

Section 3 - Crystals

3.2 Tables of Bravais Lattices

Gerhard Klimeck

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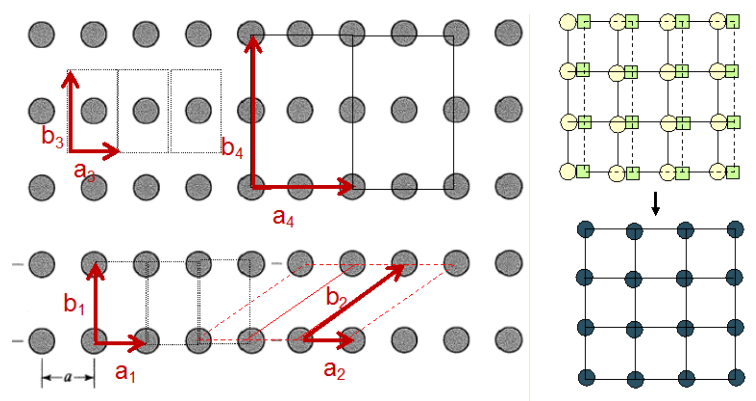


School of Electrical and
Computer Engineering

Section 3 Crystals

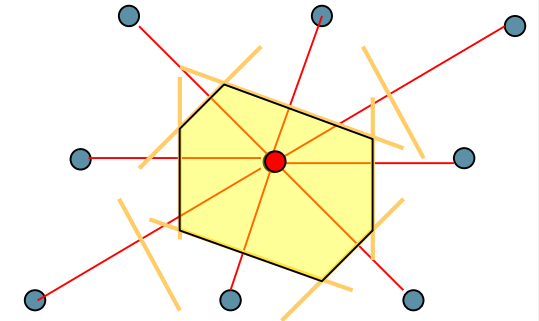
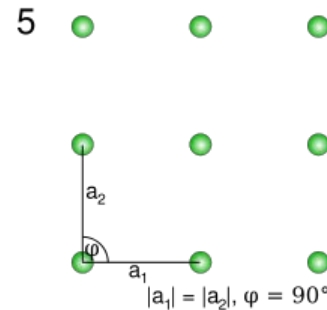
• 3.1 Crystal definitions

- » One-dimensional Crystals – simple primitive cell
- » Unit cells of a Periodic 2D Lattice
- » Bravais lattice
- » Bravais lattice with a basis
- » Non-periodic repeated cells
- » Definition of ONE Primitive Cell – Wigner-Seitz Cell



• 3.2 Tables of Bravais Lattices

- » Bravais Lattices in 2D (5 types)
- » Bravais Lattices in 3D (14 types)
- » 3 Dominant Bravais Lattices in Nature



• 3.3 Density Definitions and Applications to Common Materials

• 3.4 Surfaces, Miller Index

Reference: Vol. 6, Ch. 1, ABACUS tool at nanohub.org/tools/abacus and "Crystal Viewer Lab, <https://nanohub.org/resources/crystalviewer>

