

F432

O^3

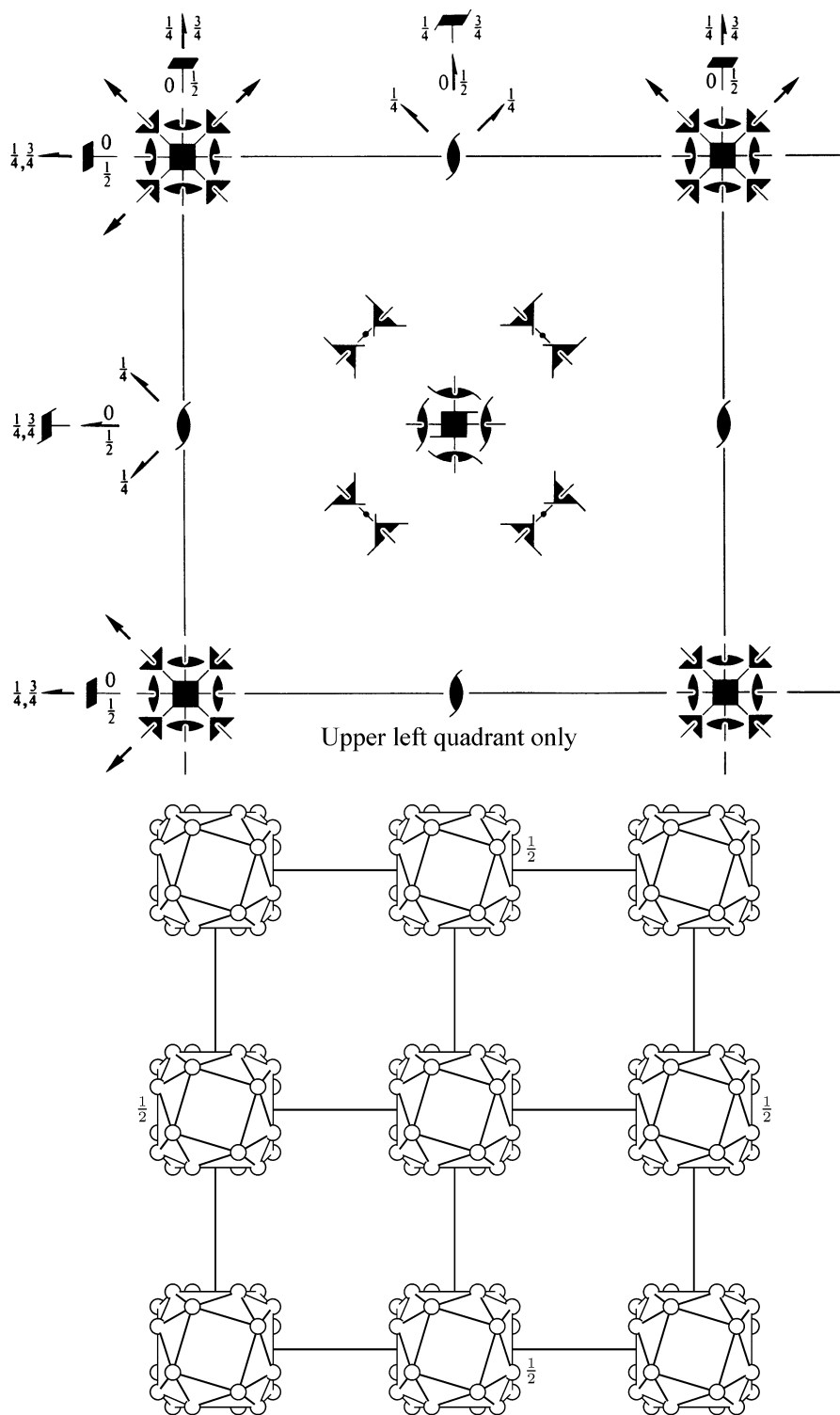
432

Cubic

No. 209

F432

Patterson symmetry $Fm\bar{3}m$



Origin at 432

Asymmetric unit $0 \leq x \leq \frac{1}{2}; 0 \leq y \leq \frac{1}{4}; -\frac{1}{4} \leq z \leq \frac{1}{4}; y \leq \min(x, \frac{1}{2} - x); -y \leq z \leq y$
Vertices $0, 0, 0 \quad \frac{1}{2}, 0, 0 \quad \frac{1}{4}, \frac{1}{4}, \frac{1}{4} \quad \frac{1}{4}, \frac{1}{4}, -\frac{1}{4}$

