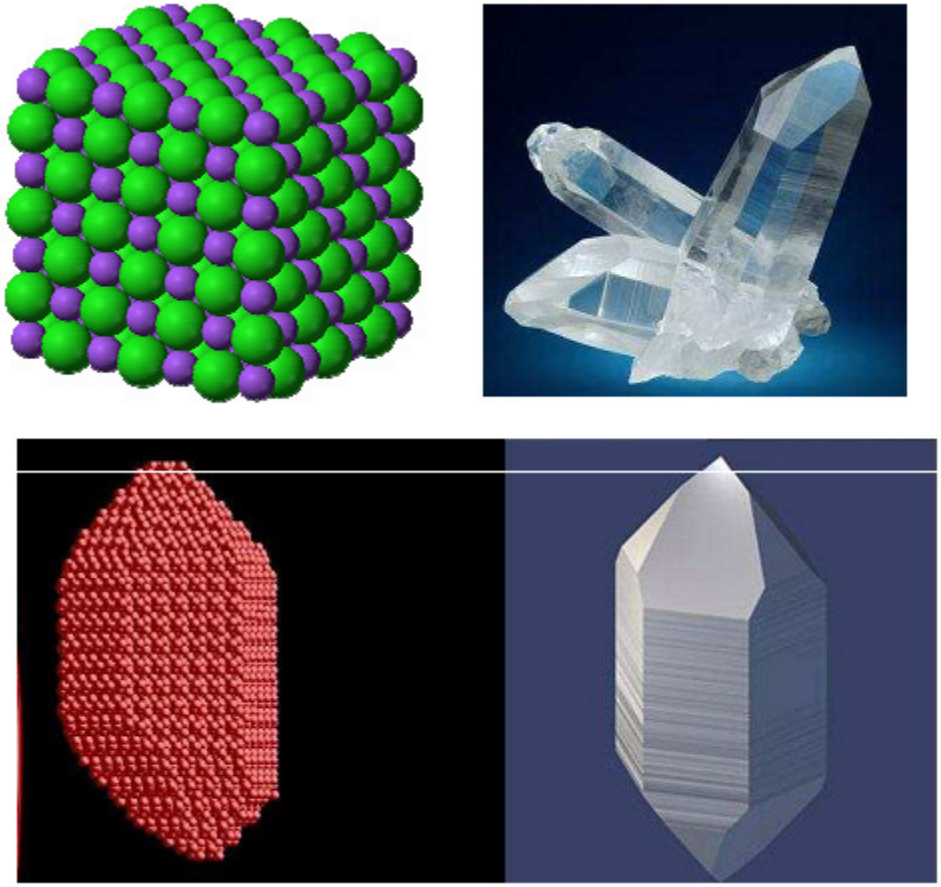
Slides
Condensed Matter Physics
Lecture 9

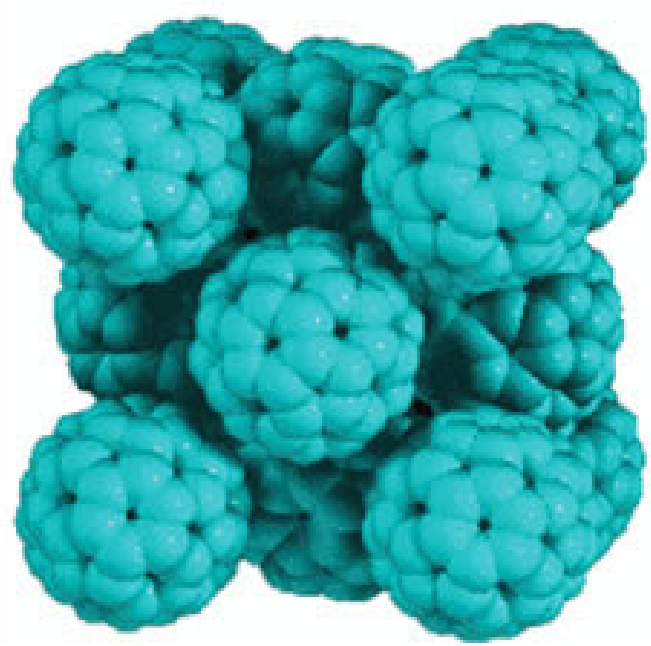
The Gecko

Example of Van der Waals

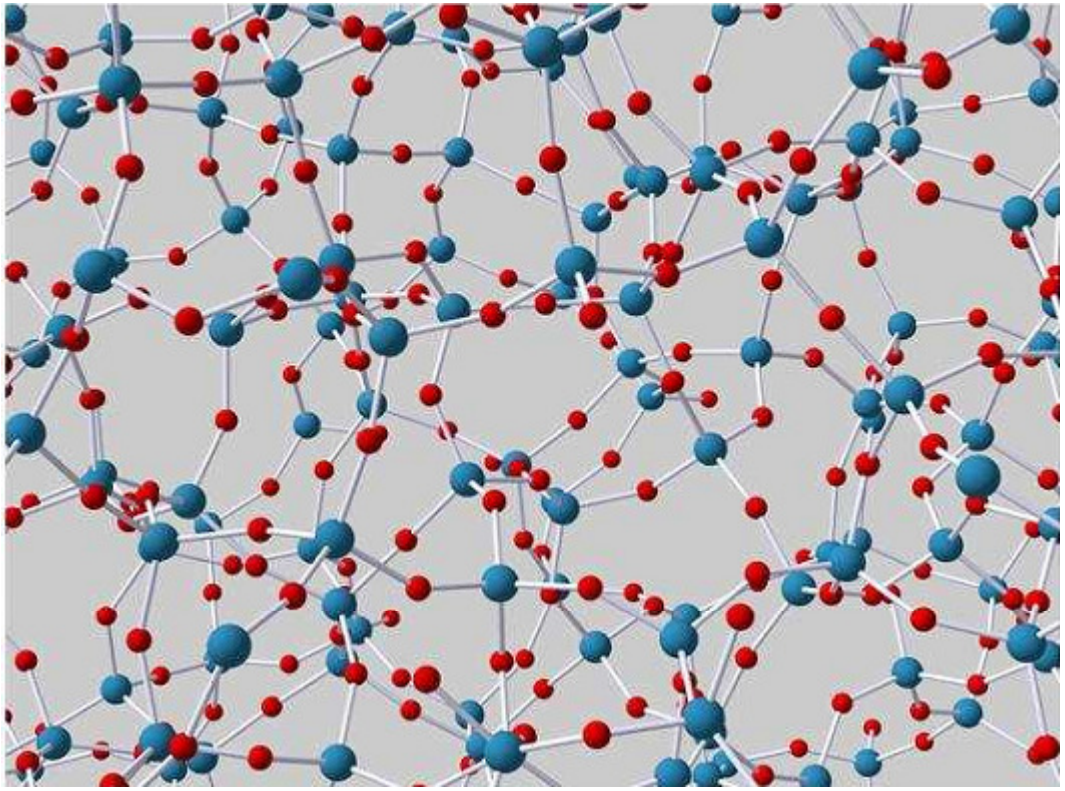
Just a few examples of condensed matter…



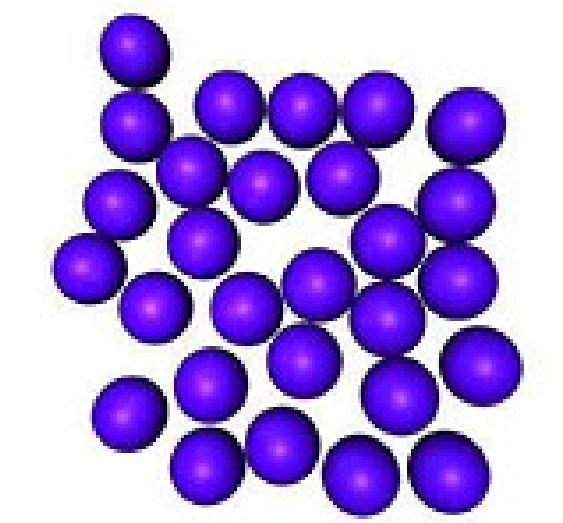
Crystalline Solids



Molecular Crystals



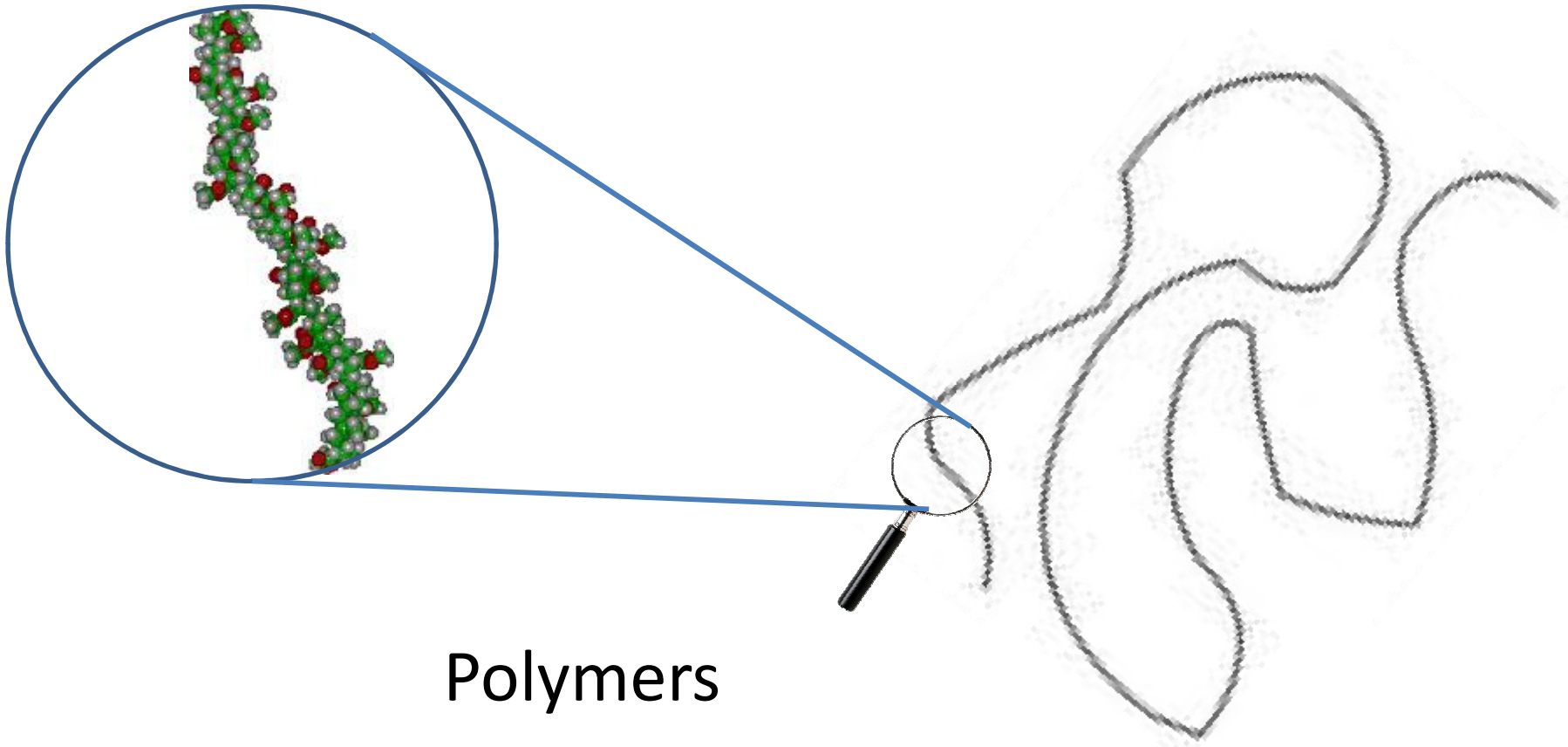
Amorphous Solids



Liquids

Liquid Crystals

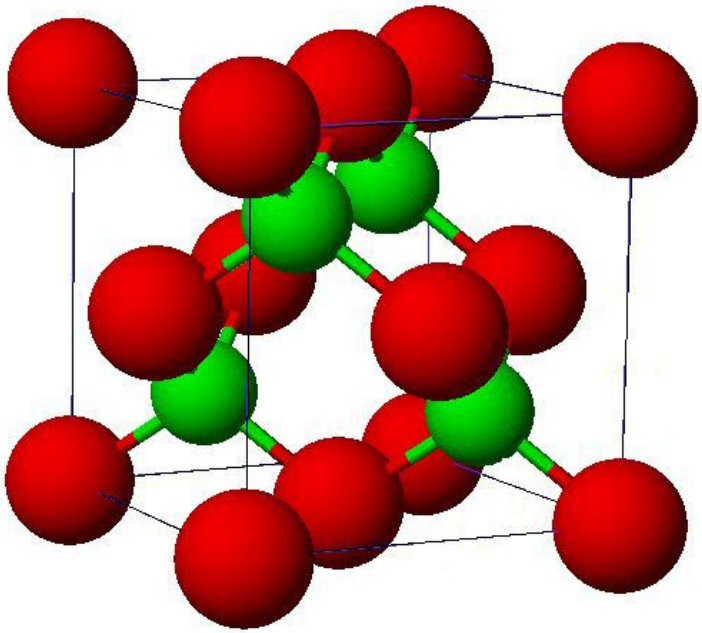
(Partial Order)

