

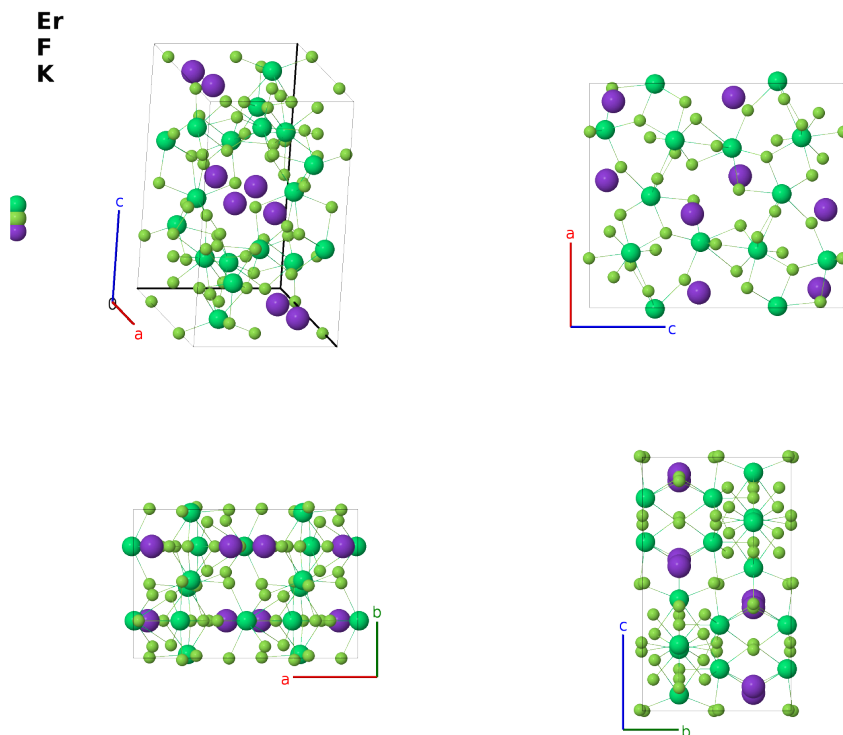
β -K Er_2F_7 Structure: A2B7C_oP80_62_2cd_6c4d_2c-001

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- 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.

<https://aflow.org/prototype-encyclopedia/4UXD>

https://aflow.org/prototype-encyclopedia/A2B7C_oP80_62_2cd_6c4d_2c-001



Prototype	$\text{Er}_2\text{F}_7\text{K}$
AFLOW prototype label	A2B7C_oP80_62_2cd_6c4d_2c-001
ICSD	40450
CCDC	1610302
Pearson symbol	oP80
Space group number	62
Space group symbol	$Pnma$
AFLOW prototype command	<pre>aflow --proto=A2B7C_oP80_62_2cd_6c4d_2c-001 --params=a,b/a,c/a,x1,z1,x2,z2,x3,z3,x4,z4,x5,z5,x6,z6,x7,z7,x8,z8,x9,z9,x10,z10,x11,y11,z11,x12,y12,z12,x13,y13,z13,x14,y14,z14,x15,y15,z15</pre>

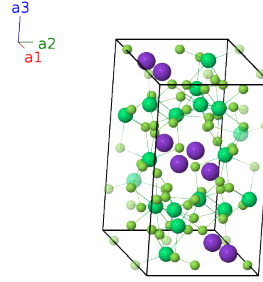
Other compounds with this structure

α -KYb₂F₇, β -KHo₂F₇

- This is the high-temperature phase of KEr₂F₇. It was prepared at a temperature of 850°. At some point below that temperature it transforms into the low temperature α -KHo₂F₇ structure. (Aleonard, 1980).
- (Aleonard, 1980) placed this structure in the non-centrosymmetric space group $Pna2_1$ #33 (ICSD entry 23384, CCDC entry 1599507). (Marsh, 1988) found the structure to be nearly indistinguishable from that found using $Pnma$ #62, stating that the interatomic distances in the two groups differ by no more than 0.22Å. It seems likely that this higher-symmetry structure is correct.
- (Marsh, 1988) give the data for this structure in the $Pnam$ setting of space group #62. We applied the transformation $(x, y, z) \rightarrow (x, z, -y)$ to change this to the standard $Pnma$ setting.

