Point Operators

$$C_{4z}^{+} \quad C_{4z}^{-} \quad \sigma_x \quad \sigma_{da}$$

$$C_{2z}^{+} \quad \sigma_y \quad \sigma_{db} \quad E$$

Point Group

$Fm3m$

Translates

Including a translation

$$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$$

Identify the Bravais Lattice.

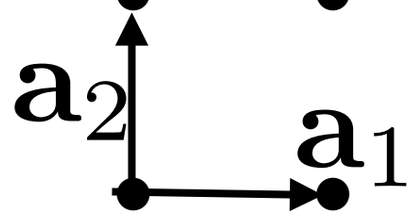
a) monoclinic I
b) monoclinic P
c) Orthorhombic P
d) Orthorhombic I

Planes and directions revisited

Identify the following planes in this crystal.

$(2,1,0)$ $(2,3,0)$

$\frac{A}{h}, \frac{A}{k}, \frac{A}{l}$



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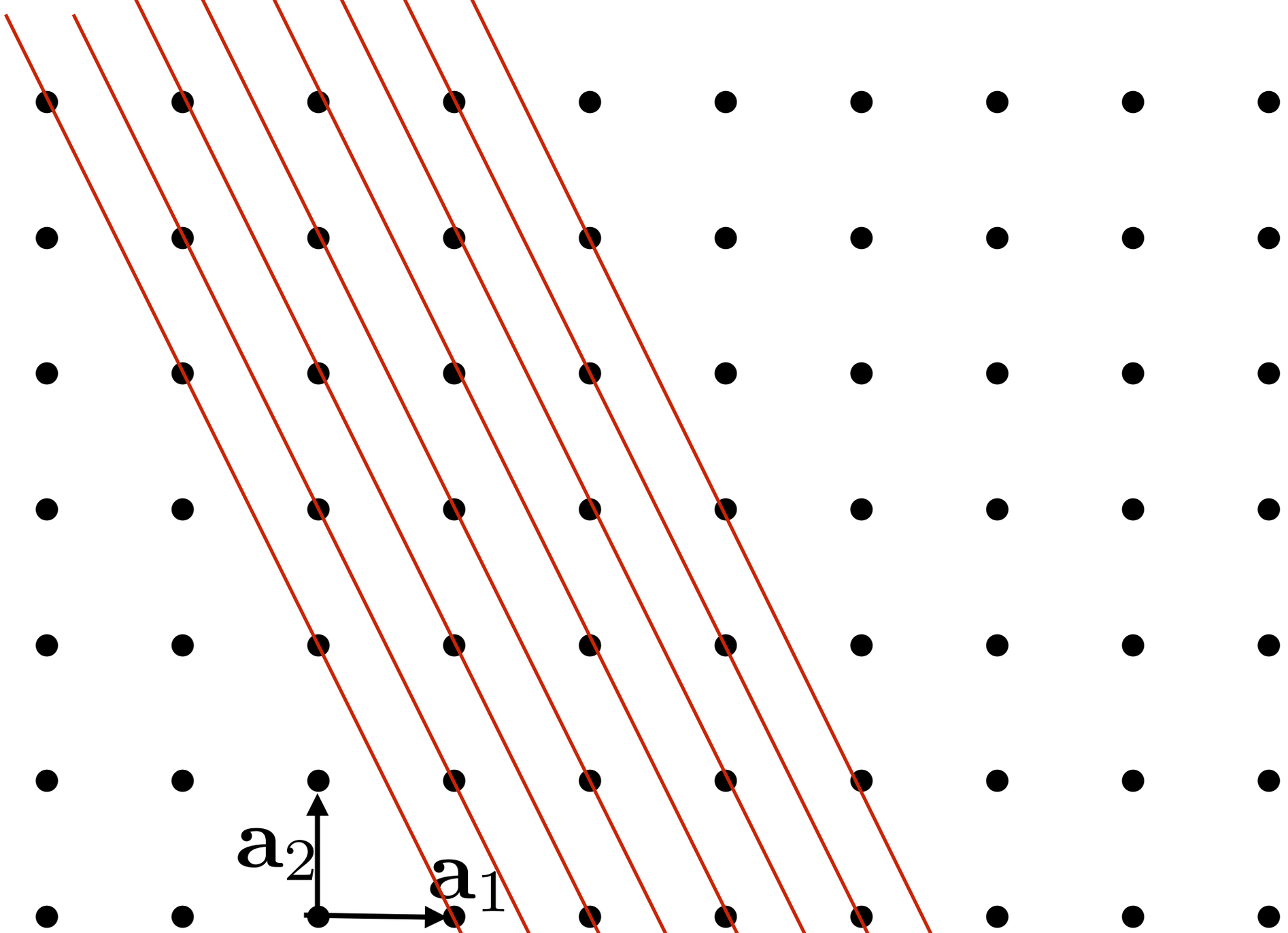

Planes and directions revisited

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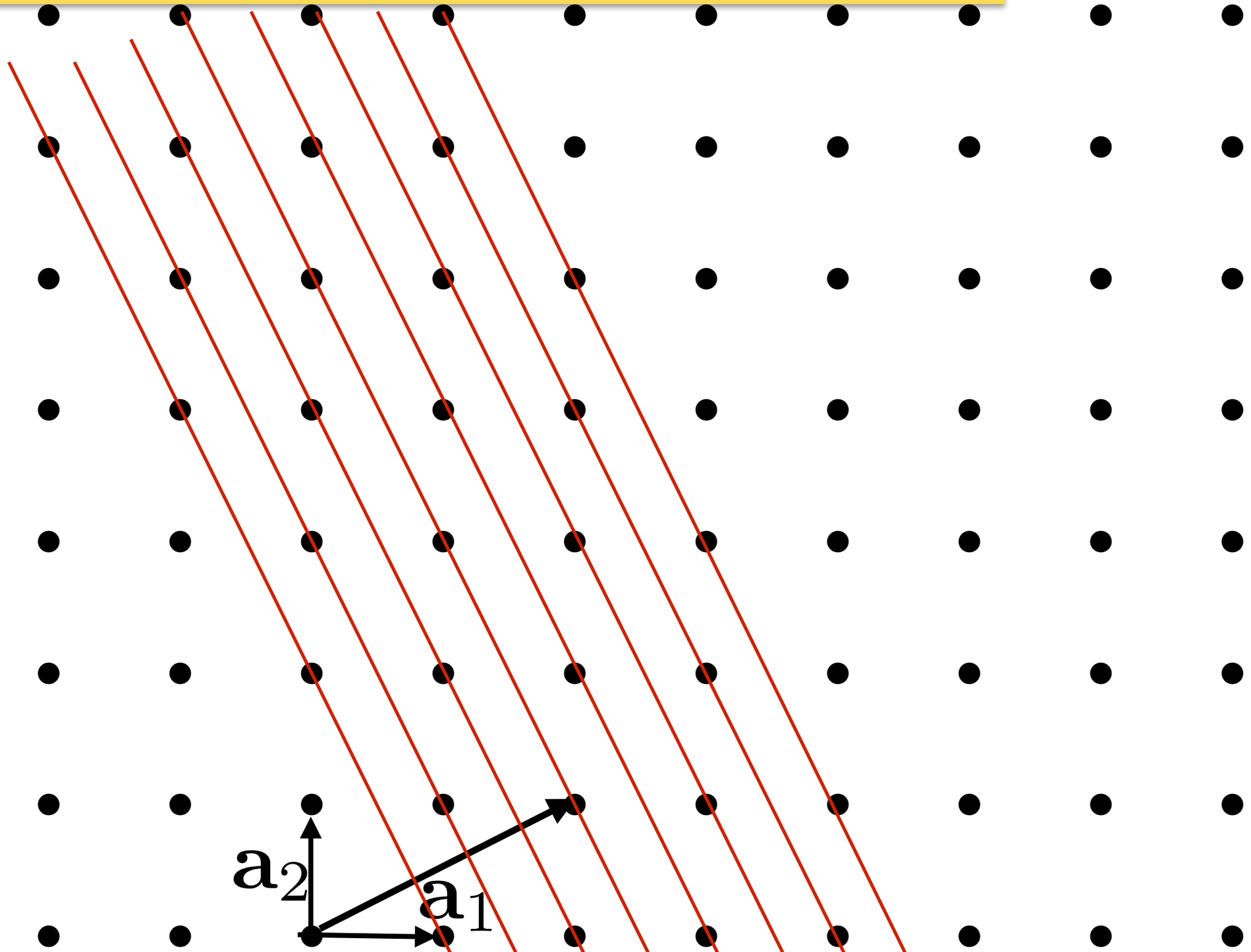
Identify the following planes in this crystal.

$(2, 1, 0)$ $(2, 3, 0)$



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$(2,3,0)$

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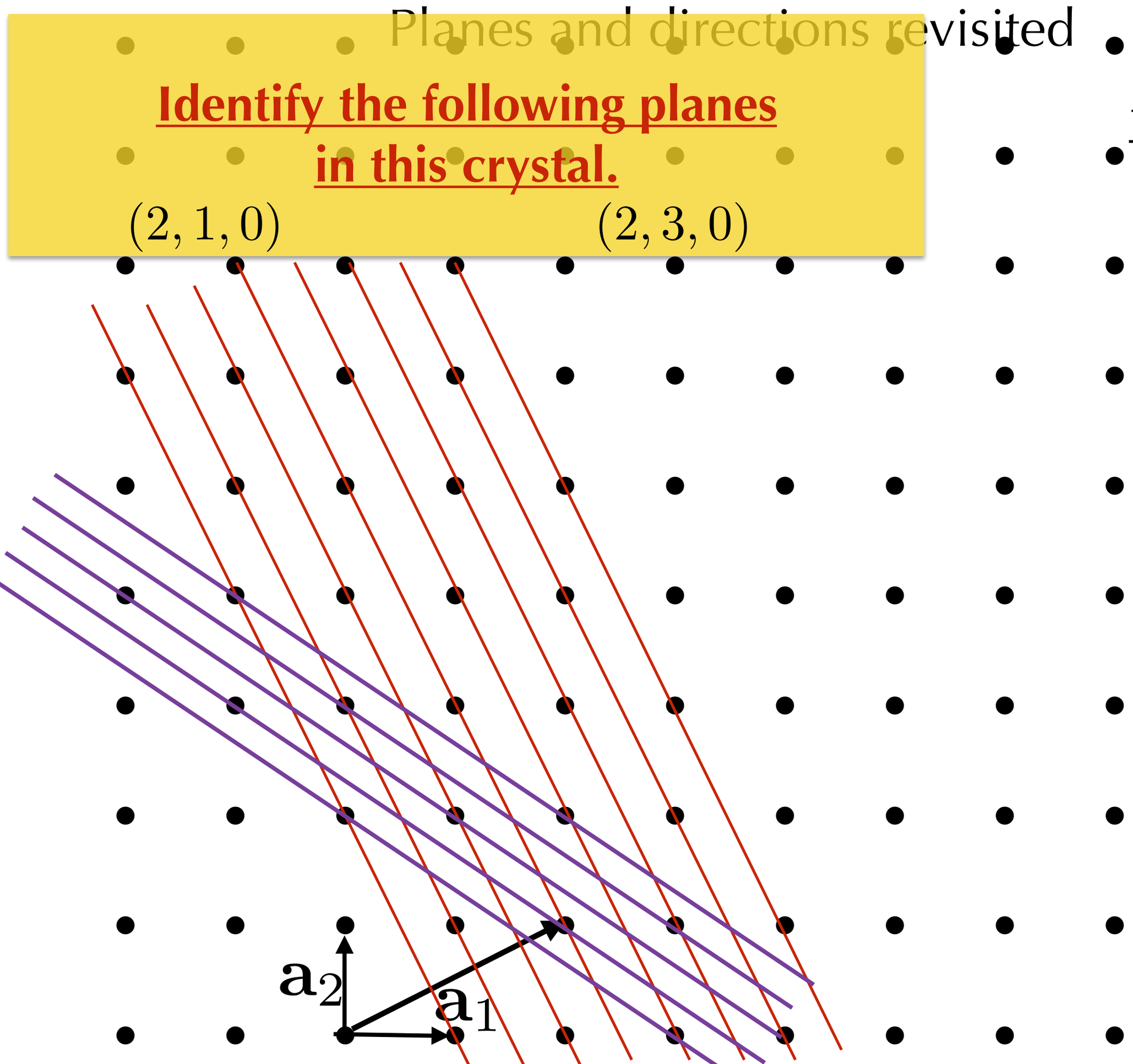

Planes and directions revisited

$$\frac{A}{h}, \frac{A}{k}, \frac{A}{l}$$

Identify the following planes in this crystal.

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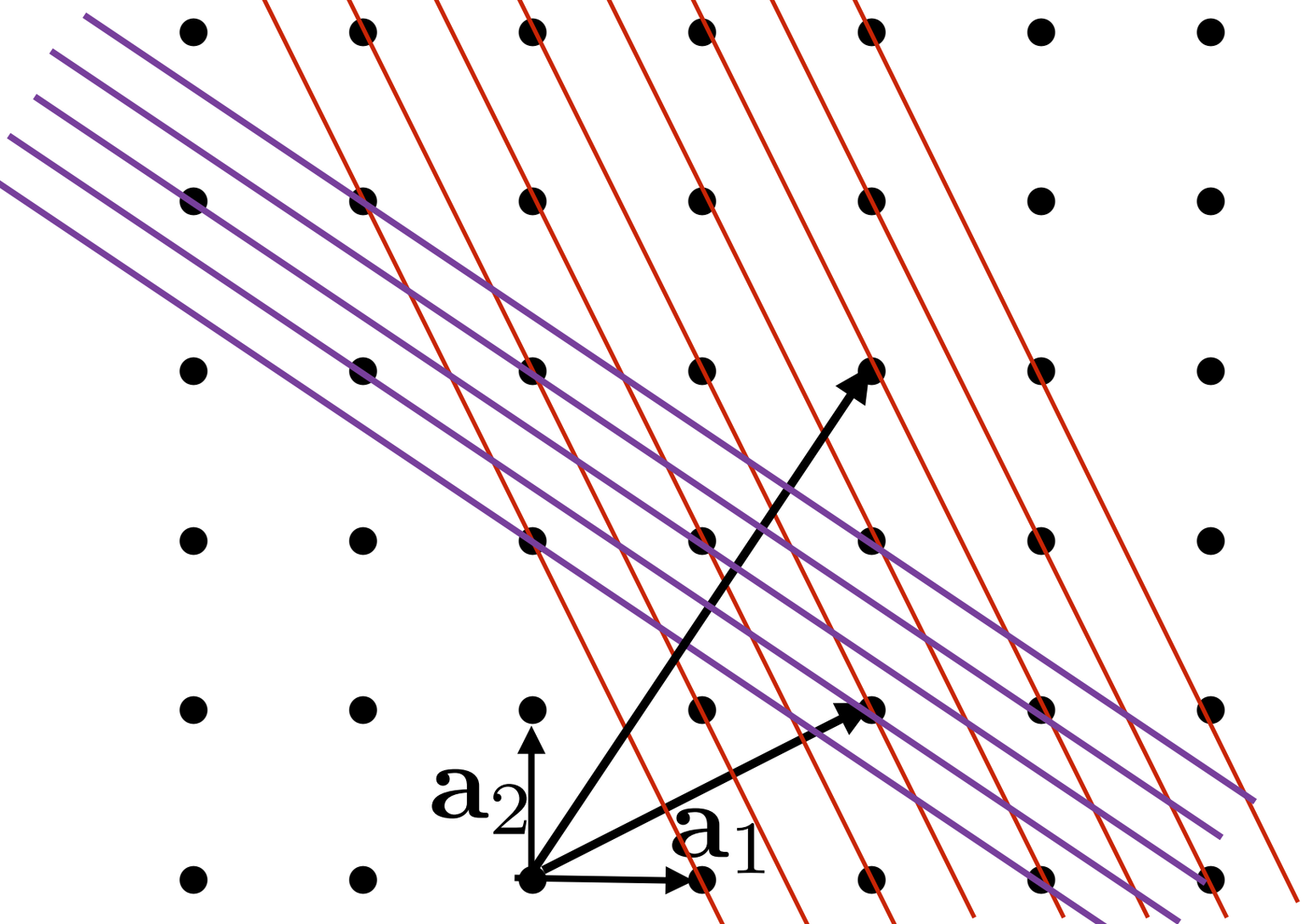

