org/p/A13B4_oP102_31_17a11b_8a2b-001



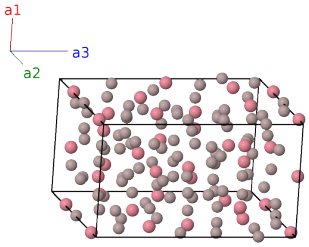
Prototype	$Al_{13}Co_4$
AFLOW prototype label	A13B4_oP102_31_17a11b_8a2b-001
ICSD	104638
Pearson symbol	oP102
Space group number	31
Space group symbol	$Pmn2_1$
AFLOW prototype command	`aflow --proto=A13B4_oP102_31_17a11b_8a2b-001 --params=`$a, b/a, c/a, y_1, z_1, y_2, z_2, y_3, z_3, y_4, z_4, y_5, z_5, y_6, z_6, y_7, z_7, y_8, z_8, y_9, z_9, y_{10}, z_{10}, y_{11}, z_{11}, y_{12}, z_{12}, y_{13}, z_{13}, y_{14}, z_{14}, y_{15}, z_{15}, y_{16}, z_{16}, y_{17}, z_{17}, y_{18}, z_{18}, y_{19}, z_{19}, y_{20}, z_{20}, y_{21}, z_{21}, y_{22}, z_{22}, y_{23}, z_{23}, y_{24}, z_{24}, y_{25}, z_{25}, x_{26}, y_{26}, z_{26}, x_{27}, y_{27}, z_{27}, x_{28}, y_{28}, z_{28}, x_{29}, y_{29}, z_{29}, x_{30}, y_{30}, z_{30}, x_{31}, y_{31}, z_{31}, x_{32}, y_{32}, z_{32}, x_{33}, y_{33}, z_{33}, x_{34}, y_{34}, z_{34}, x_{35}, y_{35}, z_{35}, x_{36}, y_{36}, z_{36}, x_{37}, y_{37}, z_{37}, x_{38}, y_{38}, z_{38}$

- (Addou, 2009) consider this as an "approximate of the decagonal Al-Ni-Co quasicrystal."

- Co_4 has also been observed in a monoclinic structure which has a large number of vacancies on the aluminum sites.
- Space group $Pmn2_1$ #31 allows an arbitrary choice for the origin of the z-axis. We follow (Grin, 1994) and set the $z_{25} = 0$.
- If we allow the rather large uncertainty of 0.6Å in the atomic positions, FINDSYM sets the symmetry as $Pnnm$ #58.