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
$\mathbf{B}_1$	$= x_1 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_1 \mathbf{a}_3$	$=$	$ax_1 \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} + cz_1 \hat{\mathbf{z}}$	(4c)	Er I
$\mathbf{B}_2$	$= -\left(x_1 - \frac{1}{2}\right) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + \left(z_1 + \frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_1 - \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} + c\left(z_1 + \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	Er I
$\mathbf{B}_3$	$= -x_1 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_1 \mathbf{a}_3$	$=$	$-ax_1 \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} - cz_1 \hat{\mathbf{z}}$	(4c)	Er I
$\mathbf{B}_4$	$= \left(x_1 + \frac{1}{2}\right) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - \left(z_1 - \frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_1 + \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} - c\left(z_1 - \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	Er I
$\mathbf{B}_5$	$= x_2 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_2 \mathbf{a}_3$	$=$	$ax_2 \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} + cz_2 \hat{\mathbf{z}}$	(4c)	Er II
$\mathbf{B}_6$	$= -\left(x_2 - \frac{1}{2}\right) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + \left(z_2 + \frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_2 - \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} + c\left(z_2 + \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	Er II
$\mathbf{B}_7$	$= -x_2 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_2 \mathbf{a}_3$	$=$	$-ax_2 \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} - cz_2 \hat{\mathbf{z}}$	(4c)	Er II
$\mathbf{B}_8$	$= \left(x_2 + \frac{1}{2}\right) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - \left(z_2 - \frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_2 + \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} - c\left(z_2 - \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	Er II
$\mathbf{B}_9$	$= x_3 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_3 \mathbf{a}_3$	$=$	$ax_3 \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} + cz_3 \hat{\mathbf{z}}$	(4c)	F I
$\mathbf{B}_{10}$	$= -\left(x_3 - \frac{1}{2}\right) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + \left(z_3 + \frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_3 - \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} + c\left(z_3 + \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	F I
$\mathbf{B}_{11}$	$= -x_3 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_3 \mathbf{a}_3$	$=$	$-ax_3 \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} - cz_3 \hat{\mathbf{z}}$	(4c)	F I
$\mathbf{B}_{12}$	$= \left(x_3 + \frac{1}{2}\right) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - \left(z_3 - \frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_3 + \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} - c\left(z_3 - \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	F I
$\mathbf{B}_{13}$	$= x_4 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_4 \mathbf{a}_3$	$=$	$ax_4 \hat{\mathbf{x}} + \frac{1}{4}b \hat{\mathbf{y}} + cz_4 \hat{\mathbf{z}}$	(4c)	F II
$\mathbf{B}_{14}$	$= -\left(x_4 - \frac{1}{2}\right) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + \left(z_4 + \frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_4 - \frac{1}{2}\right) \hat{\mathbf{x}} + \frac{3}{4}b \hat{\mathbf{y}} + c\left(z_4 + \frac{1}{2}\right) \hat{\mathbf{z}}$	(4c)	F II

