



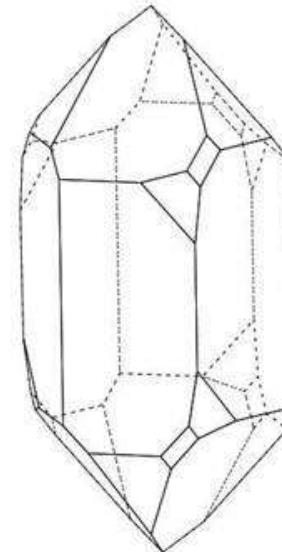
 BREIÐDALSETUR  
MÁLVÍSINDI – JARÐFRÆÐI – SAGAN  
RESEARCH AND HERITAGE CENTRE

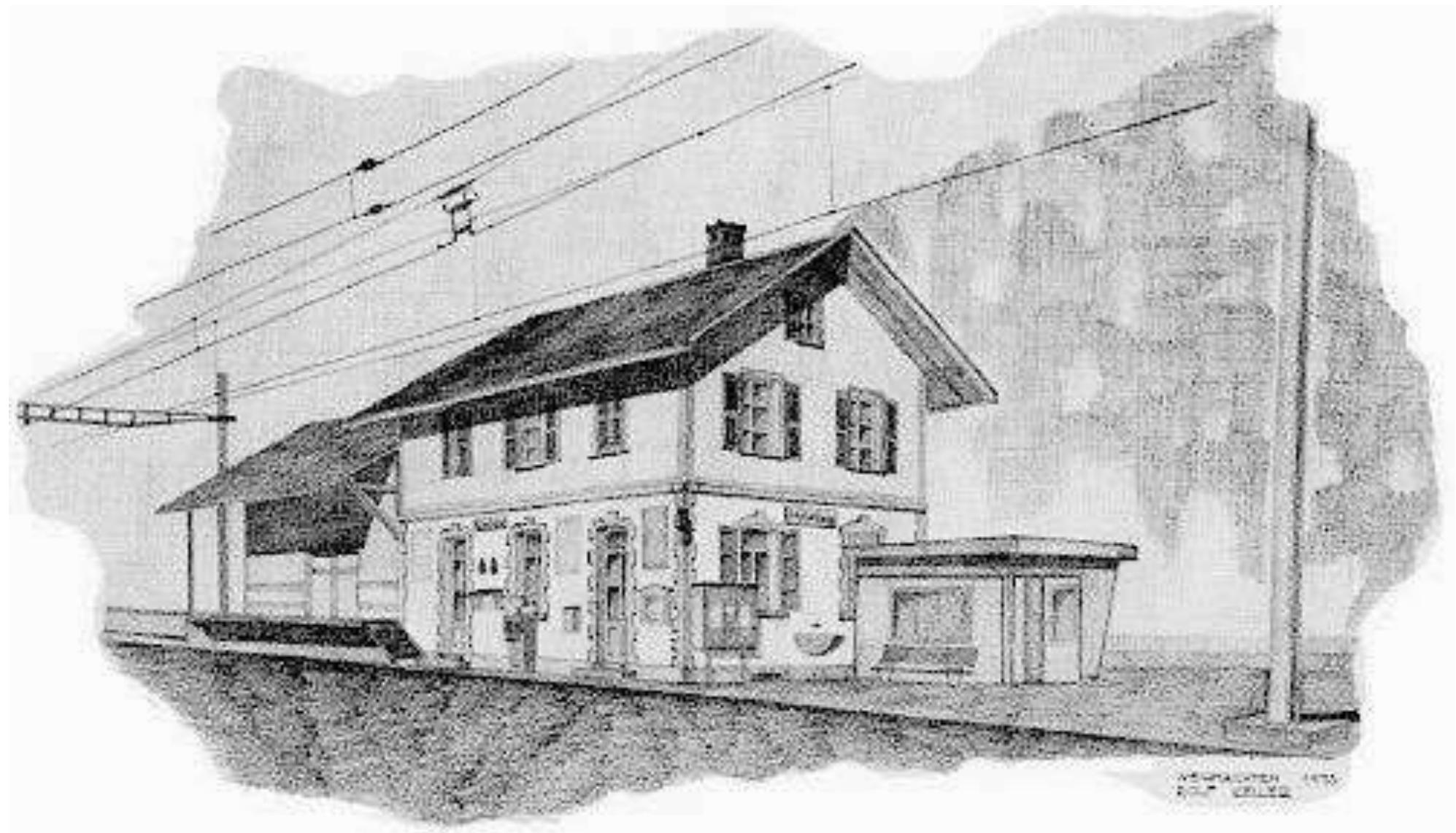
[www.breiddalssetur.is](http://www.breiddalssetur.is)

## Kristallar – regla og orka: Samantekt um kristallafræði

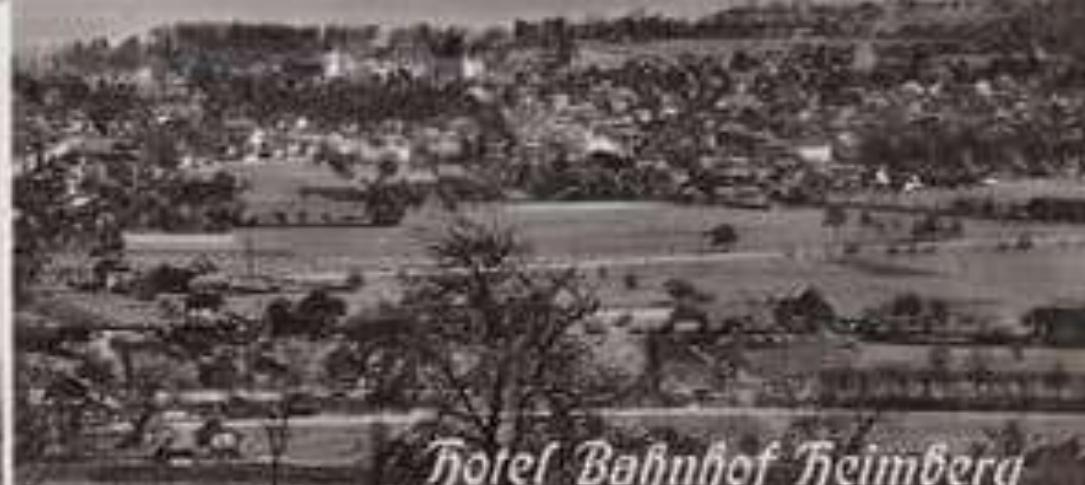
### Fyrirlestur á Breiðalsvík

Martin Gasser  
**29. apríl 2017, kl. 14**  
í Breiðalssetri  
Gamla Kaupfélaginu  
Inngangseyrir 500 kr.





W.H. WILSON 1970  
PRINTED IN U.S.A.



*Hotels Bahnhof Heimberg*



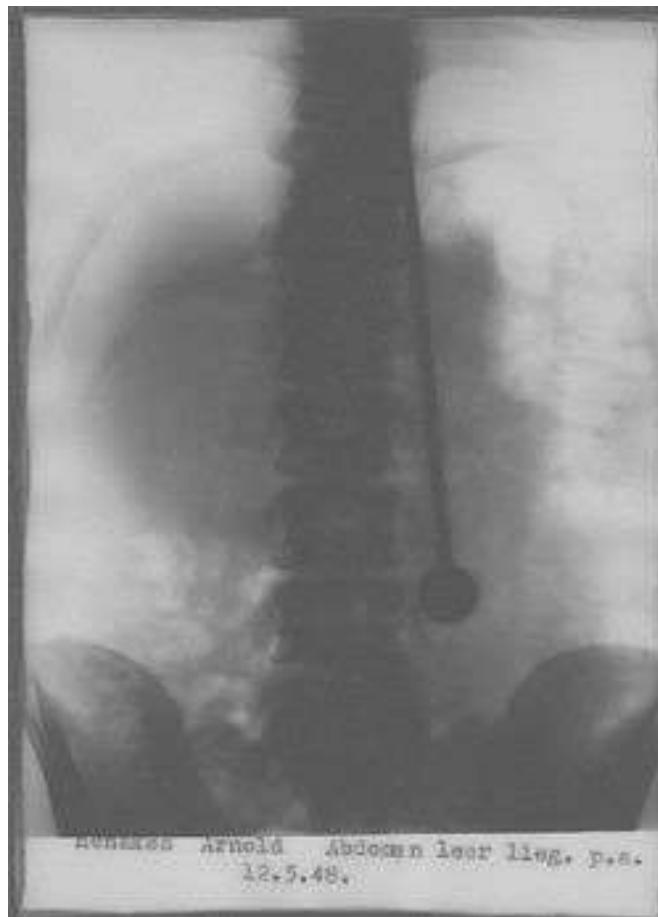












Henneke Arnold Abdomen leev. lying. p.s.  
12-5-48.

## Thoughts and Words Affect Water

After seeing water react to different environmental conditions, pollution and music, Mr. Emoto and colleagues decided to see how thoughts and words affected the formation of untreated, distilled, water crystals, using words typed onto paper and taped on glass bottles overnight.

The same procedure was performed using the names of deceased persons. The waters were then frozen and photographed.



Heavy Metal Music



You Make Me Sick, I Will Kill  
You



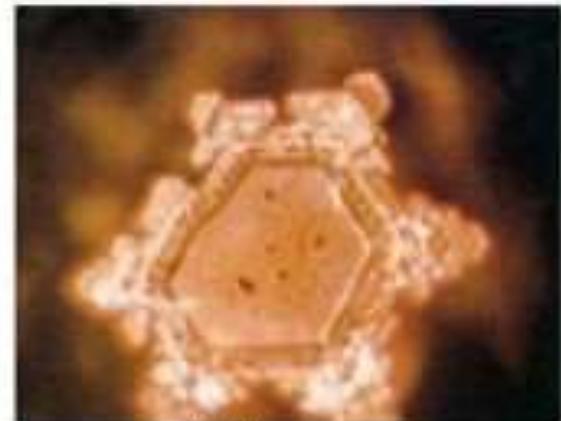
Adolph Hitler



Thank You



Love and Appreciation



Mother Teresa

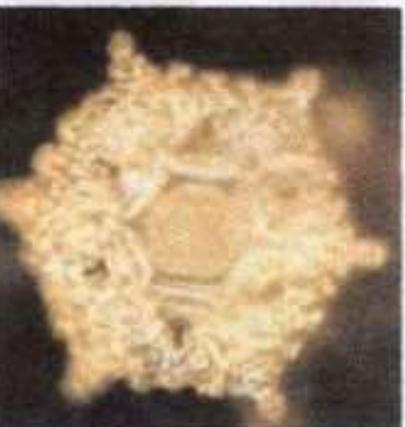


MATHIEU EZAN  
PHOTOGRAPHE



Water of Fujiwara dam before & after offering a prayer.