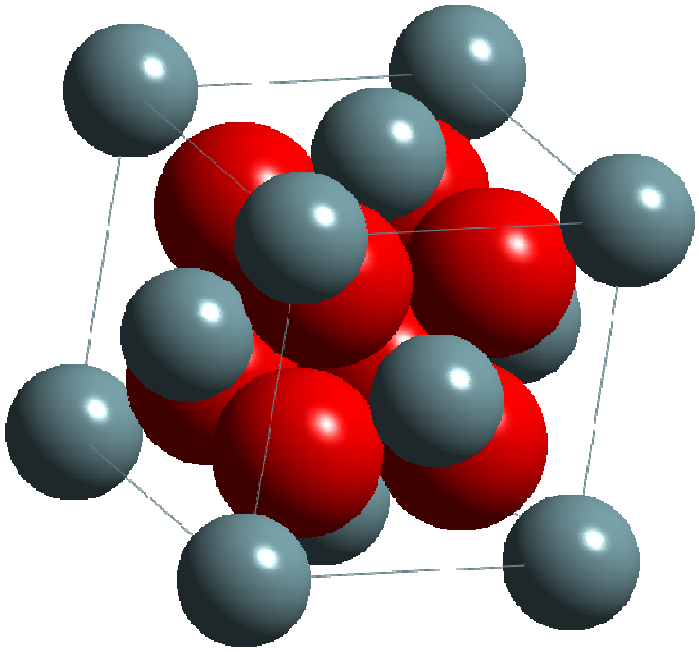


Polymers

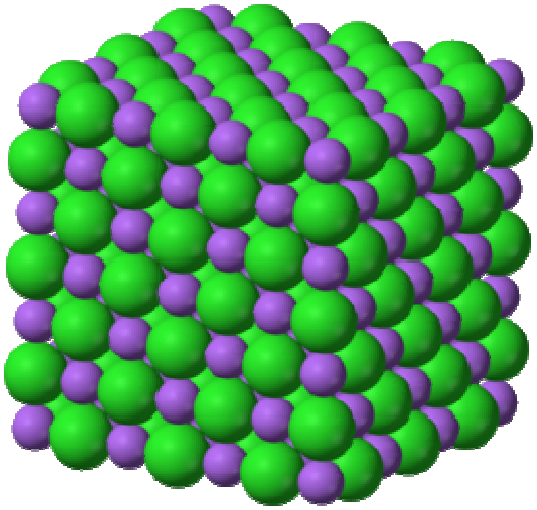
Crystal Structure Etc…

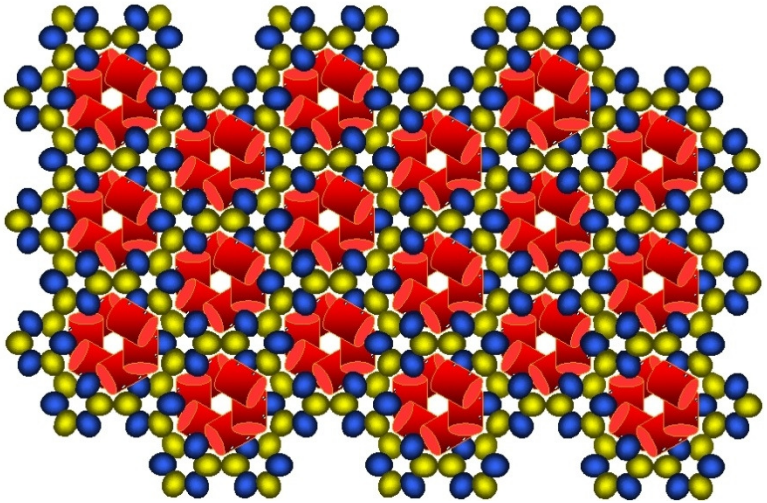
I can’t draw this on the chalkboard….