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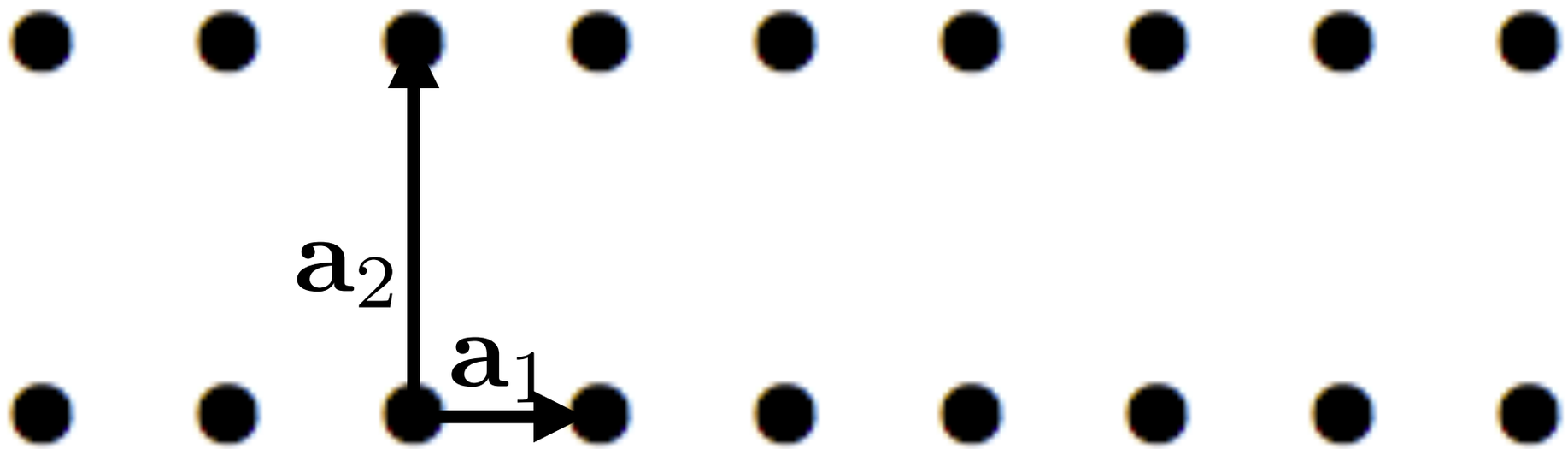

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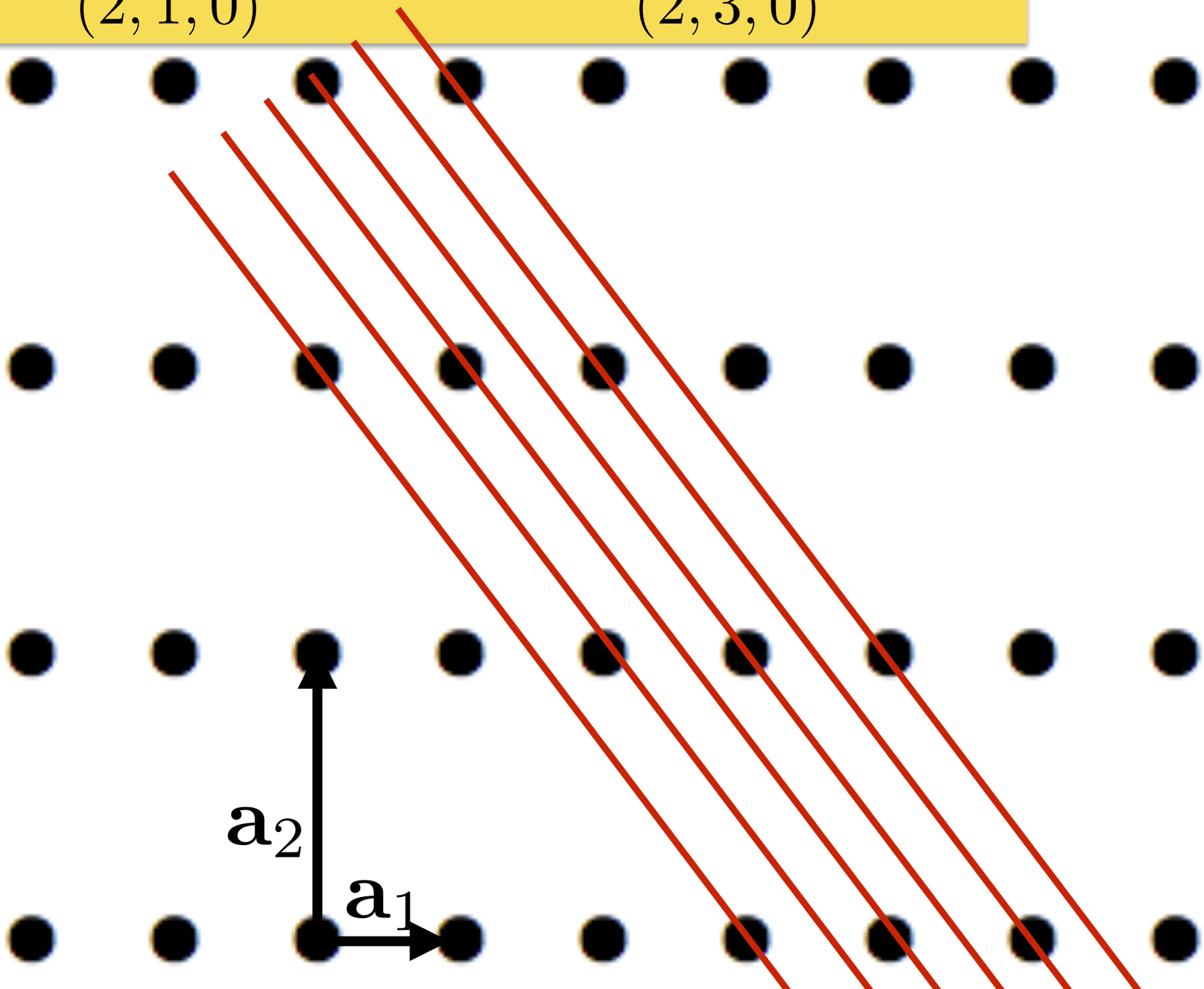

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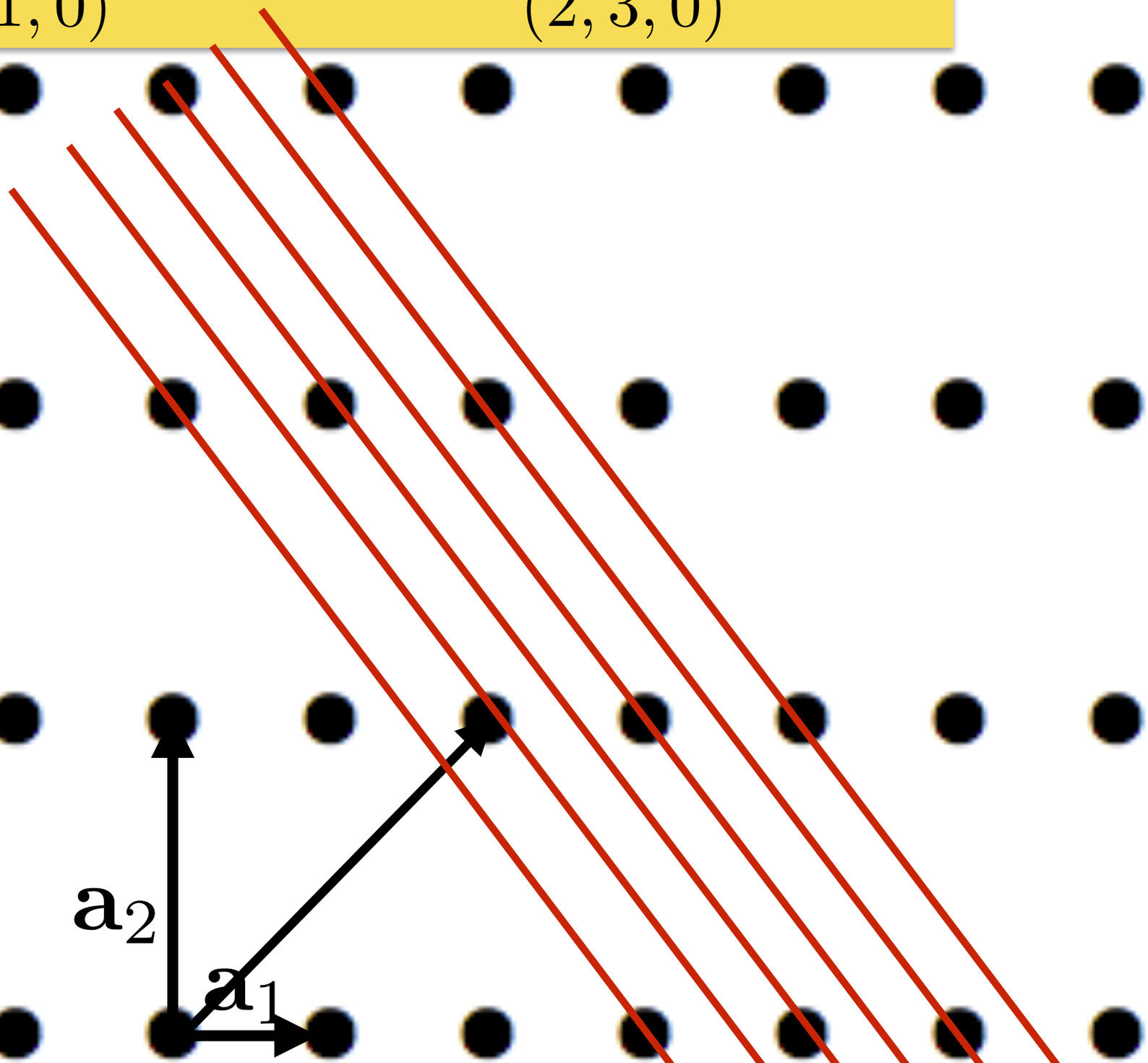

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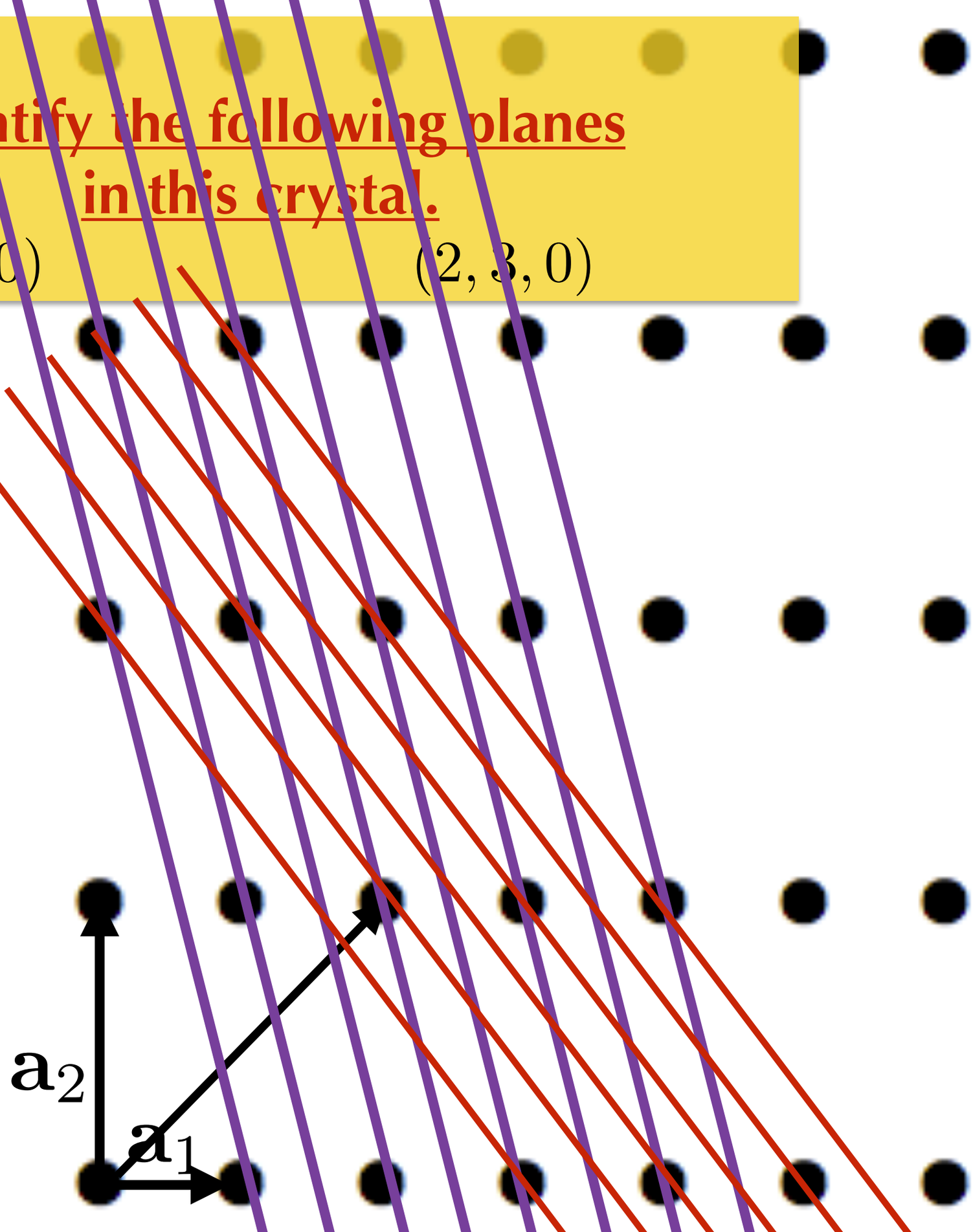