Symmetry operations

For (0,0,0)+ set

- | | | | |
|---------------------------|--|--|---|
| (1) 1 | (2) 2 0,0,z | (3) 2 0,y,0 | (4) 2 x,0,0 |
| (5) 3 ⁺ x,x,x | (6) 3 ⁺ \bar{x} ,x, \bar{x} | (7) 3 ⁺ x, \bar{x} , \bar{x} | (8) 3 ⁺ \bar{x} , \bar{x} ,x |
| (9) 3 ⁻ x,x,x | (10) 3 ⁻ x, \bar{x} , \bar{x} | (11) 3 ⁻ \bar{x} , \bar{x} ,x | (12) 3 ⁻ \bar{x} ,x, \bar{x} |
| (13) 2 x,x,0 | (14) 2 x, \bar{x} ,0 | (15) 4 ⁻ 0,0,z | (16) 4 ⁺ 0,0,z |
| (17) 4 ⁻ x,0,0 | (18) 2 0,y,y | (19) 2 0,y, \bar{y} | (20) 4 ⁺ x,0,0 |
| (21) 4 ⁺ 0,y,0 | (22) 2 x,0,x | (23) 4 ⁻ 0,y,0 | (24) 2 \bar{x} ,0,x |

Symmetry operations (continued)

For $(0, \frac{1}{2}, \frac{1}{2})+$ set

(1) $t(0, \frac{1}{2}, \frac{1}{2})$	(2) $2(0, 0, \frac{1}{2})$ $0, \frac{1}{4}, z$	(3) $2(0, \frac{1}{2}, 0)$ $0, y, \frac{1}{4}$	(4) 2 $x, \frac{1}{4}, \frac{1}{4}$
(5) $3^+(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x - \frac{1}{3}, x - \frac{1}{6}, x$	(6) 3^+ $\bar{x}, x + \frac{1}{2}, \bar{x}$	(7) $3^+(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x + \frac{1}{3}, \bar{x} - \frac{1}{6}, \bar{x}$	(8) 3^+ $\bar{x}, \bar{x} + \frac{1}{2}, x$
(9) $3^-(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x - \frac{1}{6}, x + \frac{1}{6}, x$	(10) $3^-(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x + \frac{1}{6}, \bar{x} + \frac{1}{6}, \bar{x}$	(11) 3^- $\bar{x} + \frac{1}{2}, \bar{x} + \frac{1}{2}, x$	(12) 3^- $\bar{x} - \frac{1}{2}, x + \frac{1}{2}, \bar{x}$
(13) $2(\frac{1}{4}, \frac{1}{4}, 0)$ $x, x + \frac{1}{4}, \frac{1}{4}$	(14) $2(-\frac{1}{4}, \frac{1}{4}, 0)$ $x, \bar{x} + \frac{1}{4}, \frac{1}{4}$	(15) $4^-(0, 0, \frac{1}{2})$ $\frac{1}{4}, \frac{1}{4}, z$	(16) $4^+(0, 0, \frac{1}{2})$ $-\frac{1}{4}, \frac{1}{4}, z$
(17) 4^- $x, \frac{1}{2}, 0$	(18) $2(0, \frac{1}{2}, \frac{1}{2})$ $0, y, y$	(19) 2 $0, y + \frac{1}{2}, \bar{y}$	(20) 4^+ $x, 0, \frac{1}{2}$
(21) $4^+(0, \frac{1}{2}, 0)$ $\frac{1}{4}, y, \frac{1}{4}$	(22) $2(\frac{1}{4}, 0, \frac{1}{4})$ $x - \frac{1}{4}, \frac{1}{4}, x$	(23) $4^-(0, \frac{1}{2}, 0)$ $-\frac{1}{4}, y, \frac{1}{4}$	(24) $2(-\frac{1}{4}, 0, \frac{1}{4})$ $\bar{x} + \frac{1}{4}, \frac{1}{4}, x$