$\mathbf{B}_{15} =$	$-x_4 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_4 \mathbf{a}_3$	$=$	$-ax_4 \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_4 \hat{\mathbf{z}}$	(4c)	F II
$\mathbf{B}_{16} =$	$(x_4 + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_4 - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_4 + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_4 - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F II
$\mathbf{B}_{17} =$	$x_5 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_5 \mathbf{a}_3$	$=$	$ax_5 \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} + cz_5 \hat{\mathbf{z}}$	(4c)	F III
$\mathbf{B}_{18} =$	$-(x_5 - \frac{1}{2}) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + (z_5 + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_5 - \frac{1}{2}) \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} + c(z_5 + \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F III
$\mathbf{B}_{19} =$	$-x_5 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_5 \mathbf{a}_3$	$=$	$-ax_5 \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_5 \hat{\mathbf{z}}$	(4c)	F III
$\mathbf{B}_{20} =$	$(x_5 + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_5 - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_5 + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_5 - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F III
$\mathbf{B}_{21} =$	$x_6 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_6 \mathbf{a}_3$	$=$	$ax_6 \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} + cz_6 \hat{\mathbf{z}}$	(4c)	F IV
$\mathbf{B}_{22} =$	$-(x_6 - \frac{1}{2}) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + (z_6 + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_6 - \frac{1}{2}) \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} + c(z_6 + \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F IV
$\mathbf{B}_{23} =$	$-x_6 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_6 \mathbf{a}_3$	$=$	$-ax_6 \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_6 \hat{\mathbf{z}}$	(4c)	F IV
$\mathbf{B}_{24} =$	$(x_6 + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_6 - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_6 + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_6 - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F IV
$\mathbf{B}_{25} =$	$x_7 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_7 \mathbf{a}_3$	$=$	$ax_7 \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} + cz_7 \hat{\mathbf{z}}$	(4c)	F V
$\mathbf{B}_{26} =$	$-(x_7 - \frac{1}{2}) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + (z_7 + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_7 - \frac{1}{2}) \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} + c(z_7 + \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F V
$\mathbf{B}_{27} =$	$-x_7 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_7 \mathbf{a}_3$	$=$	$-ax_7 \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_7 \hat{\mathbf{z}}$	(4c)	F V
$\mathbf{B}_{28} =$	$(x_7 + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_7 - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_7 + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_7 - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F V
$\mathbf{B}_{29} =$	$x_8 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_8 \mathbf{a}_3$	$=$	$ax_8 \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} + cz_8 \hat{\mathbf{z}}$	(4c)	F VI
$\mathbf{B}_{30} =$	$-(x_8 - \frac{1}{2}) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + (z_8 + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_8 - \frac{1}{2}) \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} + c(z_8 + \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F VI
$\mathbf{B}_{31} =$	$-x_8 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_8 \mathbf{a}_3$	$=$	$-ax_8 \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_8 \hat{\mathbf{z}}$	(4c)	F VI
$\mathbf{B}_{32} =$	$(x_8 + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_8 - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_8 + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_8 - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	F VI
$\mathbf{B}_{33} =$	$x_9 \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_9 \mathbf{a}_3$	$=$	$ax_9 \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} + cz_9 \hat{\mathbf{z}}$	(4c)	K I
$\mathbf{B}_{34} =$	$-(x_9 - \frac{1}{2}) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + (z_9 + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_9 - \frac{1}{2}) \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} + c(z_9 + \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	K I
$\mathbf{B}_{35} =$	$-x_9 \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_9 \mathbf{a}_3$	$=$	$-ax_9 \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_9 \hat{\mathbf{z}}$	(4c)	K I
$\mathbf{B}_{36} =$	$(x_9 + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_9 - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_9 + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_9 - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	K I
$\mathbf{B}_{37} =$	$x_{10} \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 + z_{10} \mathbf{a}_3$	$=$	$ax_{10} \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} + cz_{10} \hat{\mathbf{z}}$	(4c)	K II
$\mathbf{B}_{38} =$	$-(x_{10} - \frac{1}{2}) \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 + (z_{10} + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_{10} - \frac{1}{2}) \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} + c(z_{10} + \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	K II
$\mathbf{B}_{39} =$	$-x_{10} \mathbf{a}_1 + \frac{3}{4} \mathbf{a}_2 - z_{10} \mathbf{a}_3$	$=$	$-ax_{10} \hat{\mathbf{x}} + \frac{3}{4} b \hat{\mathbf{y}} - cz_{10} \hat{\mathbf{z}}$	(4c)	K II
$\mathbf{B}_{40} =$	$(x_{10} + \frac{1}{2}) \mathbf{a}_1 + \frac{1}{4} \mathbf{a}_2 - (z_{10} - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_{10} + \frac{1}{2}) \hat{\mathbf{x}} + \frac{1}{4} b \hat{\mathbf{y}} - c(z_{10} - \frac{1}{2}) \hat{\mathbf{z}}$	(4c)	K II
$\mathbf{B}_{41} =$	$x_{11} \mathbf{a}_1 + y_{11} \mathbf{a}_2 + z_{11} \mathbf{a}_3$	$=$	$ax_{11} \hat{\mathbf{x}} + by_{11} \hat{\mathbf{y}} + cz_{11} \hat{\mathbf{z}}$	(8d)	Er III
$\mathbf{B}_{42} =$	$-(x_{11} - \frac{1}{2}) \mathbf{a}_1 - y_{11} \mathbf{a}_2 + (z_{11} + \frac{1}{2}) \mathbf{a}_3$	$=$	$-a(x_{11} - \frac{1}{2}) \hat{\mathbf{x}} - by_{11} \hat{\mathbf{y}} + c(z_{11} + \frac{1}{2}) \hat{\mathbf{z}}$	(8d)	Er III
$\mathbf{B}_{43} =$	$-x_{11} \mathbf{a}_1 + (y_{11} + \frac{1}{2}) \mathbf{a}_2 - z_{11} \mathbf{a}_3$	$=$	$-ax_{11} \hat{\mathbf{x}} + b(y_{11} + \frac{1}{2}) \hat{\mathbf{y}} - cz_{11} \hat{\mathbf{z}}$	(8d)	Er III
$\mathbf{B}_{44} =$	$(x_{11} + \frac{1}{2}) \mathbf{a}_1 - (y_{11} - \frac{1}{2}) \mathbf{a}_2 - (z_{11} - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_{11} + \frac{1}{2}) \hat{\mathbf{x}} - b(y_{11} - \frac{1}{2}) \hat{\mathbf{y}} - c(z_{11} - \frac{1}{2}) \hat{\mathbf{z}}$	(8d)	Er III
$\mathbf{B}_{45} =$	$-x_{11} \mathbf{a}_1 - y_{11} \mathbf{a}_2 - z_{11} \mathbf{a}_3$	$=$	$-ax_{11} \hat{\mathbf{x}} - by_{11} \hat{\mathbf{y}} - cz_{11} \hat{\mathbf{z}}$	(8d)	Er III
$\mathbf{B}_{46} =$	$(x_{11} + \frac{1}{2}) \mathbf{a}_1 + y_{11} \mathbf{a}_2 - (z_{11} - \frac{1}{2}) \mathbf{a}_3$	$=$	$a(x_{11} + \frac{1}{2}) \hat{\mathbf{x}} + by_{11} \hat{\mathbf{y}} - c(z_{11} - \frac{1}{2}) \hat{\mathbf{z}}$	(8d)	Er III
$\mathbf{B}_{47} =$	$x_{11} \mathbf{a}_1 - (y_{11} - \frac{1}{2}) \mathbf{a}_2 + z_{11} \mathbf{a}_3$	$=$	$ax_{11} \hat{\mathbf{x}} - b(y_{11} - \frac{1}{2}) \hat{\mathbf{y}} + cz_{11} \hat{\mathbf{z}}$	(8d)	Er III