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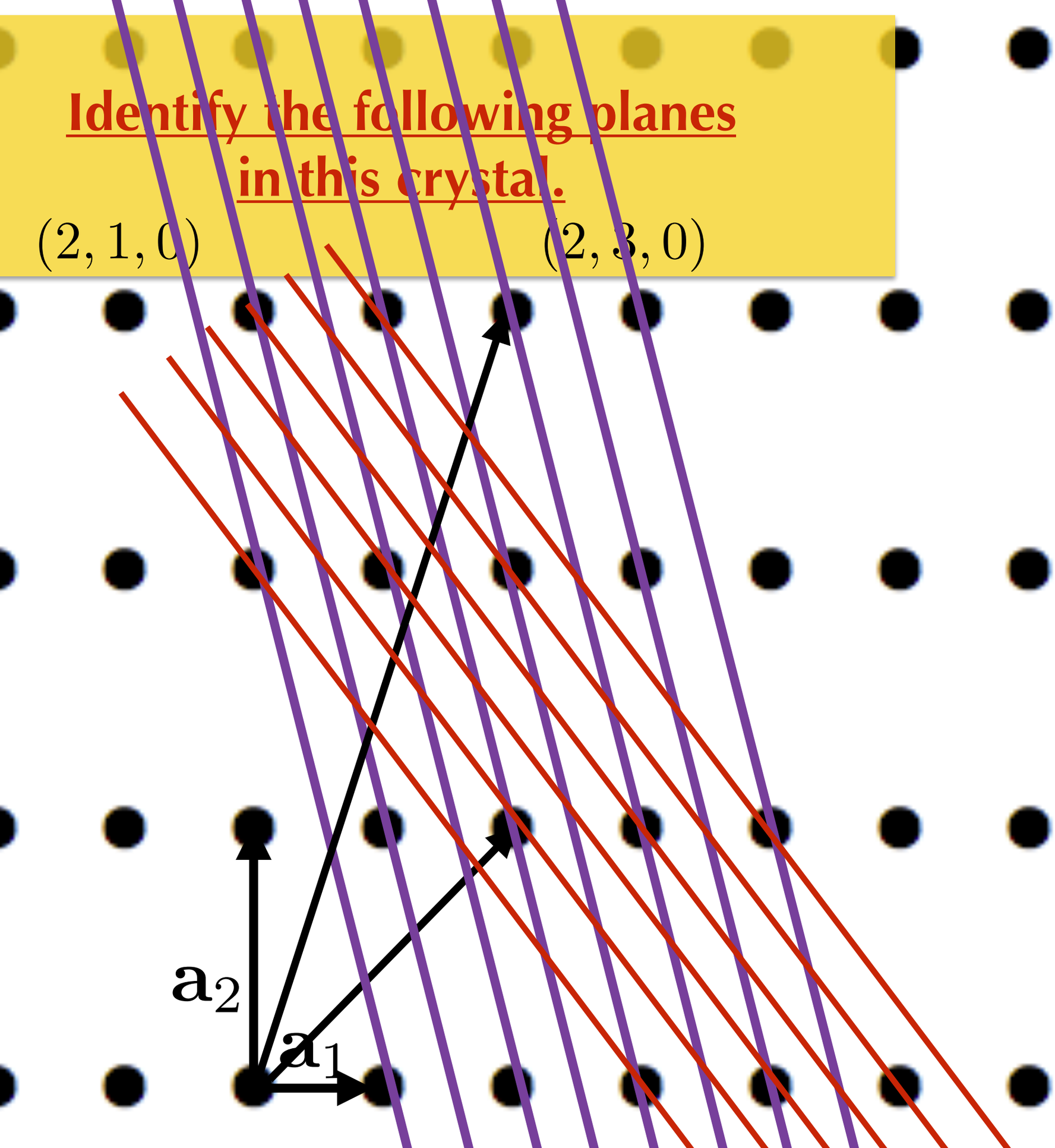

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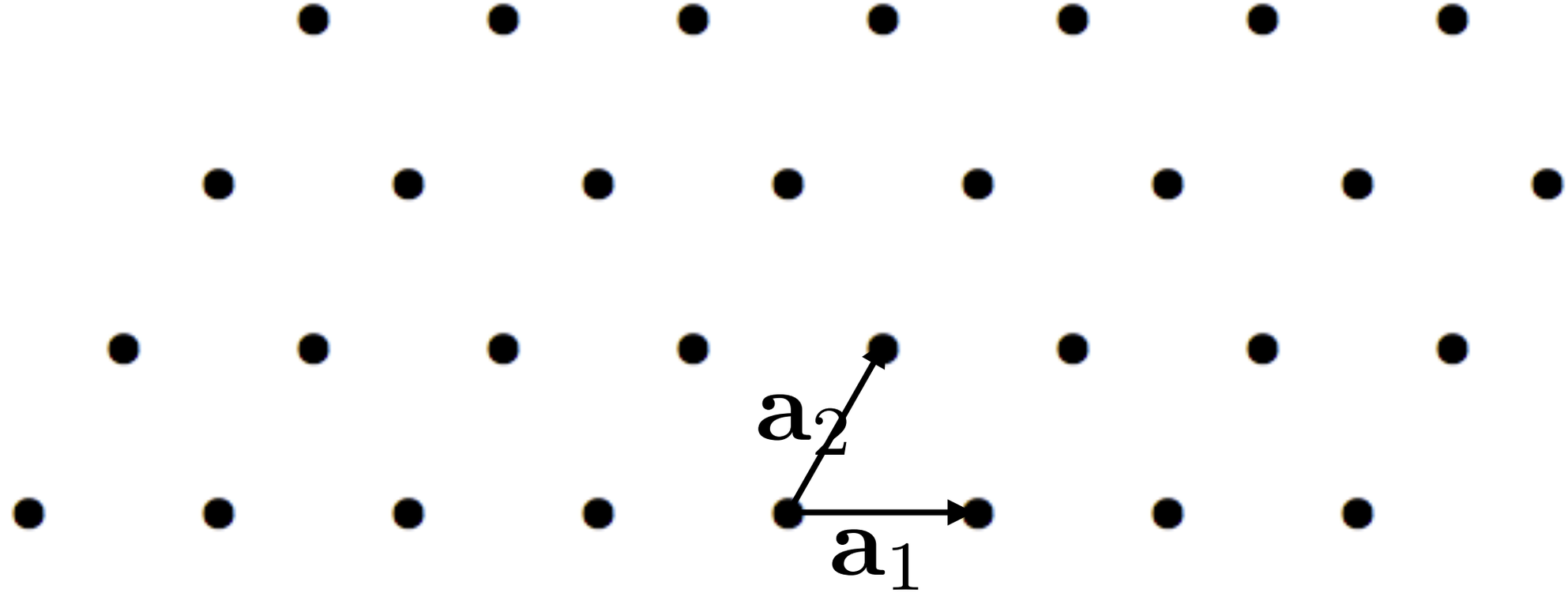

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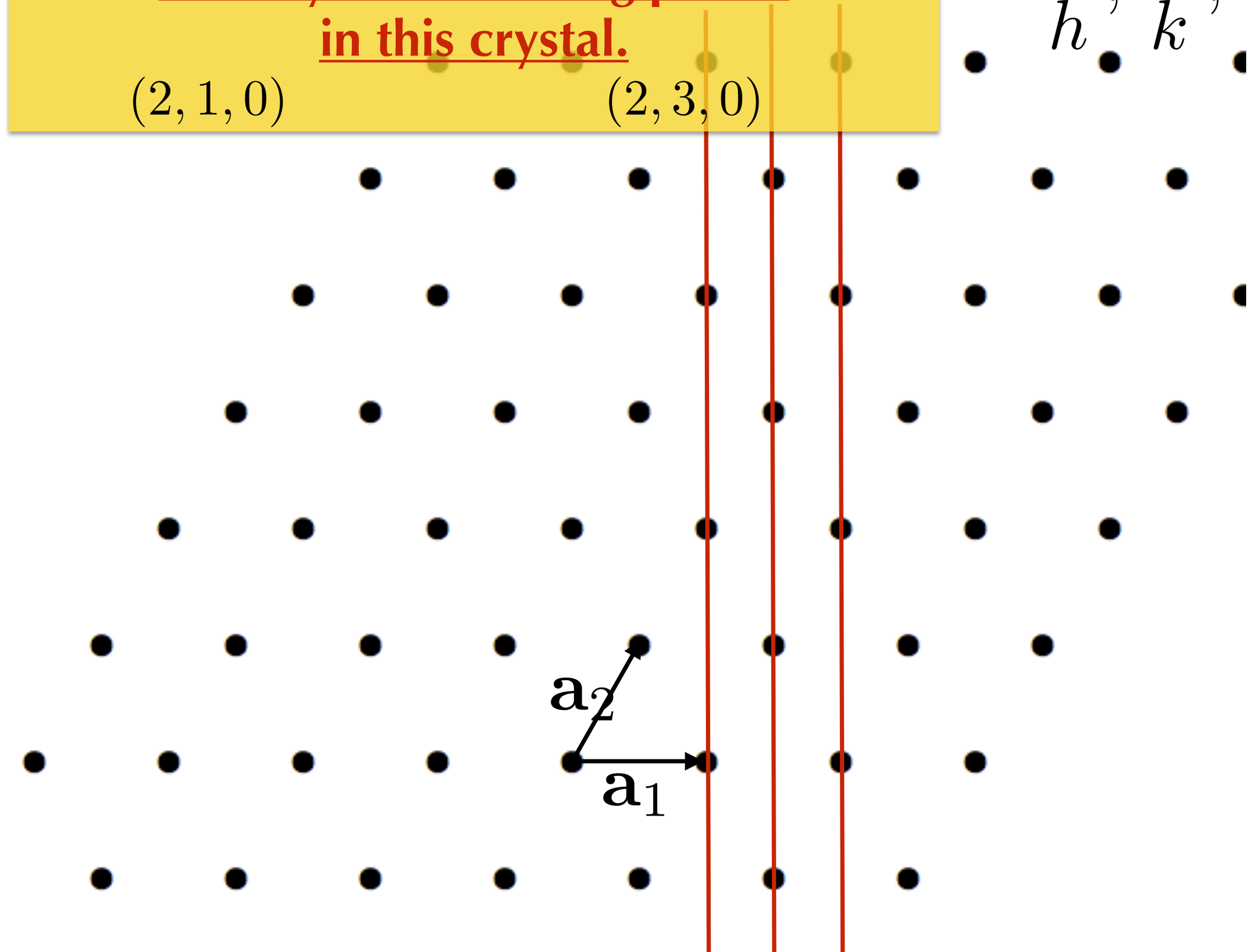

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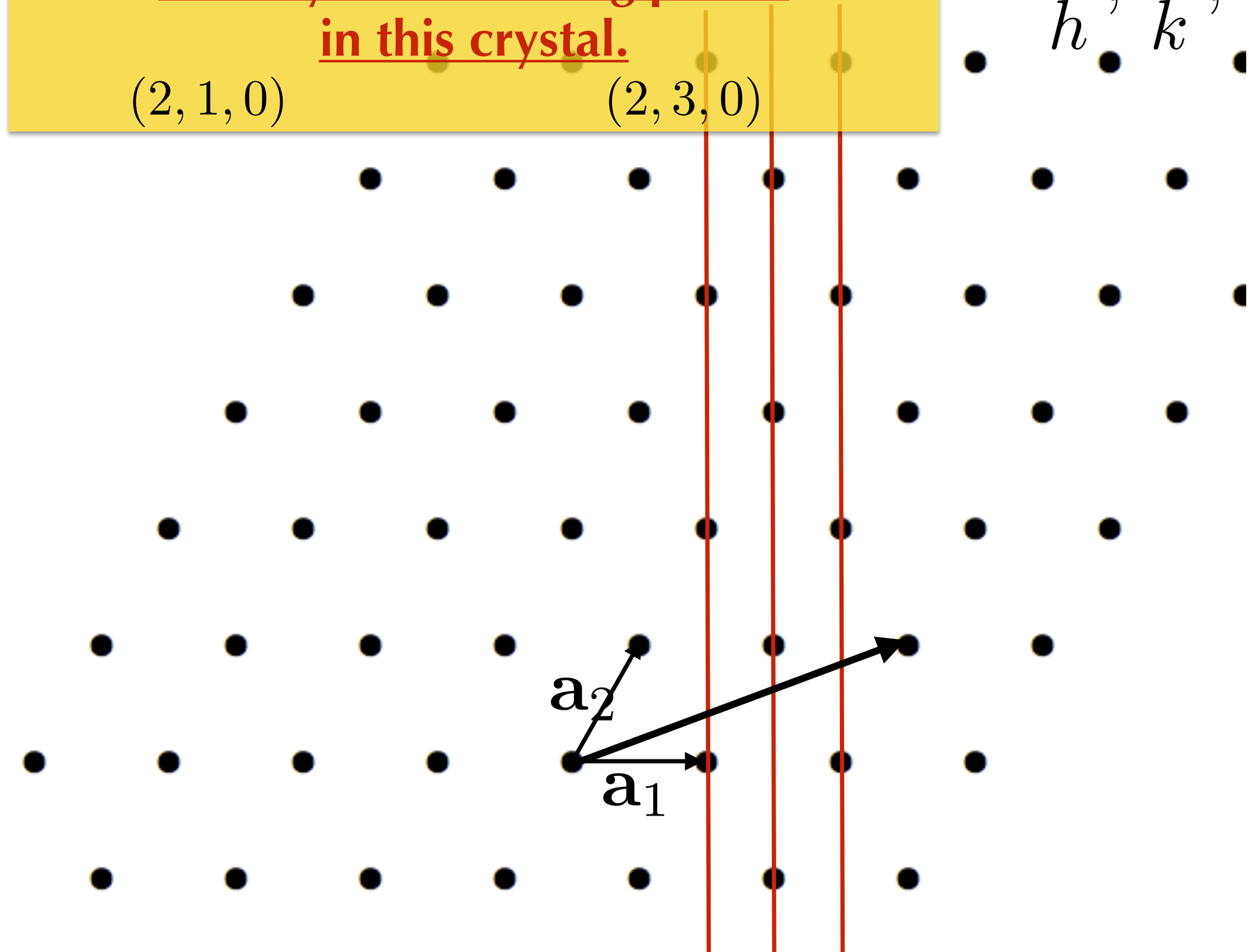