Heavy metal music

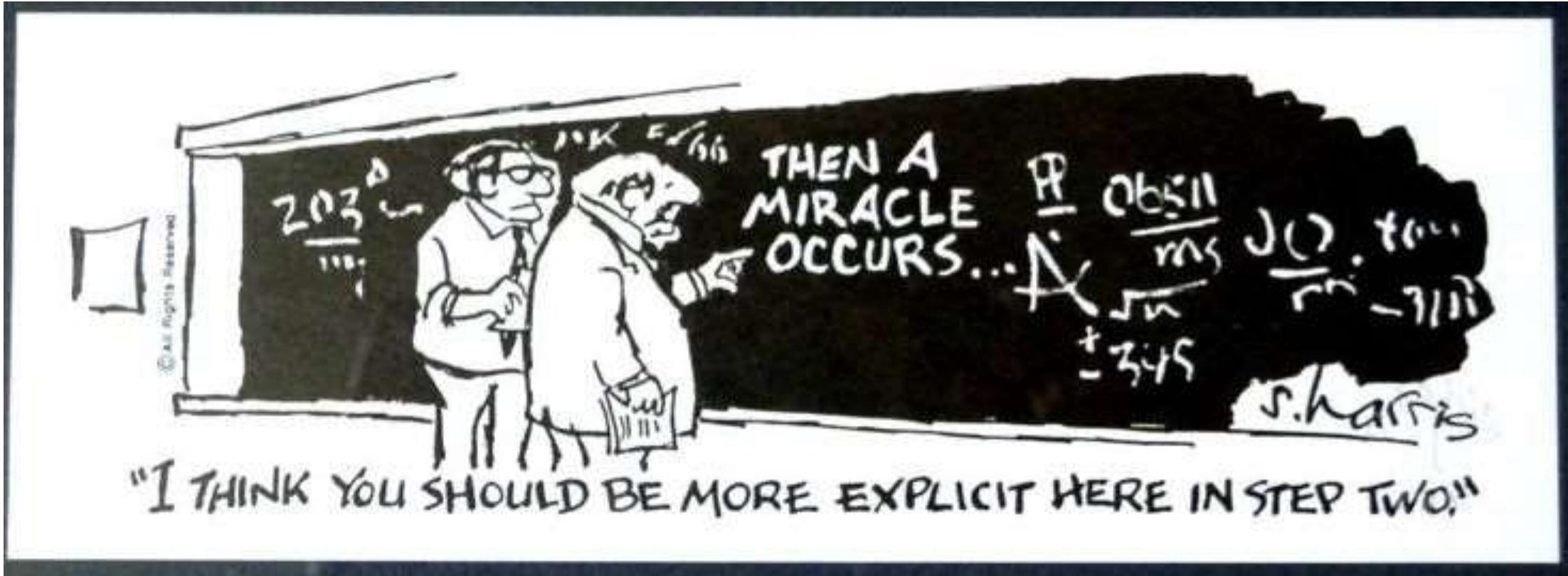


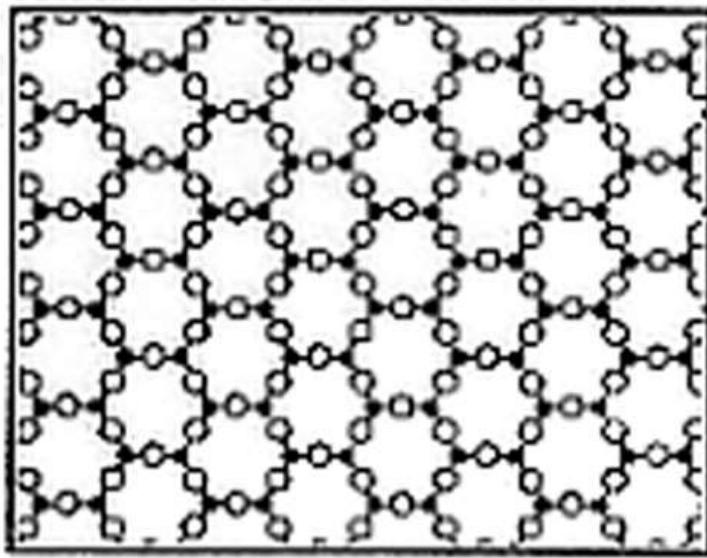
“I love you.”

“You make me sick.”

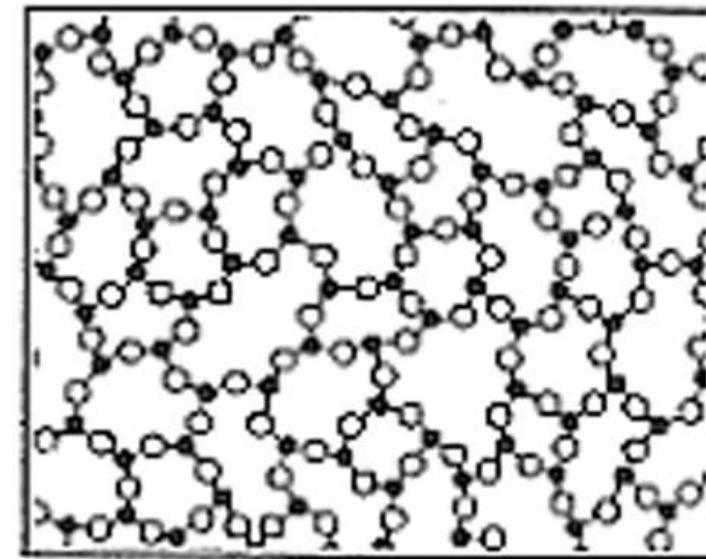
“Thank you.”

(taken from Sharp, S., 2001, online)





quartz



glass



**Shannon & Prewitt "Crystal" Radii**

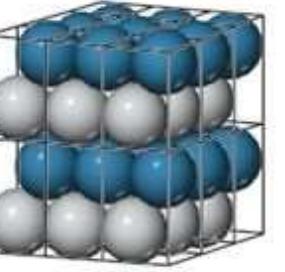
These data are taken from Shannon & Prewitt's (S&P) seminal work on "physical" ionic radii, as determined from measurements of real structures. Note that in most cases S&P quote different radii for the same element: the radii vary according to charge and coordination number. We have chosen the most-common charges (oxidation states) and coordination numbers. Where no radius value can be found for a particular element, its radius has been set to a default value of 1 Å and a circle is plotted instead of a rendered sphere.

References: Shannon RD and Prewitt CT (1969) Acta Crystallographica B25:925-946

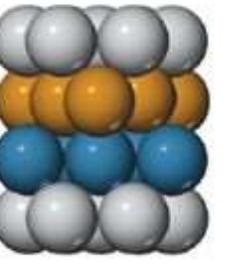
Shannon RD (1976) Acta Crystallographica A23:751-761



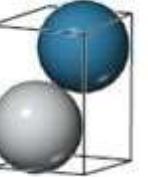
# 1. ABAB / ABCABC packing



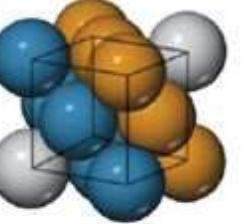
Side view



Side view



Unit cell view  
(a) Hexagonal close-packed metal

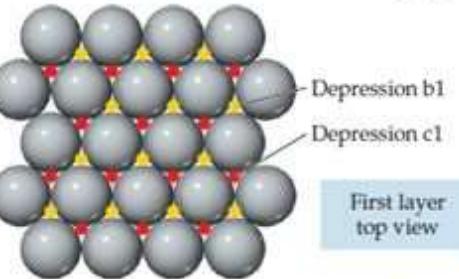


Unit cell view  
(b) Cubic close-packed metal

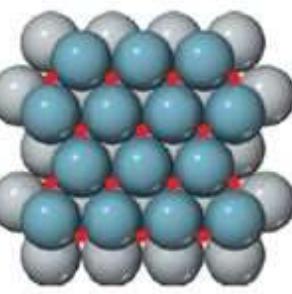
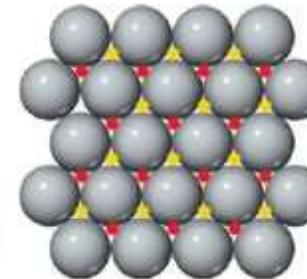
▲ FIGURE 12.14 The unit cells for (a) a hexagonal close-packed metal and (b) a cubic close-packed metal. The solid lines indicate the unit cell boundaries.

Hexagonal close packing (hcp)

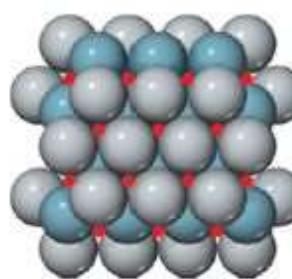
Isometric view showing depression



Cubic close packing (ccp)

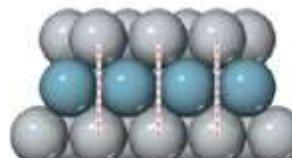


Second layer top view



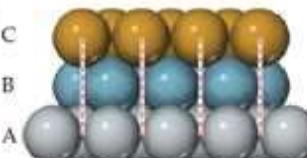
Third layer top view

Spheres sit in depressions that lie directly over spheres of first layer, ABAB... stacking.

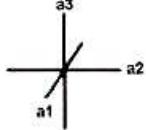
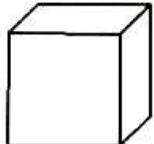
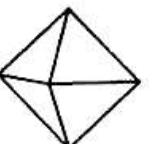
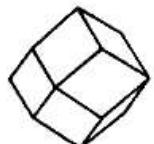
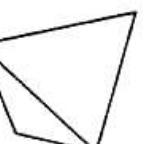
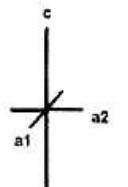
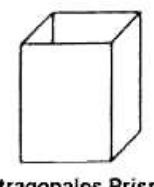
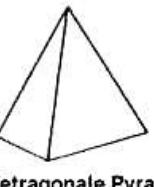
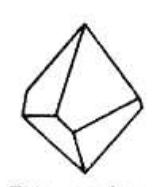
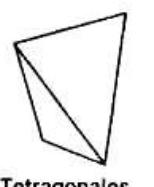
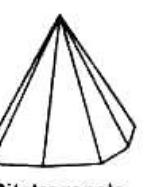
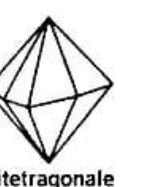
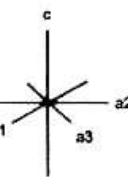
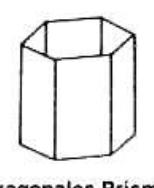
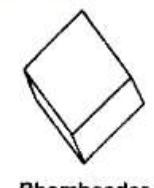
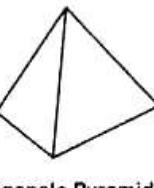
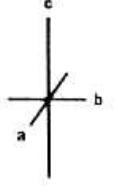
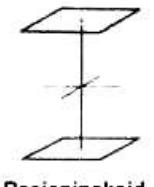
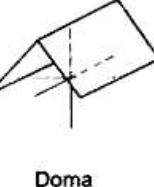
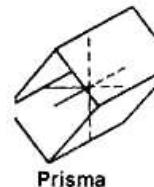
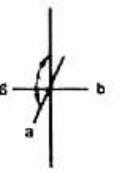
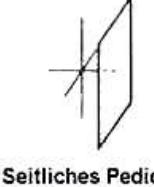
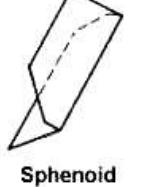
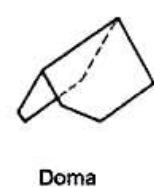
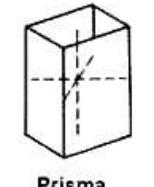
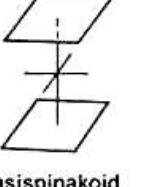
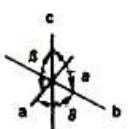
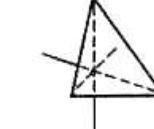
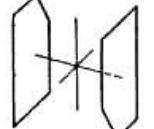
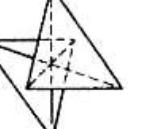