Simple Orthorhombic primitive vectors

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



Basis vectors

		Lattice coordinates		Cartesian coordinates	Wyckoff position	Atom type
$\mathbf{B_1}$	=	$y_1\,\mathbf{a}_2 + z_1\,\mathbf{a}_3$	=	$by_1\,\hat{\mathbf{y}} + cz_1\,\hat{\mathbf{z}}$	(2a)	Al I
$\mathbf{B_2}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_1\,\mathbf{a}_2 + \left(z_1 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_1\,\hat{\mathbf{y}} + c\left(z_1 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al I
$\mathbf{B_3}$	=	$y_2\,\mathbf{a}_2 + z_2\,\mathbf{a}_3$	=	$by_2\,\hat{\mathbf{y}} + cz_2\,\hat{\mathbf{z}}$	(2a)	Al II
$\mathbf{B_4}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_2\,\mathbf{a}_2 + \left(z_2 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_2\,\hat{\mathbf{y}} + c\left(z_2 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al II
$\mathbf{B_5}$	=	$y_3\,\mathbf{a}_2 + z_3\,\mathbf{a}_3$	=	$by_3\,\hat{\mathbf{y}} + cz_3\,\hat{\mathbf{z}}$	(2a)	Al III
$\mathbf{B_6}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_3\,\mathbf{a}_2 + \left(z_3 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_3\,\hat{\mathbf{y}} + c\left(z_3 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al III
$\mathbf{B_7}$	=	$y_4\,\mathbf{a}_2 + z_4\,\mathbf{a}_3$	=	$by_4\,\hat{\mathbf{y}} + cz_4\,\hat{\mathbf{z}}$	(2a)	Al IV
$\mathbf{B_8}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_4\,\mathbf{a}_2 + \left(z_4 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_4\,\hat{\mathbf{y}} + c\left(z_4 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al IV
$\mathbf{B_9}$	=	$y_5\,\mathbf{a}_2 + z_5\,\mathbf{a}_3$	=	$by_5\,\hat{\mathbf{y}} + cz_5\,\hat{\mathbf{z}}$	(2a)	Al V
$\mathbf{B_{10}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_5\,\mathbf{a}_2 + \left(z_5 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_5\,\hat{\mathbf{y}} + c\left(z_5 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al V
$\mathbf{B_{11}}$	=	$y_6\,\mathbf{a}_2 + z_6\,\mathbf{a}_3$	=	$by_6\,\hat{\mathbf{y}} + cz_6\,\hat{\mathbf{z}}$	(2a)	Al VI
$\mathbf{B_{12}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_6\,\mathbf{a}_2 + \left(z_6 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_6\,\hat{\mathbf{y}} + c\left(z_6 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al VI
$\mathbf{B_{13}}$	=	$y_7\,\mathbf{a}_2 + z_7\,\mathbf{a}_3$	=	$by_7\,\hat{\mathbf{y}} + cz_7\,\hat{\mathbf{z}}$	(2a)	Al VII
$\mathbf{B_{14}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_7\,\mathbf{a}_2 + \left(z_7 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_7\,\hat{\mathbf{y}} + c\left(z_7 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al VII
$\mathbf{B_{15}}$	=	$y_8\,\mathbf{a}_2 + z_8\,\mathbf{a}_3$	=	$by_8\,\hat{\mathbf{y}} + cz_8\,\hat{\mathbf{z}}$	(2a)	Al VIII
$\mathbf{B_{16}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_8\,\mathbf{a}_2 + \left(z_8 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_8\,\hat{\mathbf{y}} + c\left(z_8 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al VIII
$\mathbf{B_{17}}$	=	$y_9\,\mathbf{a}_2 + z_9\,\mathbf{a}_3$	=	$by_9\,\hat{\mathbf{y}} + cz_9\,\hat{\mathbf{z}}$	(2a)	Al IX
$\mathbf{B_{18}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_9\,\mathbf{a}_2 + \left(z_9 + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_9\,\hat{\mathbf{y}} + c\left(z_9 + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al IX
$\mathbf{B_{19}}$	=	$y_{10}\,\mathbf{a}_2 + z_{10}\,\mathbf{a}_3$	=	$by_{10}\,\hat{\mathbf{y}} + cz_{10}\,\hat{\mathbf{z}}$	(2a)	Al X
$\mathbf{B_{20}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_{10}\,\mathbf{a}_2 + \left(z_{10} + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{10}\,\hat{\mathbf{y}} + c\left(z_{10} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al X
$\mathbf{B_{21}}$	=	$y_{11}\,\mathbf{a}_2 + z_{11}\,\mathbf{a}_3$	=	$by_{11}\,\hat{\mathbf{y}} + cz_{11}\,\hat{\mathbf{z}}$	(2a)	Al XI
$\mathbf{B_{22}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_{11}\,\mathbf{a}_2 + \left(z_{11} + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{11}\,\hat{\mathbf{y}} + c\left(z_{11} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XI
$\mathbf{B_{23}}$	=	$y_{12}\,\mathbf{a}_2 + z_{12}\,\mathbf{a}_3$	=	$by_{12}\,\hat{\mathbf{y}} + cz_{12}\,\hat{\mathbf{z}}$	(2a)	Al XII
$\mathbf{B_{24}}$	=	$\frac{1}{2}\,\mathbf{a}_1 - y_{12}\,\mathbf{a}_2 + \left(z_{12} + \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{12}\,\hat{\mathbf{y}} + c\left(z_{12} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XII
$\mathbf{B_{25}}$	=	$y_{13}\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$by_{13}\,\hat{\mathbf{y}} + cz_{13}\,\hat{\mathbf{z}}$	(2a)	Al XIII