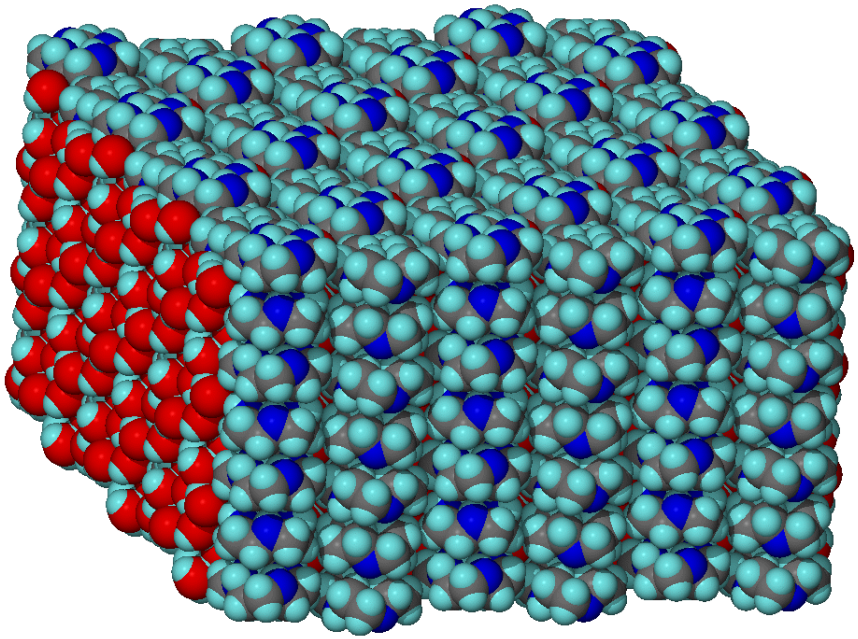


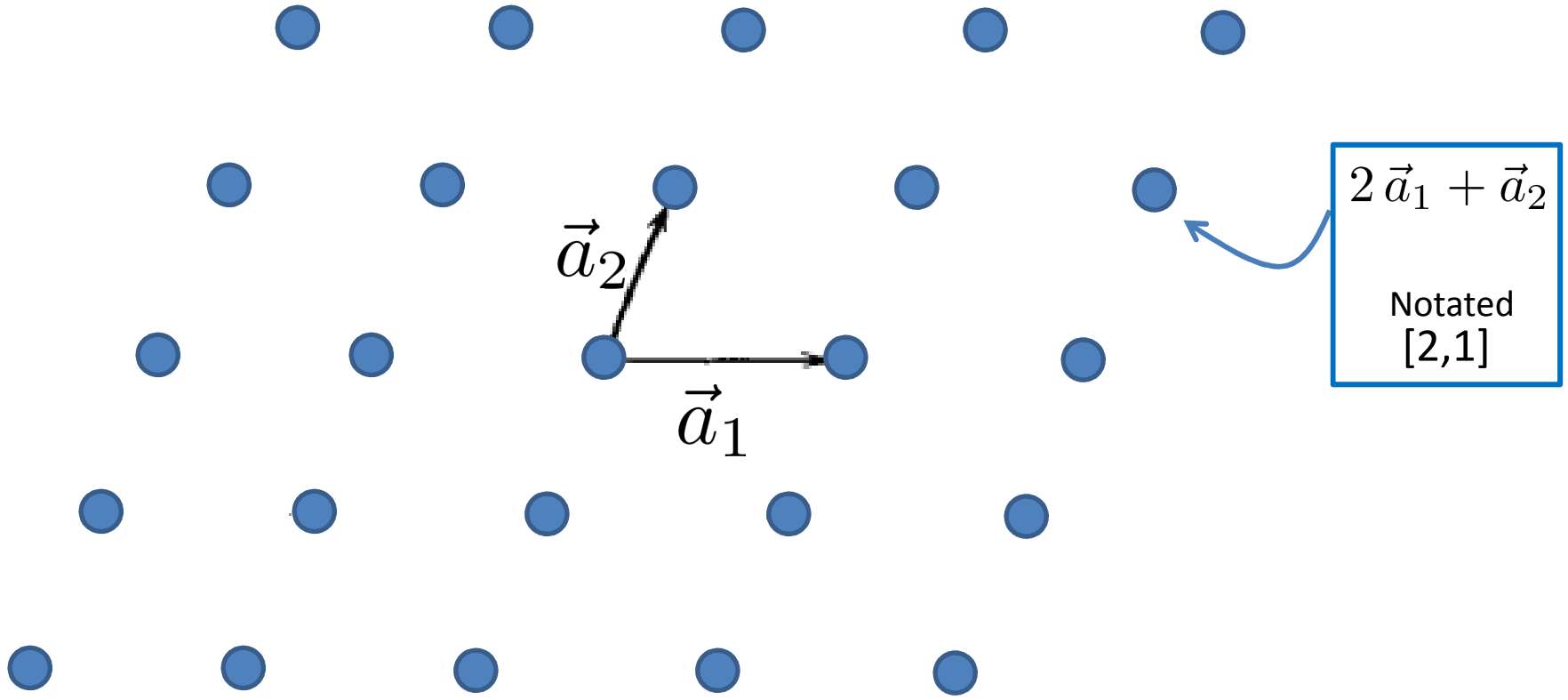


Crystals

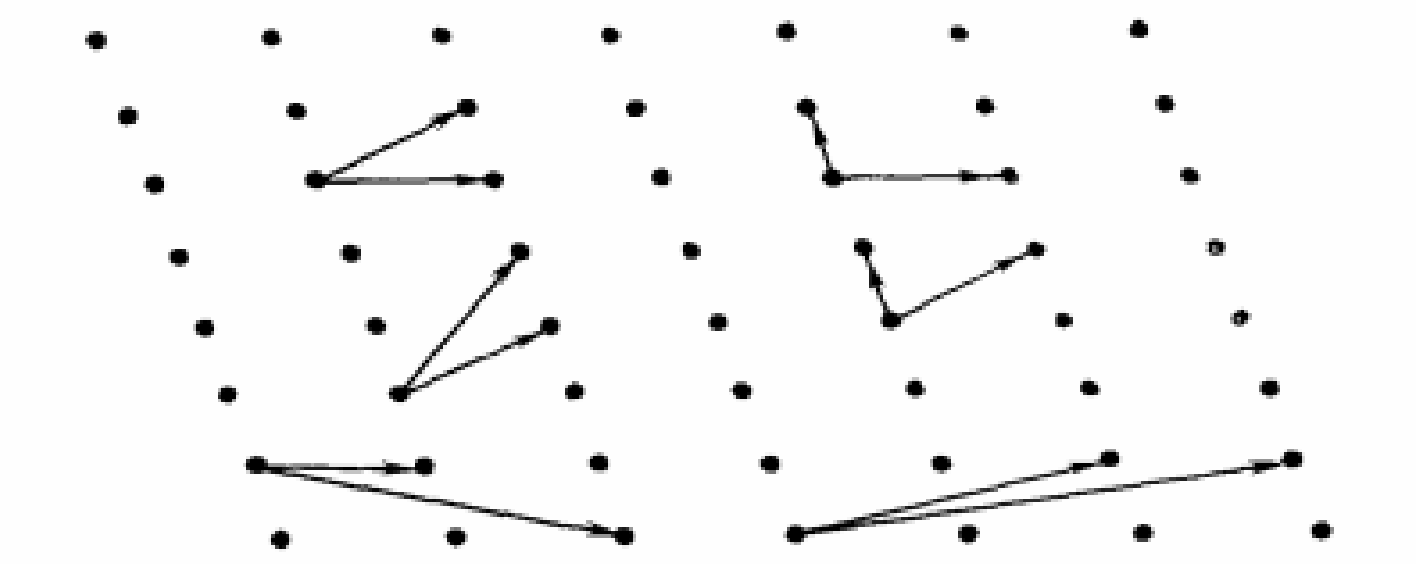




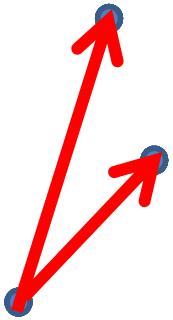




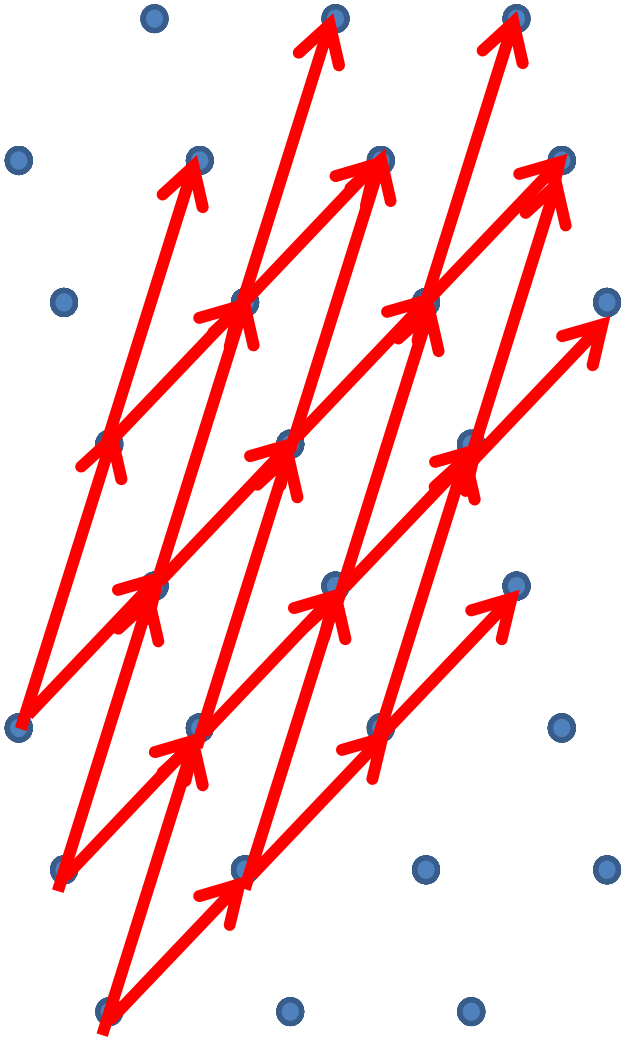
A lattice is defined as all points that are integer sums of primitive lattice vectors (primitive basis vectors).



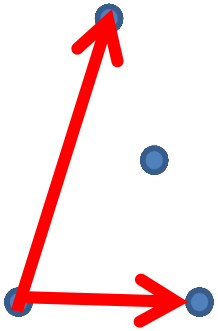
The choice of primitive lattice (basis) vectors for a lattice is not unique



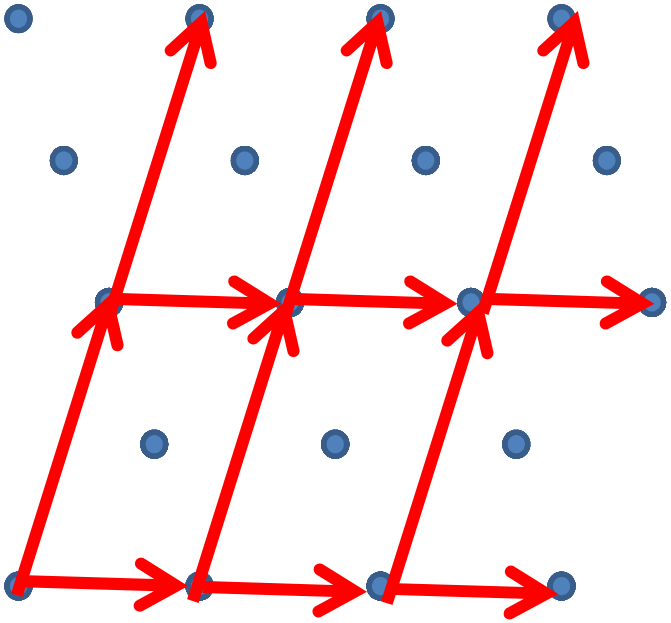
Are these primitive lattice vectors for the lattice ?



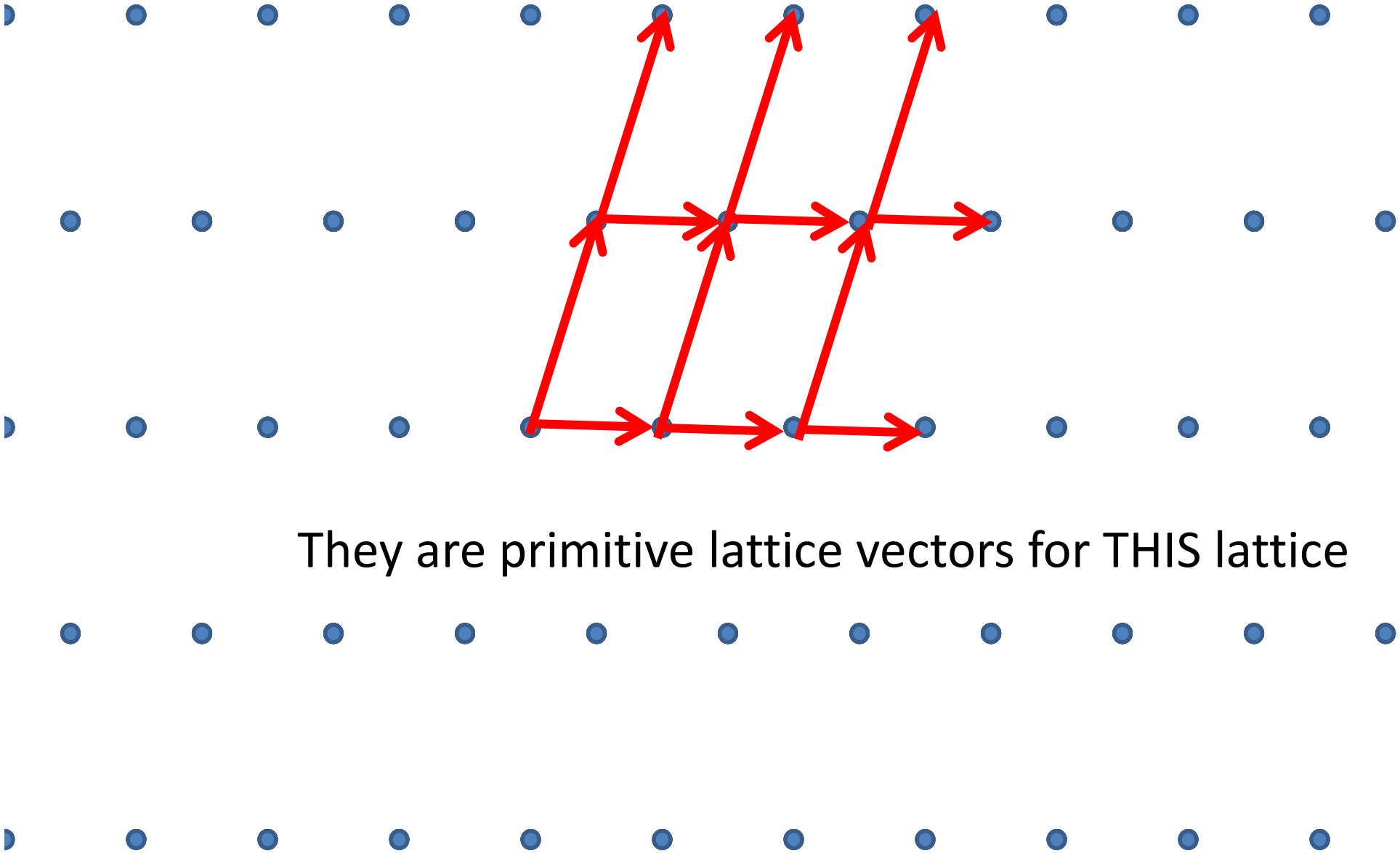
Yes !



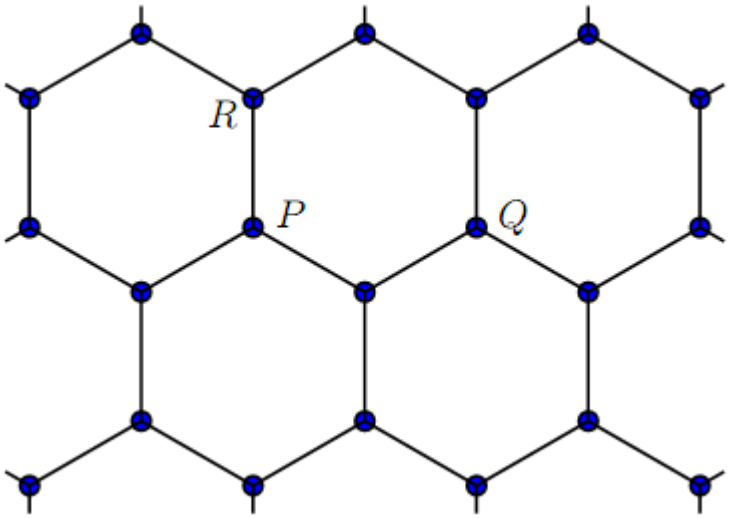
Are these primitive lattice vectors for the lattice ?



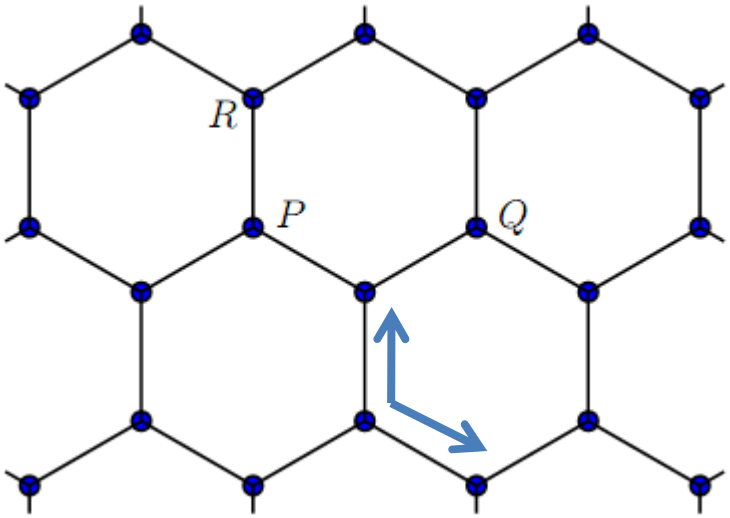
No ! (They miss every other lattice point!)



They are primitive lattice vectors for THIS lattice



is this a lattice?