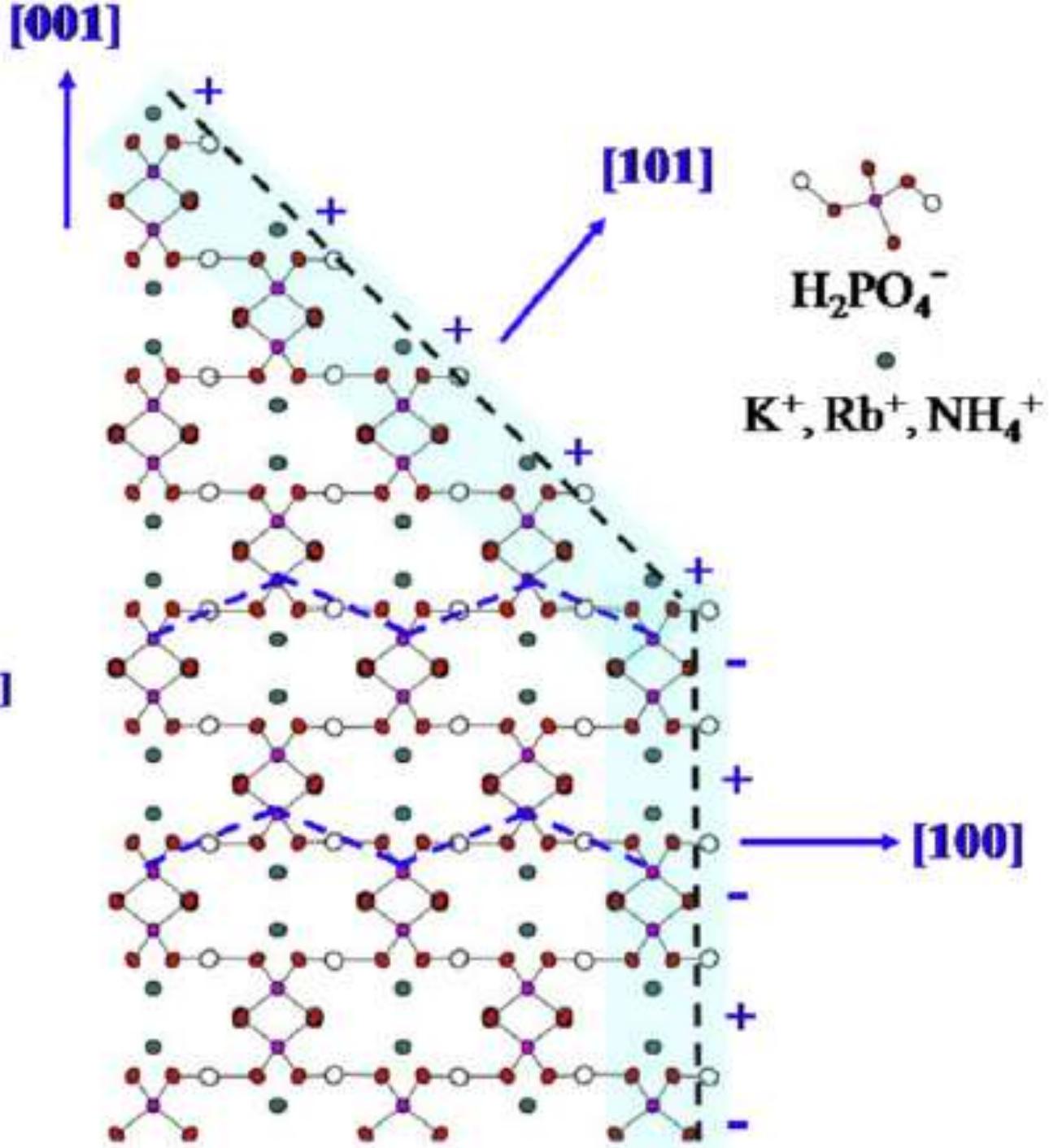
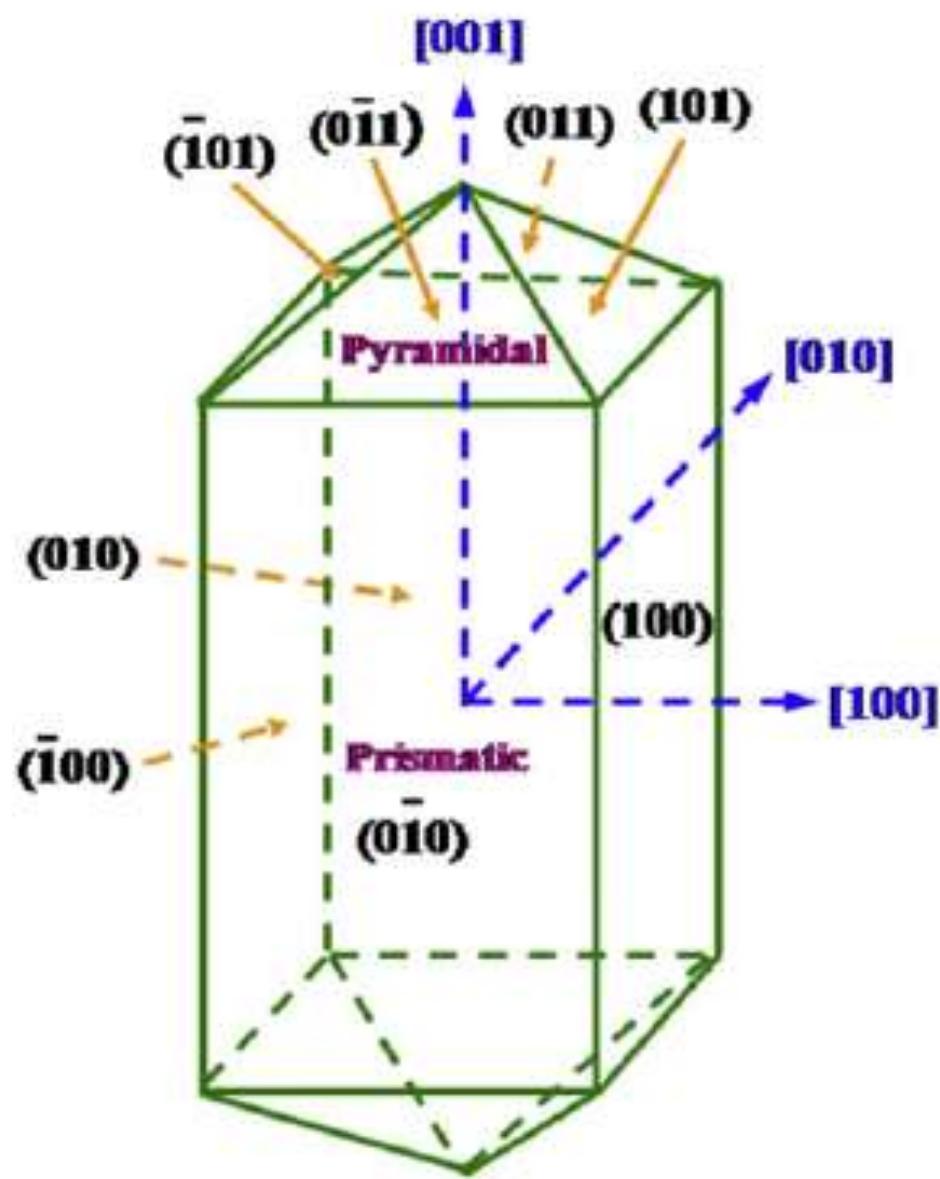
Side view

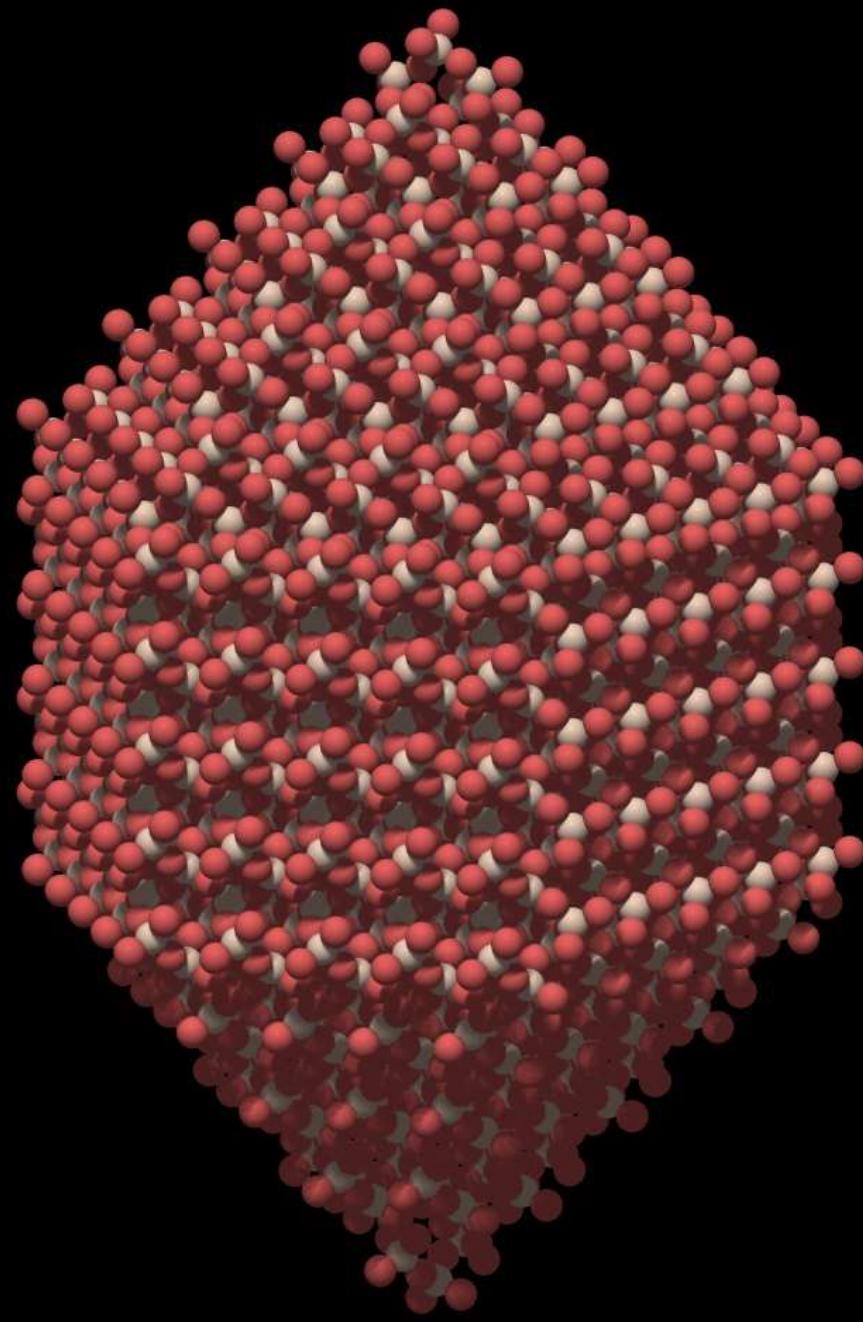
A  
B  
A



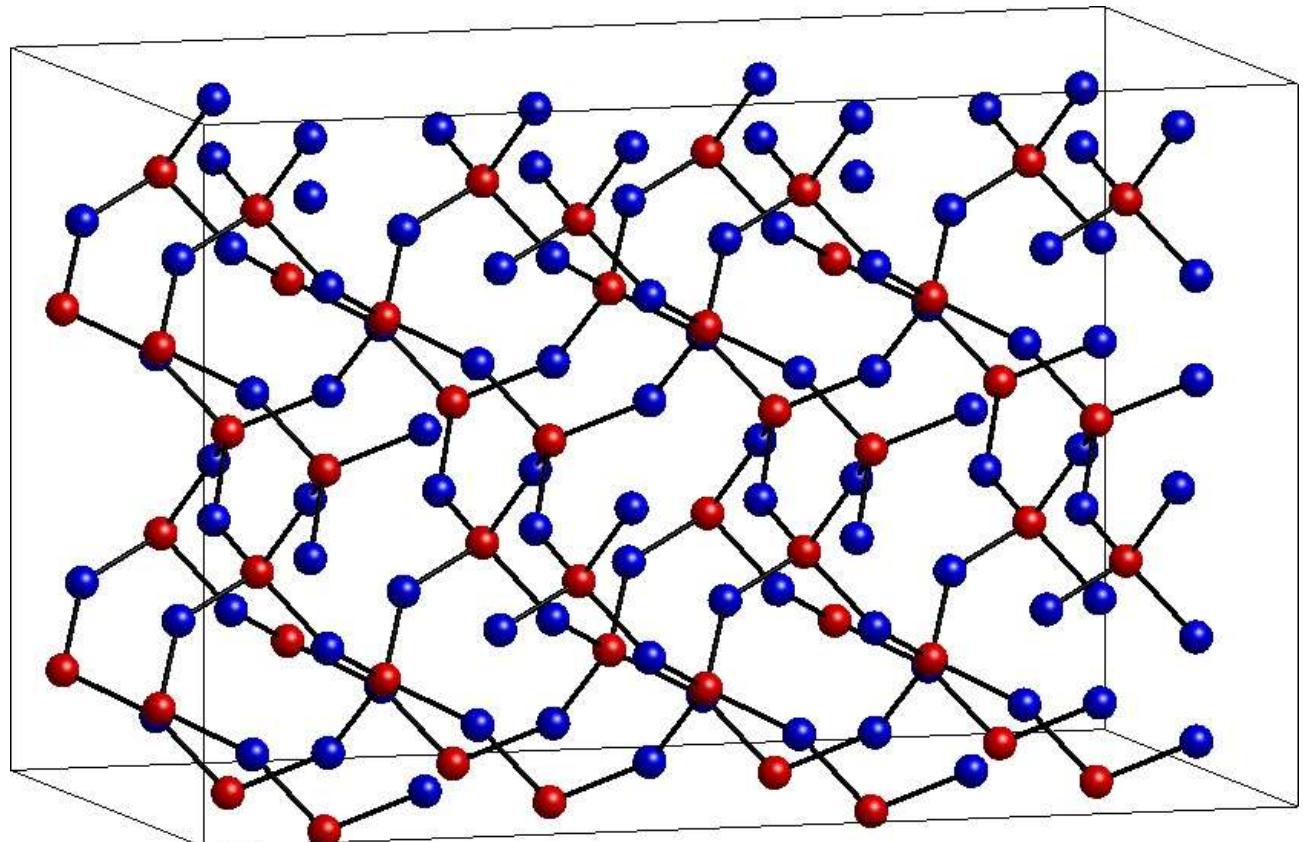
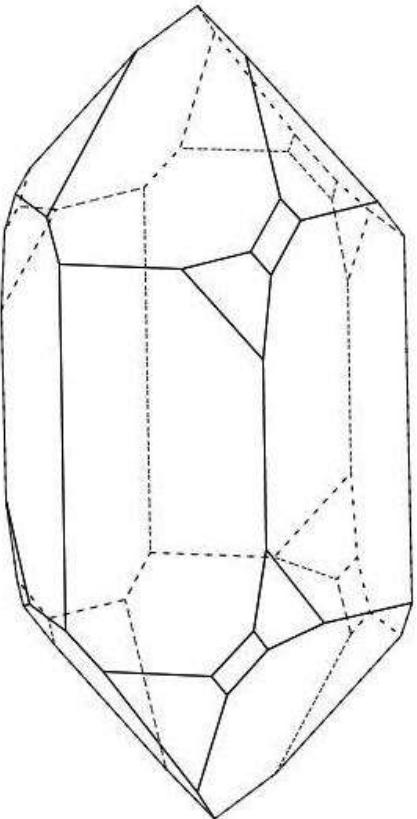
C  
B  
A

