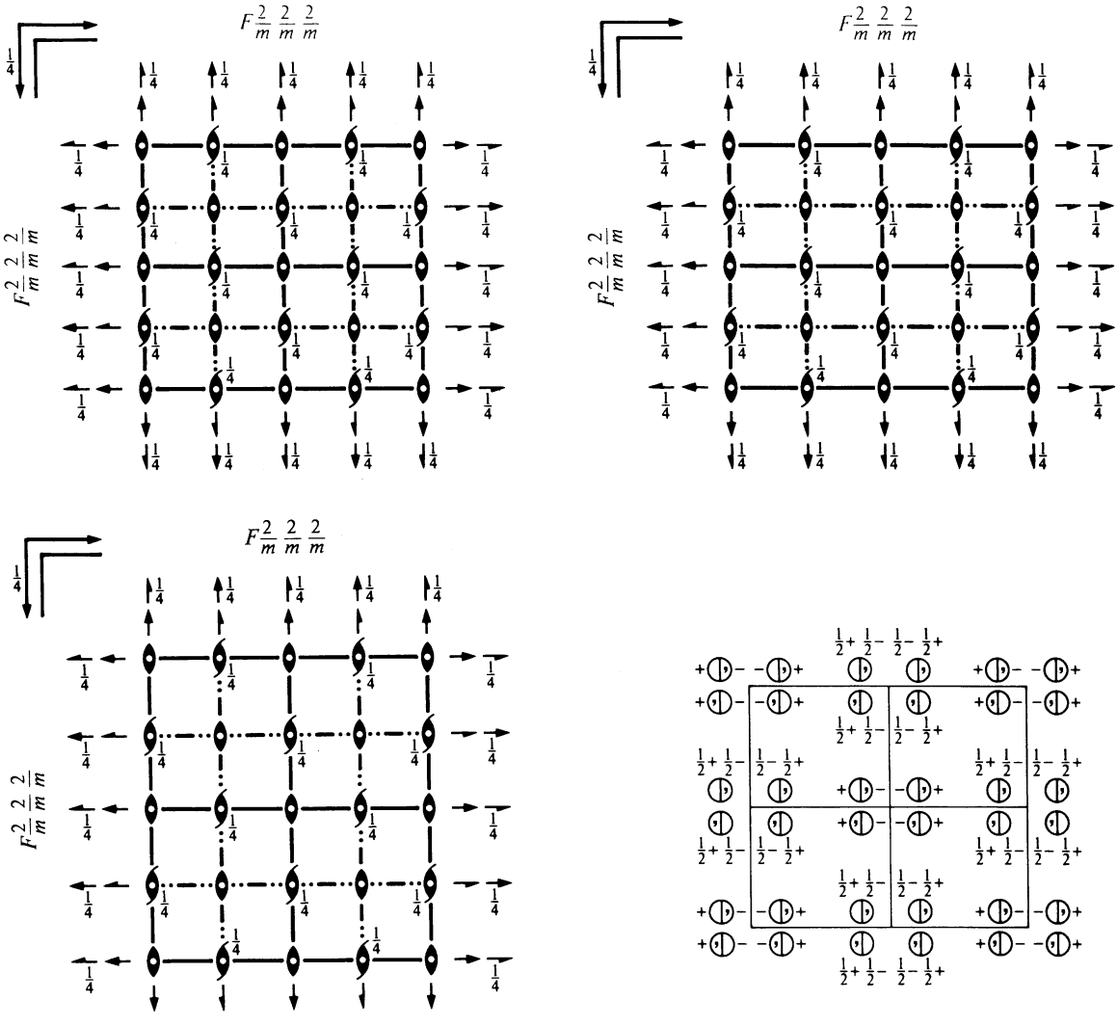
$F\,m\,m\,m$ D_{2h}^{23} $m\,m\,m$ Orthorhombic

No. 69 $F\ 2/m\ 2/m\ 2/m$ Patterson symmetry $F\,m\,m\,m$



Origin at centre $(m\,m\,m)$

Asymmetric unit $0 \le x \le \frac{1}{4}$; $0 \le y \le \frac{1}{4}$; $0 \le z \le \frac{1}{2}$

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) $\bar{1}$ $0,0,0$	(6) m $x,y,0$	(7) m $x,0,z$	(8) m $0,y,z$

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) $\bar{1}$ $0,\frac{1}{4},\frac{1}{4}$	(6) b $x,y,\frac{1}{4}$	(7) c $x,\frac{1}{4},z$	(8) $n(0,\frac{1}{2},\frac{1}{2})$ $0,y,z$

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) $\bar{1}$ $\frac{1}{4},0,\frac{1}{4}$	(6) a $x,y,\frac{1}{4}$	(7) $n(\frac{1}{2},0,\frac{1}{2})$ $x,0,z$	(8) c $\frac{1}{4},y,z$

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) $\bar{1}$ $\frac{1}{4},\frac{1}{4},0$	(6) $n(\frac{1}{2},\frac{1}{2},0)$ $x,y,0$	(7) a $x,\frac{1}{4},z$	(8) b $\frac{1}{4},y,z$

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)