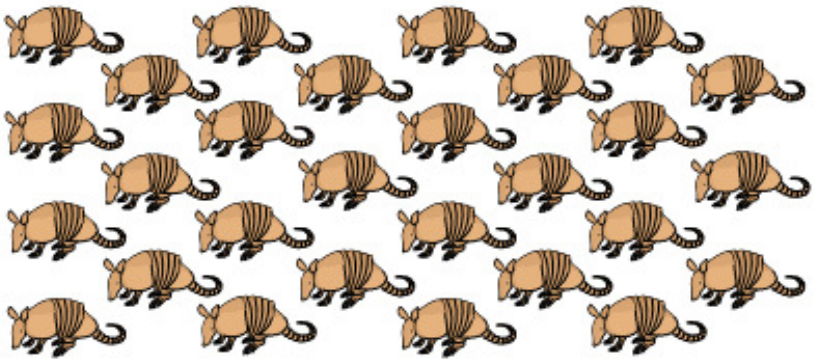


• No principle basis vectors exist which will give exactly these points (and only these points) when summed with integer coefficients.

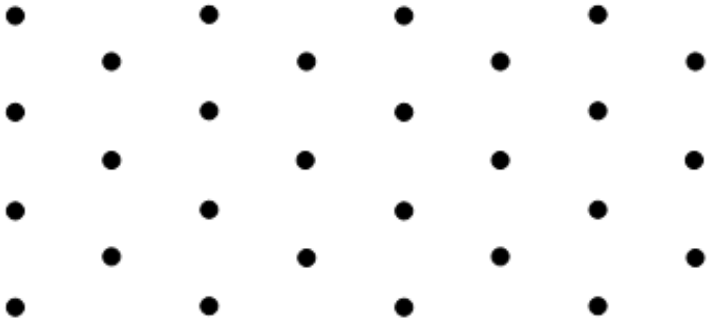
• Sum of the two blue vectors gives a point in the center of a hexagon.

• Environment of R is not the same as that of P:
(Note P *is* equivalent to Q).

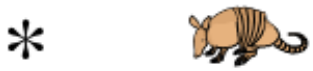
Periodic Structure



Lattice

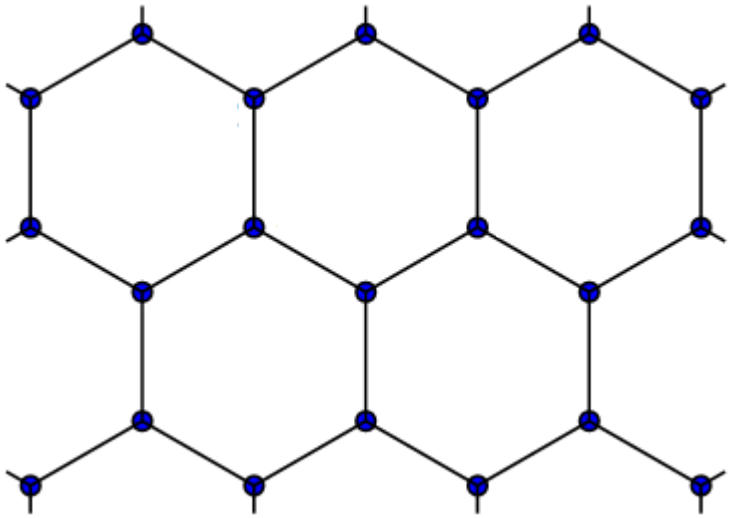


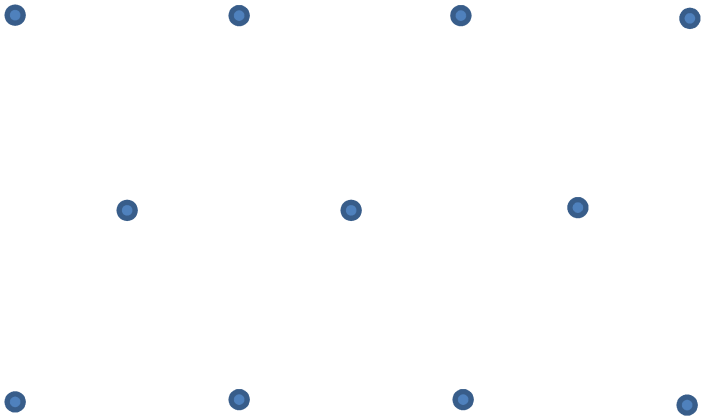
Repeating object



Any periodic structure is a lattice * repeating object

What about
This periodic
Structure?





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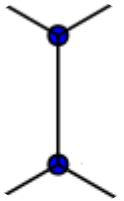
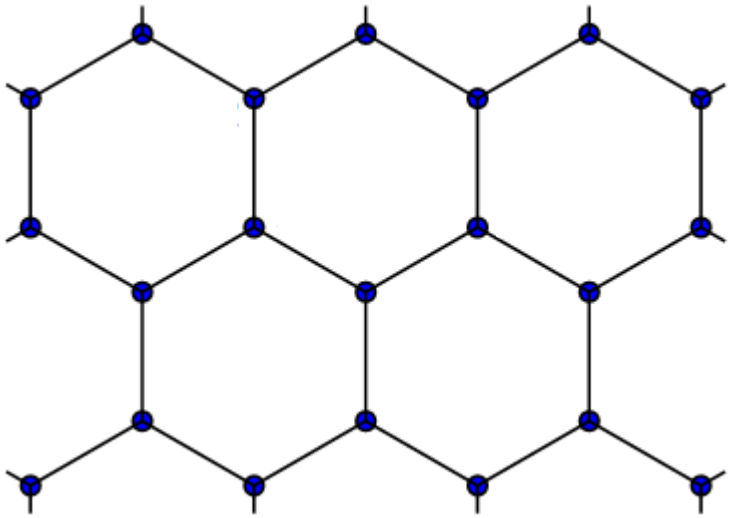
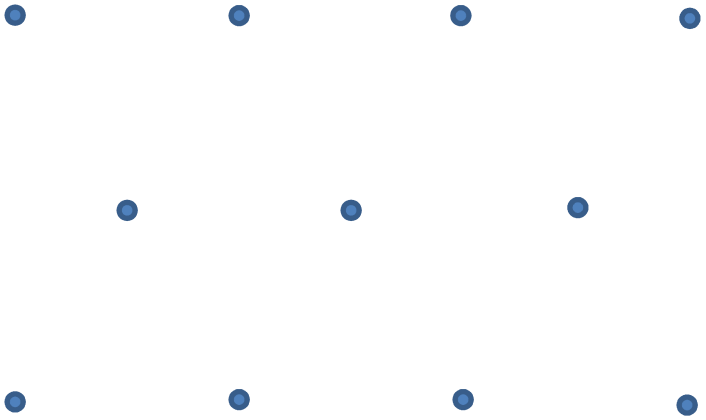


What about
This periodic
Structure?





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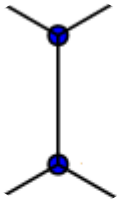

What about
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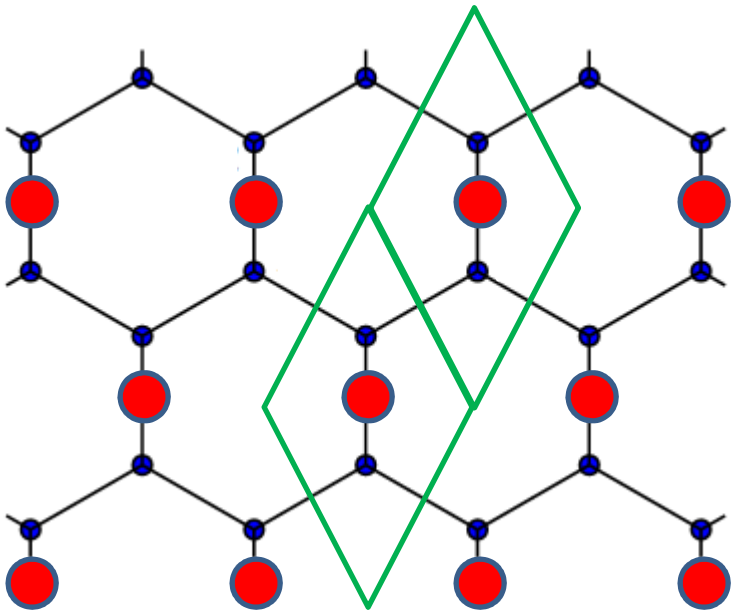
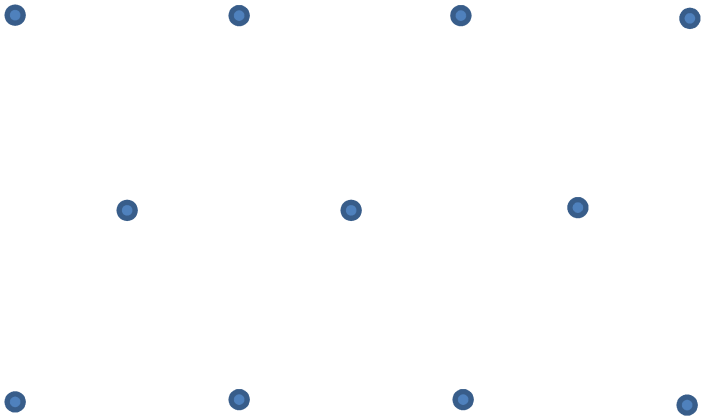
Structure?





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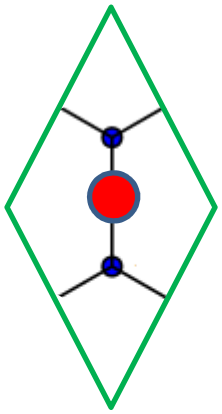
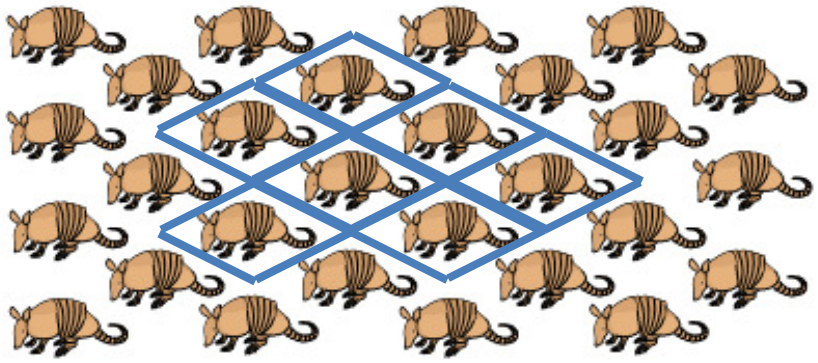
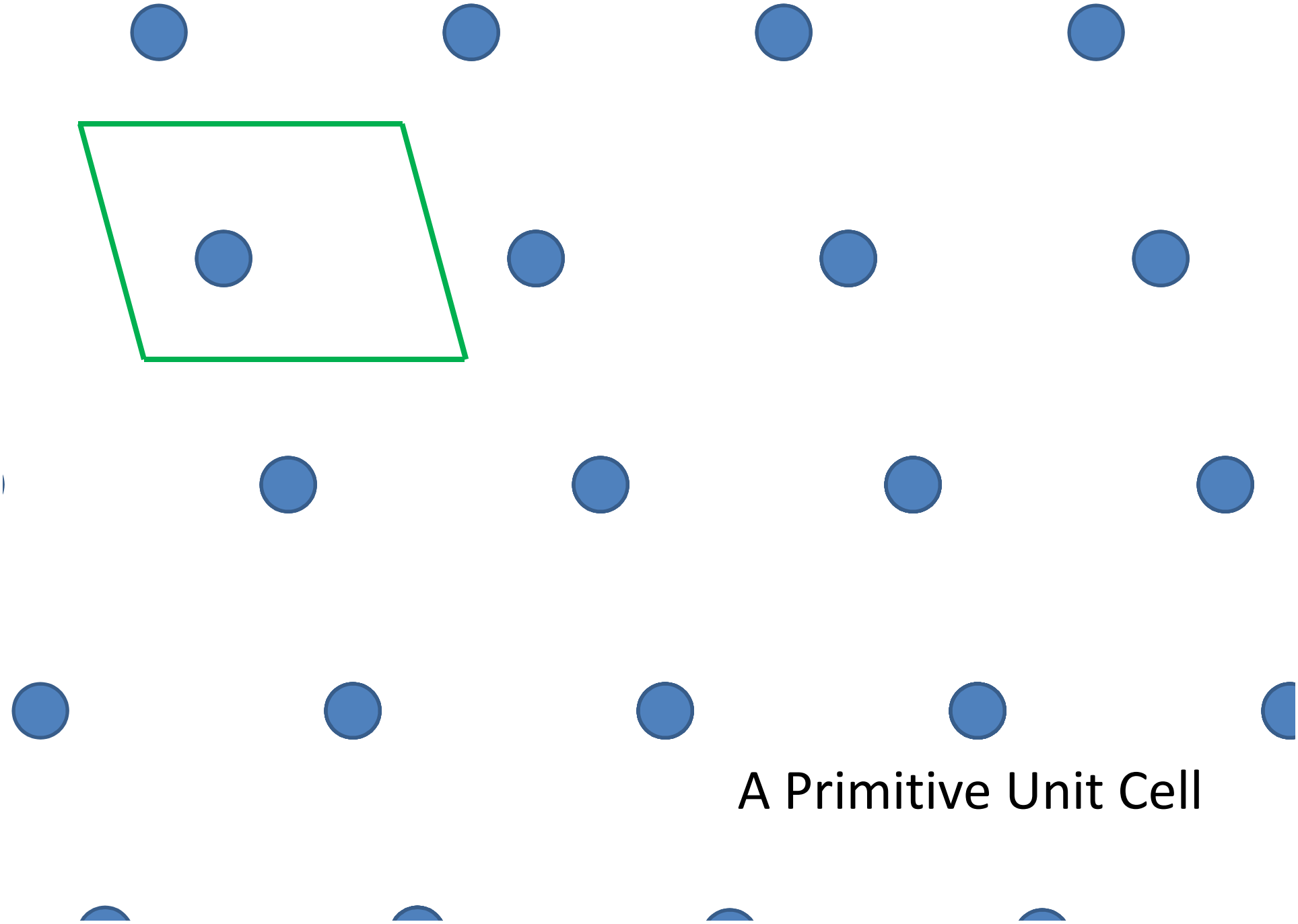