For $(\frac{1}{2}, 0, \frac{1}{2})+$ set

(1) $t(\frac{1}{2}, 0, \frac{1}{2})$	(2) $2(0, 0, \frac{1}{2})$ $\frac{1}{4}, 0, z$	(3) 2 $\frac{1}{4}, y, \frac{1}{4}$	(4) $2(\frac{1}{2}, 0, 0)$ $x, 0, \frac{1}{4}$
(5) $3^+(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x + \frac{1}{6}, x - \frac{1}{6}, x$	(6) $3^+(\frac{1}{3}, -\frac{1}{3}, \frac{1}{3})$ $\bar{x} + \frac{1}{6}, x + \frac{1}{6}, \bar{x}$	(7) 3^+ $x + \frac{1}{2}, \bar{x} - \frac{1}{2}, \bar{x}$	(8) 3^+ $\bar{x} + \frac{1}{2}, \bar{x} + \frac{1}{2}, x$
(9) $3^-(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x - \frac{1}{6}, x - \frac{1}{3}, x$	(10) 3^- $x + \frac{1}{2}, \bar{x}, \bar{x}$	(11) 3^- $\bar{x} + \frac{1}{2}, \bar{x}, x$	(12) $3^-(\frac{1}{3}, -\frac{1}{3}, \frac{1}{3})$ $\bar{x} - \frac{1}{6}, x + \frac{1}{3}, \bar{x}$
(13) $2(\frac{1}{4}, \frac{1}{4}, 0)$ $x, x - \frac{1}{4}, \frac{1}{4}$	(14) $2(\frac{1}{4}, -\frac{1}{4}, 0)$ $x, \bar{x} + \frac{1}{4}, \frac{1}{4}$	(15) $4^-(0, 0, \frac{1}{2})$ $\frac{1}{4}, -\frac{1}{4}, z$	(16) $4^+(0, 0, \frac{1}{2})$ $\frac{1}{4}, \frac{1}{4}, z$
(17) $4^-(\frac{1}{2}, 0, 0)$ $x, \frac{1}{4}, \frac{1}{4}$	(18) $2(0, \frac{1}{4}, \frac{1}{4})$ $\frac{1}{4}, y - \frac{1}{4}, y$	(19) $2(0, -\frac{1}{4}, \frac{1}{4})$ $\frac{1}{4}, y + \frac{1}{4}, \bar{y}$	(20) $4^+(\frac{1}{2}, 0, 0)$ $x, -\frac{1}{4}, \frac{1}{4}$
(21) $4^+(\frac{1}{2}, 0, 0)$ $\frac{1}{4}, y, 0$	(22) $2(\frac{1}{2}, 0, \frac{1}{2})$ $x, 0, x$	(23) 4^- $0, y, \frac{1}{2}$	(24) 2 $\bar{x} + \frac{1}{2}, 0, x$