$\mathbf{B_{26}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{13}\,\mathbf{a}_2 + \left(z_{13}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{13}\,\hat{\mathbf{y}} + c\left(z_{13}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XIII
$\mathbf{B_{27}}$	$=$	$y_{14}\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3$	$=$	$by_{14}\,\hat{\mathbf{y}} + cz_{14}\,\hat{\mathbf{z}}$	(2a)	Al XIV
$\mathbf{B_{28}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{14}\,\mathbf{a}_2 + \left(z_{14}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{14}\,\hat{\mathbf{y}} + c\left(z_{14}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XIV
$\mathbf{B_{29}}$	$=$	$y_{15}\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3$	$=$	$by_{15}\,\hat{\mathbf{y}} + cz_{15}\,\hat{\mathbf{z}}$	(2a)	Al XV
$\mathbf{B_{30}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{15}\,\mathbf{a}_2 + \left(z_{15}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{15}\,\hat{\mathbf{y}} + c\left(z_{15}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XV
$\mathbf{B_{31}}$	$=$	$y_{16}\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	$=$	$by_{16}\,\hat{\mathbf{y}} + cz_{16}\,\hat{\mathbf{z}}$	(2a)	Al XVI
$\mathbf{B_{32}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{16}\,\mathbf{a}_2 + \left(z_{16}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{16}\,\hat{\mathbf{y}} + c\left(z_{16}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XVI
$\mathbf{B_{33}}$	$=$	$y_{17}\,\mathbf{a}_2 + z_{17}\,\mathbf{a}_3$	$=$	$by_{17}\,\hat{\mathbf{y}} + cz_{17}\,\hat{\mathbf{z}}$	(2a)	Al XVII
$\mathbf{B_{34}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{17}\,\mathbf{a}_2 + \left(z_{17}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{17}\,\hat{\mathbf{y}} + c\left(z_{17}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Al XVII
$\mathbf{B_{35}}$	$=$	$y_{18}\,\mathbf{a}_2 + z_{18}\,\mathbf{a}_3$	$=$	$by_{18}\,\hat{\mathbf{y}} + cz_{18}\,\hat{\mathbf{z}}$	(2a)	Co I
$\mathbf{B_{36}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{18}\,\mathbf{a}_2 + \left(z_{18}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{18}\,\hat{\mathbf{y}} + c\left(z_{18}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co I
$\mathbf{B_{37}}$	$=$	$y_{19}\,\mathbf{a}_2 + z_{19}\,\mathbf{a}_3$	$=$	$by_{19}\,\hat{\mathbf{y}} + cz_{19}\,\hat{\mathbf{z}}$	(2a)	Co II
$\mathbf{B_{38}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{19}\,\mathbf{a}_2 + \left(z_{19}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{19}\,\hat{\mathbf{y}} + c\left(z_{19}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co II
$\mathbf{B_{39}}$	$=$	$y_{20}\,\mathbf{a}_2 + z_{20}\,\mathbf{a}_3$	$=$	$by_{20}\,\hat{\mathbf{y}} + cz_{20}\,\hat{\mathbf{z}}$	(2a)	Co III