Periodic Structure

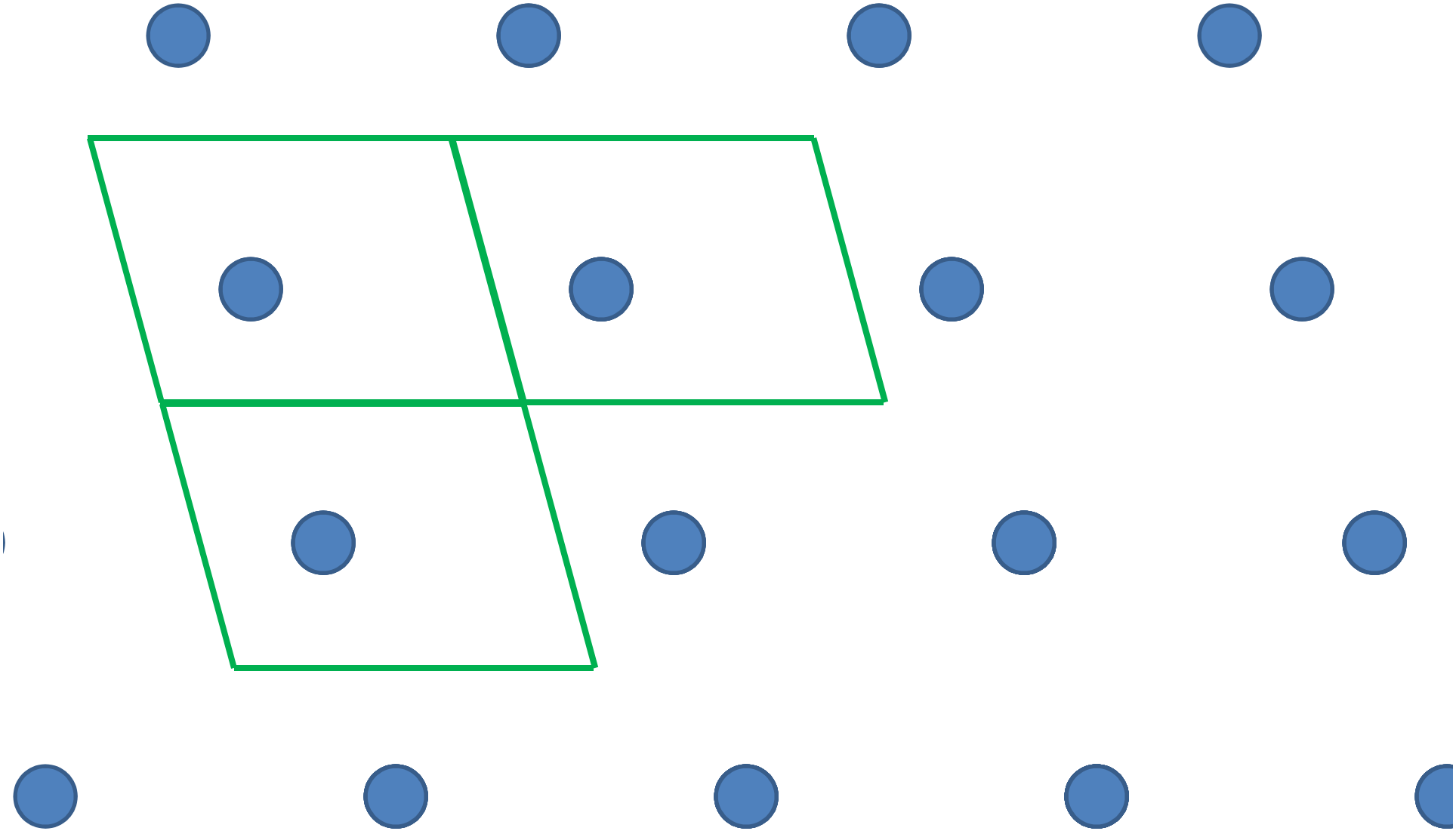


Unit Cell

The unit cell tiles space and reproduces the periodic structure



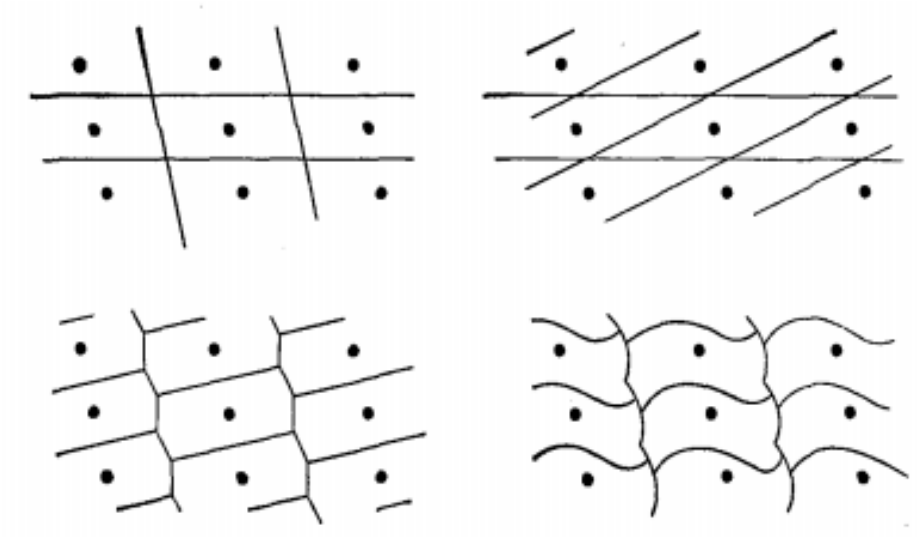
A Primitive Unit Cell



A Primitive Unit Cell.

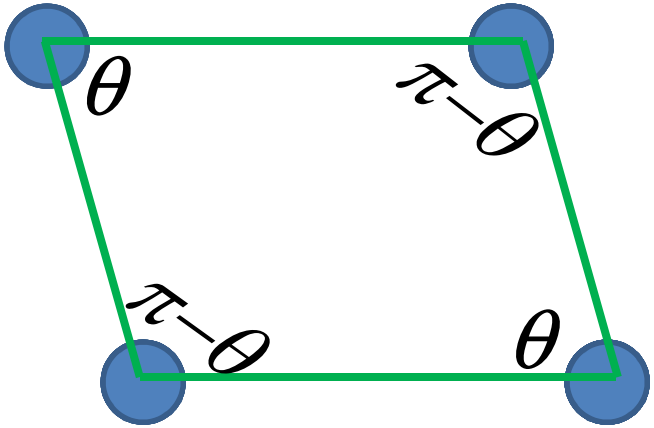
Tiles space and encloses 1 lattice point.

Primitive unit cell is not unique



This is a good primitive unit cell too!

The one lattice point enclosed is split into 4 pieces, but they add up to 1 point.



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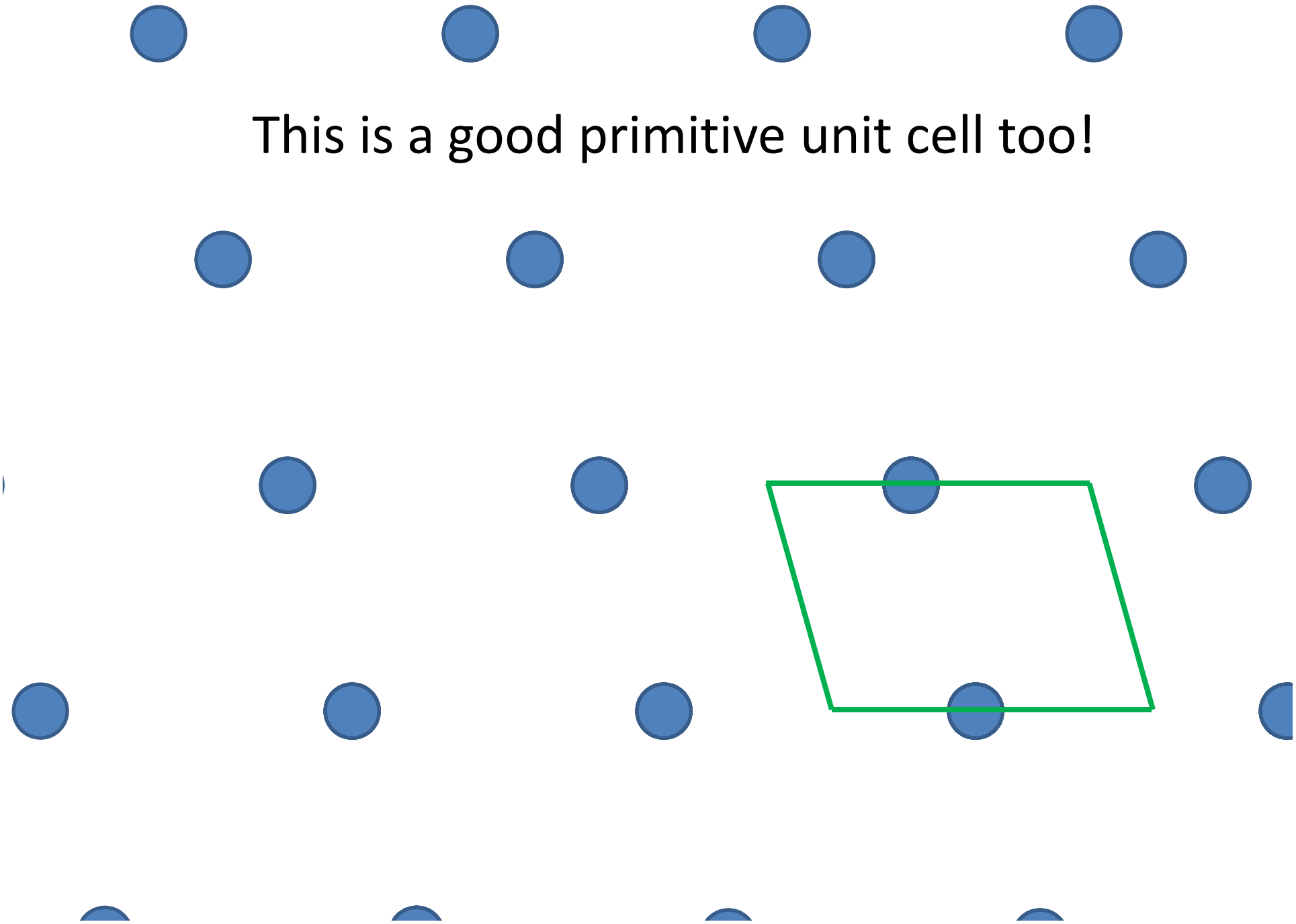