$\mathbf{B}_{48}$	$=$	$-\left(x_{11}-\frac{1}{2}\right) \mathbf{a}_1+\left(y_{11}+\frac{1}{2}\right) \mathbf{a}_2+$ $\left(z_{11}+\frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_{11}-\frac{1}{2}\right) \hat{\mathbf{x}}+b\left(y_{11}+\frac{1}{2}\right) \hat{\mathbf{y}}+$ $c\left(z_{11}+\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	Er III
$\mathbf{B}_{49}$	$=$	$x_{12} \mathbf{a}_1+y_{12} \mathbf{a}_2+z_{12} \mathbf{a}_3$	$=$	$ax_{12} \hat{\mathbf{x}}+by_{12} \hat{\mathbf{y}}+cz_{12} \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{50}$	$=$	$-\left(x_{12}-\frac{1}{2}\right) \mathbf{a}_1-y_{12} \mathbf{a}_2+$ $\left(z_{12}+\frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_{12}-\frac{1}{2}\right) \hat{\mathbf{x}}-by_{12} \hat{\mathbf{y}}+c\left(z_{12}+\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{51}$	$=$	$-x_{12} \mathbf{a}_1+\left(y_{12}+\frac{1}{2}\right) \mathbf{a}_2-z_{12} \mathbf{a}_3$	$=$	$-ax_{12} \hat{\mathbf{x}}+b\left(y_{12}+\frac{1}{2}\right) \hat{\mathbf{y}}-cz_{12} \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{52}$	$=$	$\left(x_{12}+\frac{1}{2}\right) \mathbf{a}_1-\left(y_{12}-\frac{1}{2}\right) \mathbf{a}_2-$ $\left(z_{12}-\frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_{12}+\frac{1}{2}\right) \hat{\mathbf{x}}-b\left(y_{12}-\frac{1}{2}\right) \hat{\mathbf{y}}-$ $c\left(z_{12}-\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{53}$	$=$	$-x_{12} \mathbf{a}_1-y_{12} \mathbf{a}_2-z_{12} \mathbf{a}_3$	$=$	$-ax_{12} \hat{\mathbf{x}}-by_{12} \hat{\mathbf{y}}-cz_{12} \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{54}$	$=$	$\left(x_{12}+\frac{1}{2}\right) \mathbf{a}_1+y_{12} \mathbf{a}_2-$ $\left(z_{12}-\frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_{12}+\frac{1}{2}\right) \hat{\mathbf{x}}+by_{12} \hat{\mathbf{y}}-c\left(z_{12}-\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{55}$	$=$	$x_{12} \mathbf{a}_1-\left(y_{12}-\frac{1}{2}\right) \mathbf{a}_2+z_{12} \mathbf{a}_3$	$=$	$ax_{12} \hat{\mathbf{x}}-b\left(y_{12}-\frac{1}{2}\right) \hat{\mathbf{y}}+cz_{12} \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{56}$	$=$	$-\left(x_{12}-\frac{1}{2}\right) \mathbf{a}_1+\left(y_{12}+\frac{1}{2}\right) \mathbf{a}_2+$ $\left(z_{12}+\frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_{12}-\frac{1}{2}\right) \hat{\mathbf{x}}+b\left(y_{12}+\frac{1}{2}\right) \hat{\mathbf{y}}+$ $c\left(z_{12}+\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VII