$\mathbf{B_{40}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{20}\,\mathbf{a}_2 + \left(z_{20}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{20}\,\hat{\mathbf{y}} + c\left(z_{20}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co III
$\mathbf{B_{41}}$	$=$	$y_{21}\,\mathbf{a}_2 + z_{21}\,\mathbf{a}_3$	$=$	$by_{21}\,\hat{\mathbf{y}} + cz_{21}\,\hat{\mathbf{z}}$	(2a)	Co IV
$\mathbf{B_{42}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{21}\,\mathbf{a}_2 + \left(z_{21}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{21}\,\hat{\mathbf{y}} + c\left(z_{21}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co IV
$\mathbf{B_{43}}$	$=$	$y_{22}\,\mathbf{a}_2 + z_{22}\,\mathbf{a}_3$	$=$	$by_{22}\,\hat{\mathbf{y}} + cz_{22}\,\hat{\mathbf{z}}$	(2a)	Co V
$\mathbf{B_{44}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{22}\,\mathbf{a}_2 + \left(z_{22}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{22}\,\hat{\mathbf{y}} + c\left(z_{22}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co V
$\mathbf{B_{45}}$	$=$	$y_{23}\,\mathbf{a}_2 + z_{23}\,\mathbf{a}_3$	$=$	$by_{23}\,\hat{\mathbf{y}} + cz_{23}\,\hat{\mathbf{z}}$	(2a)	Co VI
$\mathbf{B_{46}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{23}\,\mathbf{a}_2 + \left(z_{23}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{23}\,\hat{\mathbf{y}} + c\left(z_{23}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co VI
$\mathbf{B_{47}}$	$=$	$y_{24}\,\mathbf{a}_2 + z_{24}\,\mathbf{a}_3$	$=$	$by_{24}\,\hat{\mathbf{y}} + cz_{24}\,\hat{\mathbf{z}}$	(2a)	Co VII
$\mathbf{B_{48}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{24}\,\mathbf{a}_2 + \left(z_{24}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{24}\,\hat{\mathbf{y}} + c\left(z_{24}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co VII
$\mathbf{B_{49}}$	$=$	$y_{25}\,\mathbf{a}_2 + z_{25}\,\mathbf{a}_3$	$=$	$by_{25}\,\hat{\mathbf{y}} + cz_{25}\,\hat{\mathbf{z}}$	(2a)	Co VIII
$\mathbf{B_{50}}$	$=$	$\frac{1}{2}\,\mathbf{a}_1 - y_{25}\,\mathbf{a}_2 + \left(z_{25}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$\frac{1}{2}a\,\hat{\mathbf{x}} - by_{25}\,\hat{\mathbf{y}} + c\left(z_{25}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(2a)	Co VIII
$\mathbf{B_{51}}$	$=$	$x_{26}\,\mathbf{a}_1 + y_{26}\,\mathbf{a}_2 + z_{26}\,\mathbf{a}_3$	$=$	$ax_{26}\,\hat{\mathbf{x}} + by_{26}\,\hat{\mathbf{y}} + cz_{26}\,\hat{\mathbf{z}}$	(4b)	Al XVIII
$\mathbf{B_{52}}$	$=$	$-\left(x_{26}-\frac{1}{2}\right)\,\mathbf{a}_1 - y_{26}\,\mathbf{a}_2 + \left(z_{26}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$-a\left(x_{26}-\frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{26}\,\hat{\mathbf{y}} + c\left(z_{26}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XVIII
