

$F\bar{4}3m$

T_d^2

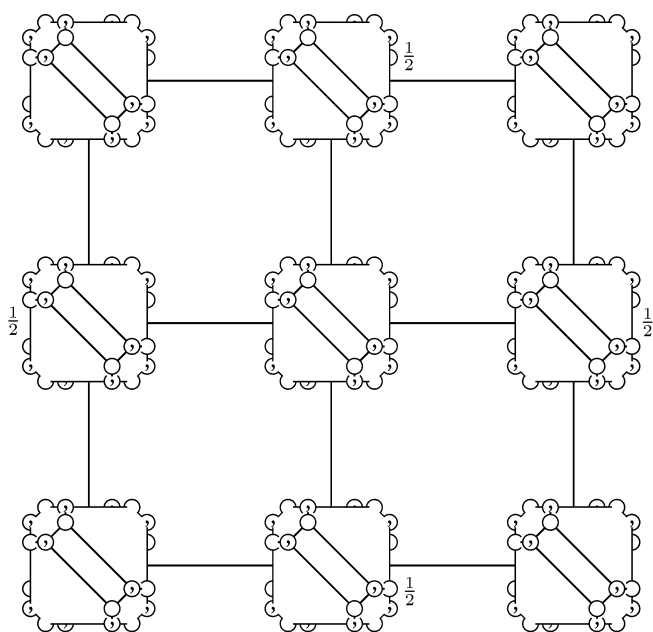
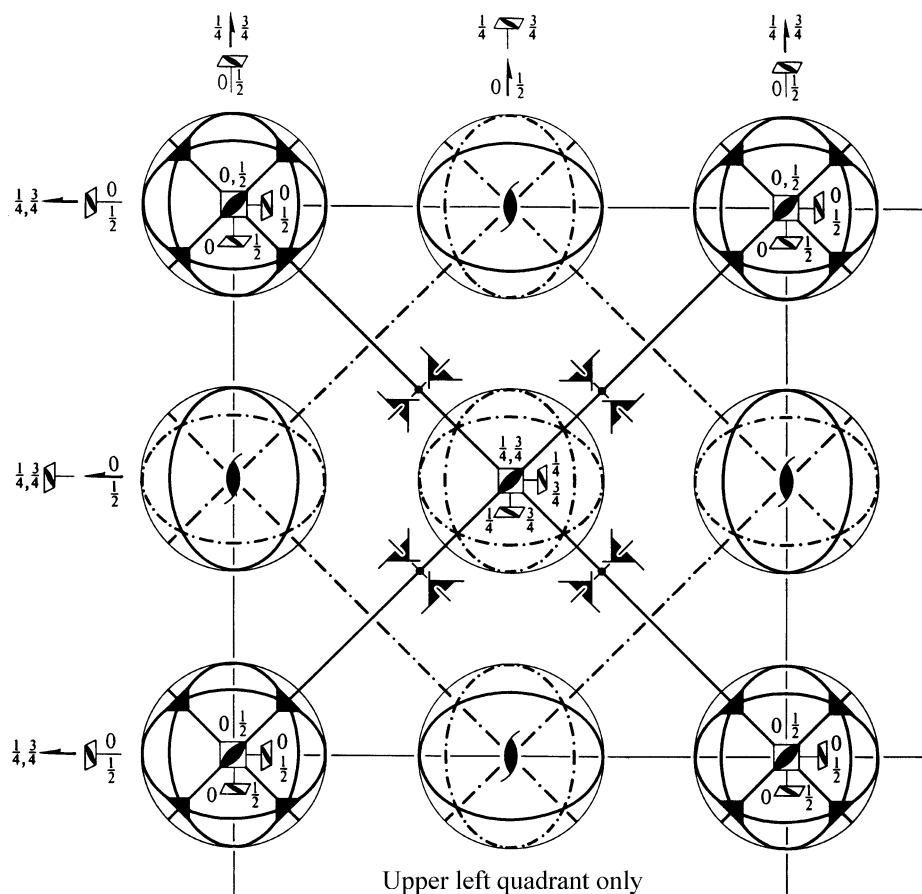
$\bar{4}3m$