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
							General:
32	p	1	(1) x,y,z (5) $\bar{x},\bar{y},\bar{z}$	(2) $\bar{x},\bar{y},z$ (6) $x,y,\bar{z}$	(3) $\bar{x},y,\bar{z}$ (7) $x,\bar{y},z$	(4) $x,\bar{y},\bar{z}$ (8) $\bar{x},y,z$	hkl : $h+k,h+l,k+l=2n$ $0kl$: $k,l=2n$ $h0l$: $h,l=2n$ $hk0$: $h,k=2n$ $h00$: $h=2n$ $0k0$: $k=2n$ $00l$: $l=2n$
							Special: as above, plus
16	o	$..m$	$x,y,0$	$\bar{x},\bar{y},0$	$\bar{x},y,0$	$x,\bar{y},0$	no extra conditions
16	n	$.m.$	$x,0,z$	$\bar{x},0,z$	$\bar{x},0,\bar{z}$	$x,0,\bar{z}$	no extra conditions
16	m	$m..$	$0,y,z$	$0,\bar{y},z$	$0,y,\bar{z}$	$0,\bar{y},\bar{z}$	no extra conditions
16	l	$2..$	$x,\frac{1}{4},\frac{1}{4}$	$\bar{x},\frac{3}{4},\frac{1}{4}$	$\bar{x},\frac{3}{4},\frac{3}{4}$	$x,\frac{1}{4},\frac{3}{4}$	hkl : $h=2n$
16	k	$.2.$	$\frac{1}{4},y,\frac{1}{4}$	$\frac{3}{4},\bar{y},\frac{1}{4}$	$\frac{3}{4},\bar{y},\frac{3}{4}$	$\frac{1}{4},y,\frac{3}{4}$	hkl : $h=2n$
16	j	$..2$	$\frac{1}{4},\frac{1}{4},z$	$\frac{3}{4},\frac{1}{4},\bar{z}$	$\frac{3}{4},\frac{3}{4},\bar{z}$	$\frac{1}{4},\frac{3}{4},z$	hkl : $h=2n$
8	i	$m\,m\,2$	$0,0,z$	$0,0,\bar{z}$			no extra conditions
8	h	$m\,2\,m$	$0,y,0$	$0,\bar{y},0$			no extra conditions
8	g	$2\,m\,m$	$x,0,0$	$\bar{x},0,0$			no extra conditions
8	f	$2\,2\,2$	$\frac{1}{4},\frac{1}{4},\frac{1}{4}$	$\frac{3}{4},\frac{3}{4},\frac{3}{4}$			hkl : $h=2n$
8	e	$..2/m$	$\frac{1}{4},\frac{1}{4},0$	$\frac{3}{4},\frac{1}{4},0$			hkl : $h=2n$
8	d	$.2/m.$	$\frac{1}{4},0,\frac{1}{4}$	$\frac{3}{4},0,\frac{1}{4}$			hkl : $h=2n$
8	c	$2/m..$	$0,\frac{1}{4},\frac{1}{4}$	$0,\frac{3}{4},\frac{1}{4}$			hkl : $h=2n$
4	b	$m\,m\,m$	$0,0,\frac{1}{2}$				no extra conditions
4	a	$m\,m\,m$	$0,0,0$				no extra conditions

Symmetry of special projections

Along [001] $p2mm$
$\mathbf{a}' = \frac{1}{2}\mathbf{a}$ $\mathbf{b}' = \frac{1}{2}\mathbf{b}$
Origin at $0,0,z$

Along [100] $p2mm$
$\mathbf{a}' = \frac{1}{2}\mathbf{b}$ $\mathbf{b}' = \frac{1}{2}\mathbf{c}$
Origin at $x,0,0$

Along [010] $p2mm$
$\mathbf{a}' = \frac{1}{2}\mathbf{c}$ $\mathbf{b}' = \frac{1}{2}\mathbf{a}$
Origin at $0,y,0$

Maximal non-isomorphic subgroups

I
[2] $Fmm2$ (42) (1; 2; 7; 8)+
[2] $Fm2m$ ($Fmm2$, 42) (1; 3; 6; 8)+
[2] $F2mm$ ($Fmm2$, 42) (1; 4; 6; 7)+
[2] $F222$ (22) (1; 2; 3; 4)+
[2] $F112/m$ ($C2/m$, 12) (1; 2; 5; 6)+
[2] $F12/m1$ ($C2/m$, 12) (1; 3; 5; 7)+
[2] $F2/m11$ ($C2/m$, 12) (1; 4; 5; 8)+