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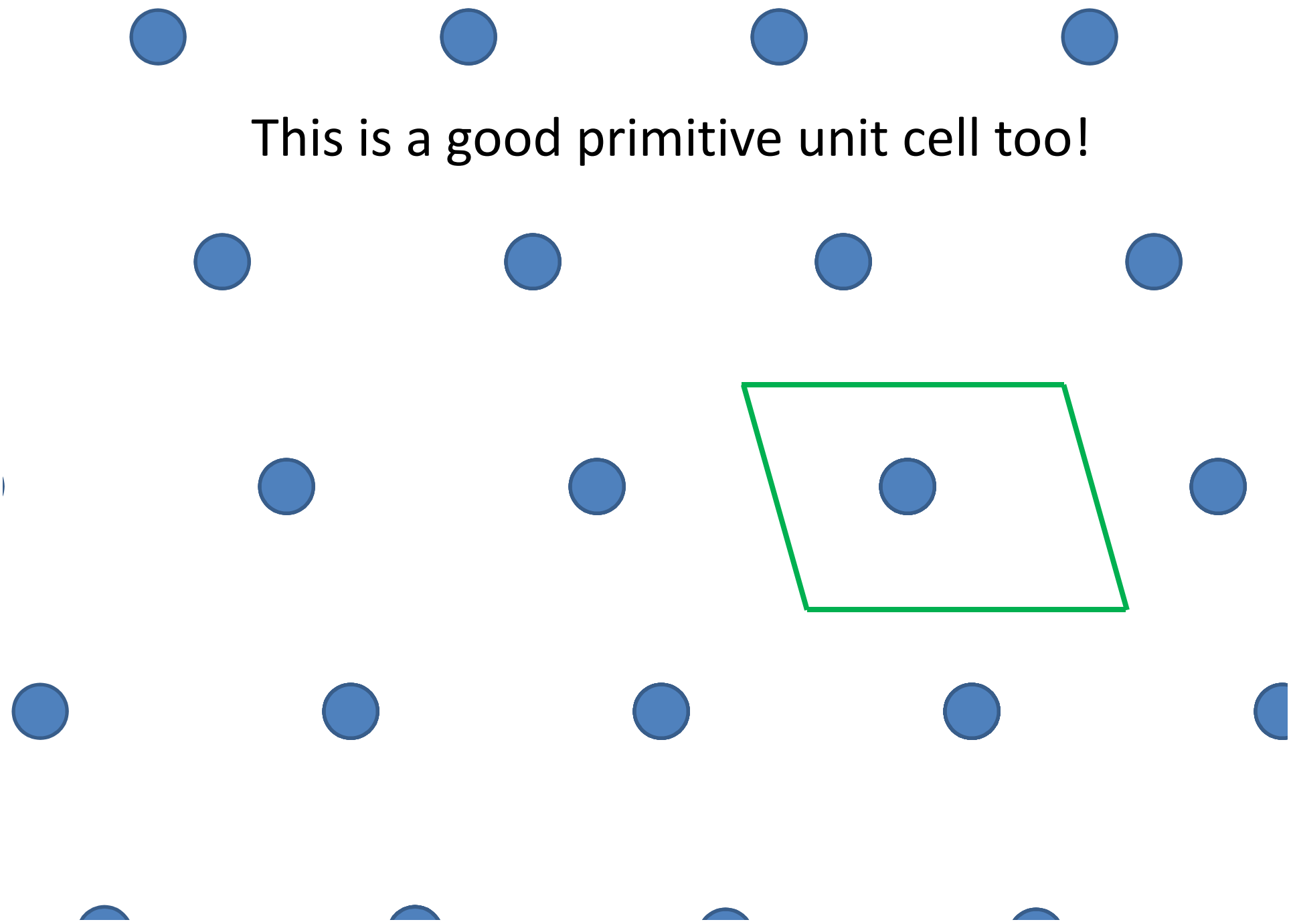
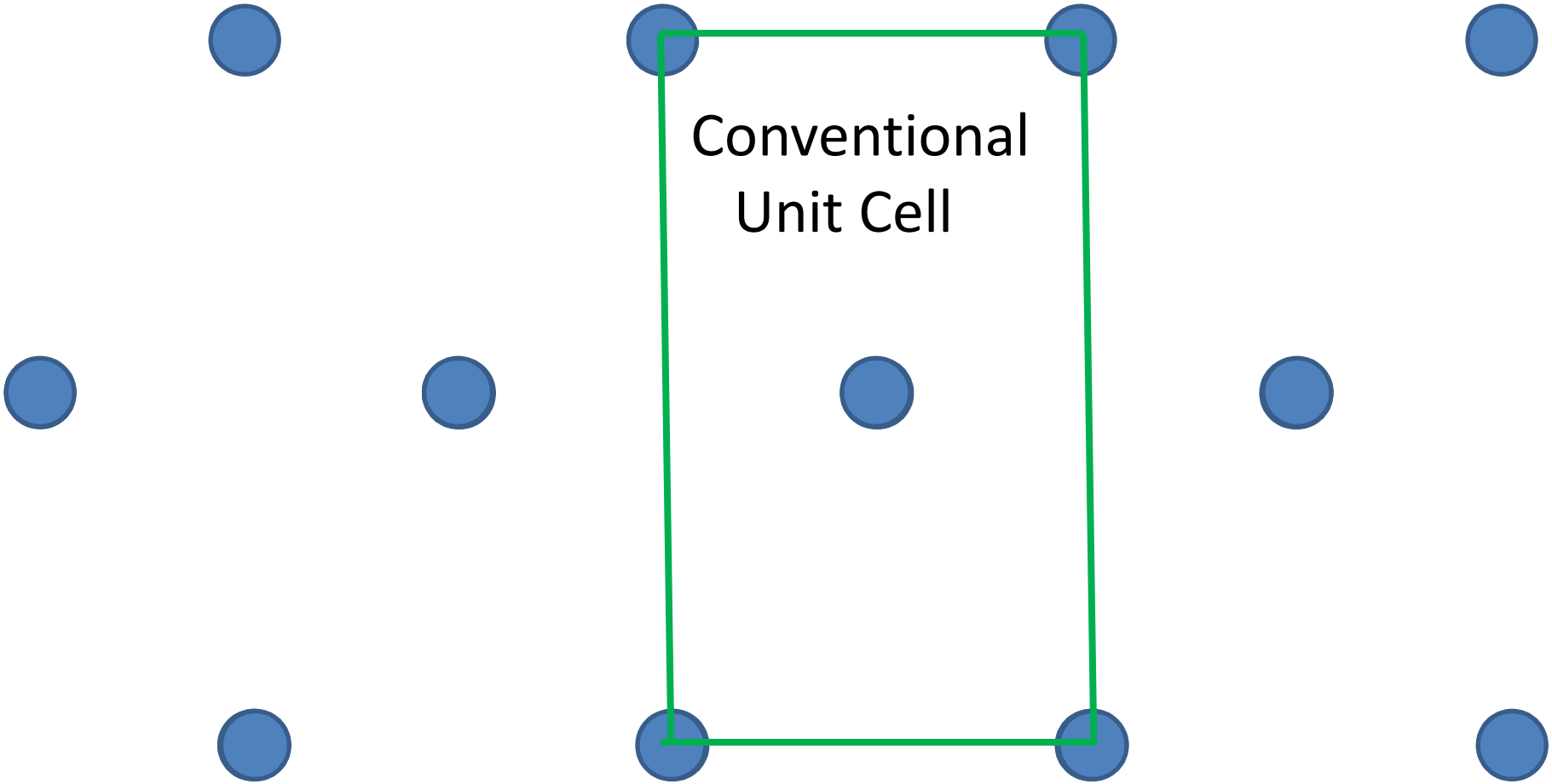
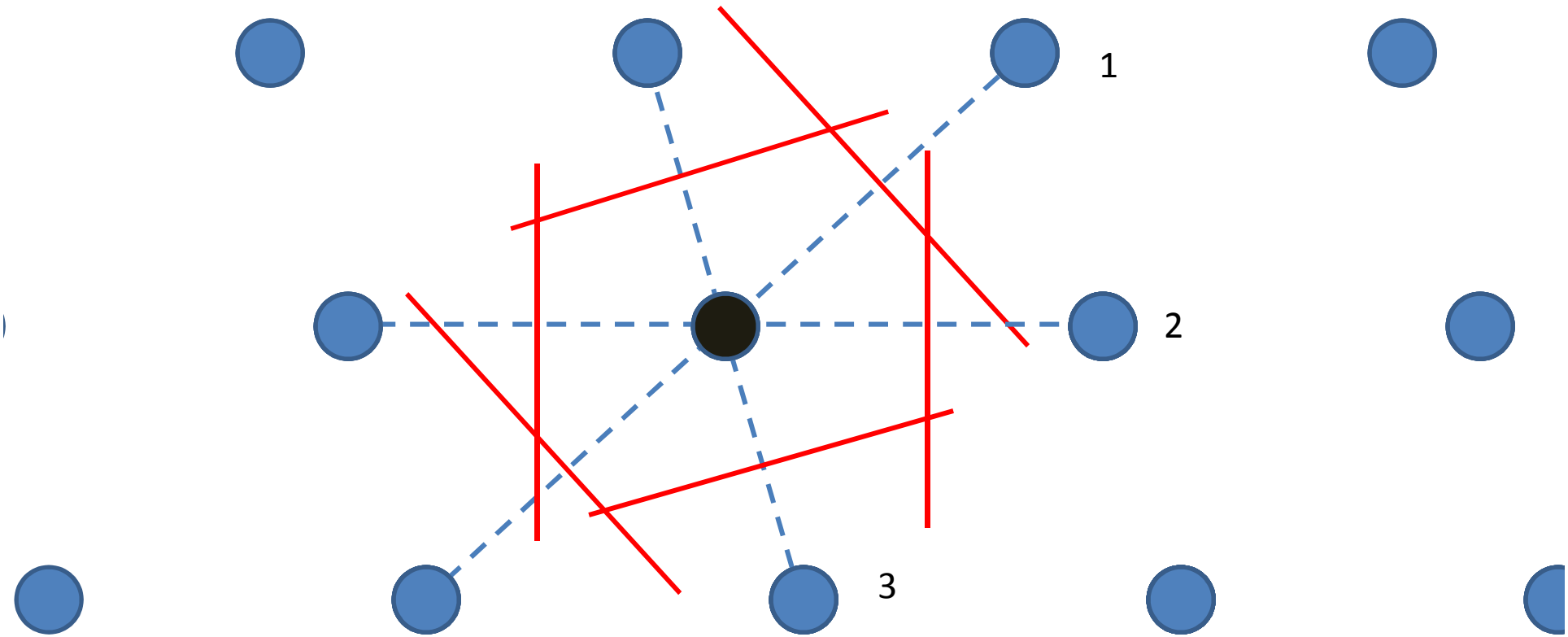