$\mathbf{B}_{57}$	$=$	$x_{13} \mathbf{a}_1+y_{13} \mathbf{a}_2+z_{13} \mathbf{a}_3$	$=$	$ax_{13} \hat{\mathbf{x}}+by_{13} \hat{\mathbf{y}}+cz_{13} \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{58}$	$=$	$-\left(x_{13}-\frac{1}{2}\right) \mathbf{a}_1-y_{13} \mathbf{a}_2+$ $\left(z_{13}+\frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_{13}-\frac{1}{2}\right) \hat{\mathbf{x}}-by_{13} \hat{\mathbf{y}}+c\left(z_{13}+\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{59}$	$=$	$-x_{13} \mathbf{a}_1+\left(y_{13}+\frac{1}{2}\right) \mathbf{a}_2-z_{13} \mathbf{a}_3$	$=$	$-ax_{13} \hat{\mathbf{x}}+b\left(y_{13}+\frac{1}{2}\right) \hat{\mathbf{y}}-cz_{13} \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{60}$	$=$	$\left(x_{13}+\frac{1}{2}\right) \mathbf{a}_1-\left(y_{13}-\frac{1}{2}\right) \mathbf{a}_2-$ $\left(z_{13}-\frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_{13}+\frac{1}{2}\right) \hat{\mathbf{x}}-b\left(y_{13}-\frac{1}{2}\right) \hat{\mathbf{y}}-$ $c\left(z_{13}-\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{61}$	$=$	$-x_{13} \mathbf{a}_1-y_{13} \mathbf{a}_2-z_{13} \mathbf{a}_3$	$=$	$-ax_{13} \hat{\mathbf{x}}-by_{13} \hat{\mathbf{y}}-cz_{13} \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{62}$	$=$	$\left(x_{13}+\frac{1}{2}\right) \mathbf{a}_1+y_{13} \mathbf{a}_2-$ $\left(z_{13}-\frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_{13}+\frac{1}{2}\right) \hat{\mathbf{x}}+by_{13} \hat{\mathbf{y}}-c\left(z_{13}-\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{63}$	$=$	$x_{13} \mathbf{a}_1-\left(y_{13}-\frac{1}{2}\right) \mathbf{a}_2+z_{13} \mathbf{a}_3$	$=$	$ax_{13} \hat{\mathbf{x}}-b\left(y_{13}-\frac{1}{2}\right) \hat{\mathbf{y}}+cz_{13} \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{64}$	$=$	$-\left(x_{13}-\frac{1}{2}\right) \mathbf{a}_1+\left(y_{13}+\frac{1}{2}\right) \mathbf{a}_2+$ $\left(z_{13}+\frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_{13}-\frac{1}{2}\right) \hat{\mathbf{x}}+b\left(y_{13}+\frac{1}{2}\right) \hat{\mathbf{y}}+$ $c\left(z_{13}+\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F VIII
$\mathbf{B}_{65}$	$=$	$x_{14} \mathbf{a}_1+y_{14} \mathbf{a}_2+z_{14} \mathbf{a}_3$	$=$	$ax_{14} \hat{\mathbf{x}}+by_{14} \hat{\mathbf{y}}+cz_{14} \hat{\mathbf{z}}$	$(8d)$	F IX
$\mathbf{B}_{66}$	$=$	$-\left(x_{14}-\frac{1}{2}\right) \mathbf{a}_1-y_{14} \mathbf{a}_2+$ $\left(z_{14}+\frac{1}{2}\right) \mathbf{a}_3$	$=$	$-a\left(x_{14}-\frac{1}{2}\right) \hat{\mathbf{x}}-by_{14} \hat{\mathbf{y}}+c\left(z_{14}+\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F IX
$\mathbf{B}_{67}$	$=$	$-x_{14} \mathbf{a}_1+\left(y_{14}+\frac{1}{2}\right) \mathbf{a}_2-z_{14} \mathbf{a}_3$	$=$	$-ax_{14} \hat{\mathbf{x}}+b\left(y_{14}+\frac{1}{2}\right) \hat{\mathbf{y}}-cz_{14} \hat{\mathbf{z}}$	$(8d)$	F IX
$\mathbf{B}_{68}$	$=$	$\left(x_{14}+\frac{1}{2}\right) \mathbf{a}_1-\left(y_{14}-\frac{1}{2}\right) \mathbf{a}_2-$ $\left(z_{14}-\frac{1}{2}\right) \mathbf{a}_3$	$=$	$a\left(x_{14}+\frac{1}{2}\right) \hat{\mathbf{x}}-b\left(y_{14}-\frac{1}{2}\right) \hat{\mathbf{y}}-$ $c\left(z_{14}-\frac{1}{2}\right) \hat{\mathbf{z}}$	$(8d)$	F IX
$\mathbf{B}_{69}$	$=$	$-x_{14} \mathbf{a}_1-y_{14} \mathbf{a}_2-z_{14} \mathbf{a}_3$	$=$	$-ax_{14} \hat{\mathbf{x}}-$		