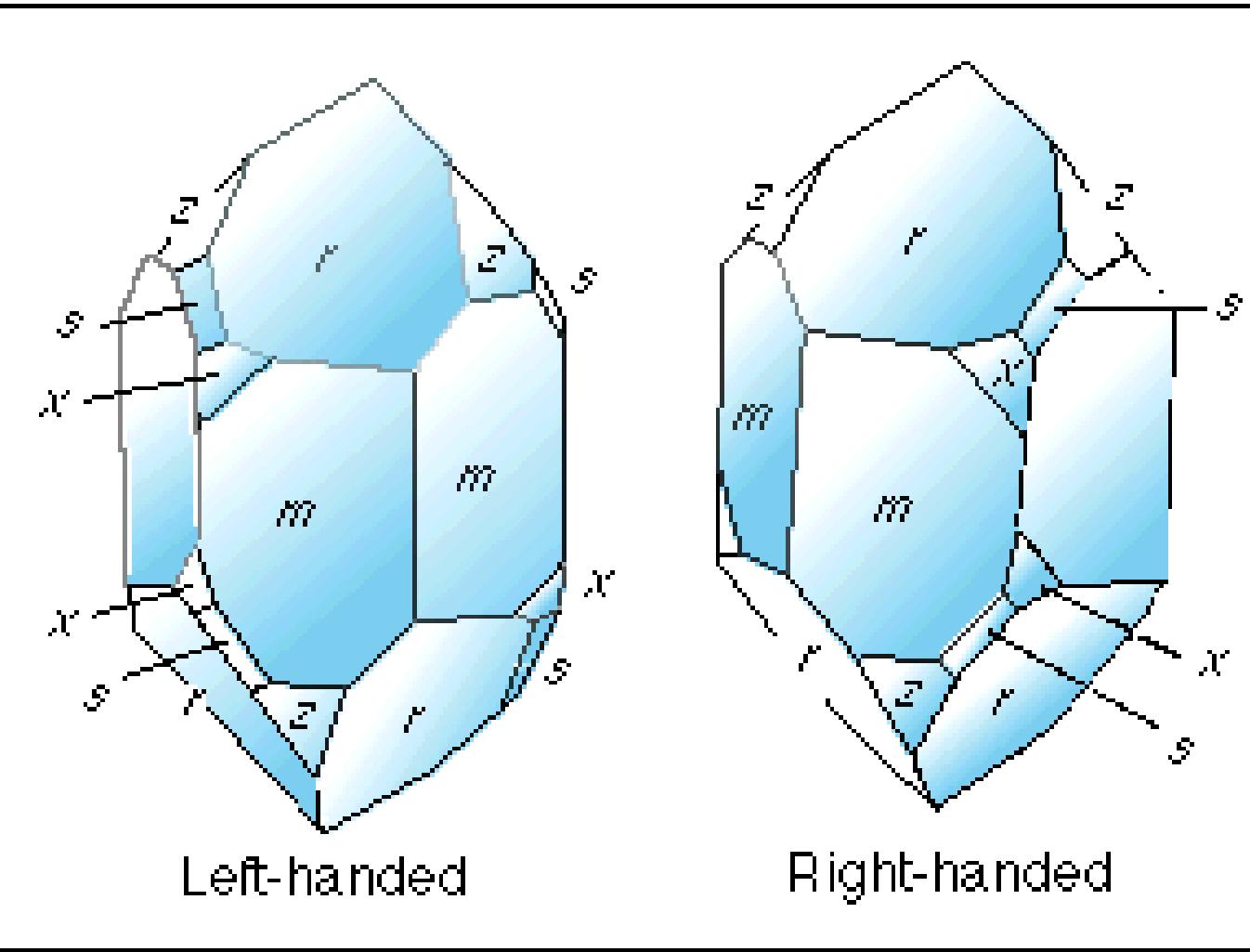
<b>kubisch</b>							
<b>tetragonal</b>							
<b>hexagonal / trigonal</b>							
<b>rhombisch</b>							
<b>monoklin</b>							
<b>triklin</b>							



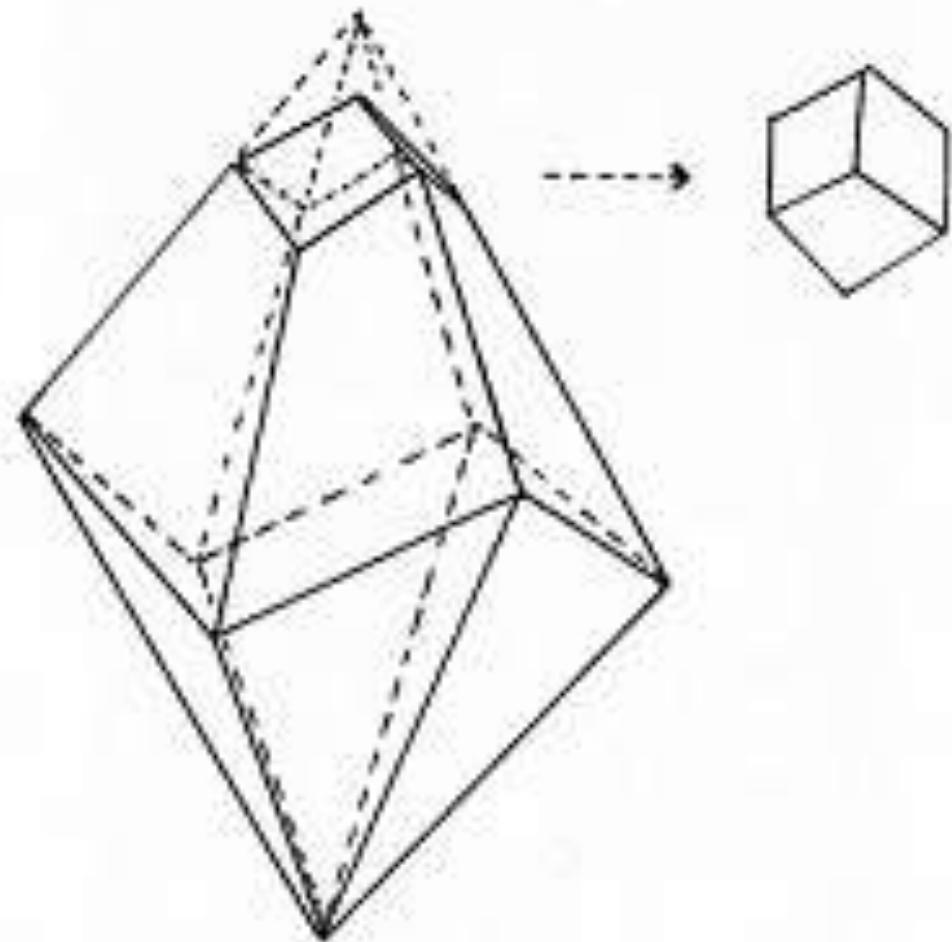


# Kvars $\text{SiO}_2$

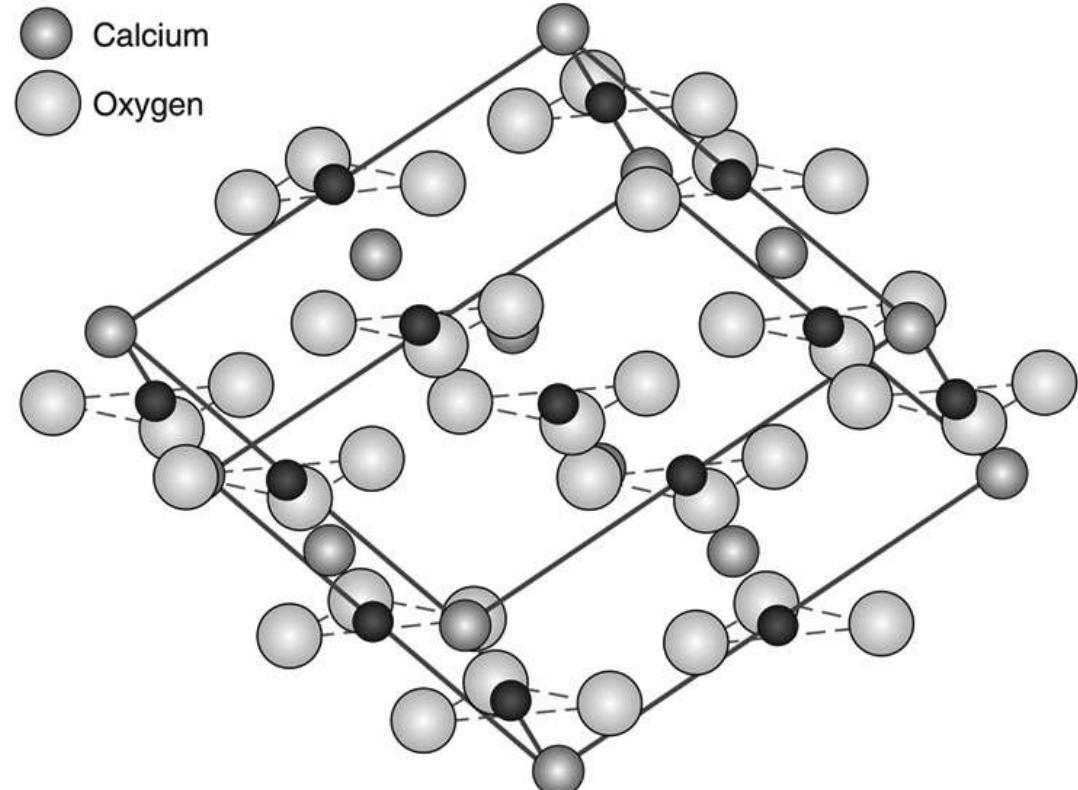




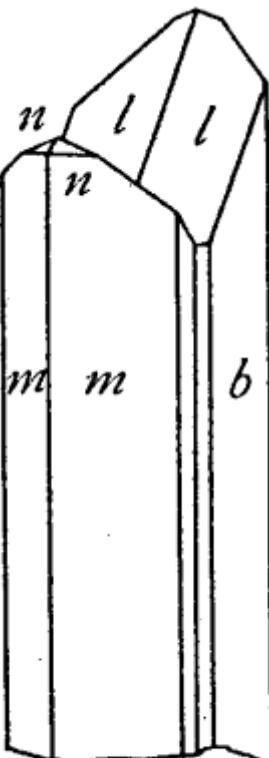
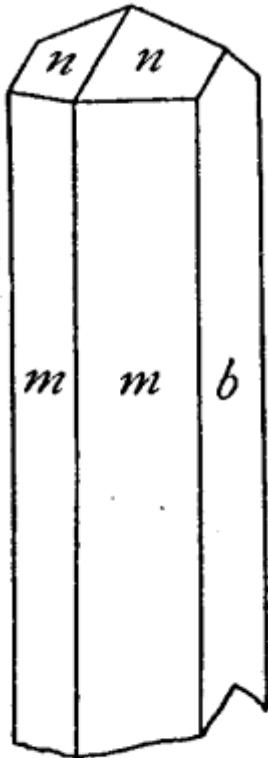
# Kalsít/Silfurberg $\text{CaCO}_3$