$\mathbf{B_{53}}$	$=$	$\left(x_{26}+\frac{1}{2}\right)\,\mathbf{a}_1 - y_{26}\,\mathbf{a}_2 + \left(z_{26}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$a\left(x_{26}+\frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{26}\,\hat{\mathbf{y}} + c\left(z_{26}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XVIII
$\mathbf{B_{54}}$	$=$	$-x_{26}\,\mathbf{a}_1 + y_{26}\,\mathbf{a}_2 + z_{26}\,\mathbf{a}_3$	$=$	$-ax_{26}\,\hat{\mathbf{x}} + by_{26}\,\hat{\mathbf{y}} + cz_{26}\,\hat{\mathbf{z}}$	(4b)	Al XVIII
$\mathbf{B_{55}}$	$=$	$x_{27}\,\mathbf{a}_1 + y_{27}\,\mathbf{a}_2 + z_{27}\,\mathbf{a}_3$	$=$	$ax_{27}\,\hat{\mathbf{x}} + by_{27}\,\hat{\mathbf{y}} + cz_{27}\,\hat{\mathbf{z}}$	(4b)	Al XIX
$\mathbf{B_{56}}$	$=$	$-\left(x_{27}-\frac{1}{2}\right)\,\mathbf{a}_1 - y_{27}\,\mathbf{a}_2 + \left(z_{27}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$-a\left(x_{27}-\frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{27}\,\hat{\mathbf{y}} + c\left(z_{27}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XIX
$\mathbf{B_{57}}$	$=$	$\left(x_{27}+\frac{1}{2}\right)\,\mathbf{a}_1 - y_{27}\,\mathbf{a}_2 + \left(z_{27}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$a\left(x_{27}+\frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{27}\,\hat{\mathbf{y}} + c\left(z_{27}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XIX
$\mathbf{B_{58}}$	$=$	$-x_{27}\,\mathbf{a}_1 + y_{27}\,\mathbf{a}_2 + z_{27}\,\mathbf{a}_3$	$=$	$-ax_{27}\,\hat{\mathbf{x}} + by_{27}\,\hat{\mathbf{y}} + cz_{27}\,\hat{\mathbf{z}}$	(4b)	Al XIX
$\mathbf{B_{59}}$	$=$	$x_{28}\,\mathbf{a}_1 + y_{28}\,\mathbf{a}_2 + z_{28}\,\mathbf{a}_3$	$=$	$ax_{28}\,\hat{\mathbf{x}} + by_{28}\,\hat{\mathbf{y}} + cz_{28}\,\hat{\mathbf{z}}$	(4b)	Al XX
$\mathbf{B_{60}}$	$=$	$-\left(x_{28}-\frac{1}{2}\right)\,\mathbf{a}_1 - y_{28}\,\mathbf{a}_2 + \left(z_{28}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$-a\left(x_{28}-\frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{28}\,\hat{\mathbf{y}} + c\left(z_{28}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XX
$\mathbf{B_{61}}$	$=$	$\left(x_{28}+\frac{1}{2}\right)\,\mathbf{a}_1 - y_{28}\,\mathbf{a}_2 + \left(z_{28}+\frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$a\left(x_{28}+\frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{28}\,\hat{\mathbf{y}} + c\left(z_{28}+\frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XX
$\mathbf{B_{62}}$	$=$	$-x_{28}\,\mathbf{a}_1 + y_{28}\,\mathbf{a}_2 + z_{28}\,\mathbf{a}_3$	$=$	$-ax_{28}\,\hat{\mathbf{x}} + by_{28}\,\hat{\mathbf{y}} + cz_{28}\,\hat{\mathbf{z}}$	(4b)	Al XX