For $(\frac{1}{2}, \frac{1}{2}, 0)+$ set

(1) $t(\frac{1}{2}, \frac{1}{2}, 0)$	(2) 2 $\frac{1}{4}, \frac{1}{4}, z$	(3) $2(0, \frac{1}{2}, 0)$ $\frac{1}{4}, y, 0$	(4) $2(\frac{1}{2}, 0, 0)$ $x, \frac{1}{4}, 0$
(5) $3^+(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x + \frac{1}{6}, x + \frac{1}{3}, x$	(6) 3^+ $\bar{x} + \frac{1}{2}, x, \bar{x}$	(7) 3^+ $x + \frac{1}{2}, \bar{x}, \bar{x}$	(8) $3^+(\frac{1}{3}, \frac{1}{3}, -\frac{1}{3})$ $\bar{x} + \frac{1}{6}, \bar{x} + \frac{1}{3}, x$
(9) $3^-(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ $x + \frac{1}{3}, x + \frac{1}{6}, x$	(10) 3^- $x, \bar{x} + \frac{1}{2}, \bar{x}$	(11) $3^-(\frac{1}{3}, \frac{1}{3}, -\frac{1}{3})$ $\bar{x} + \frac{1}{3}, \bar{x} + \frac{1}{6}, x$	(12) 3^- $\bar{x}, x + \frac{1}{2}, \bar{x}$
(13) $2(\frac{1}{2}, \frac{1}{2}, 0)$ $x, x, 0$	(14) 2 $x, \bar{x} + \frac{1}{2}, 0$	(15) 4^- $\frac{1}{2}, 0, z$	(16) 4^+ $0, \frac{1}{2}, z$
(17) $4^-(\frac{1}{2}, 0, 0)$ $x, \frac{1}{4}, -\frac{1}{4}$	(18) $2(0, \frac{1}{4}, \frac{1}{4})$ $\frac{1}{4}, y + \frac{1}{4}, y$	(19) $2(0, \frac{1}{4}, -\frac{1}{4})$ $\frac{1}{4}, y + \frac{1}{4}, \bar{y}$	(20) $4^+(\frac{1}{2}, 0, 0)$ $x, \frac{1}{4}, \frac{1}{4}$
(21) $4^+(0, \frac{1}{2}, 0)$ $\frac{1}{4}, y, -\frac{1}{4}$	(22) $2(\frac{1}{4}, 0, \frac{1}{4})$ $x + \frac{1}{4}, \frac{1}{4}, x$	(23) $4^-(0, \frac{1}{2}, 0)$ $\frac{1}{4}, y, \frac{1}{4}$	(24) $2(\frac{1}{4}, 0, -\frac{1}{4})$ $\bar{x} + \frac{1}{4}, \frac{1}{4}, x$

Generators selected (1); $t(1, 0, 0)$; $t(0, 1, 0)$; $t(0, 0, 1)$; $t(0, \frac{1}{2}, \frac{1}{2})$; $t(\frac{1}{2}, 0, \frac{1}{2})$; (2); (3); (5); (13)

Positions

Multiplicity,
Wyckoff letter,
Site symmetry

Coordinates

 $(0, 0, 0)+$ $(0, \frac{1}{2}, \frac{1}{2})+$ $(\frac{1}{2}, 0, \frac{1}{2})+$ $(\frac{1}{2}, \frac{1}{2}, 0)+$

Reflection conditions

 h, k, l permutable

General:

96	j	1	(1) x, y, z	(2) \bar{x}, \bar{y}, z	(3) \bar{x}, y, \bar{z}	(4) x, \bar{y}, \bar{z}	$hkl: h + k, h + l, k + l = 2n$
			(5) z, x, y	(6) z, \bar{x}, \bar{y}	(7) \bar{z}, \bar{x}, y	(8) \bar{z}, x, \bar{y}	$0kl: k, l = 2n$
			(9) y, z, x	(10) \bar{y}, z, \bar{x}	(11) y, \bar{z}, \bar{x}	(12) \bar{y}, \bar{z}, x	$hhl: h + l = 2n$
			(13) y, x, \bar{z}	(14) $\bar{y}, \bar{x}, \bar{z}$	(15) y, \bar{x}, z	(16) \bar{y}, x, z	$h00: h = 2n$
			(17) x, z, \bar{y}	(18) \bar{x}, z, y	(19) $\bar{x}, \bar{z}, \bar{y}$	(20) x, \bar{z}, y	
			(21) z, y, \bar{x}	(22) z, \bar{y}, x	(23) \bar{z}, y, x	(24) $\bar{z}, \bar{y}, \bar{x}$	