● Carbon  
● Calcium  
● Oxygen

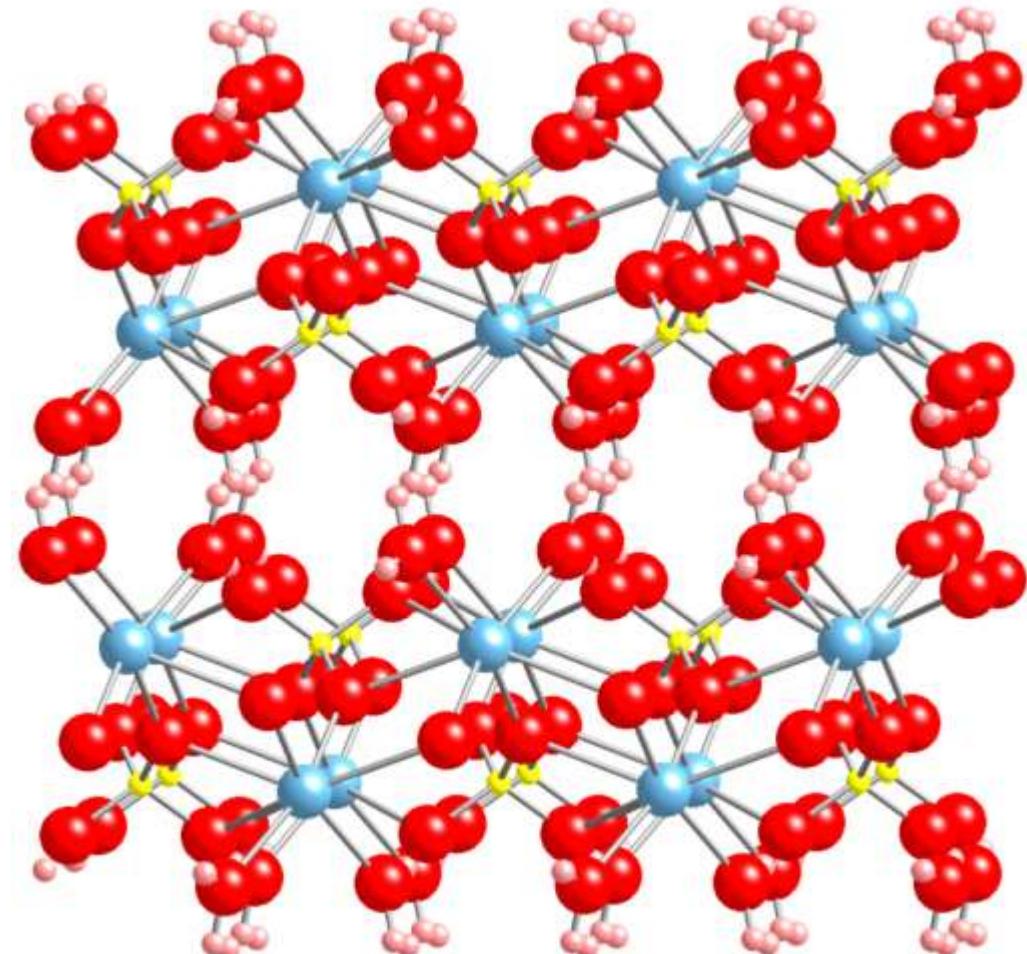


# Gifs/Selenít $\text{CaSO}_4$

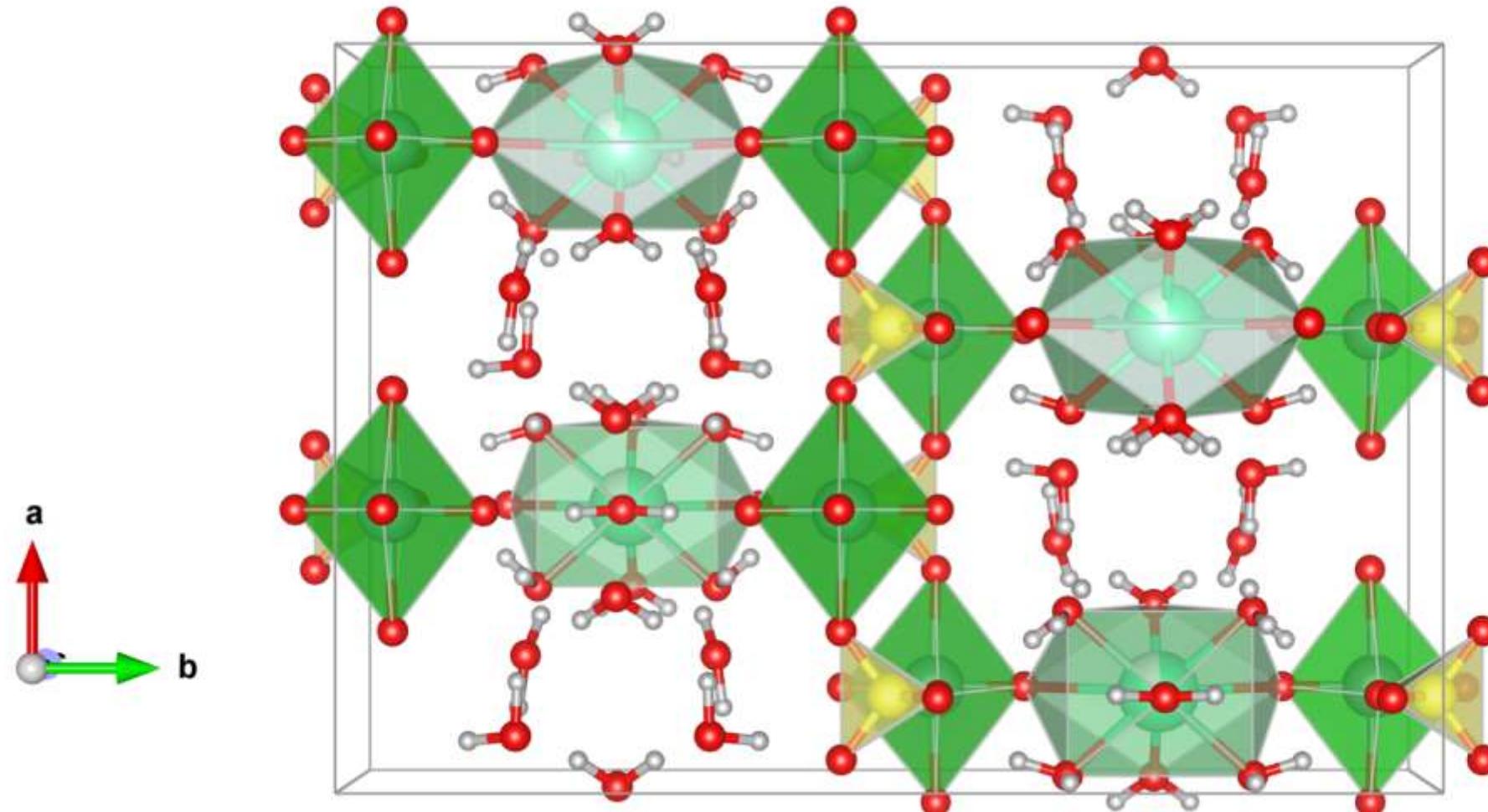


*A*

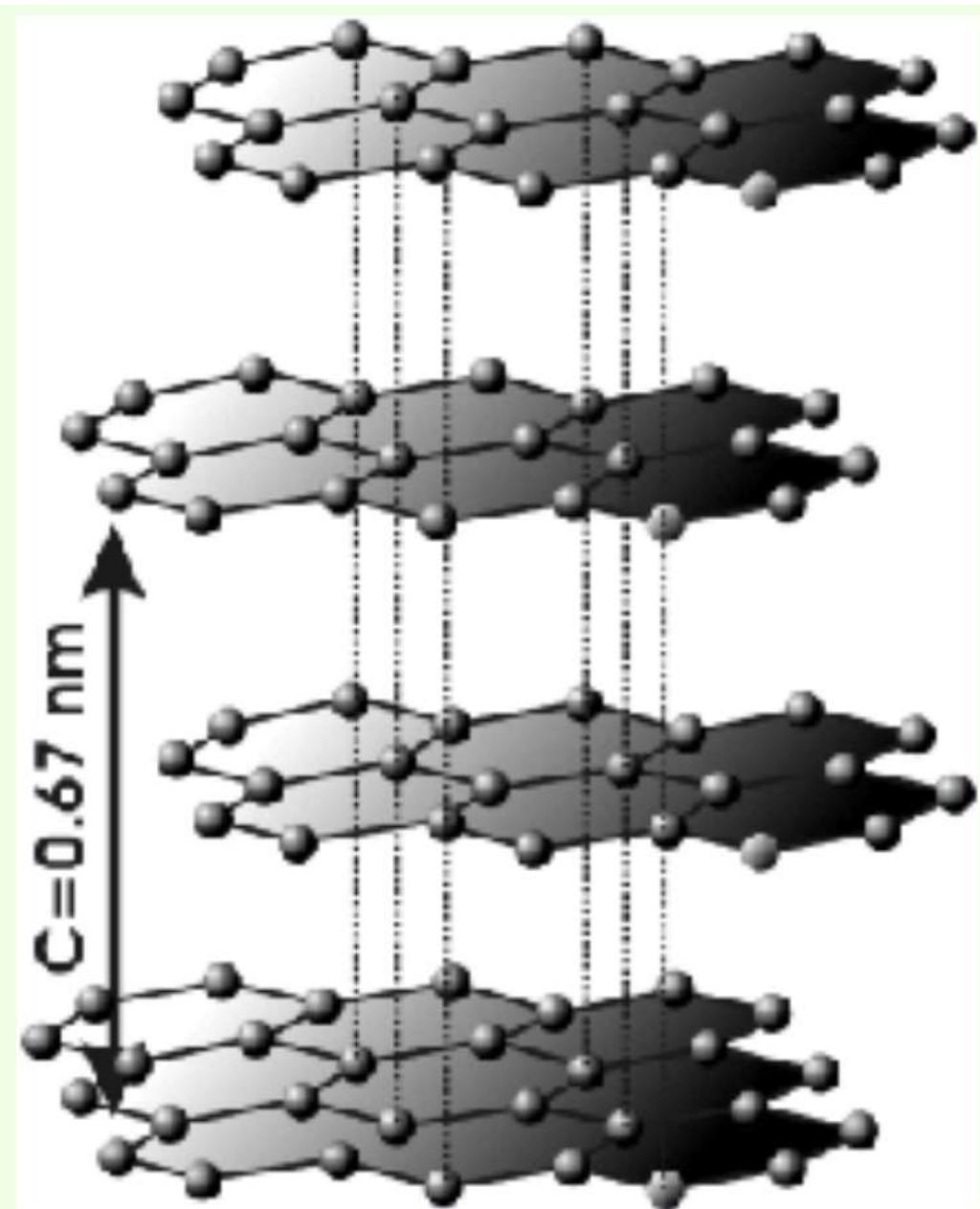
*B*



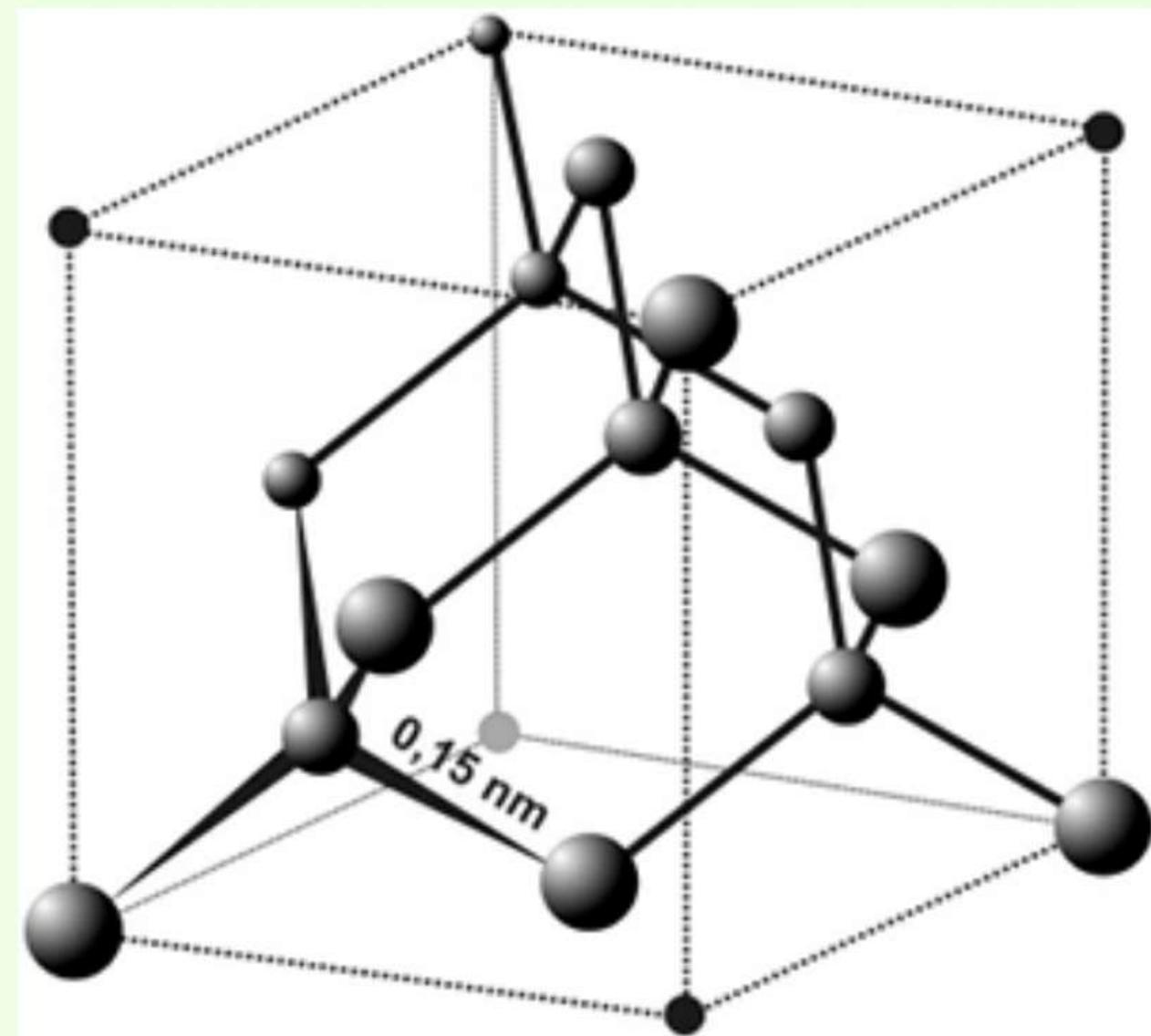
# Autunít $\text{Ca}[(\text{UO}_2)(\text{PO}_4)]_2 \cdot 11 \text{ H}_2\text{O}$

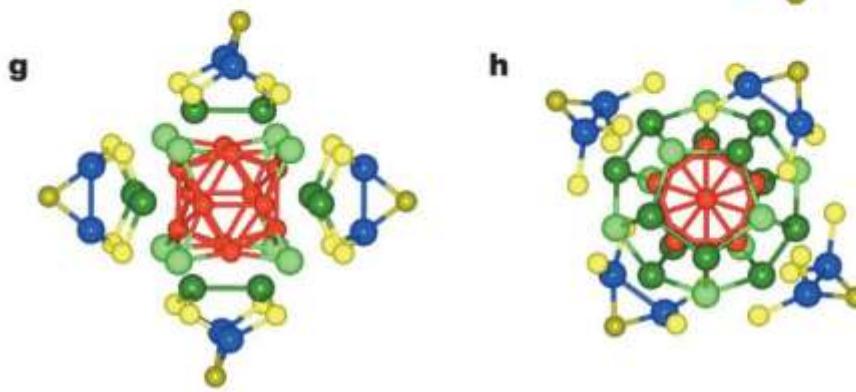
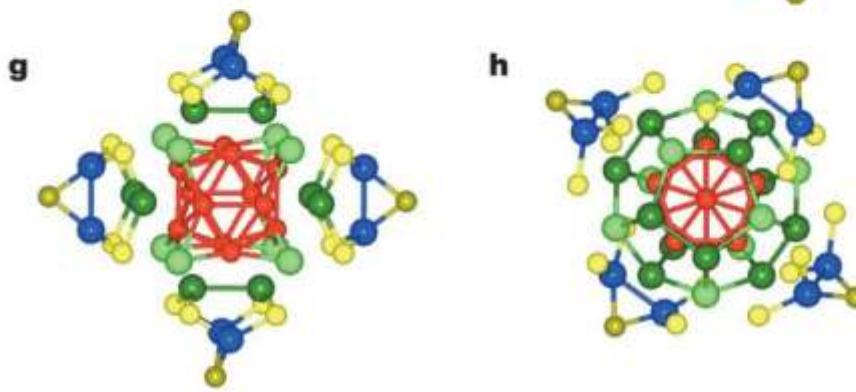
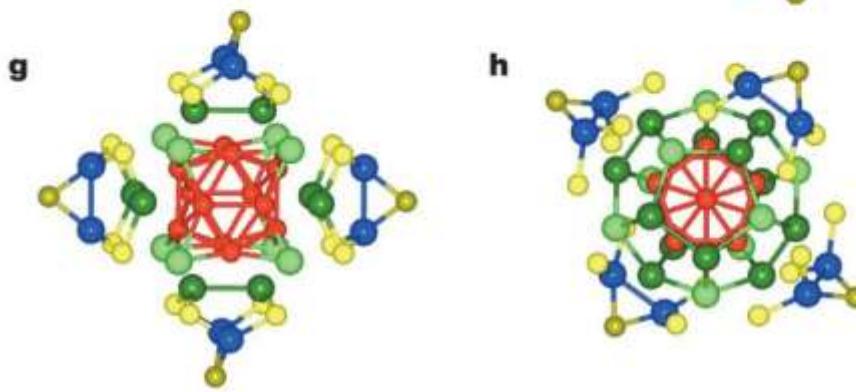
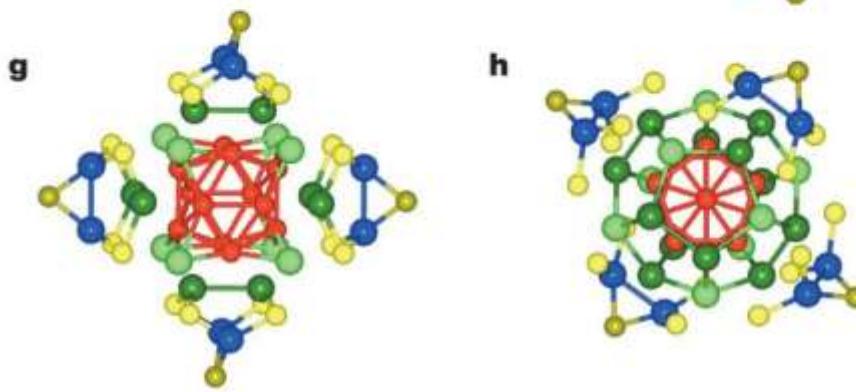
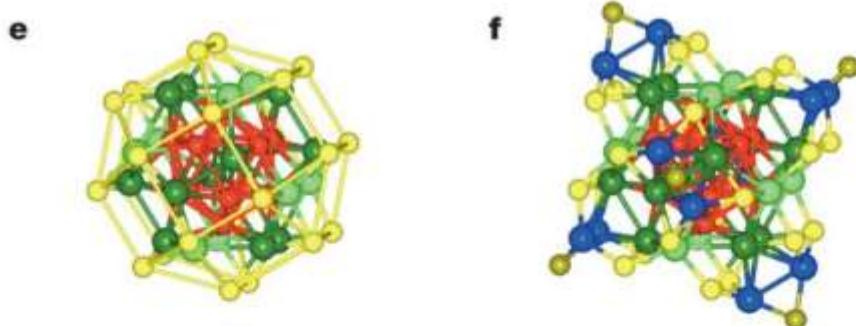
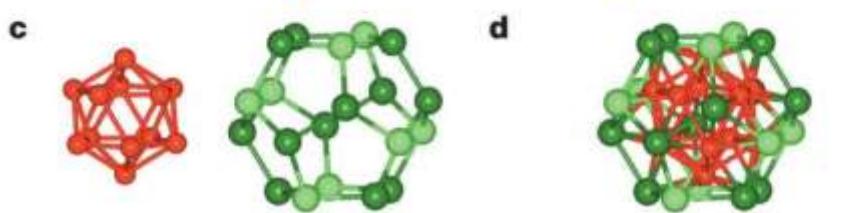
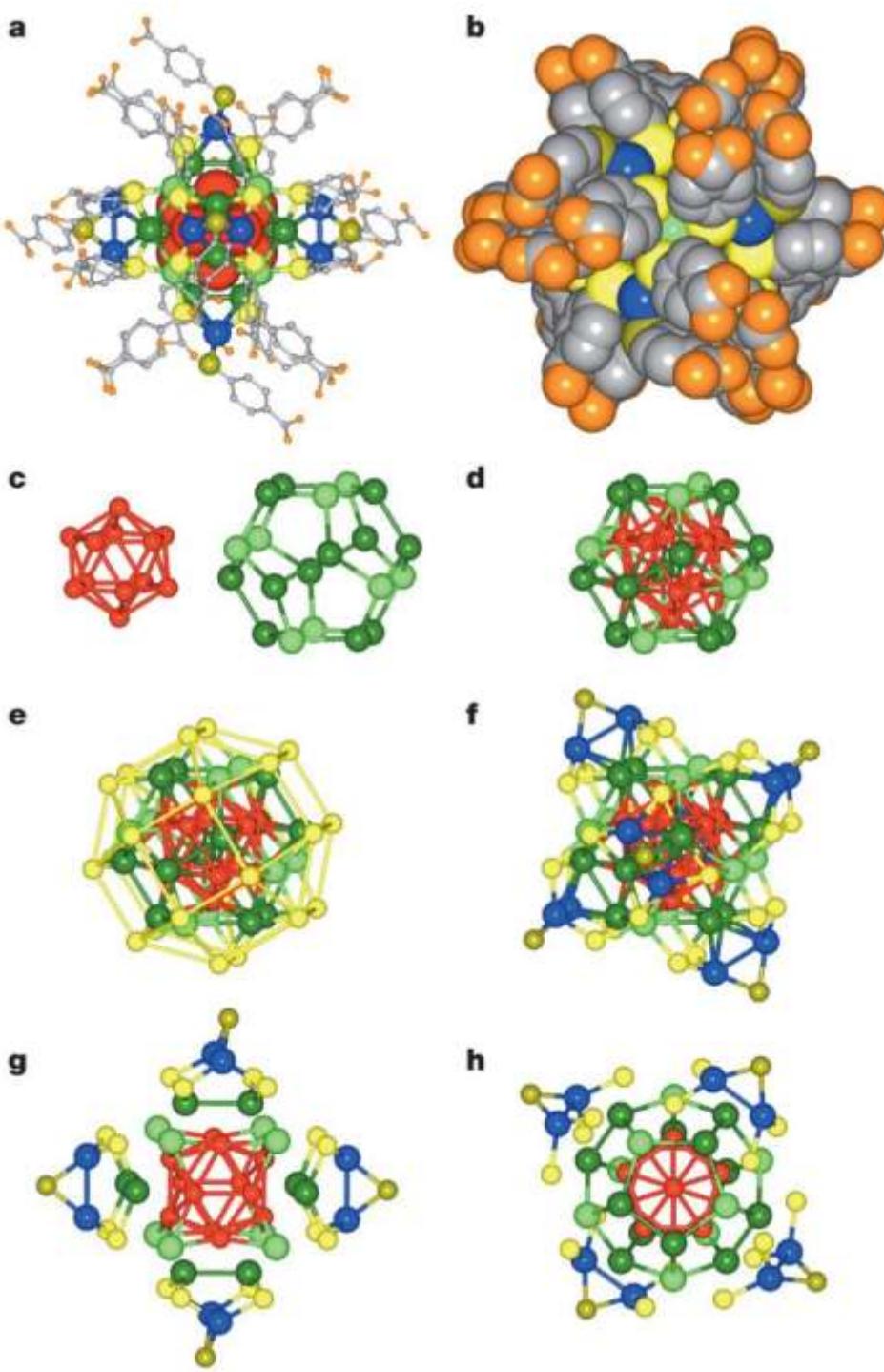


