

*I*432

$O^5$

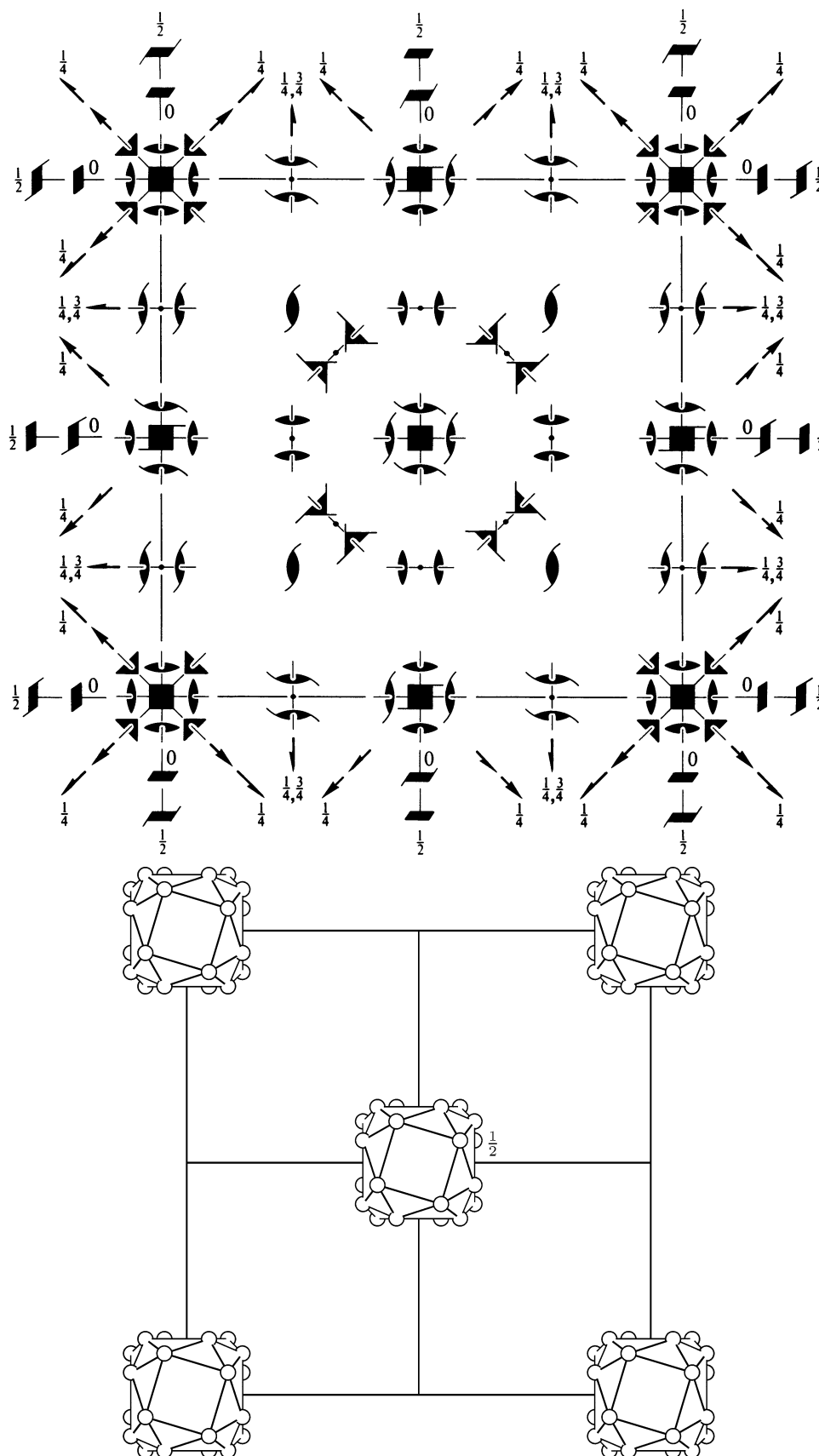
432

Cubic

No. 211

*I*432

Patterson symmetry  $Im\bar{3}m$



Origin at 432

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

## 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 <sup>+</sup> x,x,x	(6) 3 <sup>+</sup> $\bar{x}$ , $\bar{x}$ , $\bar{x}$	(7) 3 <sup>+</sup> x, $\bar{x}$ , $\bar{x}$	(8) 3 <sup>+</sup> $\bar{x}$ , $\bar{x}$ ,x
(9) 3 <sup>-</sup> x,x,x	(10) 3 <sup>-</sup> x, $\bar{x}$ , $\bar{x}$	(11) 3 <sup>-</sup> $\bar{x}$ , $\bar{x}$ ,x	(12) 3 <sup>-</sup> $\bar{x}$ ,x, $\bar{x}$
(13) 2 x,x,0	(14) 2 x, $\bar{x}$ ,0	(15) 4 <sup>-</sup> 0,0,z	(16) 4 <sup>+</sup> 0,0,z
(17) 4 <sup>-</sup> x,0,0	(18) 2 0,y,y	(19) 2 0,y, $\bar{y}$	(20) 4 <sup>+</sup> x,0,0
(21) 4 <sup>+</sup> 0,y,0	(22) 2 x,0,x	(23) 4 <sup>-</sup> 0,y,0	(24) 2 $\bar{x}$ ,0,x