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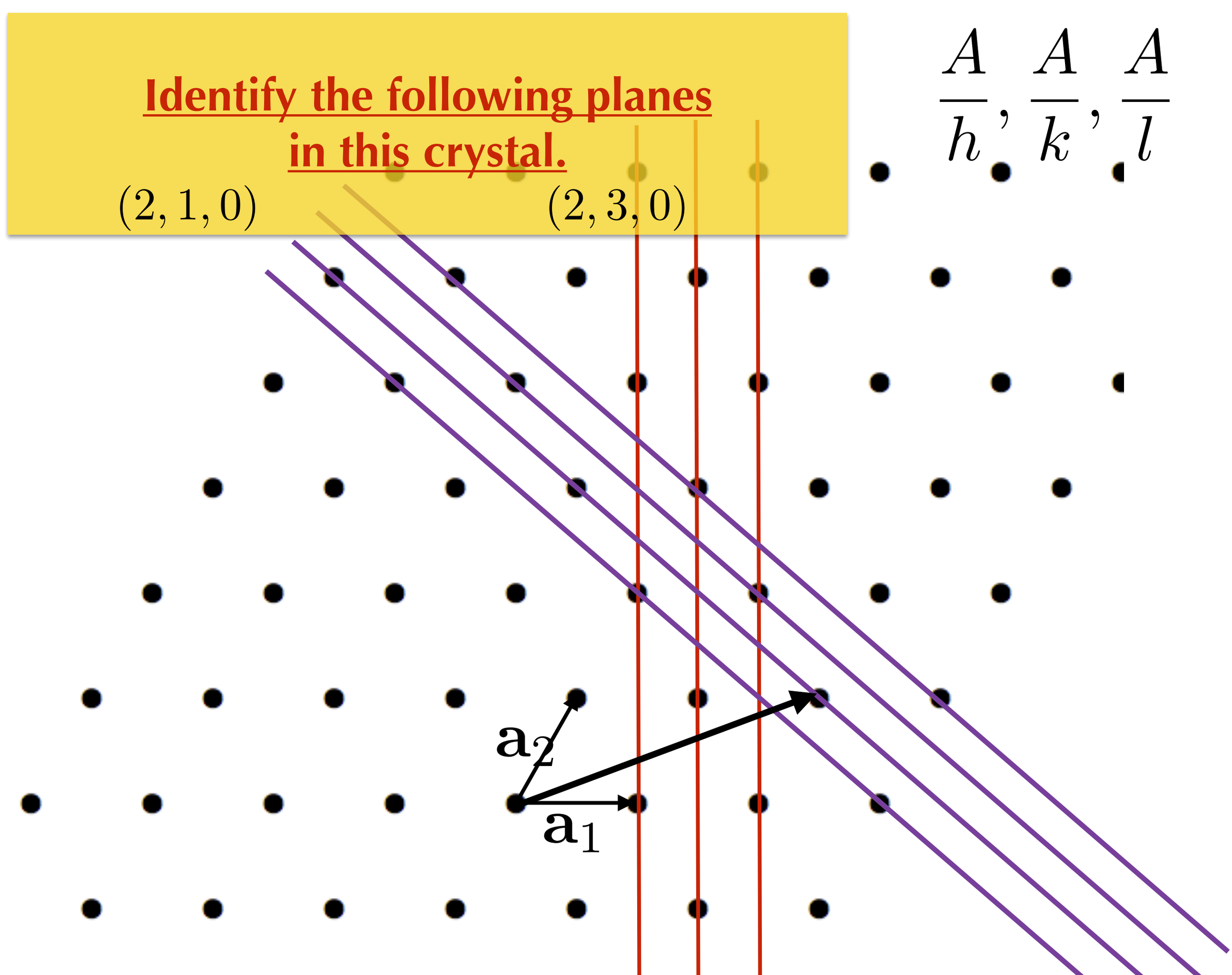

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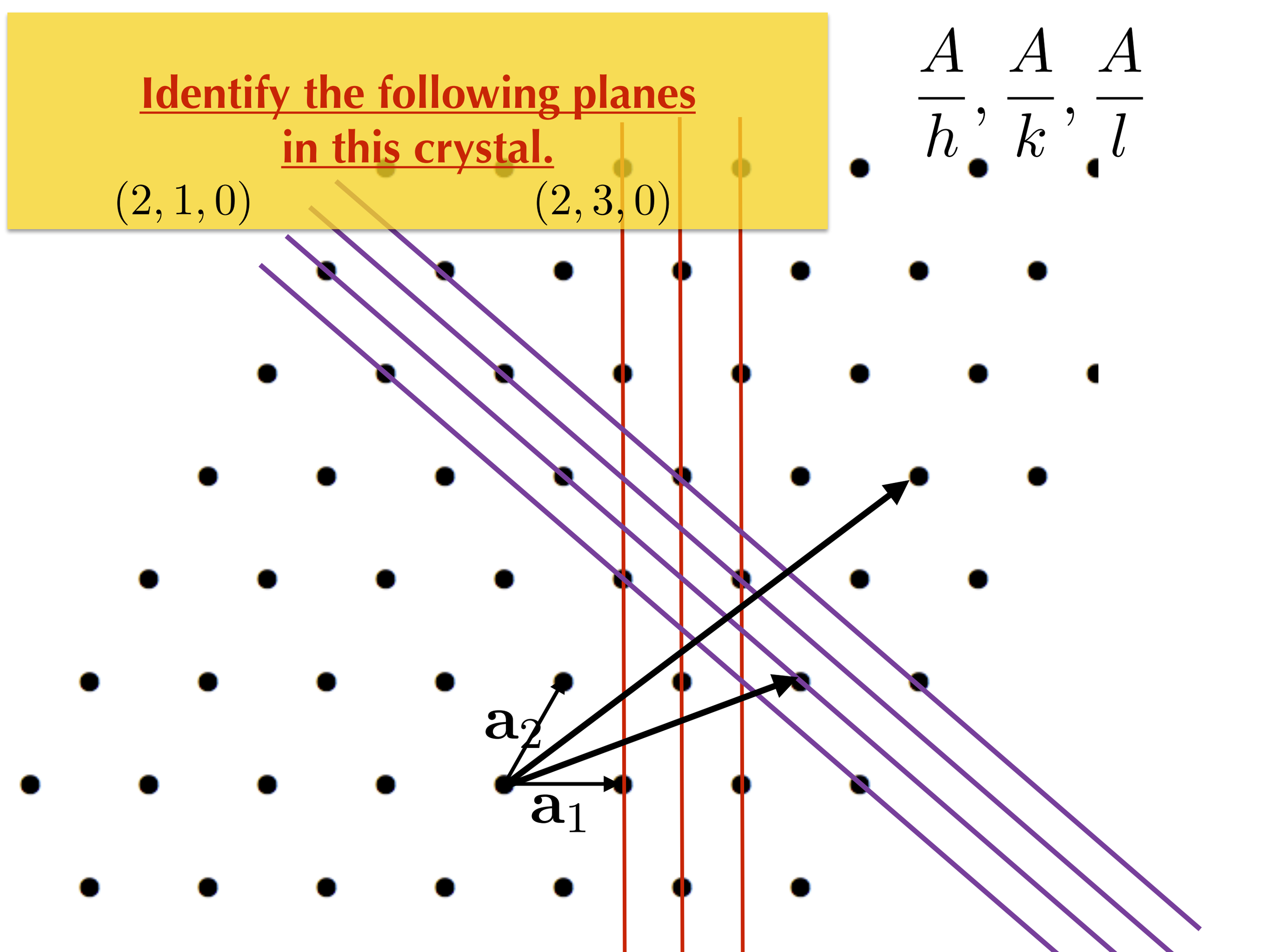
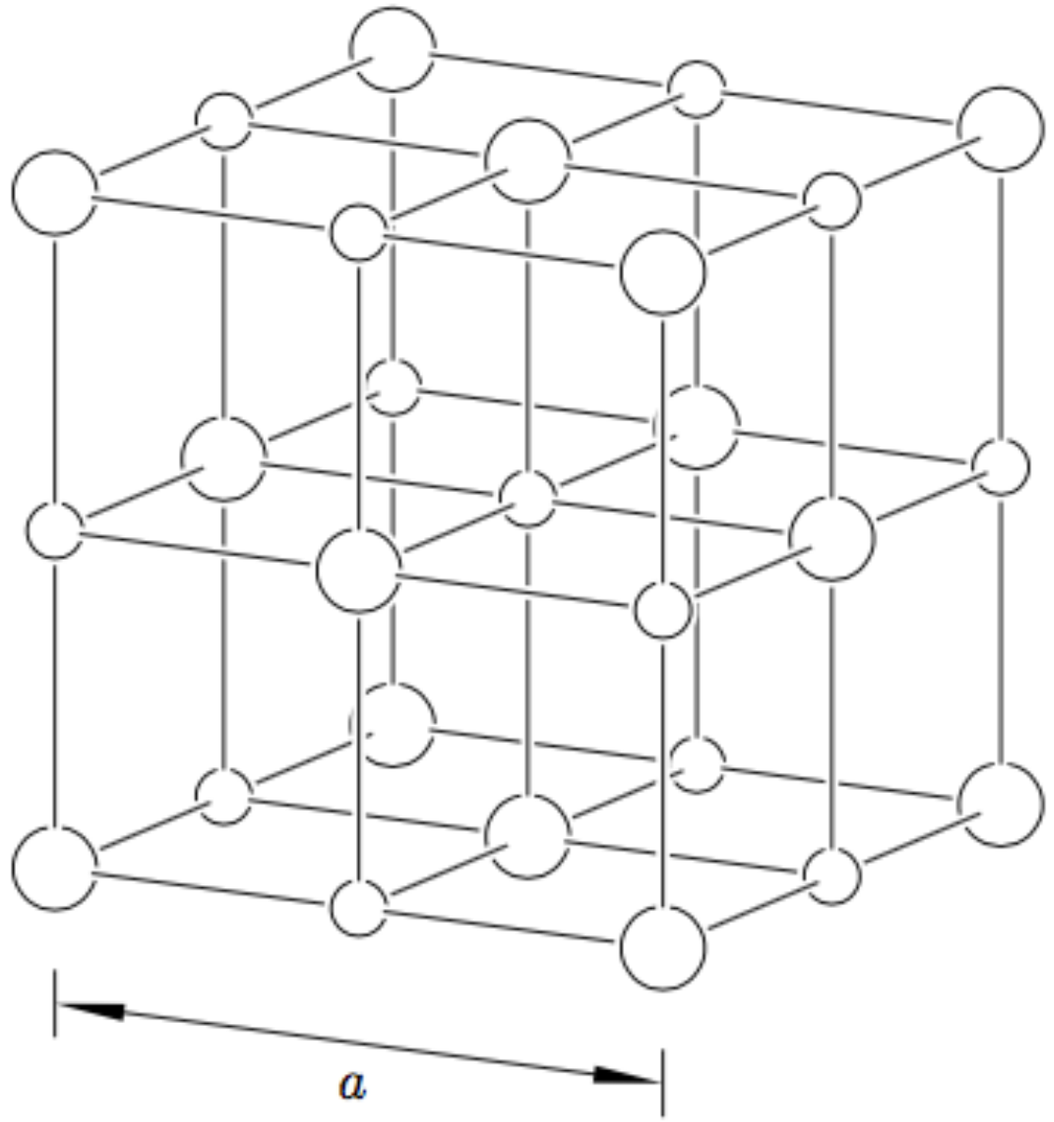


Which are not symmetry operators for NaCl?

$$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$$

$$\{C_{2x}^{+}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$$



$$\{E|\frac{1}{2}0\frac{1}{2}\}$$

$$\{C_{4x}^{-}|000\}$$

$$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$$

$$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$$

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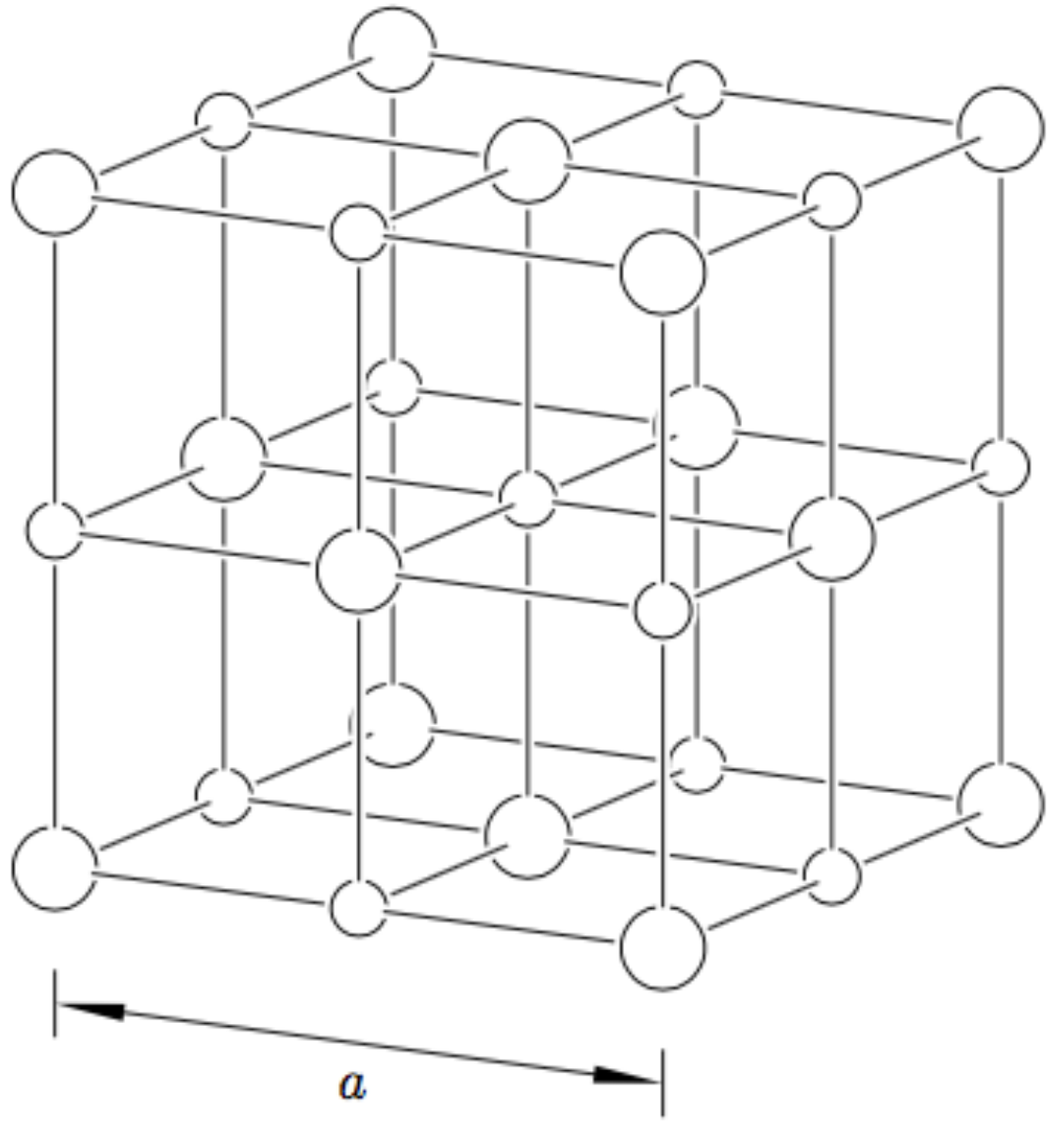