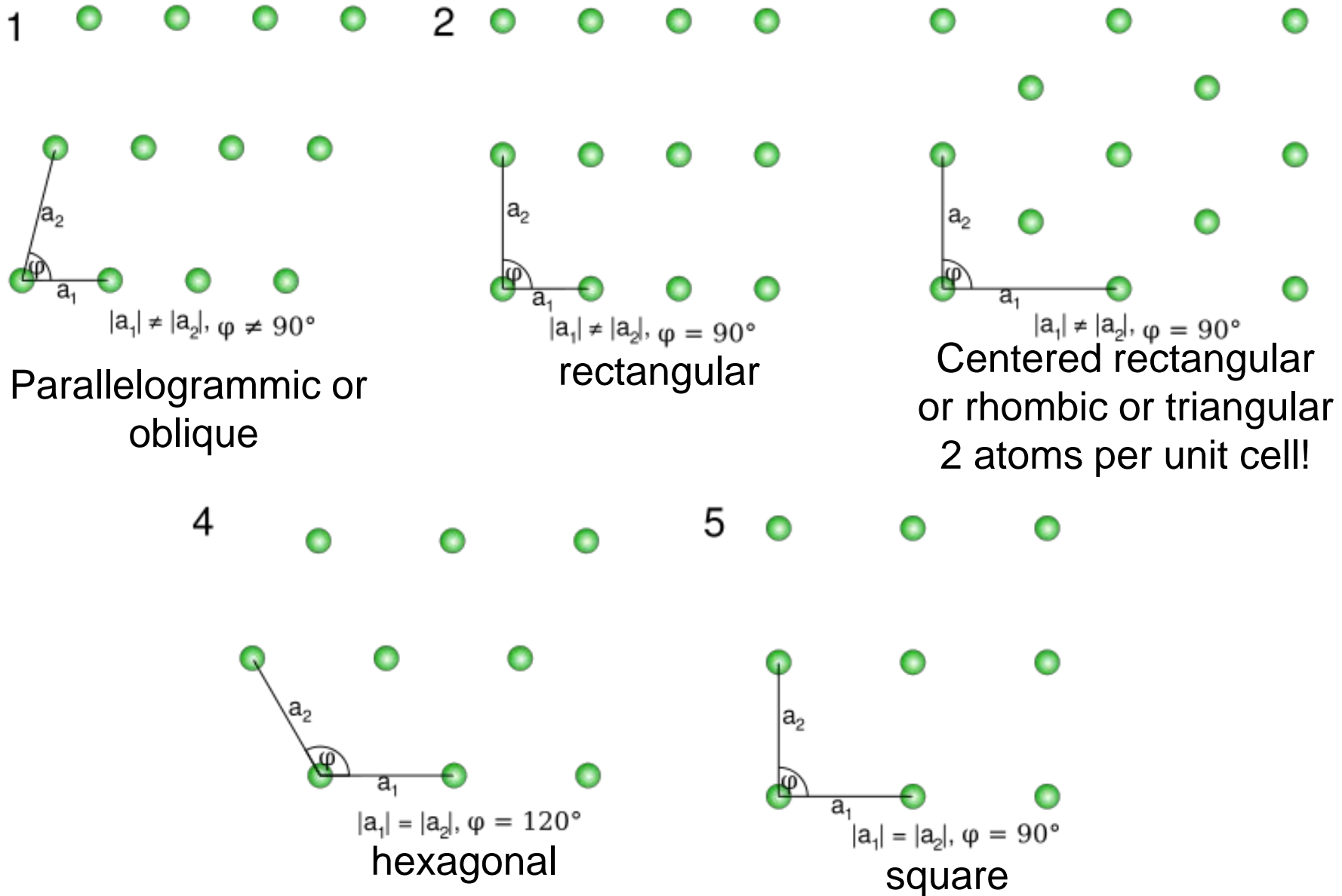
One Video Segment

One Video Segment

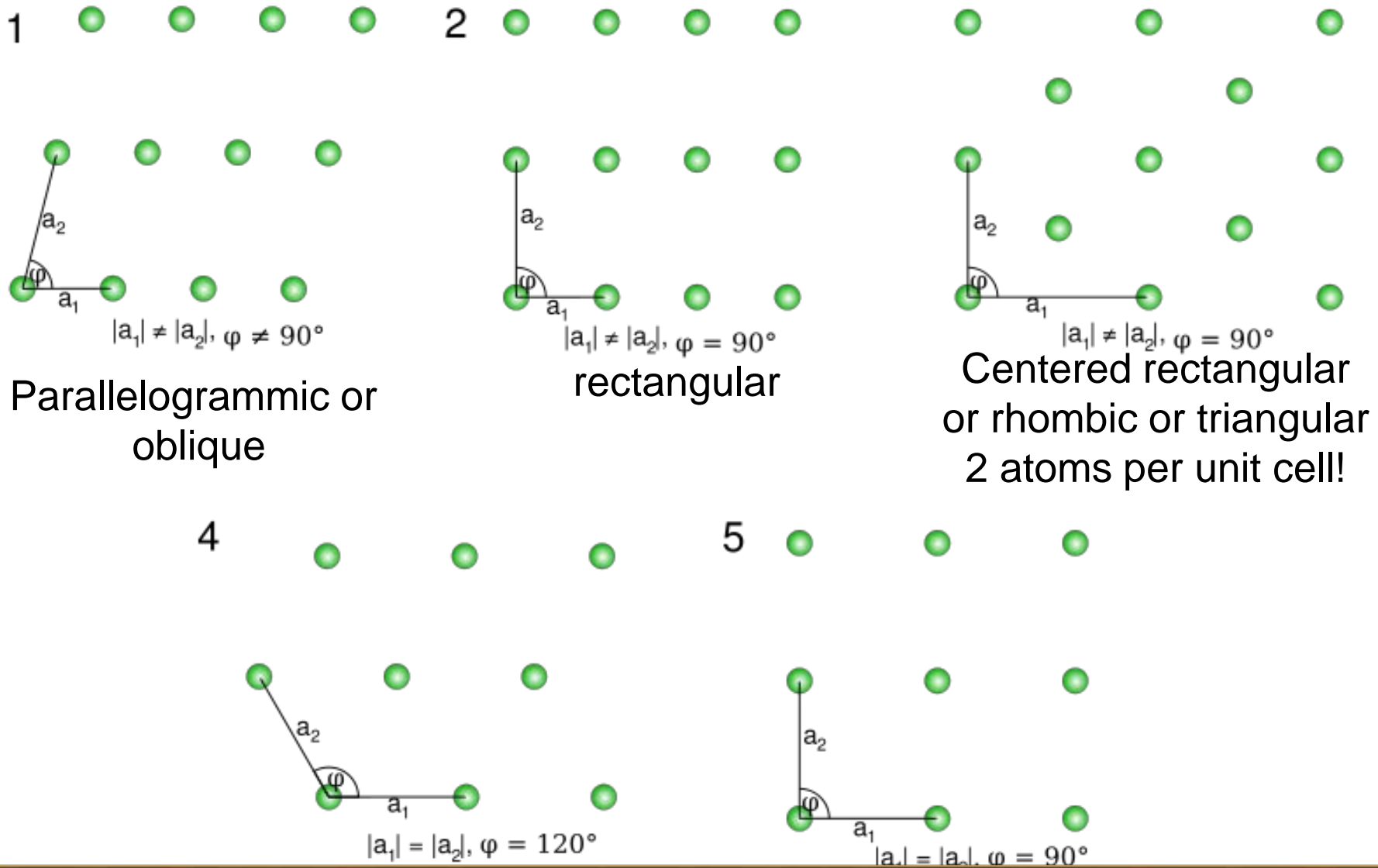
One Video Segment

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Bravais Lattices in 2D (5-types)



Bravais Lattices in 2D (5-types)