IIa
[2] $Aeaa$ ($Ccce$, 68) 1; 2; 3; 4; (1; 2; 3; 4) + $(0,\frac{1}{2},\frac{1}{2})$; (5; 6; 7; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (5; 6; 7; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Bbeb$ ($Ccce$, 68) 1; 2; 3; 4; (1; 2; 3; 4) + $(\frac{1}{2},0,\frac{1}{2})$; (5; 6; 7; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (5; 6; 7; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Ccce$ (68) 1; 2; 3; 4; (1; 2; 3; 4) + $(\frac{1}{2},\frac{1}{2},0)$; (5; 6; 7; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (5; 6; 7; 8) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Cmme$ (67) 1; 2; 7; 8; (1; 2; 7; 8) + $(\frac{1}{2},\frac{1}{2},0)$; (3; 4; 5; 6) + $(0,\frac{1}{2},\frac{1}{2})$; (3; 4; 5; 6) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Bmem$ ($Cmme$, 67) 1; 3; 6; 8; (1; 3; 6; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 4; 5; 7) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 4; 5; 7) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Aemm$ ($Cmme$, 67) 1; 4; 6; 7; (1; 4; 6; 7) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 3; 5; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 3; 5; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Cccm$ (66) 1; 2; 5; 6; (1; 2; 5; 6) + $(\frac{1}{2},\frac{1}{2},0)$; (3; 4; 7; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (3; 4; 7; 8) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Bbmb$ ($Cccm$, 66) 1; 3; 5; 7; (1; 3; 5; 7) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 4; 6; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 4; 6; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Amaa$ ($Cccm$, 66) 1; 4; 5; 8; (1; 4; 5; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 3; 6; 7) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 3; 6; 7) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Ammm$ ($Cmmm$, 65) 1; 2; 3; 4; 5; 6; 7; 8; (1; 2; 3; 4; 5; 6; 7; 8) + $(0,\frac{1}{2},\frac{1}{2})$
[2] $Bmmm$ ($Cmmm$, 65) 1; 2; 3; 4; 5; 6; 7; 8; (1; 2; 3; 4; 5; 6; 7; 8) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Cmmm$ (65) 1; 2; 3; 4; 5; 6; 7; 8; (1; 2; 3; 4; 5; 6; 7; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Aeam$ ($Cmce$, 64) 1; 2; 5; 6; (1; 2; 5; 6) + $(0,\frac{1}{2},\frac{1}{2})$; (3; 4; 7; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (3; 4; 7; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Bbem$ ($Cmce$, 64) 1; 2; 5; 6; (1; 2; 5; 6) + $(\frac{1}{2},0,\frac{1}{2})$; (3; 4; 7; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (3; 4; 7; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Aema$ ($Cmce$, 64) 1; 3; 5; 7; (1; 3; 5; 7) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 4; 6; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 4; 6; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Ccme$ ($Cmce$, 64) 1; 3; 5; 7; (1; 3; 5; 7) + $(\frac{1}{2},\frac{1}{2},0)$; (2; 4; 6; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 4; 6; 8) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Bmeb$ ($Cmce$, 64) 1; 4; 5; 8; (1; 4; 5; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 3; 6; 7) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 3; 6; 7) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Cmce$ (64) 1; 4; 5; 8; (1; 4; 5; 8) + $(\frac{1}{2},\frac{1}{2},0)$; (2; 3; 6; 7) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 3; 6; 7) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Amam$ ($Cmcm$, 63) 1; 3; 6; 8; (1; 3; 6; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 4; 5; 7) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 4; 5; 7) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Amma$ ($Cmcm$, 63) 1; 2; 7; 8; (1; 2; 7; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (3; 4; 5; 6) + $(\frac{1}{2},0,\frac{1}{2})$; (3; 4; 5; 6) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Bmmb$ ($Cmcm$, 63) 1; 2; 7; 8; (1; 2; 7; 8) + $(\frac{1}{2},0,\frac{1}{2})$; (3; 4; 5; 6) + $(0,\frac{1}{2},\frac{1}{2})$; (3; 4; 5; 6) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Bbmm$ ($Cmcm$, 63) 1; 4; 6; 7; (1; 4; 6; 7) + $(\frac{1}{2},0,\frac{1}{2})$; (2; 3; 5; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 3; 5; 8) + $(\frac{1}{2},\frac{1}{2},0)$
[2] $Cmcm$ (63) 1; 3; 6; 8; (1; 3; 6; 8) + $(\frac{1}{2},\frac{1}{2},0)$; (2; 4; 5; 7) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 4; 5; 7) + $(\frac{1}{2},0,\frac{1}{2})$
[2] $Ccmm$ ($Cmcm$, 63) 1; 4; 6; 7; (1; 4; 6; 7) + $(\frac{1}{2},\frac{1}{2},0)$; (2; 3; 5; 8) + $(0,\frac{1}{2},\frac{1}{2})$; (2; 3; 5; 8) + $(\frac{1}{2},0,\frac{1}{2})$

IIb none

Maximal isomorphic subgroups of lowest index

IIc [3] $Fmmm$ ($\mathbf{a}' = 3\mathbf{a}$ or $\mathbf{b}' = 3\mathbf{b}$ or $\mathbf{c}' = 3\mathbf{c}$) (69)

Minimal non-isomorphic supergroups

I [2] $I4/mmm$ (139); [2] $I4/mcm$ (140); [3] $Fm\bar{3}$ (202)

II [2] $Pmmm$ ($\mathbf{a}' = \frac{1}{2}\mathbf{a}, \mathbf{b}' = \frac{1}{2}\mathbf{b}, \mathbf{c}' = \frac{1}{2}\mathbf{c}$) (47)