$$\mathbf{B}_{78} = \begin{pmatrix} x_{15} + \frac{1}{2} \\ z_{15} - \frac{1}{2} \end{pmatrix} \mathbf{a}_1 + y_{15} \mathbf{a}_2 - \begin{pmatrix} x_{15} + \frac{1}{2} \\ z_{15} - \frac{1}{2} \end{pmatrix} \mathbf{a}_3 = a \left(x_{15} + \frac{1}{2} \right) \hat{\mathbf{x}} + by_{15} \hat{\mathbf{y}} - c \left(z_{15} - \frac{1}{2} \right) \hat{\mathbf{z}} \quad (8d) \quad \text{F X}$$

$$\mathbf{B}_{79} = x_{15} \mathbf{a}_1 - \left(y_{15} - \frac{1}{2} \right) \mathbf{a}_2 + z_{15} \mathbf{a}_3 = ax_{15} \hat{\mathbf{x}} - b \left(y_{15} - \frac{1}{2} \right) \hat{\mathbf{y}} + cz_{15} \hat{\mathbf{z}} \quad (8d) \quad \text{F X}$$

$$\mathbf{B}_{80} = - \left(x_{15} - \frac{1}{2} \right) \mathbf{a}_1 + \left(y_{15} + \frac{1}{2} \right) \mathbf{a}_2 + \begin{pmatrix} x_{15} - \frac{1}{2} \\ z_{15} + \frac{1}{2} \end{pmatrix} \mathbf{a}_3 = -a \left(x_{15} - \frac{1}{2} \right) \hat{\mathbf{x}} + b \left(y_{15} + \frac{1}{2} \right) \hat{\mathbf{y}} + c \left(z_{15} + \frac{1}{2} \right) \hat{\mathbf{z}} \quad (8d) \quad \text{F X}$$

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