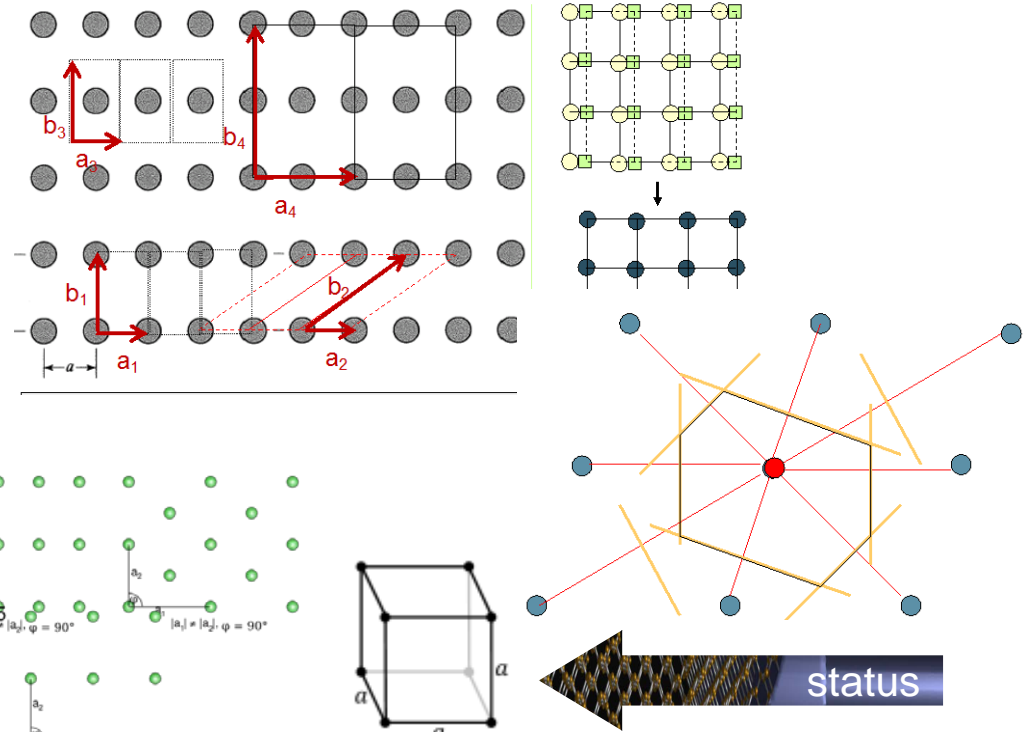


Can construct all periodic 2D lattices from these basis sets

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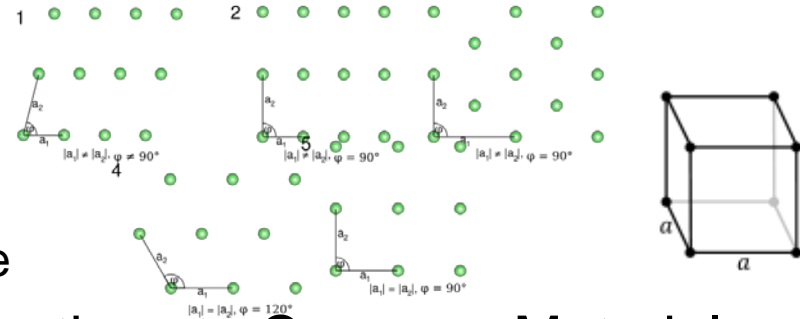
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• 3.3 Density Definitions and Applications to Common Materials

- » Number, Packing, and Areal Density
- » Common Crystals – Non-Primitive Unit Cells (NaCl, GaAs, CdS)

• 3.4 Surfaces, Miller Index

Reference: Vol. 6, Ch. 1, ABACUS tool at nanohub.org/tools/abacus and "Crystal Viewer Lab, <https://nanohub.org/resources/crystalviewer>

Bravais lattice in 3D (14-types)

Rotation

points

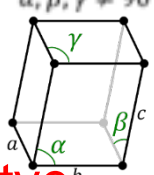
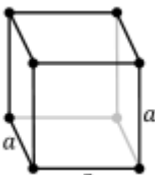
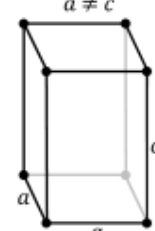
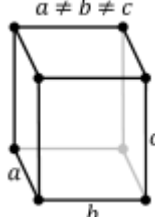
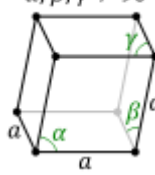


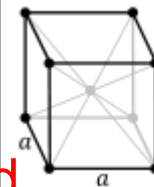
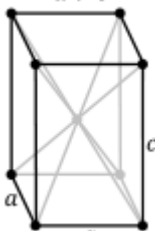
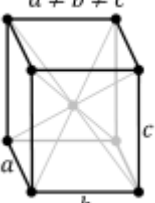
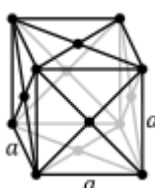

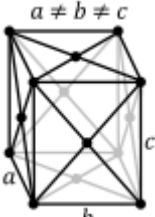
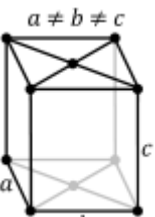
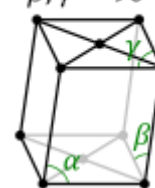
primitive

Body centered

Face centered

C

Single face centered

	Triclinic	Cubic	Tetragonal	Orthorhombic	Rhombohedral	Hexagonal	Monoclinic
P	$\alpha, \beta, \gamma \neq 90^\circ$ 		$a \neq c$ 	$a \neq b \neq c$ 	$\alpha, \beta, \gamma \neq 90^\circ$ 	$a \neq c$ 	$\alpha \neq 90^\circ$ $\beta, \gamma = 90^\circ$ 
I			$a \neq c$ 	$a \neq b \neq c$ 			
F				$a \neq b \neq c$ 			
C				$a \neq b \neq c$ 			$\alpha \neq 90^\circ$ $\beta, \gamma = 90^\circ$ 