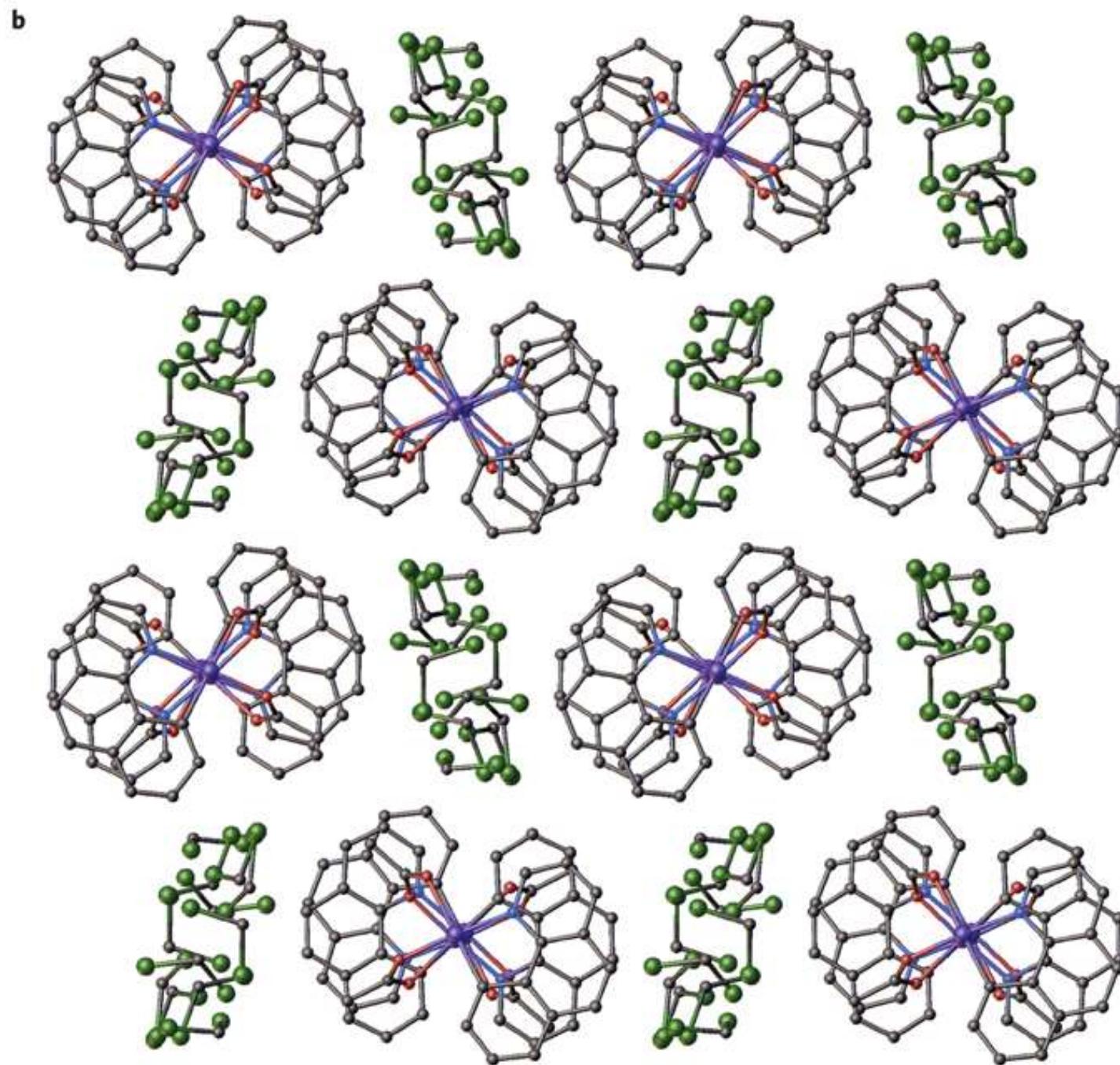
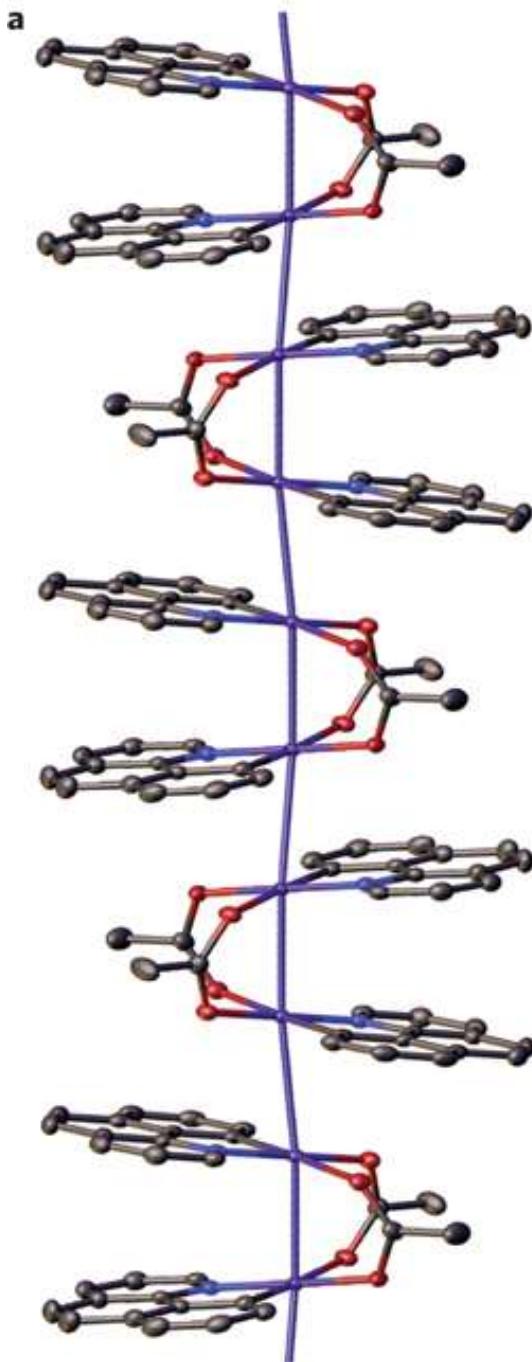
# C – Grafit

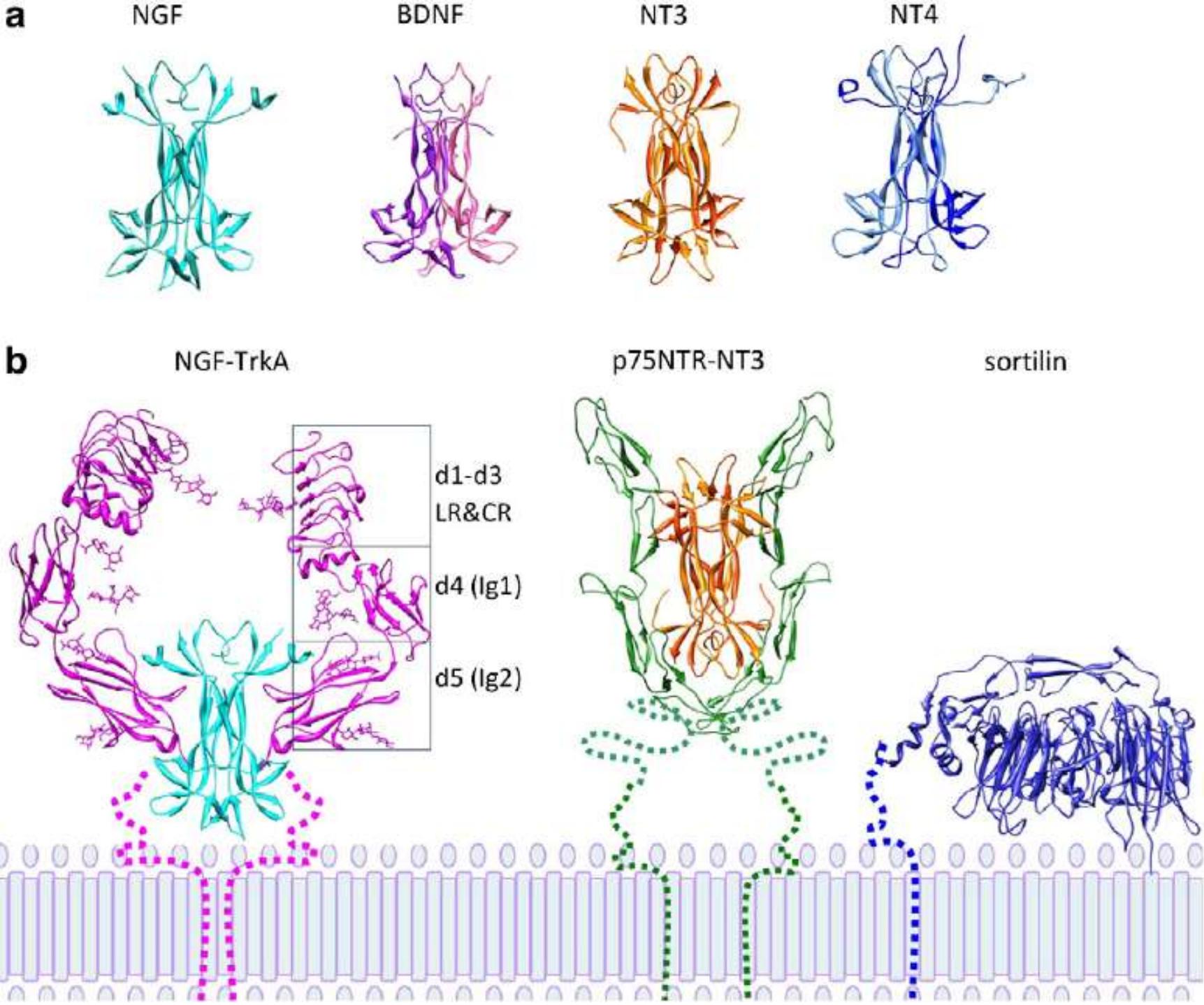


# C - Demantur





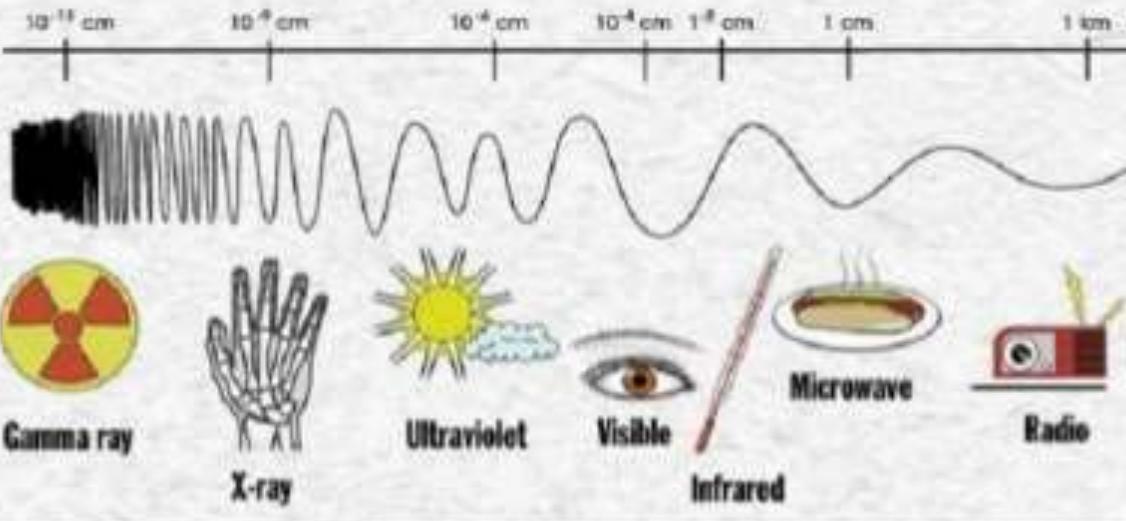




# What are X-rays?



*The Electromagnetic Spectrum*



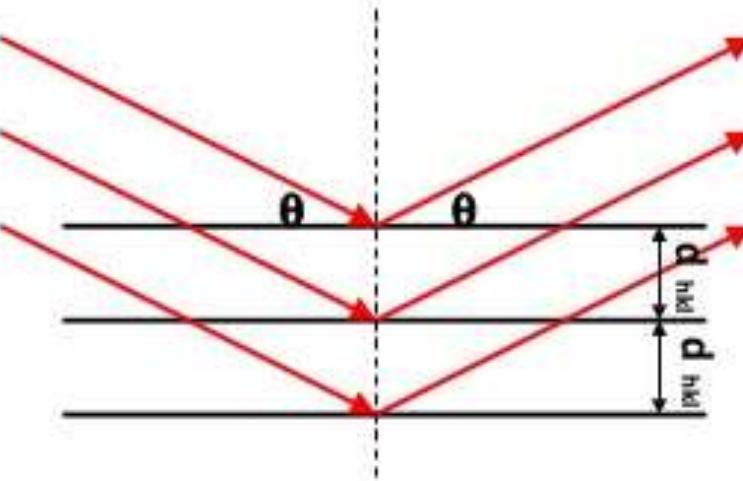
*Extracted from [www.nasa.gov](http://www.nasa.gov)*