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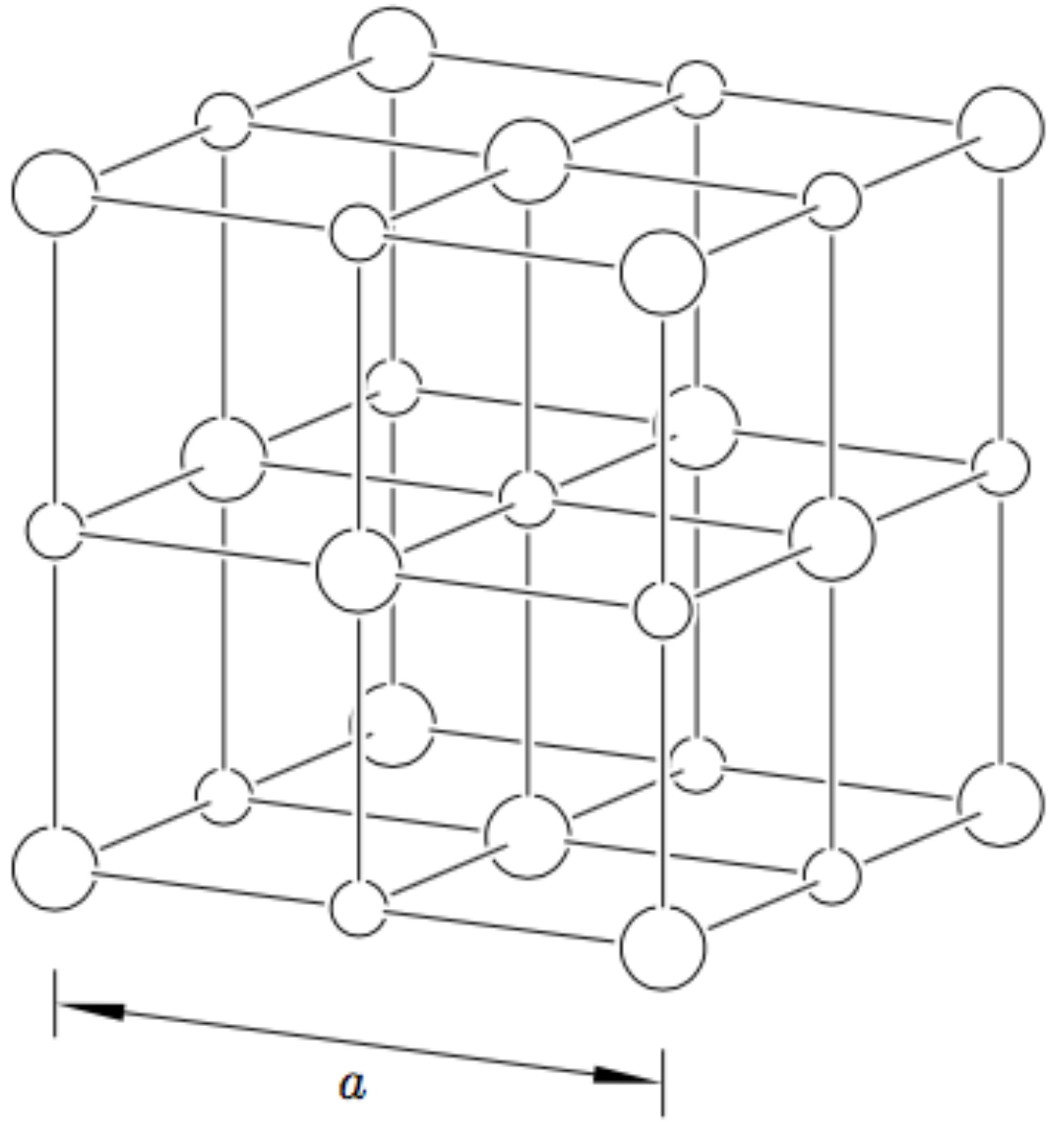


$$\{E|\frac{1}{2}0\frac{1}{2}\}$$

$$\{C_{4x}^{-}|000\}$$

$$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$$

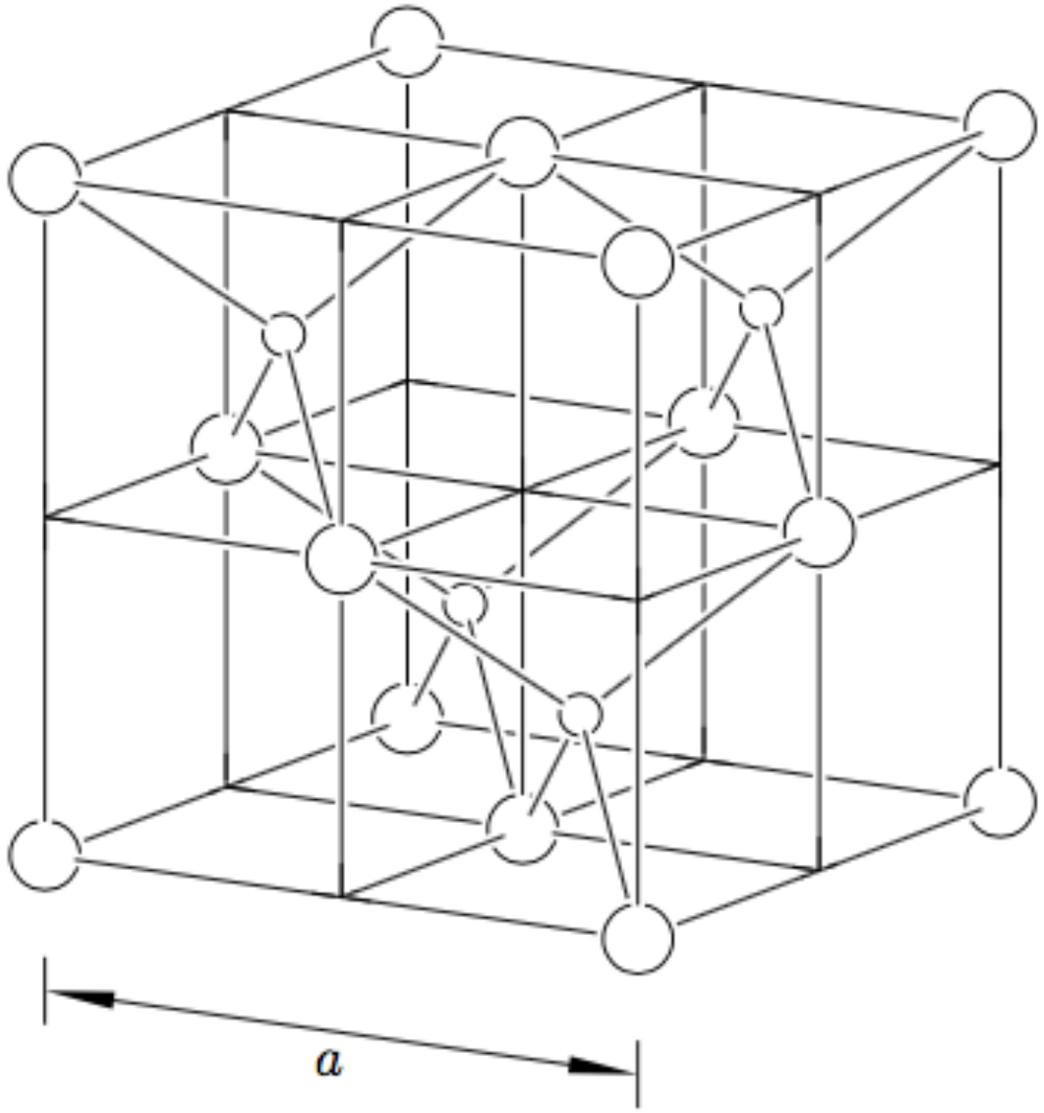
$$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$$

$$Fm\bar{3}m$$

Which are not symmetry operators for zincblende?

$$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$$

$$\{C_{2x}^{+}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\} \quad \{C_{2x}^{+}|\frac{1}{2}0\frac{1}{2}\}$$



$$\{E|\frac{1}{2}0\frac{1}{2}\} \qquad \{C_{4x}^{-}|000\}$$

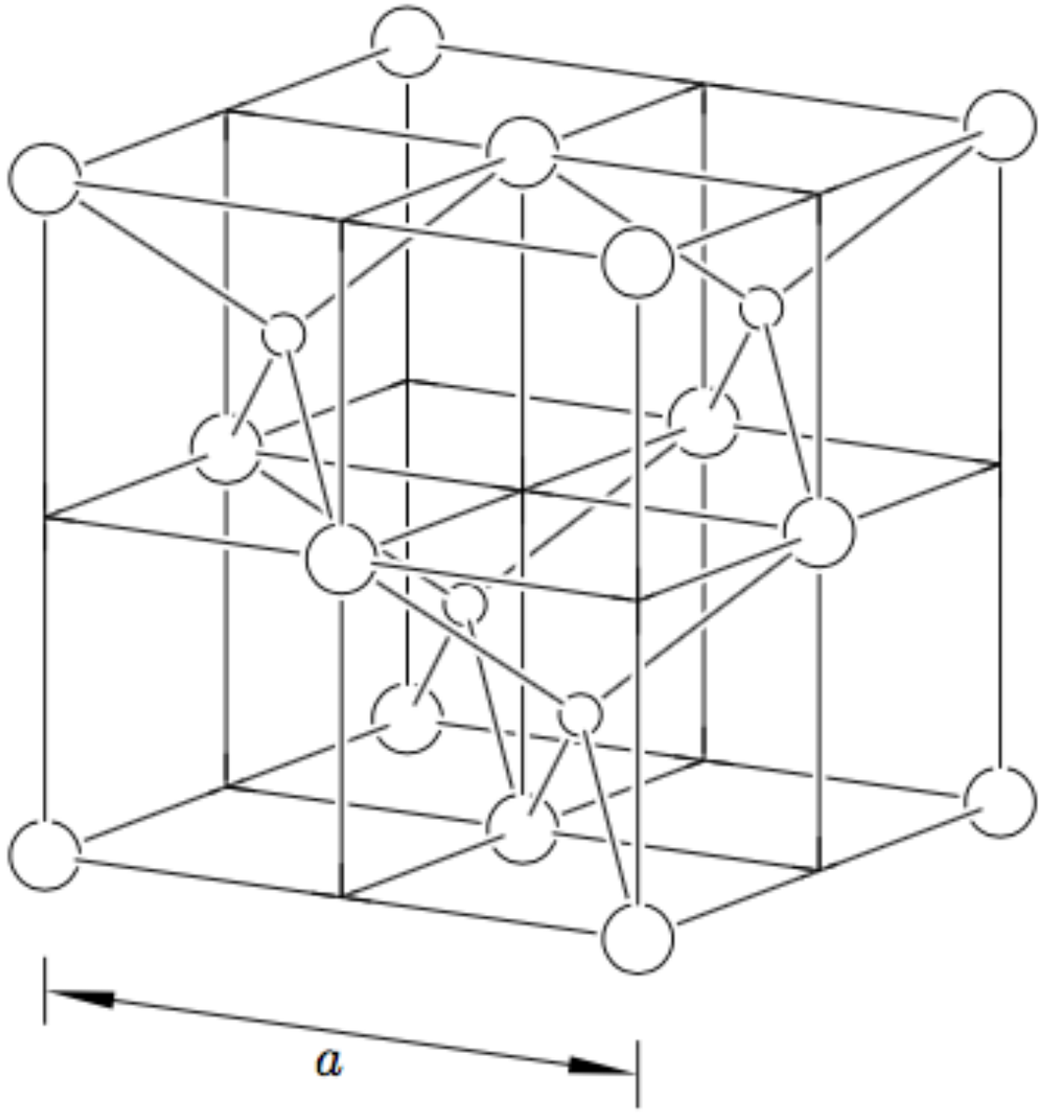
$$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\} \qquad \{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$$

Which are not symmetry operators for zincblende?

$$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$$

$$\{C_{2x}^{+}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$$

$$\{C_{2x}^{+}|\frac{1}{2}0\frac{1}{2}\}$$



$$\{E|\frac{1}{2}0\frac{1}{2}\}$$

$$\{C_{4x}^{-}|000\}$$

$$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$$

$$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$$

Which are not symmetry operators for zincblende?

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$\{C_{2x}^{+}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$

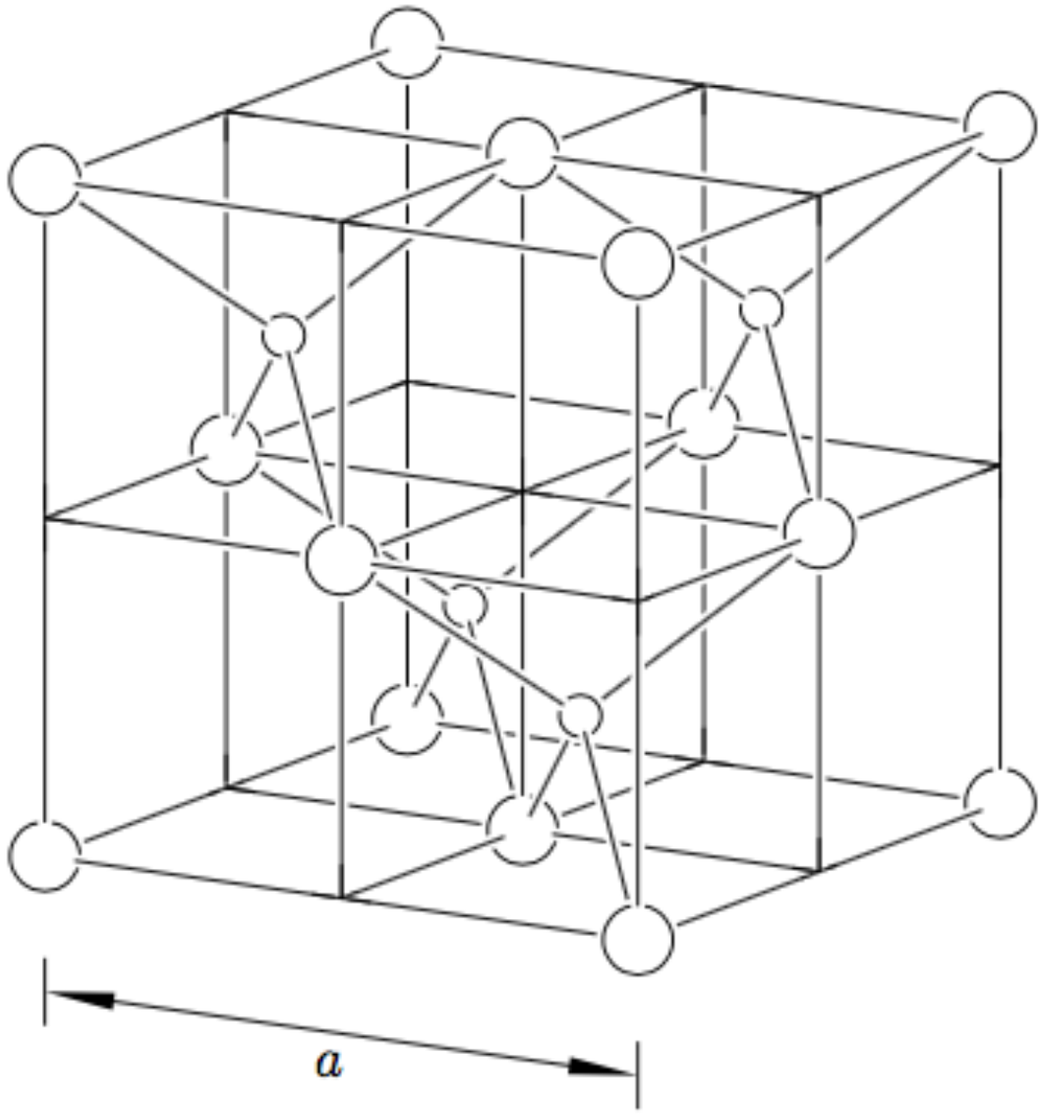
$\{C_{2x}^{+}|\frac{1}{2}0\frac{1}{2}\}$