Bravais lattice in 3D (14-types)

Rotation

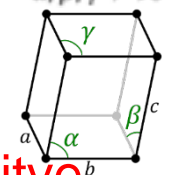
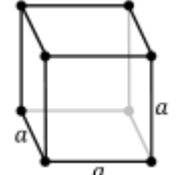
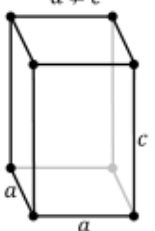
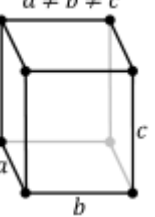
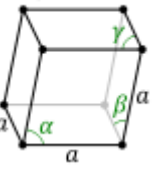
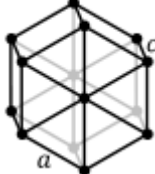
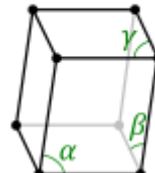
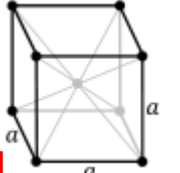
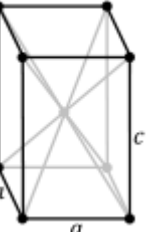
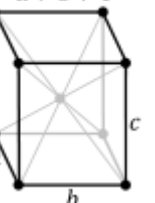
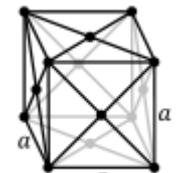
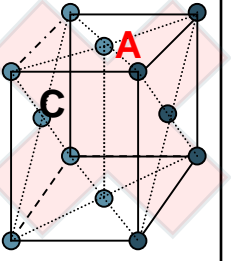
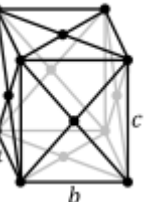
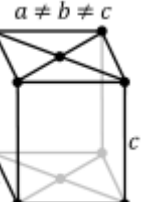
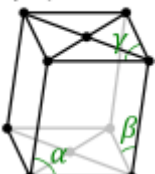
points

primitive

Body centered

Face centered

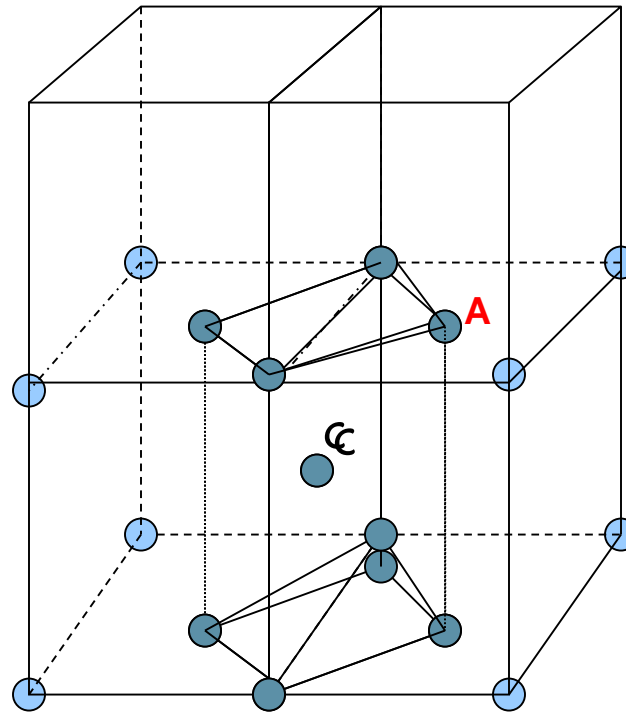
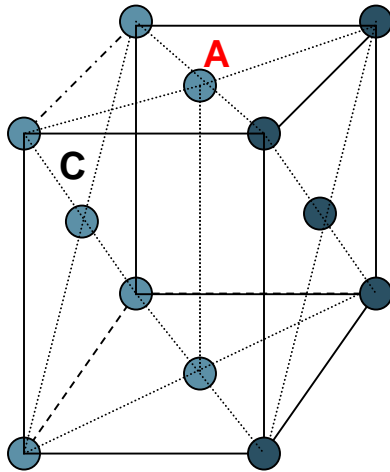
Single face centered