$$\mathbf{B_{63}} = x_{29}\,\mathbf{a}_1 + y_{29}\,\mathbf{a}_2 + z_{29}\,\mathbf{a}_3 = ax_{29}\,\hat{\mathbf{x}} + by_{29}\,\hat{\mathbf{y}} + cz_{29}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXI}$$

$$\mathbf{B_{64}} = -\left(x_{29} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{29}\,\mathbf{a}_2 + \left(z_{29} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{29} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{29}\,\hat{\mathbf{y}} + c\left(z_{29} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXI}$$

$$\mathbf{B_{65}} = \left(x_{29} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{29}\,\mathbf{a}_2 + \left(z_{29} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{29} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{29}\,\hat{\mathbf{y}} + c\left(z_{29} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXI}$$

$$\mathbf{B_{66}} = -x_{29}\,\mathbf{a}_1 + y_{29}\,\mathbf{a}_2 + z_{29}\,\mathbf{a}_3 = -ax_{29}\,\hat{\mathbf{x}} + by_{29}\,\hat{\mathbf{y}} + cz_{29}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXI}$$

$$\mathbf{B_{67}} = x_{30}\,\mathbf{a}_1 + y_{30}\,\mathbf{a}_2 + z_{30}\,\mathbf{a}_3 = ax_{30}\,\hat{\mathbf{x}} + by_{30}\,\hat{\mathbf{y}} + cz_{30}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXII}$$

$$\mathbf{B_{68}} = -\left(x_{30} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{30}\,\mathbf{a}_2 + \left(z_{30} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{30} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{30}\,\hat{\mathbf{y}} + c\left(z_{30} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXII}$$

$$\mathbf{B_{69}} = \left(x_{30} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{30}\,\mathbf{a}_2 + \left(z_{30} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{30} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{30}\,\hat{\mathbf{y}} + c\left(z_{30} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXII}$$

$$\mathbf{B_{70}} = -x_{30}\,\mathbf{a}_1 + y_{30}\,\mathbf{a}_2 + z_{30}\,\mathbf{a}_3 = -ax_{30}\,\hat{\mathbf{x}} + by_{30}\,\hat{\mathbf{y}} + cz_{30}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXII}$$

$$\mathbf{B_{71}} = x_{31}\,\mathbf{a}_1 + y_{31}\,\mathbf{a}_2 + z_{31}\,\mathbf{a}_3 = ax_{31}\,\hat{\mathbf{x}} + by_{31}\,\hat{\mathbf{y}} + cz_{31}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIII}$$

$$\mathbf{B_{72}} = -\left(x_{31} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{31}\,\mathbf{a}_2 + \left(z_{31} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{31} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{31}\,\hat{\mathbf{y}} + c\left(z_{31} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIII}$$

$$\mathbf{B_{73}} = \left(x_{31} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{31}\,\mathbf{a}_2 + \left(z_{31} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{31} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{31}\,\hat{\mathbf{y}} + c\left(z_{31} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIII}$$

$$\mathbf{B_{74}} = -x_{31}\,\mathbf{a}_1 + y_{31}\,\mathbf{a}_2 + z_{31}\,\mathbf{a}_3 = -ax_{31}\,\hat{\mathbf{x}} + by_{31}\,\hat{\mathbf{y}} + cz_{31}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIII}$$

$$\mathbf{B_{75}} = x_{32}\,\mathbf{a}_1 + y_{32}\,\mathbf{a}_2 + z_{32}\,\mathbf{a}_3 = ax_{32}\,\hat{\mathbf{x}} + by_{32}\,\hat{\mathbf{y}} + cz_{32}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIV}$$

$$\mathbf{B_{76}} = -\left(x_{32} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{32}\,\mathbf{a}_2 + \left(z_{32} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{32} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{32}\,\hat{\mathbf{y}} + c\left(z_{32} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIV}$$

$$\mathbf{B_{77}} = \left(x_{32} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{32}\,\mathbf{a}_2 + \left(z_{32} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{32} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{32}\,\hat{\mathbf{y}} + c\left(z_{32} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIV}$$

$$\mathbf{B_{78}} = -x_{32}\,\mathbf{a}_1 + y_{32}\,\mathbf{a}_2 + z_{32}\,\mathbf{a}_3 = -ax_{32}\,\hat{\mathbf{x}} + by_{32}\,\hat{\mathbf{y}} + cz_{32}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXIV}$$

$$\mathbf{B_{79}} = x_{33}\,\mathbf{a}_1 + y_{33}\,\mathbf{a}_2 + z_{33}\,\mathbf{a}_3 = ax_{33}\,\hat{\mathbf{x}} + by_{33}\,\hat{\mathbf{y}} + cz_{33}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXV}$$

$$\mathbf{B_{80}} = -\left(x_{33} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{33}\,\mathbf{a}_2 + \left(z_{33} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{33} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{33}\,\hat{\mathbf{y}} + c\left(z_{33} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXV}$$