$\{E|\frac{1}{2}0\frac{1}{2}\}$

$\{C_{4x}^{-}|000\}$

$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$

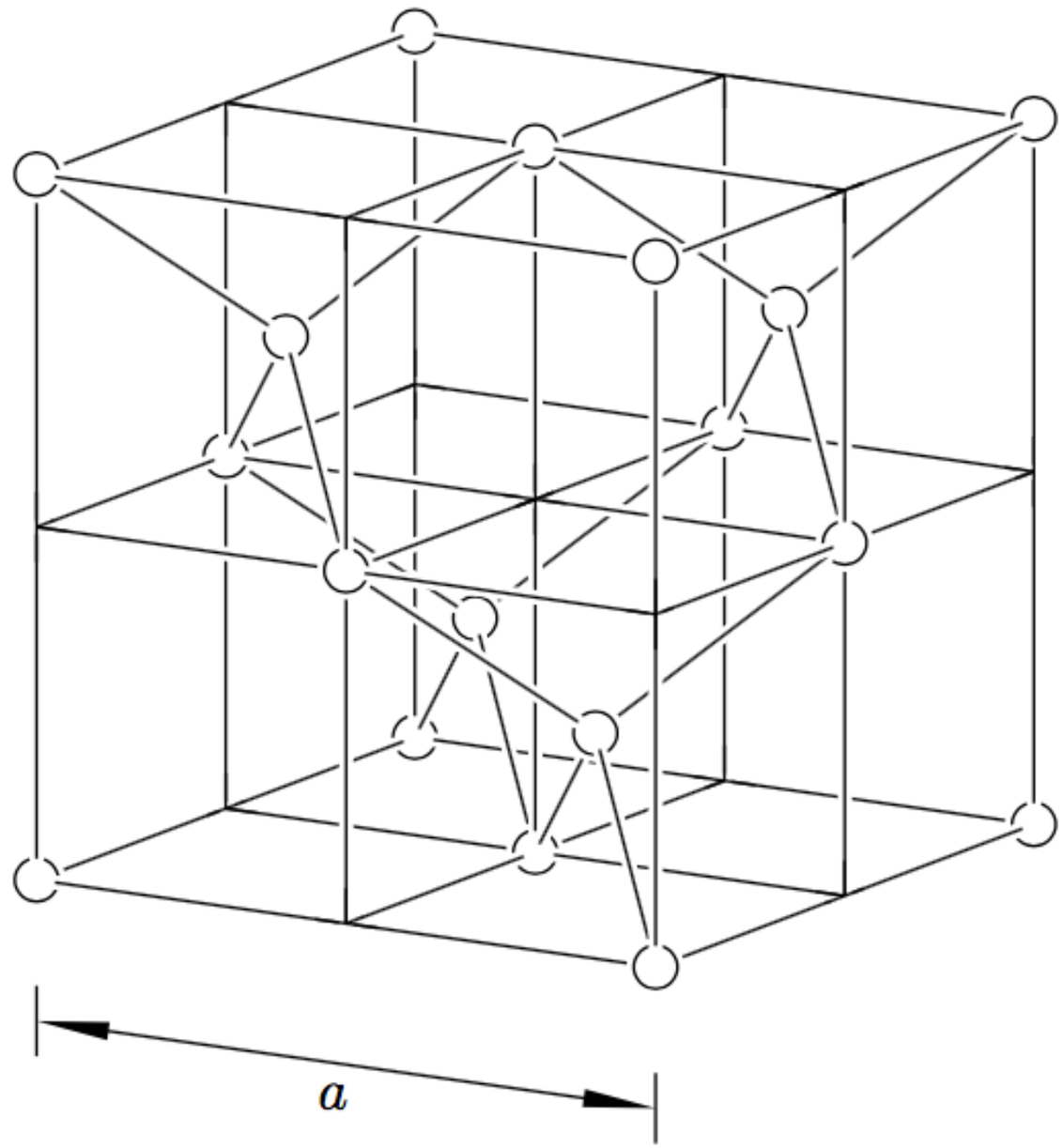


$F\bar{4}3m$

Which are not symmetry operato
for diamond?

$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$ $\{C_{4z}^{+}|00\frac{1}{4}\}$

$\{C_{2x}^{+}|0\frac{1}{2}\frac{1}{2}\}$ $\{C_{2x}^{+}|\frac{1}{2}0\frac{1}{2}\}$



$\{E|\frac{1}{2}0\frac{1}{2}\}$ $\{\sigma_z|\frac{1}{4}\frac{1}{4}\frac{1}{4}\}$

$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$ $\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$

Which are not symmetry operato for diamond?

$\{C_{4z}^+|0\frac{1}{2}\frac{1}{2}\}$ ✗

$\{C_{4z}^+|00\frac{1}{4}\}$

$\{C_{2x}^+|0\frac{1}{2}\frac{1}{2}\}$

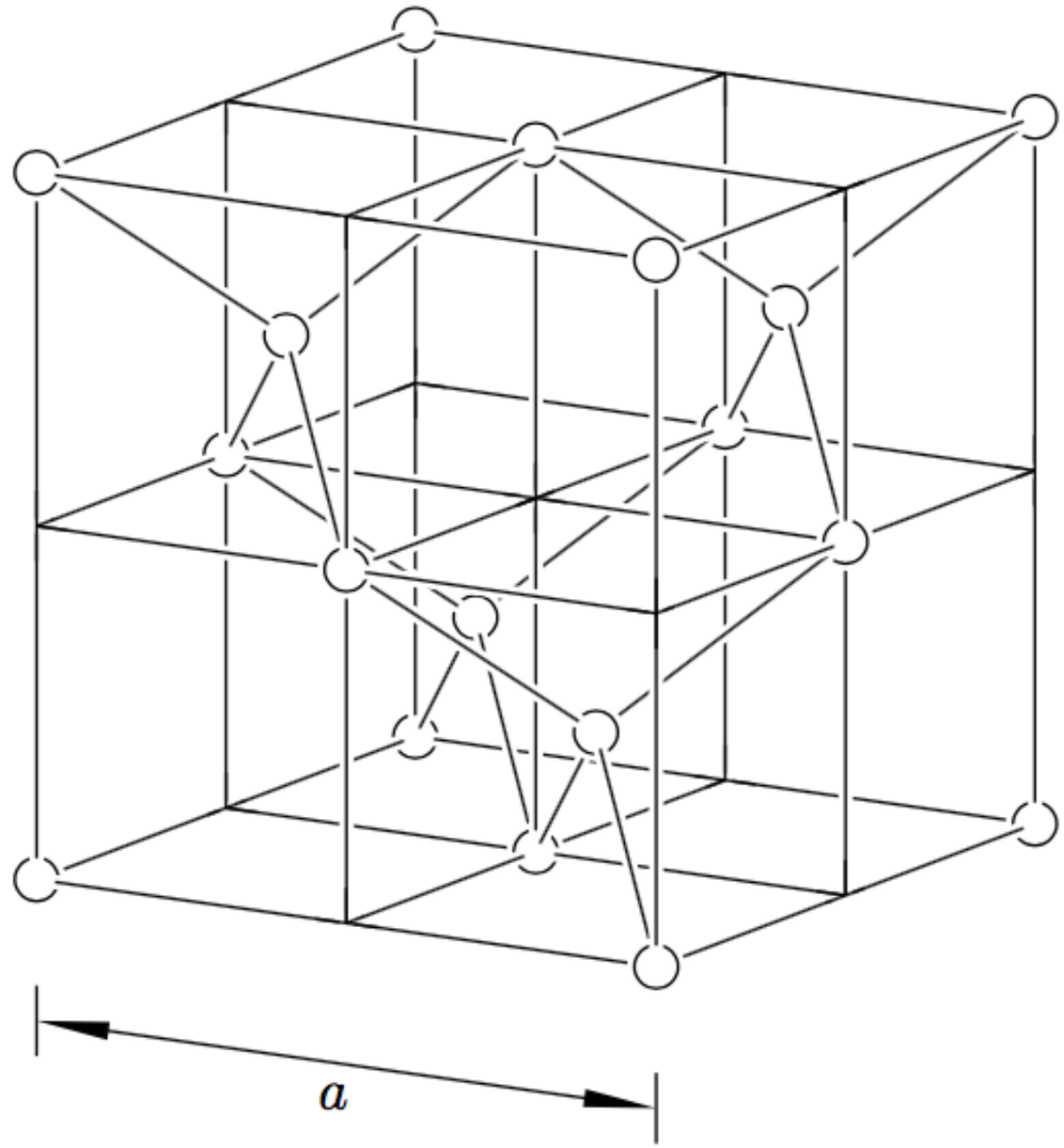
$\{C_{2x}^+|\frac{1}{2}0\frac{1}{2}\}$

$\{E|\frac{1}{2}0\frac{1}{2}\}$

$\{\sigma_z|\frac{1}{4}\frac{1}{4}\frac{1}{4}\}$

$\{C_{4z}^-|\frac{3}{2}\frac{1}{2}0\}$ ✗

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ ✗



Which are not symmetry operato for diamond?

$\{C_{4z}^+|0\frac{1}{2}\frac{1}{2}\}$ ✗

$\{C_{4z}^+|00\frac{1}{4}\}$

$\{C_{2x}^+|0\frac{1}{2}\frac{1}{2}\}$

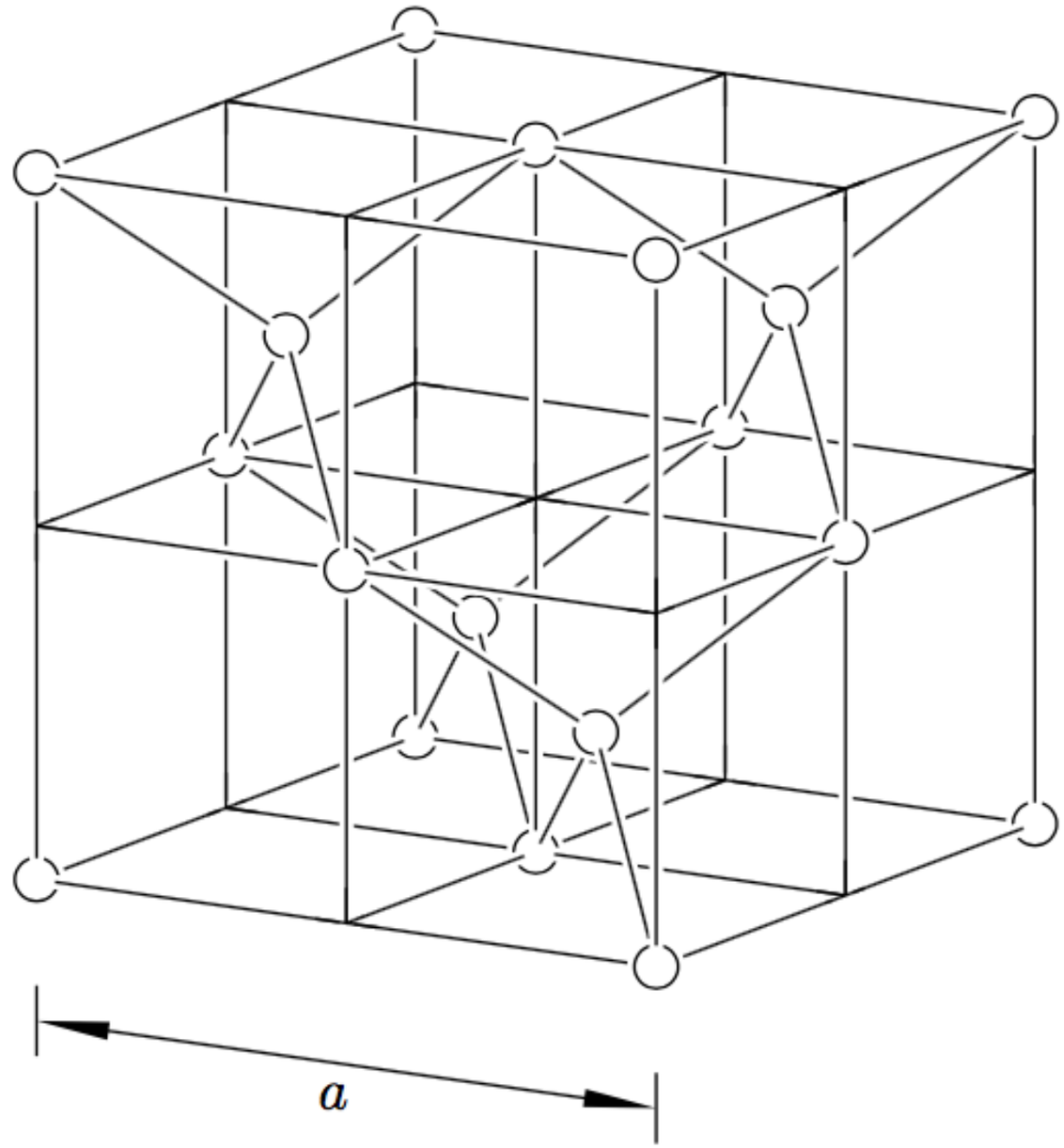
$\{C_{2x}^+|\frac{1}{2}0\frac{1}{2}\}$

$\{E|\frac{1}{2}0\frac{1}{2}\}$

$\{\sigma_z|\frac{1}{4}\frac{1}{4}\frac{1}{4}\}$

$\{C_{4z}^-|\frac{3}{2}\frac{1}{2}0\}$ ✗

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ ✗



$Fm\bar{3}m$

Which are not symmetry operato for diamond?