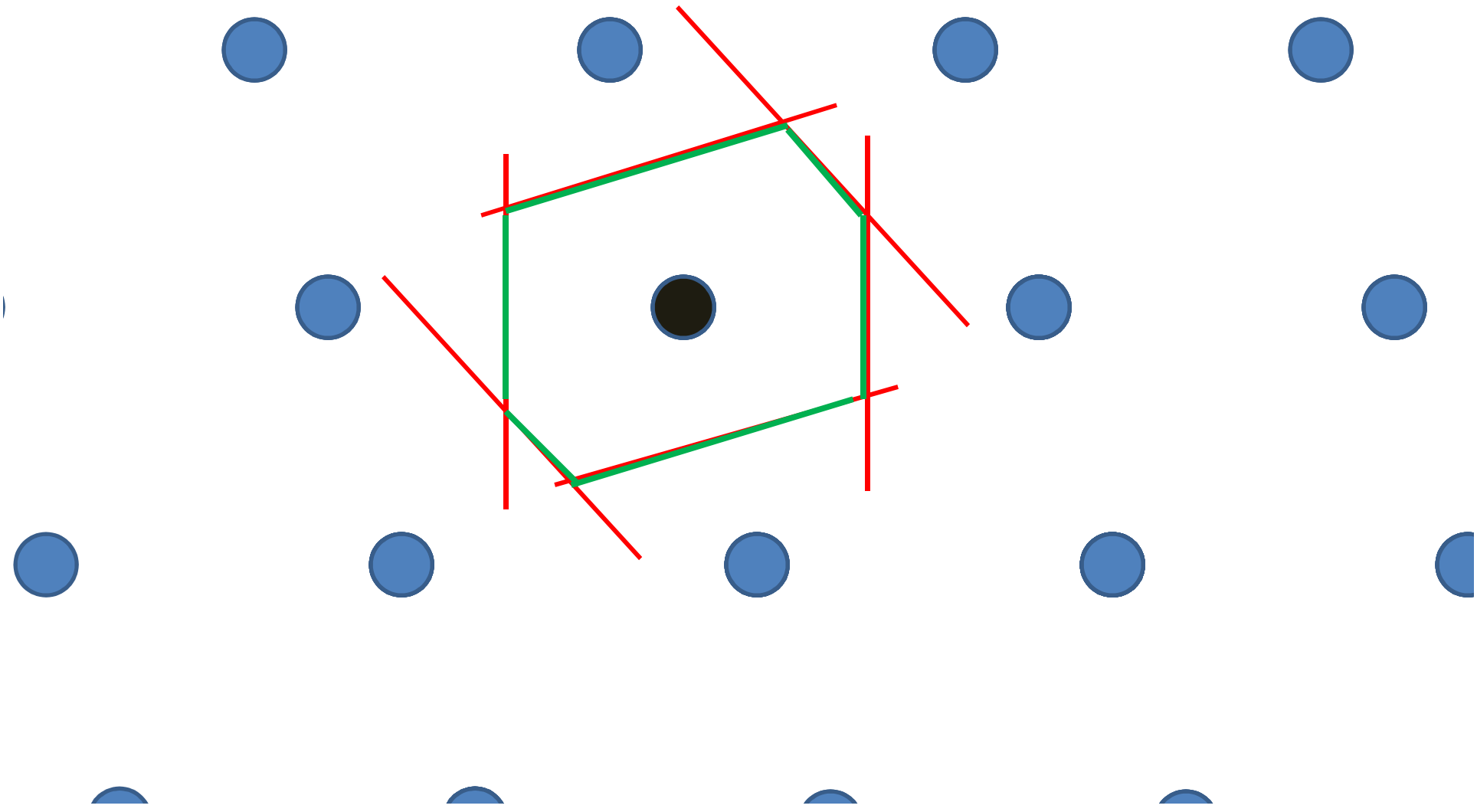
(Triangular Lattice)