$$\mathbf{B_{81}} = \left(x_{33} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{33}\,\mathbf{a}_2 + \left(z_{33} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{33} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{33}\,\hat{\mathbf{y}} + c\left(z_{33} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXV}$$

$$\mathbf{B_{82}} = -x_{33}\,\mathbf{a}_1 + y_{33}\,\mathbf{a}_2 + z_{33}\,\mathbf{a}_3 = -ax_{33}\,\hat{\mathbf{x}} + by_{33}\,\hat{\mathbf{y}} + cz_{33}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXV}$$

$$\mathbf{B_{83}} = x_{34}\,\mathbf{a}_1 + y_{34}\,\mathbf{a}_2 + z_{34}\,\mathbf{a}_3 = ax_{34}\,\hat{\mathbf{x}} + by_{34}\,\hat{\mathbf{y}} + cz_{34}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVI}$$

$$\mathbf{B_{84}} = -\left(x_{34} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{34}\,\mathbf{a}_2 + \left(z_{34} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{34} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{34}\,\hat{\mathbf{y}} + c\left(z_{34} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVI}$$

$$\mathbf{B_{85}} = \left(x_{34} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{34}\,\mathbf{a}_2 + \left(z_{34} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{34} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{34}\,\hat{\mathbf{y}} + c\left(z_{34} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVI}$$

$$\mathbf{B_{86}} = -x_{34}\,\mathbf{a}_1 + y_{34}\,\mathbf{a}_2 + z_{34}\,\mathbf{a}_3 = -ax_{34}\,\hat{\mathbf{x}} + by_{34}\,\hat{\mathbf{y}} + cz_{34}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVI}$$

$$\mathbf{B_{87}} = x_{35}\,\mathbf{a}_1 + y_{35}\,\mathbf{a}_2 + z_{35}\,\mathbf{a}_3 = ax_{35}\,\hat{\mathbf{x}} + by_{35}\,\hat{\mathbf{y}} + cz_{35}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVII}$$

$$\mathbf{B_{88}} = -\left(x_{35} - \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{35}\,\mathbf{a}_2 + \left(z_{35} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = -a\left(x_{35} - \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{35}\,\hat{\mathbf{y}} + c\left(z_{35} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVII}$$

$$\mathbf{B_{89}} = \left(x_{35} + \tfrac{1}{2}\right)\,\mathbf{a}_1 - y_{35}\,\mathbf{a}_2 + \left(z_{35} + \tfrac{1}{2}\right)\,\mathbf{a}_3 = a\left(x_{35} + \tfrac{1}{2}\right)\,\hat{\mathbf{x}} - by_{35}\,\hat{\mathbf{y}} + c\left(z_{35} + \tfrac{1}{2}\right)\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVII}$$

$$\mathbf{B_{90}} = -x_{35}\,\mathbf{a}_1 + y_{35}\,\mathbf{a}_2 + z_{35}\,\mathbf{a}_3 = -ax_{35}\,\hat{\mathbf{x}} + by_{35}\,\hat{\mathbf{y}} + cz_{35}\,\hat{\mathbf{z}} \quad (4b) \quad \text{Al XXVII}$$