Screw axis

$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$ ✗

$\{C_{4z}^{+}|00\frac{1}{4}\}$

$\{C_{2x}^{+}|0\frac{1}{2}\frac{1}{2}\}$

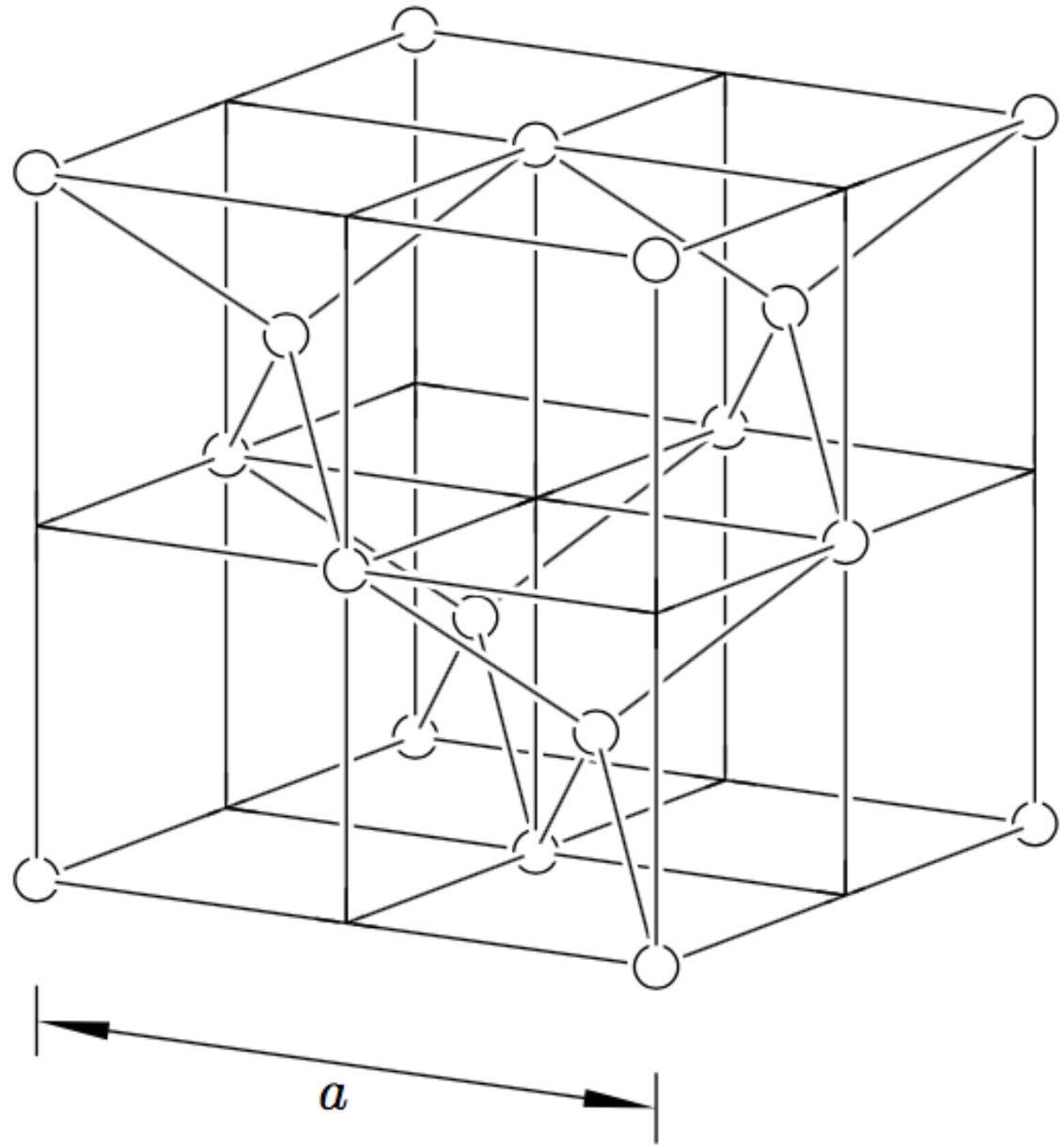
$\{C_{2x}^{+}|\frac{1}{2}0\frac{1}{2}\}$

$\{E|\frac{1}{2}0\frac{1}{2}\}$

$\{\sigma_z|\frac{1}{4}\frac{1}{4}\frac{1}{4}\}$

$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$ ✗

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ ✗



$Fm\bar{3}m$

Which are not symmetry operato for diamond?

$\{C_{4z}^+|0\frac{1}{2}\frac{1}{2}\}$ ✗

Screw axis

$\{C_{4z}^+|00\frac{1}{4}\}$

$\{C_{2x}^+|0\frac{1}{2}\frac{1}{2}\}$

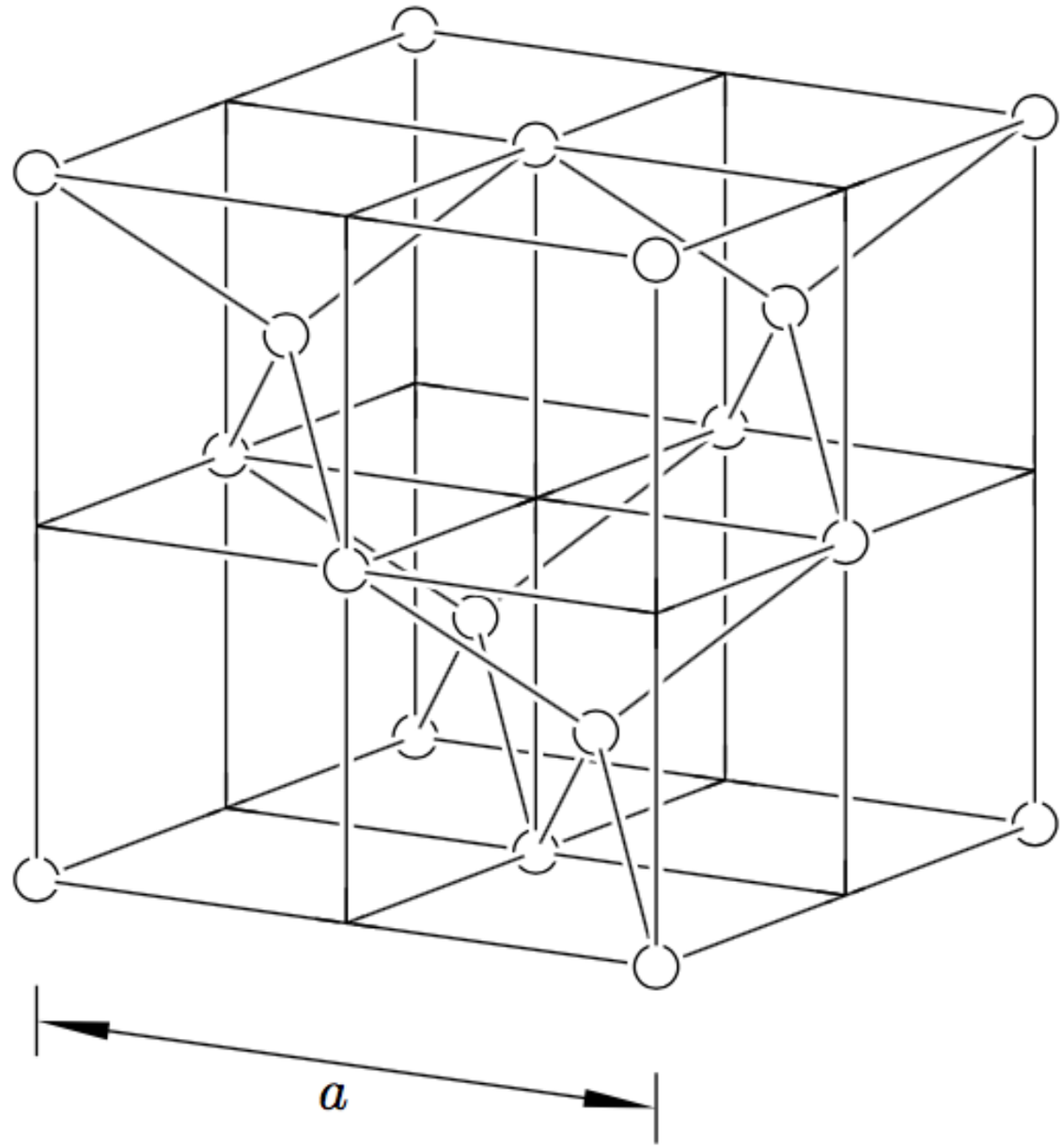
$\{C_{2x}^+|\frac{1}{2}0\frac{1}{2}\}$

$\{E|\frac{1}{2}0\frac{1}{2}\}$

$\{\sigma_z|\frac{1}{4}\frac{1}{4}\frac{1}{4}\}$ **Glide plane**

$\{C_{4z}^-|\frac{3}{2}\frac{1}{2}0\}$ ✗

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ ✗



$Fm\bar{3}m$

Which are not symmetry operato for diamond?

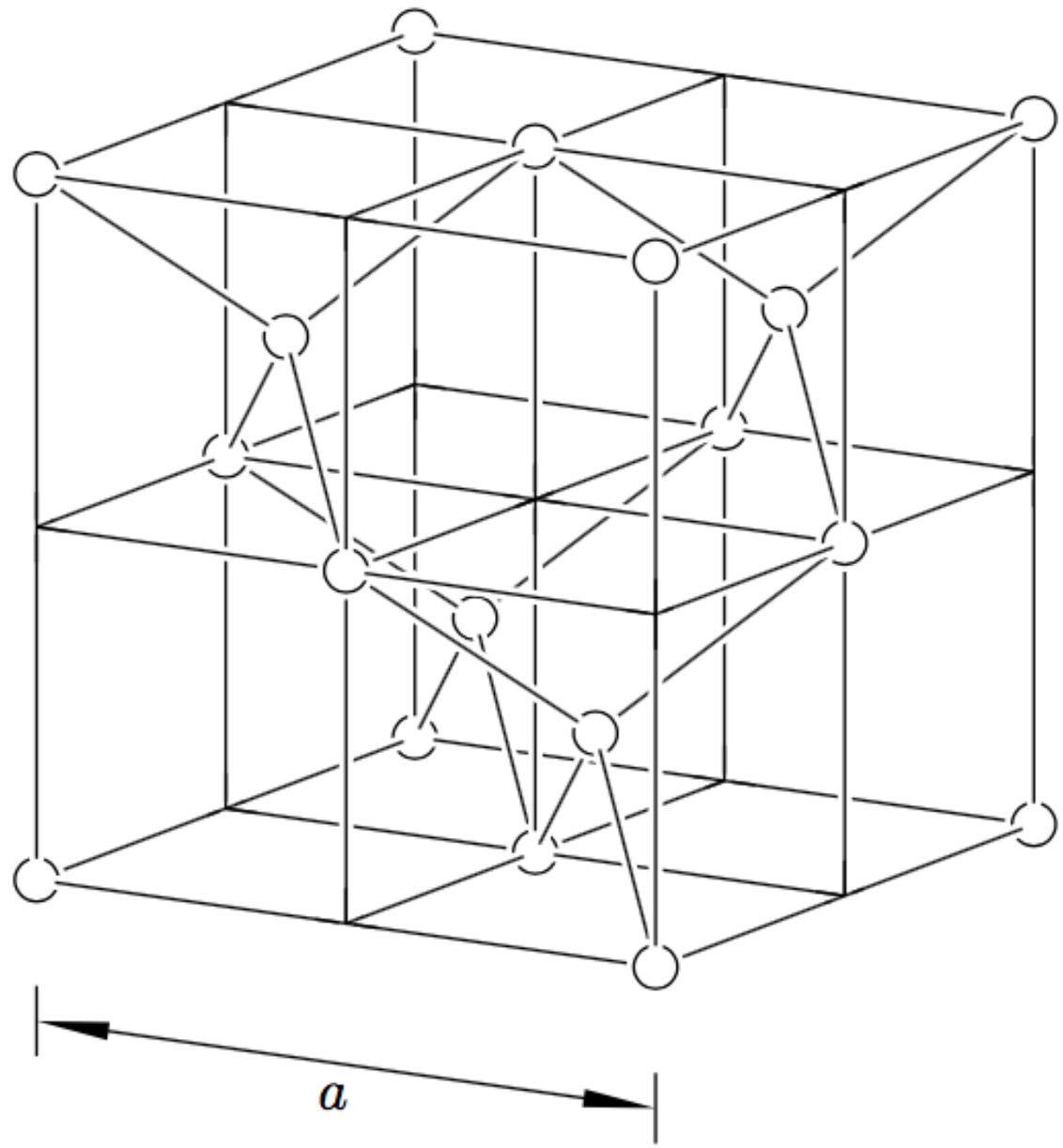
Screw axis

$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$ ✗

$\{C_{4z}^{+}|00\frac{1}{4}\}$

$\{C_{2x}^{+}|0\frac{1}{2}\frac{1}{2}\}$

$\{C_{2x}^{+}|\frac{1}{2}0\frac{1}{2}\}$



$\{E|\frac{1}{2}0\frac{1}{2}\}$

$\{\sigma_z|\frac{1}{4}\frac{1}{4}\frac{1}{4}\}$ **Glide plane**

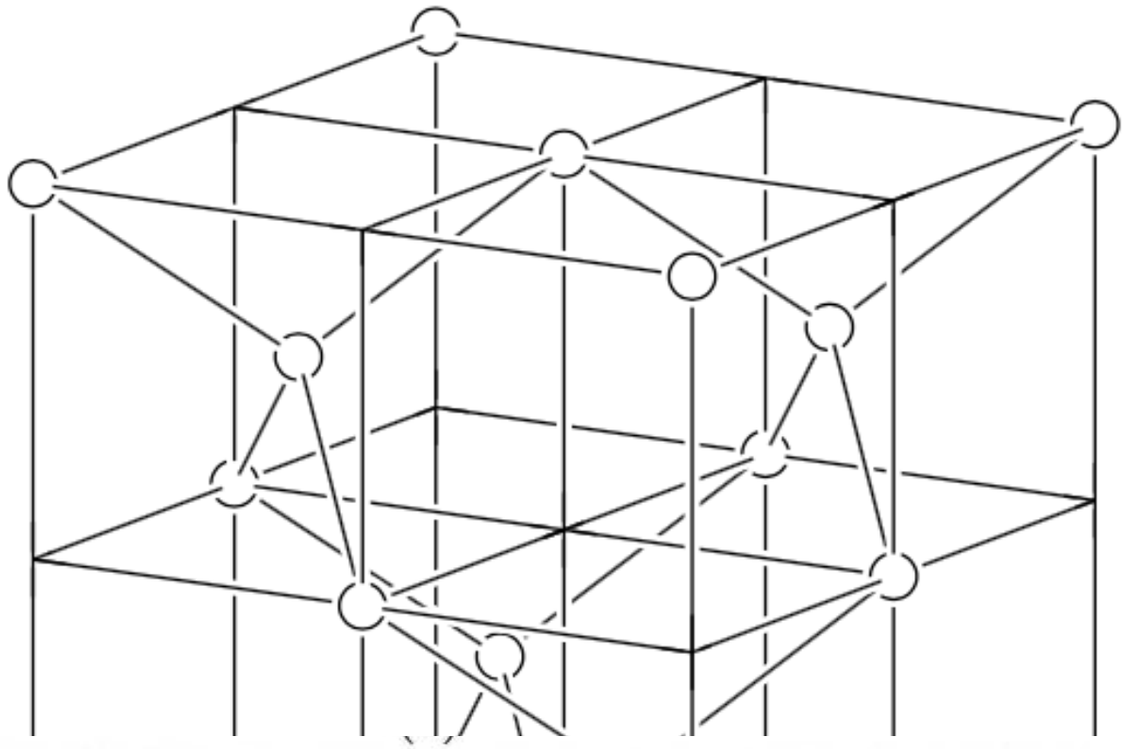
$\{C_{4z}^{-}|\frac{3}{2}\frac{1}{2}0\}$ ✗

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ ✗

$Fm\bar{3}m$

Non-symmorphic

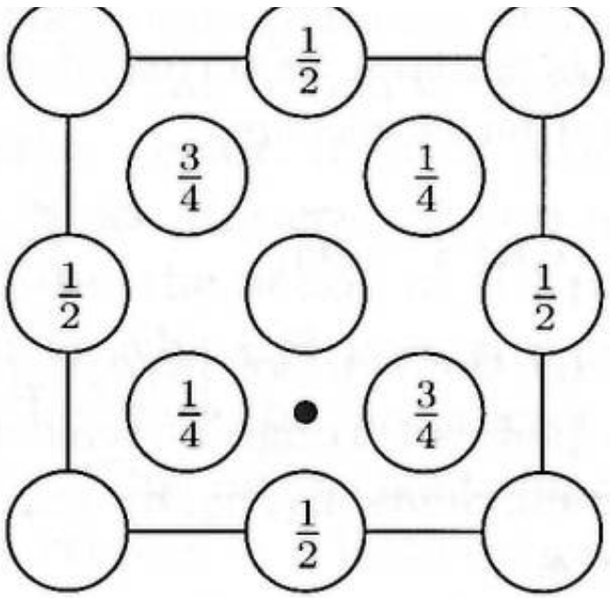
Which are not symmetry operato for diamond?