Special: as above, plus

48	i	2..	$x, \frac{1}{4}, \frac{1}{4}$ $\frac{1}{4}, x, \frac{3}{4}$	$\bar{x}, \frac{3}{4}, \frac{1}{4}$ $\frac{3}{4}, \bar{x}, \frac{3}{4}$	$\frac{1}{4}, x, \frac{1}{4}$ $x, \frac{1}{4}, \frac{3}{4}$	$\frac{1}{4}, \bar{x}, \frac{3}{4}$ $\bar{x}, \frac{1}{4}, \frac{1}{4}$	$\frac{1}{4}, \frac{1}{4}, x$ $\frac{1}{4}, \frac{1}{4}, \bar{x}$	$\frac{3}{4}, \frac{1}{4}, \bar{x}$ $\frac{1}{4}, \frac{3}{4}, x$	$hkl: h = 2n$
48	h	..2	$\frac{1}{2}, y, y$ $\bar{y}, \frac{1}{2}, y$	$\frac{1}{2}, \bar{y}, y$ $\bar{y}, \frac{1}{2}, \bar{y}$	$\frac{1}{2}, y, \bar{y}$ $y, y, \frac{1}{2}$	$\frac{1}{2}, \bar{y}, \bar{y}$ $\bar{y}, y, \frac{1}{2}$	$y, \frac{1}{2}, y$ $y, \bar{y}, \frac{1}{2}$	$y, \frac{1}{2}, \bar{y}$ $\bar{y}, \bar{y}, \frac{1}{2}$	no extra conditions
48	g	..2	$0, y, y$ $\bar{y}, 0, y$	$0, \bar{y}, y$ $\bar{y}, 0, \bar{y}$	$0, y, \bar{y}$ $y, y, 0$	$0, \bar{y}, \bar{y}$ $\bar{y}, y, 0$	$y, 0, y$ $y, \bar{y}, 0$	$y, 0, \bar{y}$ $\bar{y}, \bar{y}, 0$	no extra conditions
32	f	.3.	x, x, x x, x, \bar{x}	\bar{x}, \bar{x}, x $\bar{x}, \bar{x}, \bar{x}$	\bar{x}, x, \bar{x} x, \bar{x}, x	x, \bar{x}, \bar{x} \bar{x}, x, x			no extra conditions
24	e	4..	$x, 0, 0$	$\bar{x}, 0, 0$	$0, x, 0$	$0, \bar{x}, 0$	$0, 0, x$	$0, 0, \bar{x}$	no extra conditions
24	d	2.22	$0, \frac{1}{4}, \frac{1}{4}$	$0, \frac{3}{4}, \frac{1}{4}$	$\frac{1}{4}, 0, \frac{1}{4}$	$\frac{1}{4}, 0, \frac{3}{4}$	$\frac{1}{4}, \frac{1}{4}, 0$	$\frac{3}{4}, \frac{1}{4}, 0$	$hkl: h = 2n$
8	c	23.	$\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$	$\frac{1}{4}, \frac{1}{4}, \frac{3}{4}$					$hkl: h = 2n$
4	b	432	$\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$						no extra conditions
4	a	432	$0, 0, 0$						no extra conditions

Symmetry of special projections

Along $[001]$ $p4mm$
 $\mathbf{a}' = \frac{1}{2}\mathbf{a}$ $\mathbf{b}' = \frac{1}{2}\mathbf{b}$
Origin at $0, 0, z$ Along $[111]$ $p3m1$
 $\mathbf{a}' = \frac{1}{6}(2\mathbf{a} - \mathbf{b} - \mathbf{c})$ $\mathbf{b}' = \frac{1}{6}(-\mathbf{a} + 2\mathbf{b} - \mathbf{c})$
Origin at x, x, x Along $[110]$ $c2mm$
 $\mathbf{a}' = \frac{1}{2}(-\mathbf{a} + \mathbf{b})$ $\mathbf{b}' = \mathbf{c}$
Origin at $x, x, 0$