Cubic

No. 216

$F\bar{4}3m$

Patterson symmetry $Fm\bar{3}m$



Origin at $\bar{4}3m$

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) m x,x,z | (14) m x,\bar{x},z | (15) $\bar{4}^+$ $0,0,z; 0,0,0$ | (16) $\bar{4}^-$ $0,0,z; 0,0,0$ |
| (17) m x,y,y | (18) $\bar{4}^+$ $x,0,0; 0,0,0$ | (19) $\bar{4}^-$ $x,0,0; 0,0,0$ | (20) m x,y,\bar{y} |
| (21) m x,y,x | (22) $\bar{4}^-$ $0,y,0; 0,0,0$ | (23) m \bar{x},y,x | (24) $\bar{4}^+$ $0,y,0; 0,0,0$ |

Symmetry operations (continued)

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

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

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

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

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

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

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				Reflection conditions		
	$(0, 0, 0)+$	$(0, \frac{1}{2}, \frac{1}{2})+$	$(\frac{1}{2}, 0, \frac{1}{2})+$	$(\frac{1}{2}, \frac{1}{2}, 0)+$	h, k, l permutable General: $hkl: h + k, h + l, k + l = 2n$ $OkI: k, l = 2n$ $hhl: h + l = 2n$ $h00: h = 2n$		
96 $i \quad 1$	(1) x, y, z (5) z, x, y (9) y, z, x (13) y, x, z (17) x, z, y (21) z, y, x	(2) \bar{x}, \bar{y}, z (6) z, \bar{x}, \bar{y} (10) \bar{y}, z, \bar{x} (14) \bar{y}, \bar{x}, z (18) \bar{x}, z, \bar{y} (22) z, \bar{y}, \bar{x}	(3) \bar{x}, y, \bar{z} (7) \bar{z}, \bar{x}, y (11) y, \bar{z}, \bar{x} (15) y, \bar{x}, \bar{z} (19) \bar{x}, \bar{z}, y (23) \bar{z}, y, \bar{x}	(4) x, \bar{y}, \bar{z} (8) \bar{z}, x, \bar{y} (12) \bar{y}, \bar{z}, x (16) \bar{y}, x, \bar{z} (20) x, \bar{z}, \bar{y} (24) \bar{z}, \bar{y}, x			
48 $h \quad . . m$	x, x, z \bar{z}, \bar{x}, x	\bar{x}, \bar{x}, z \bar{z}, x, \bar{x}	\bar{x}, x, \bar{z} x, z, x	x, \bar{x}, \bar{z} \bar{x}, z, \bar{x}	z, x, x x, \bar{z}, \bar{x}	z, \bar{x}, \bar{x} \bar{x}, \bar{z}, x	
24 $g \quad 2 . mm$	$x, \frac{1}{4}, \frac{1}{4}$	$\bar{x}, \frac{3}{4}, \frac{1}{4}$	$\frac{1}{4}, x, \frac{1}{4}$	$\frac{1}{4}, \bar{x}, \frac{3}{4}$	$\frac{1}{4}, \frac{1}{4}, x$	$\frac{3}{4}, \frac{1}{4}, \bar{x}$	
24 $f \quad 2 . mm$	$x, 0, 0$	$\bar{x}, 0, 0$	$0, x, 0$	$0, \bar{x}, 0$	$0, 0, x$	$0, 0, \bar{x}$	
16 $e \quad . 3 m$	x, x, x	\bar{x}, \bar{x}, x	\bar{x}, x, \bar{x}	x, \bar{x}, \bar{x}			
4 $d \quad \bar{4} 3 m$	$\frac{3}{4}, \frac{3}{4}, \frac{3}{4}$						
4 $c \quad \bar{4} 3 m$	$\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$						
4 $b \quad \bar{4} 3 m$	$\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$						
4 $a \quad \bar{4} 3 m$	$0, 0, 0$						

Symmetry of special projections

Along [001] $p4mm$ $\mathbf{a}' = \frac{1}{2}\mathbf{a} \quad \mathbf{b}' = \frac{1}{2}\mathbf{b}$ Origin at $0, 0, z$	Along [111] $p31m$ $\mathbf{a}' = \frac{1}{6}(2\mathbf{a} - \mathbf{b} - \mathbf{c}) \quad \mathbf{b}' = \frac{1}{6}(-\mathbf{a} + 2\mathbf{b} - \mathbf{c})$ Origin at x, x, x	Along [110] $c1m1$ $\mathbf{a}' = \frac{1}{2}(-\mathbf{a} + \mathbf{b}) \quad \mathbf{b}' = \mathbf{c}$ Origin at $x, x, 0$
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