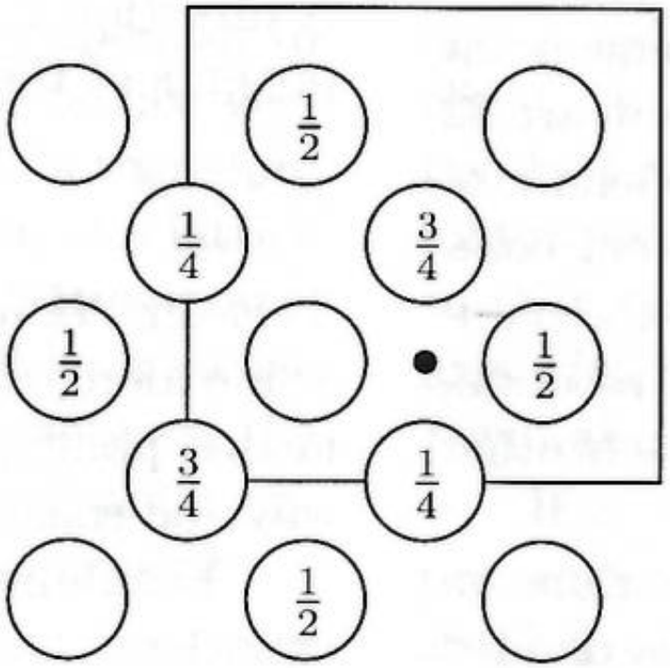


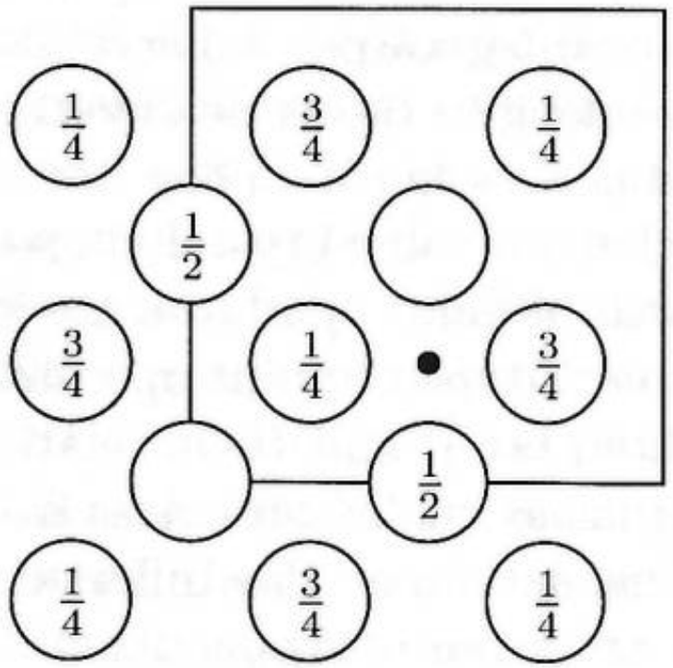
Screw axis

$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$ X

$\{C_{4z}^{+}|00\frac{1}{4}\}$







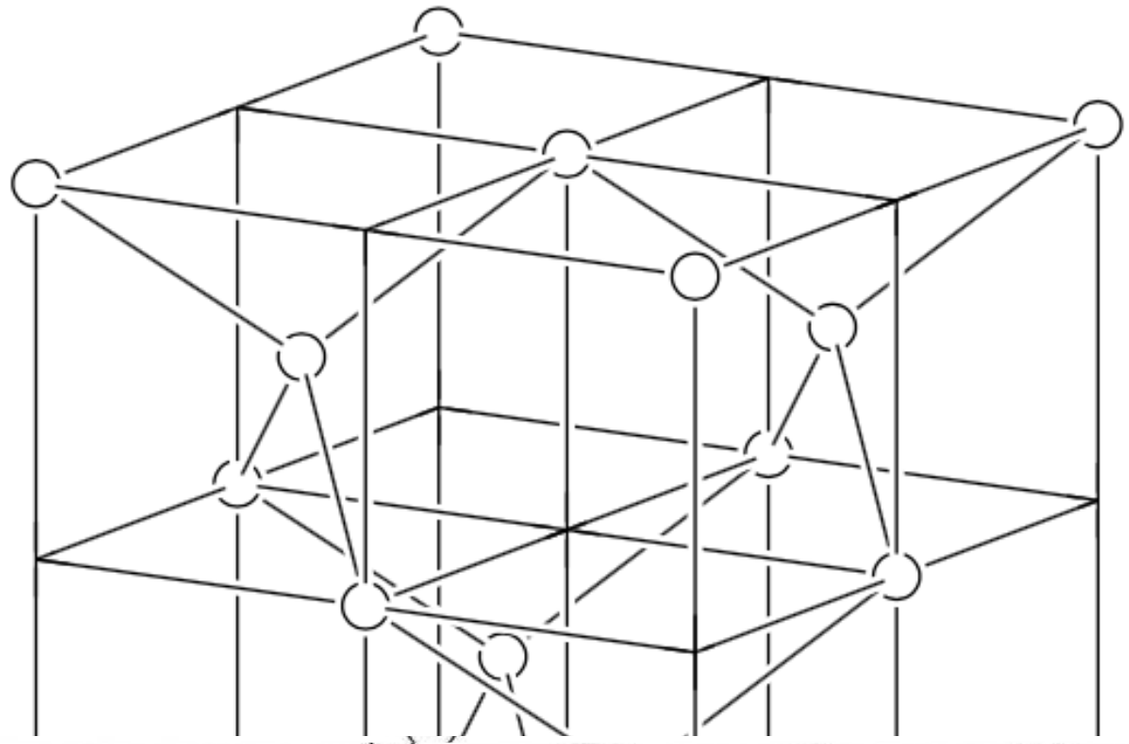
$\{C_{4z}^{-}|\frac{1}{2}\frac{1}{2}0\}$ X

$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ X

$Fm\bar{3}m$

Non-symmorphic

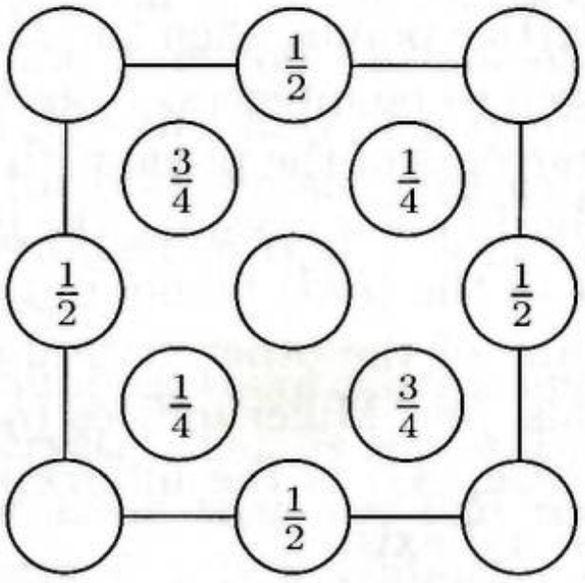
Which are not symmetry operato for diamond?



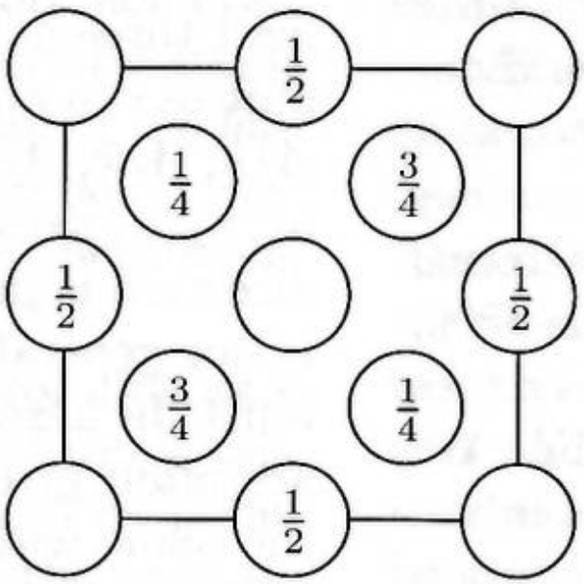
Screw axis

$\{C_{4z}^{+}|0\frac{1}{2}\frac{1}{2}\}$ X

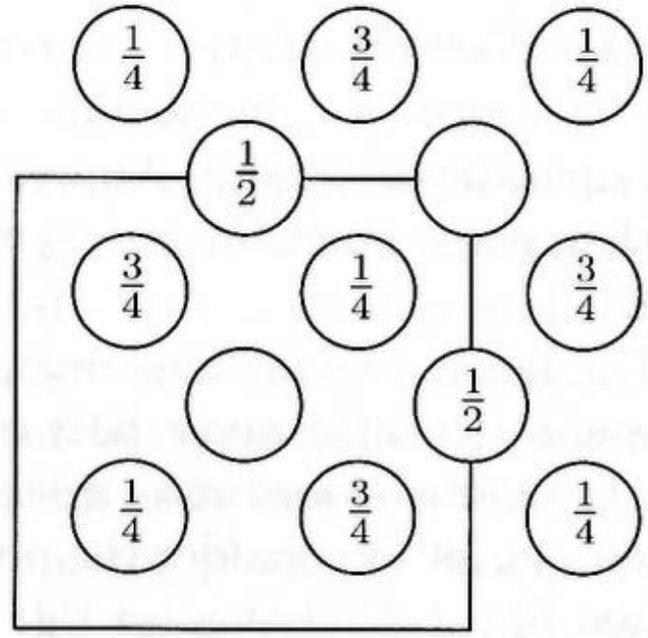
$\{C_{4z}^{+}|00\frac{1}{4}\}$



$\{C_{4z}^{-}|\frac{1}{2}\frac{1}{2}0\}$ X



$\{E|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ X



$Fm\bar{3}m$

Non-symmorphic

Wyckoff Positions

You are told that a crystal has the space group shown and that there is one A atom at location (0,0,0) and one B atom at location $(\frac{1}{2}\frac{1}{2}\frac{1}{2})$

$Fm\bar{3}m$

What is the crystal?

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b) Zincblend
c) Diamond
d) CsCl
e) fcc

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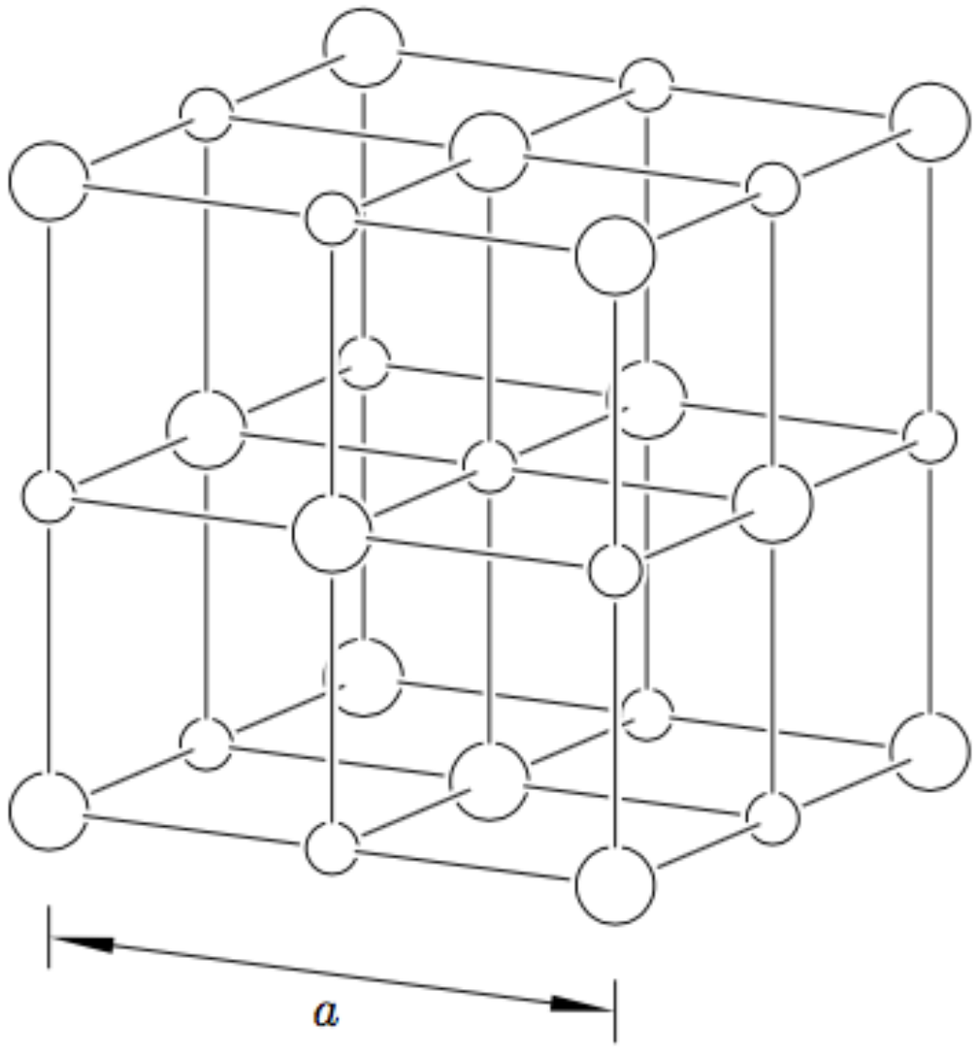

	Bravais Lattice (only consider the lattice)	Crystal Structure (consider the lattice + the atoms)
Number of Point groups. (Just point operators)	7 (The 7 crystal systems)	32 (The 32 crystallographic point groups)
Number of Space Groups. (now add translations)	14 (The 14 Bravais Lattices)	230 (The 230 space groups)