$\mathbf{B_{91}}$	$=$	$x_{36}\,\mathbf{a}_1 + y_{36}\,\mathbf{a}_2 + z_{36}\,\mathbf{a}_3$	$=$	$ax_{36}\,\hat{\mathbf{x}} + by_{36}\,\hat{\mathbf{y}} + cz_{36}\,\hat{\mathbf{z}}$	(4b)	Al XXVIII
$\mathbf{B_{92}}$	$=$	$-\left(x_{36} - \frac{1}{2}\right)\,\mathbf{a}_1 - y_{36}\,\mathbf{a}_2 + \left(z_{36} + \frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$-a\left(x_{36} - \frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{36}\,\hat{\mathbf{y}} + c\left(z_{36} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XXVIII
$\mathbf{B_{93}}$	$=$	$\left(x_{36} + \frac{1}{2}\right)\,\mathbf{a}_1 - y_{36}\,\mathbf{a}_2 + \left(z_{36} + \frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$a\left(x_{36} + \frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{36}\,\hat{\mathbf{y}} + c\left(z_{36} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Al XXVIII
$\mathbf{B_{94}}$	$=$	$-x_{36}\,\mathbf{a}_1 + y_{36}\,\mathbf{a}_2 + z_{36}\,\mathbf{a}_3$	$=$	$-ax_{36}\,\hat{\mathbf{x}} + by_{36}\,\hat{\mathbf{y}} + cz_{36}\,\hat{\mathbf{z}}$	(4b)	Al XXVIII
$\mathbf{B_{95}}$	$=$	$x_{37}\,\mathbf{a}_1 + y_{37}\,\mathbf{a}_2 + z_{37}\,\mathbf{a}_3$	$=$	$ax_{37}\,\hat{\mathbf{x}} + by_{37}\,\hat{\mathbf{y}} + cz_{37}\,\hat{\mathbf{z}}$	(4b)	Co IX
$\mathbf{B_{96}}$	$=$	$-\left(x_{37} - \frac{1}{2}\right)\,\mathbf{a}_1 - y_{37}\,\mathbf{a}_2 + \left(z_{37} + \frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$-a\left(x_{37} - \frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{37}\,\hat{\mathbf{y}} + c\left(z_{37} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Co IX
$\mathbf{B_{97}}$	$=$	$\left(x_{37} + \frac{1}{2}\right)\,\mathbf{a}_1 - y_{37}\,\mathbf{a}_2 + \left(z_{37} + \frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$a\left(x_{37} + \frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{37}\,\hat{\mathbf{y}} + c\left(z_{37} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Co IX
$\mathbf{B_{98}}$	$=$	$-x_{37}\,\mathbf{a}_1 + y_{37}\,\mathbf{a}_2 + z_{37}\,\mathbf{a}_3$	$=$	$-ax_{37}\,\hat{\mathbf{x}} + by_{37}\,\hat{\mathbf{y}} + cz_{37}\,\hat{\mathbf{z}}$	(4b)	Co IX
$\mathbf{B_{99}}$	$=$	$x_{38}\,\mathbf{a}_1 + y_{38}\,\mathbf{a}_2 + z_{38}\,\mathbf{a}_3$	$=$	$ax_{38}\,\hat{\mathbf{x}} + by_{38}\,\hat{\mathbf{y}} + cz_{38}\,\hat{\mathbf{z}}$	(4b)	Co X
$\mathbf{B_{100}}$	$=$	$-\left(x_{38} - \frac{1}{2}\right)\,\mathbf{a}_1 - y_{38}\,\mathbf{a}_2 + \left(z_{38} + \frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$-a\left(x_{38} - \frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{38}\,\hat{\mathbf{y}} + c\left(z_{38} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Co X
$\mathbf{B_{101}}$	$=$	$\left(x_{38} + \frac{1}{2}\right)\,\mathbf{a}_1 - y_{38}\,\mathbf{a}_2 + \left(z_{38} + \frac{1}{2}\right)\,\mathbf{a}_3$	$=$	$a\left(x_{38} + \frac{1}{2}\right)\,\hat{\mathbf{x}} - by_{38}\,\hat{\mathbf{y}} + c\left(z_{38} + \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(4b)	Co X
$\mathbf{B_{102}}$	$=$	$-x_{38}\,\mathbf{a}_1 + y_{38}\,\mathbf{a}_2 + z_{38}\,\mathbf{a}_3$	$=$	$-ax_{38}\,\hat{\mathbf{x}} + by_{38}\,\hat{\mathbf{y}} + cz_{38}\,\hat{\mathbf{z}}$	(4b)	Co X

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