	Triclinic	Cubic	Tetragonal	Orthorhombic	Rhombohedral	Hexagonal	Monoclinic
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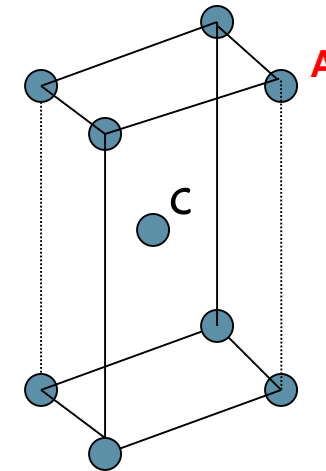
Duplicated Bravais Lattice

Unlucky Frankenheim (1842)
counted 15 unit cells!
Bravais pointed out that
2 cells were duplicated

Tetragonal face centered


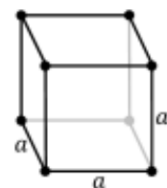
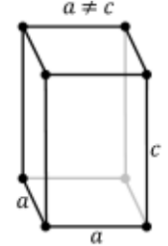
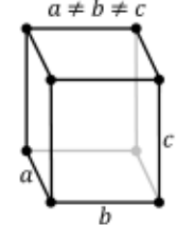
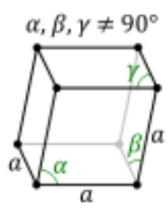

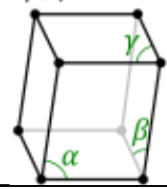
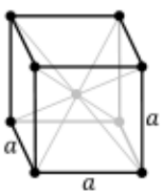
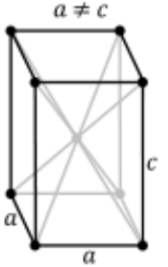
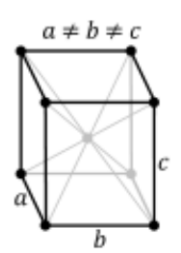
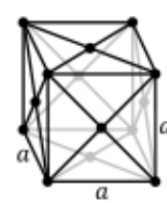
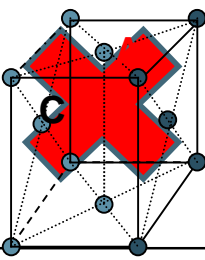
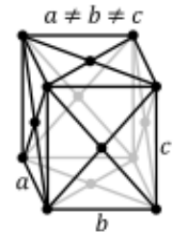
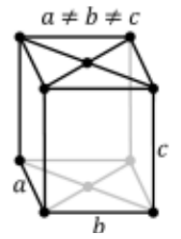
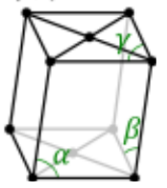


Tetragonal body centered


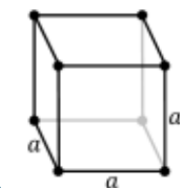

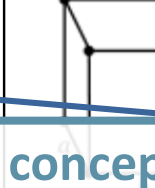

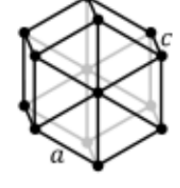
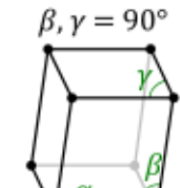
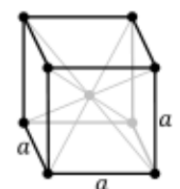
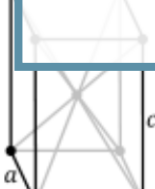
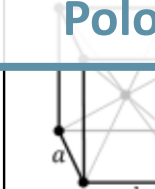
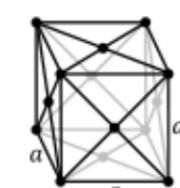
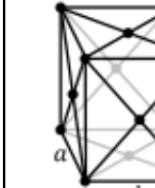
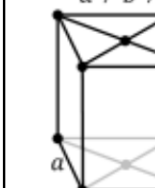
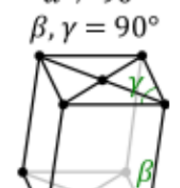


Tetragonal FC = Tetragonal BC

Bravais lattice in 3D (14-types)

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3 Dominant Bravais Lattices in Nature

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Cubic conceptionally simple,
but experimentally very unusual
Polonium84

70-75% of all natural
crystalline materials