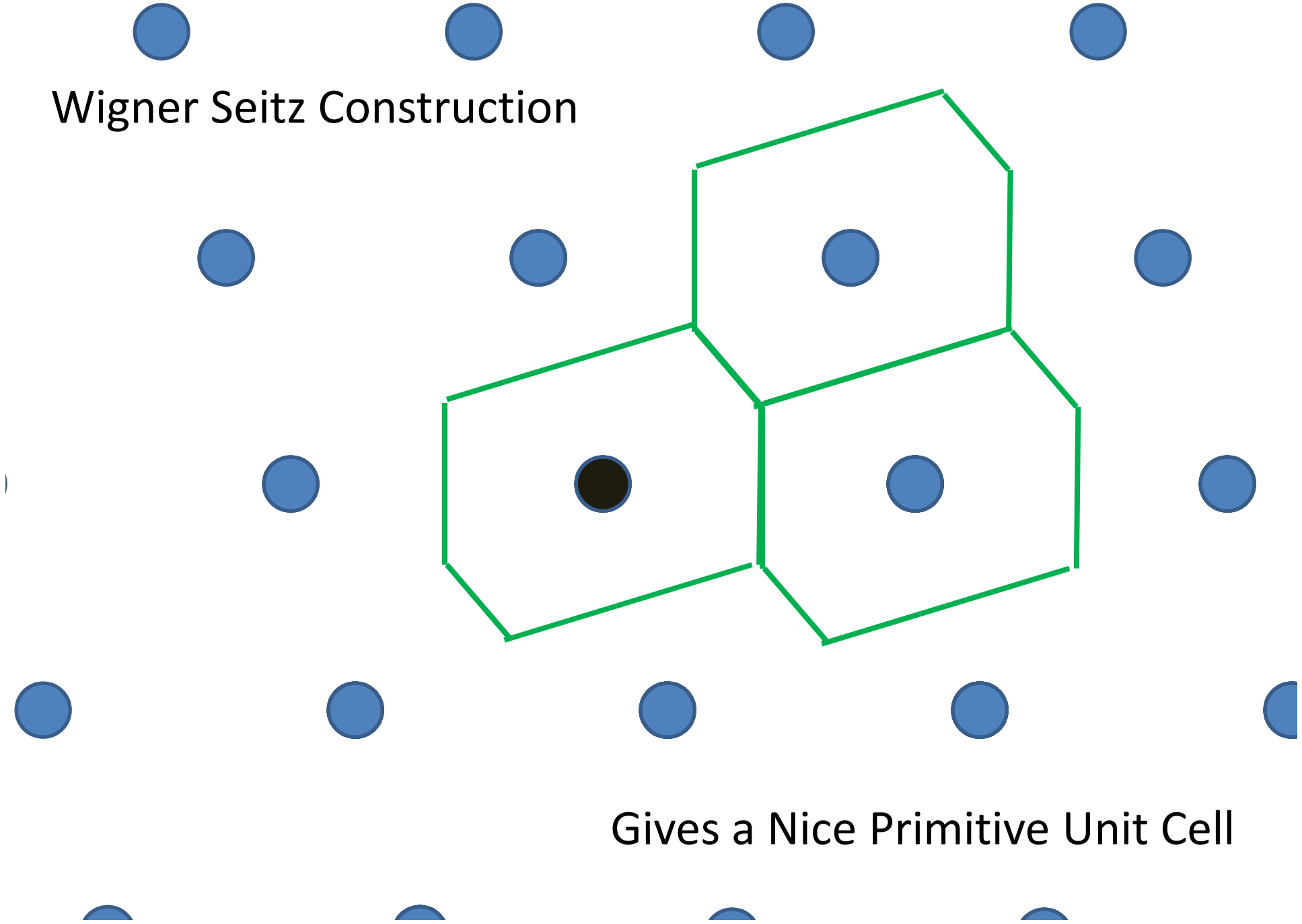
Wigner Seitz Construction



Wigner Seitz Construction

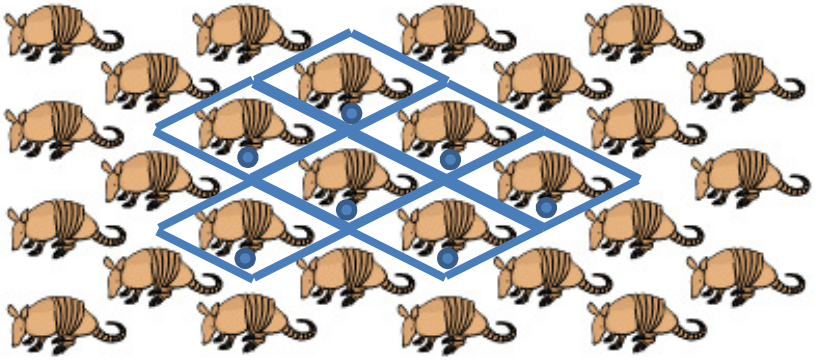


Wigner Seitz Construction



Gives a Nice Primitive Unit Cell

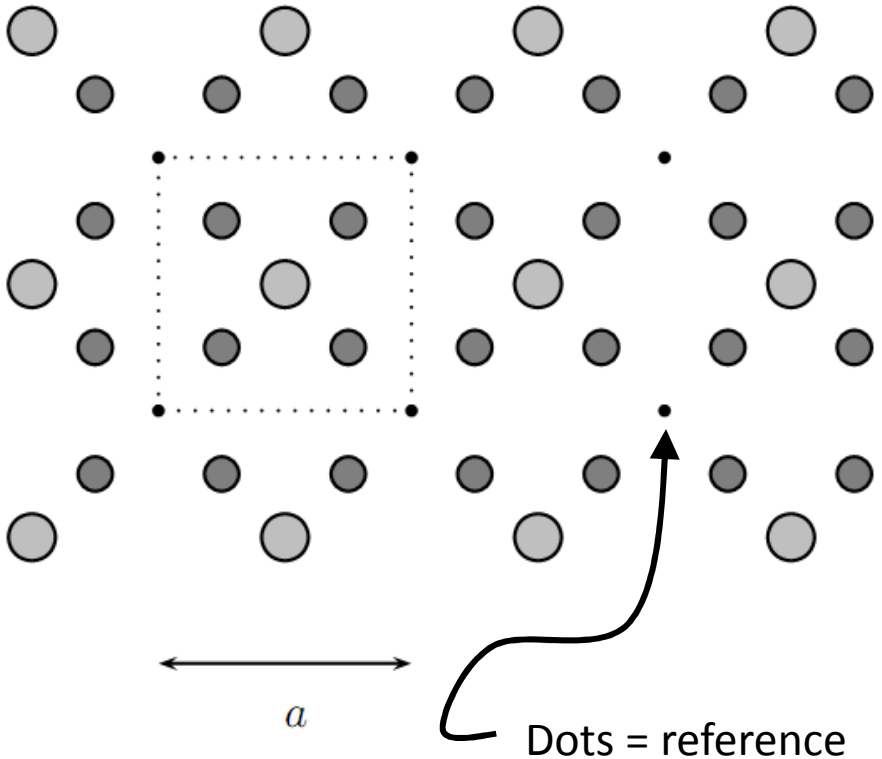
Periodic Structure



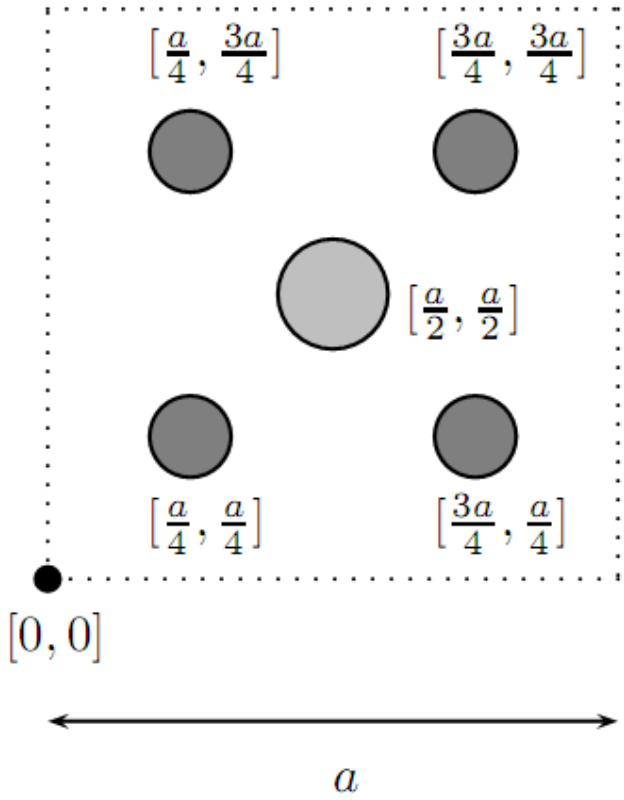
Unit Cell

Basis is a description of the unit cell
With respect to a reference lattice

Crystal



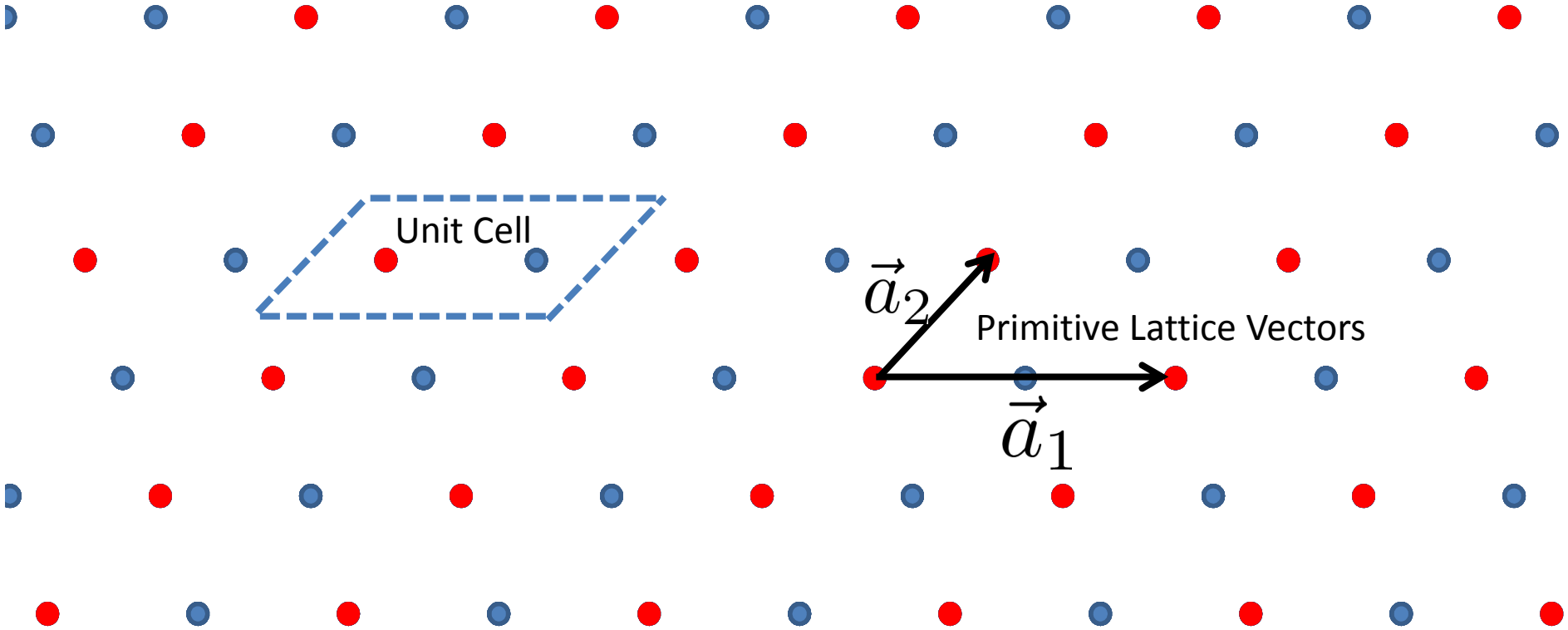
Unit Cell



Basis =

Large Light Gray Atom	Position=	$[a/2, a/2]$
Small Dark Gray Atoms	Position=	$[a/4, a/4]$ $[a/4, 3a/4]$ $[3a/4, a/4]$ $[3a/4, 3a/4]$

Reference Lattice is often taken coincident with some atom

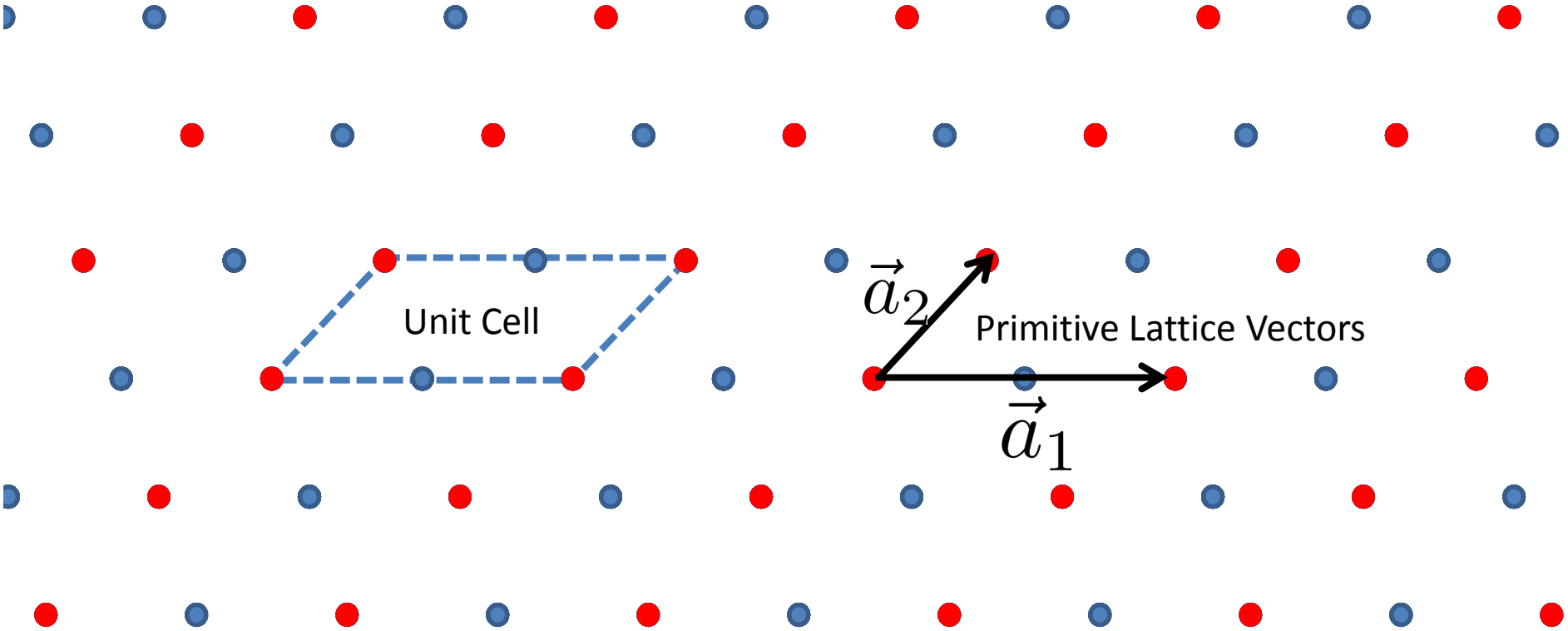


Put Reference Lattice on the Red Atoms:

Basis is: Red atom at [0,0]
Blue atom at [1/2,0]

note [1/2,0] = $(1/2)\vec{a}_1$

Reference Lattice is often taken coincident with some atom



Put Reference Lattice on the Red Atoms:

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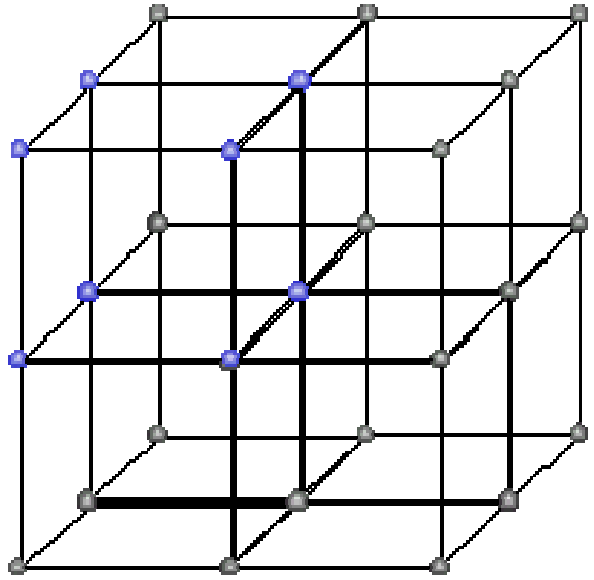
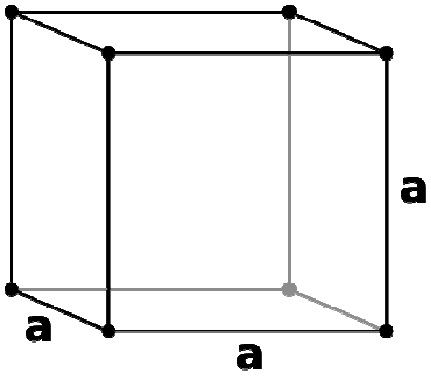
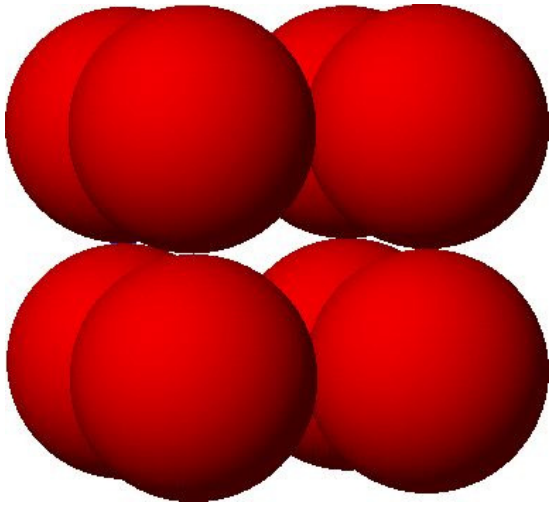
Simple (Primitive) Cubic Lattice

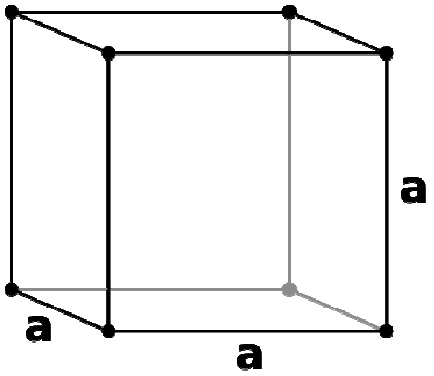


Simple Cubic Unit Cell



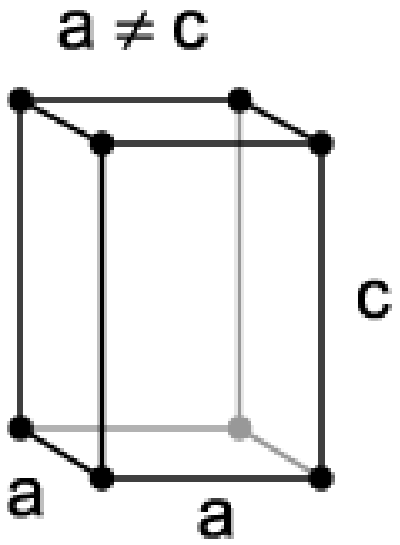


Atoms arranged in Simple Cubic Lattice (very unusual)



Simple Cubic Unit Cell

Simple Tetragonal Unit Cell



Simple Orthorhombic Unit Cell