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

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

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

## Positions

Multiplicity, Wyckoff letter, Site symmetry	Coordinates				Reflection conditions	
	(0,0,0)+ ( $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$ )+				$h, k, l$ permutable	
					General:	
48 j 1	(1) x,y,z	(2) $\bar{x}, \bar{y}, z$	(3) $\bar{x}, y, \bar{z}$	(4) x, $\bar{y}, \bar{z}$	$hkl: h+k+l=2n$	
	(5) z,x,y	(6) z, $\bar{x}, \bar{y}$	(7) $\bar{z}, \bar{x}, y$	(8) $\bar{z}, x, \bar{y}$	$Ok: k+l=2n$	
	(9) y,z,x	(10) $\bar{y}, z, \bar{x}$	(11) y, $\bar{z}, \bar{x}$	(12) $\bar{y}, \bar{z}, x$	$hhl: l=2n$	
	(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	
24 i .. 2	$\frac{1}{4}, y, \bar{y} + \frac{1}{2}$	$\frac{3}{4}, \bar{y}, \bar{y} + \frac{1}{2}$	$\frac{3}{4}, y, y + \frac{1}{2}$	$\frac{1}{4}, \bar{y}, y + \frac{1}{2}$	no extra conditions	
	$\bar{y} + \frac{1}{2}, \frac{1}{4}, y$	$\bar{y} + \frac{1}{2}, \frac{3}{4}, \bar{y}$	$y + \frac{1}{2}, \frac{3}{4}, y$	$y + \frac{1}{2}, \frac{1}{4}, \bar{y}$		
	$y, \bar{y} + \frac{1}{2}, \frac{1}{4}$	$\bar{y}, \bar{y} + \frac{1}{2}, \frac{3}{4}$	$y, y + \frac{1}{2}, \frac{3}{4}$	$\bar{y}, y + \frac{1}{2}, \frac{1}{4}$		
24 h .. 2	0,y,y	0, $\bar{y}, y$	0,y, $\bar{y}$	0, $\bar{y}, \bar{y}$	y,0,y	y,0, $\bar{y}$
	$\bar{y}, 0, y$	$\bar{y}, 0, \bar{y}$	y,y,0	$\bar{y}, y, 0$	y, $\bar{y}, 0$	$\bar{y}, \bar{y}, 0$
24 g 2..	$x, \frac{1}{2}, 0$	$\bar{x}, \frac{1}{2}, 0$	0,x, $\frac{1}{2}$	0, $\bar{x}, \frac{1}{2}$	$\frac{1}{2}, 0, x$	$\frac{1}{2}, 0, \bar{x}$
	$\frac{1}{2}, x, 0$	$\frac{1}{2}, \bar{x}, 0$	x,0, $\frac{1}{2}$	$\bar{x}, 0, \frac{1}{2}$	0, $\frac{1}{2}, \bar{x}$	0, $\frac{1}{2}, x$
16 f .3.	x,x,x	$\bar{x}, \bar{x}, x$	$\bar{x}, x, \bar{x}$	x, $\bar{x}, \bar{x}$	no extra conditions	
	x,x, $\bar{x}$	$\bar{x}, \bar{x}, \bar{x}$	x, $\bar{x}, x$	$\bar{x}, x, x$		
12 e 4..	x,0,0	$\bar{x}, 0, 0$	0,x,0	0, $\bar{x}, 0$	0,0,x	0,0, $\bar{x}$
12 d 2.22	$\frac{1}{4}, \frac{1}{2}, 0$	$\frac{3}{4}, \frac{1}{2}, 0$	0, $\frac{1}{4}, \frac{1}{2}$	0, $\frac{3}{4}, \frac{1}{2}$	$\frac{1}{2}, 0, \frac{1}{4}$	$\frac{1}{2}, 0, \frac{3}{4}$
8 c .32	$\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$	$\frac{3}{4}, \frac{3}{4}, \frac{1}{4}$	$\frac{3}{4}, \frac{1}{4}, \frac{3}{4}$	$\frac{1}{4}, \frac{3}{4}, \frac{3}{4}$	$hkl: k, l=2n$	
6 b 42.2	0, $\frac{1}{2}, \frac{1}{2}$	$\frac{1}{2}, 0, \frac{1}{2}$	$\frac{1}{2}, \frac{1}{2}, 0$	no extra conditions		
2 a 432	0,0,0	no extra conditions				

## Symmetry of special projections

Along [001]  $p4mm$ 

$$\mathbf{a}' = \frac{1}{2}(\mathbf{a} - \mathbf{b}) \quad \mathbf{b}' = \frac{1}{2}(\mathbf{a} + \mathbf{b})$$

Origin at 0,0,z

Along [111]  $p3m1$ 

$$\mathbf{a}' = \frac{1}{3}(2\mathbf{a} - \mathbf{b} - \mathbf{c}) \quad \mathbf{b}' = \frac{1}{3}(-\mathbf{a} + 2\mathbf{b} - \mathbf{c})$$

Origin at x,x,x

Along [110]  $p2mm$ 

$$\mathbf{a}' = \frac{1}{2}(-\mathbf{a} + \mathbf{b}) \quad \mathbf{b}' = \frac{1}{2}\mathbf{c}$$

Origin at x,x,0