X-rays were discovered in 1895 by Wilhelm Röntgen.

$$E = h\nu \quad h = \text{Planck's number} = 4.136 \times 10^{-15} \text{ eV}\cdot\text{s}$$

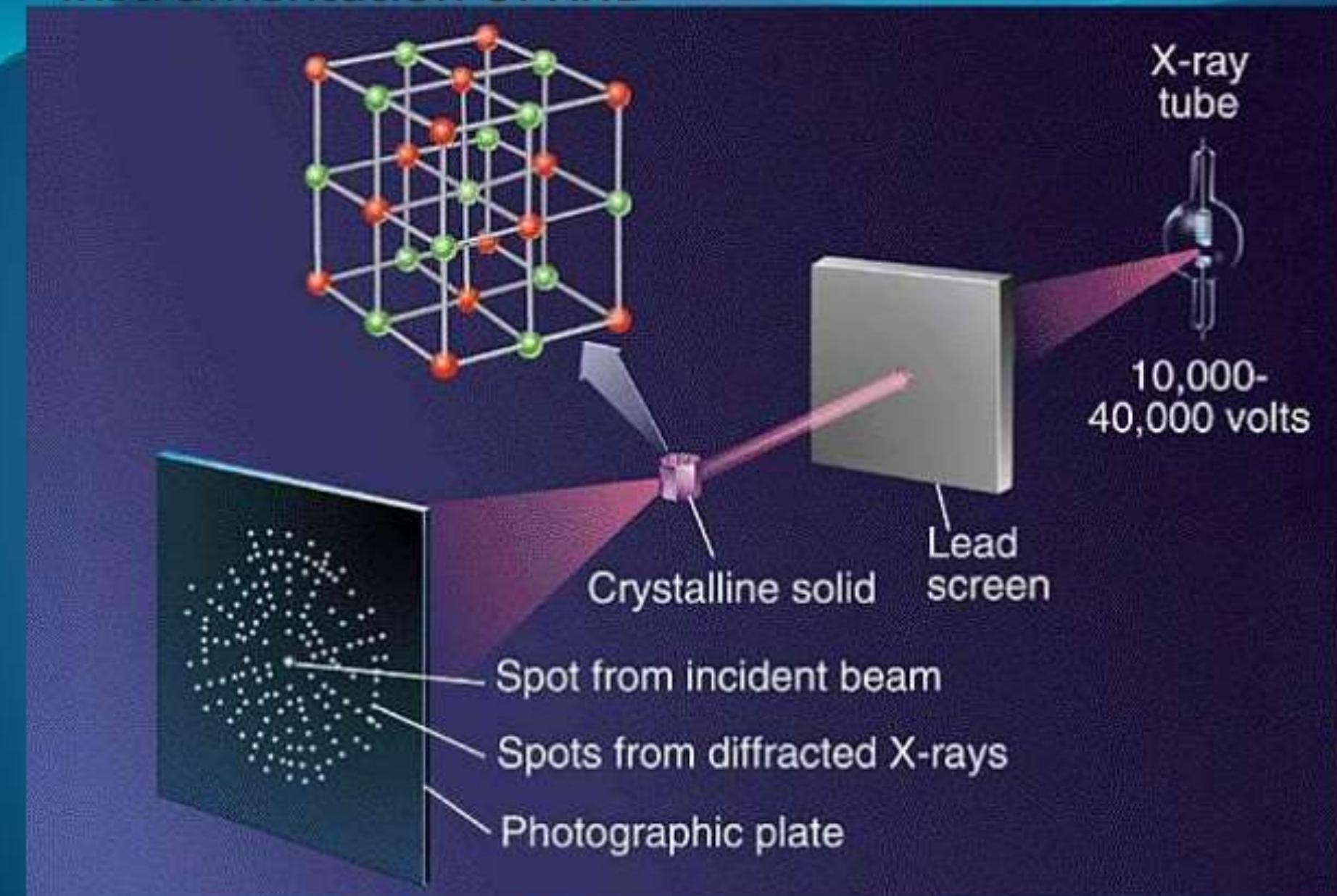
Bragg's law is a simplistic model to understand what conditions are required for diffraction.

$$\lambda = 2d_{hkl} \sin \theta$$

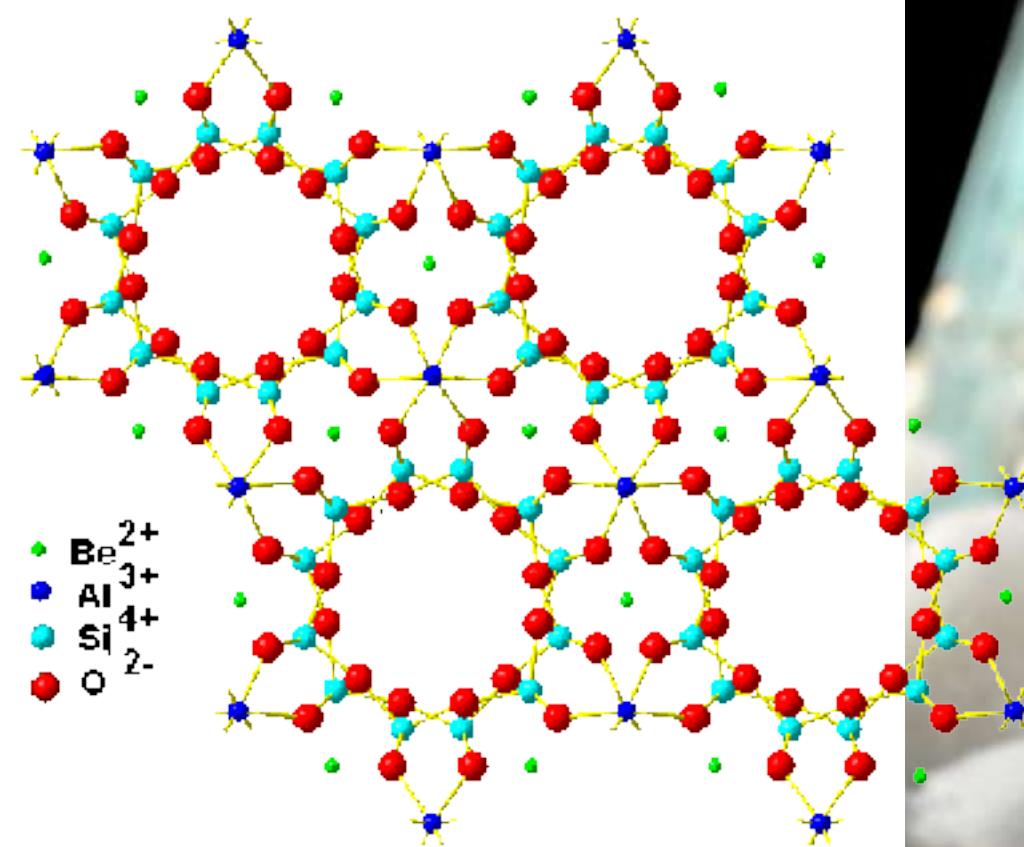
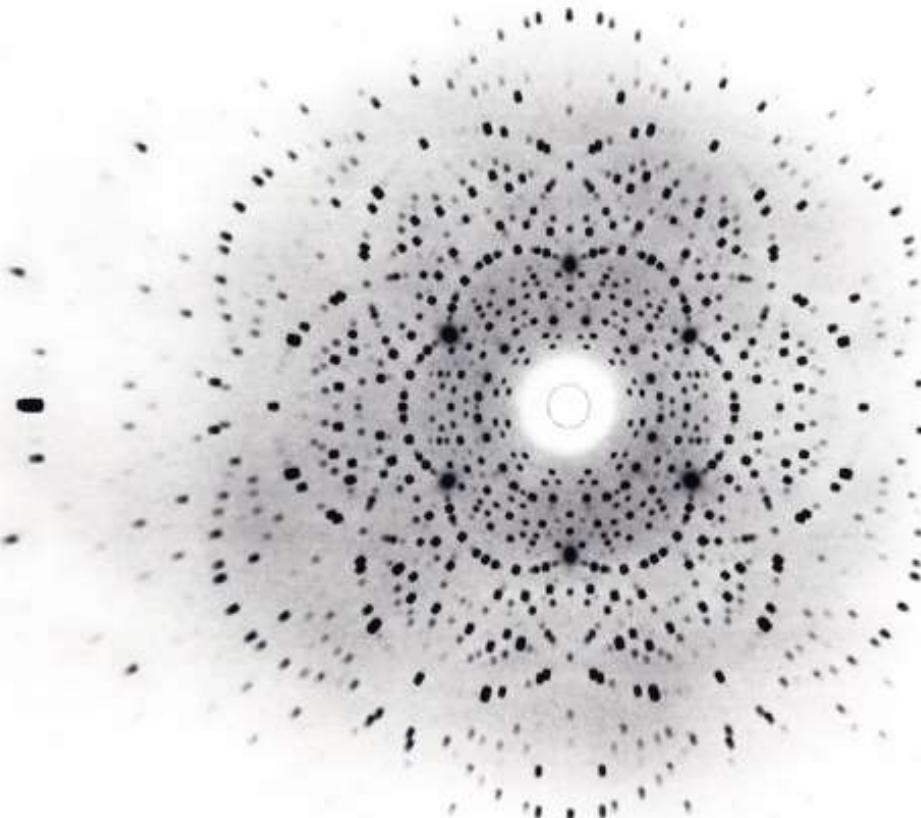


- For parallel planes of atoms, with a space  $d_{hkl}$  between the planes, constructive interference only occurs when Bragg's law is satisfied.
  - In our diffractometers, the X-ray wavelength  $\lambda$  is fixed.
  - Consequently, a family of planes produces a diffraction peak only at a specific angle  $\theta$ .
  - Additionally, the plane normal must be parallel to the diffraction vector
    - Plane normal: the direction perpendicular to a plane of atoms
    - Diffraction vector: the vector that bisects the angle between the incident and diffracted beam
- **The space between diffracting planes of atoms determines peak positions.**
- **The peak intensity is determined by what atoms are in the diffracting plane.**

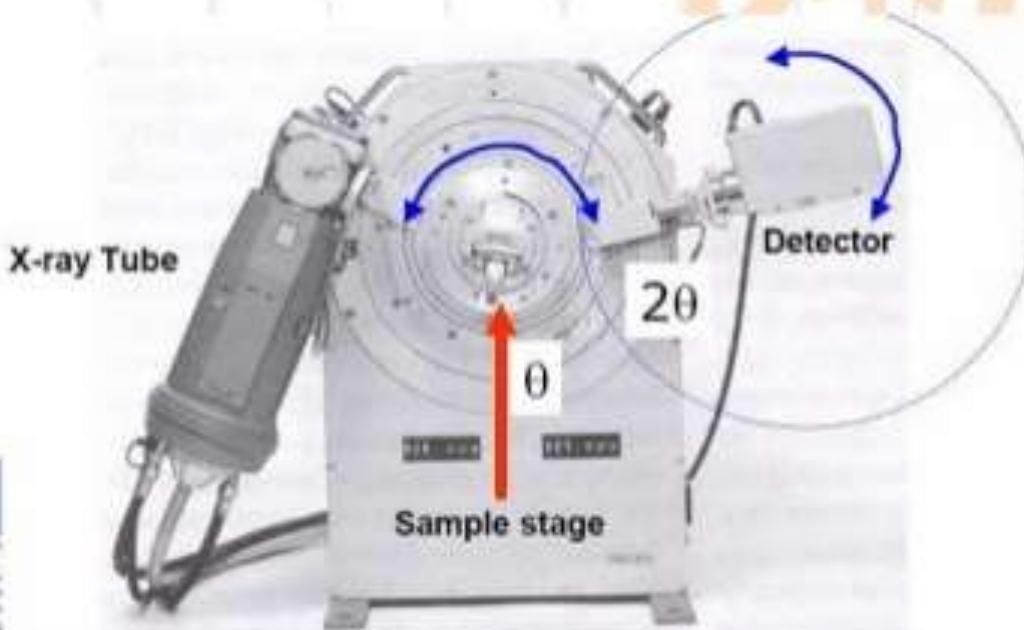
## Instrumentation of XRD



# Beryl Al<sub>2</sub>Be<sub>3</sub>[Si<sub>6</sub>O<sub>18</sub>]

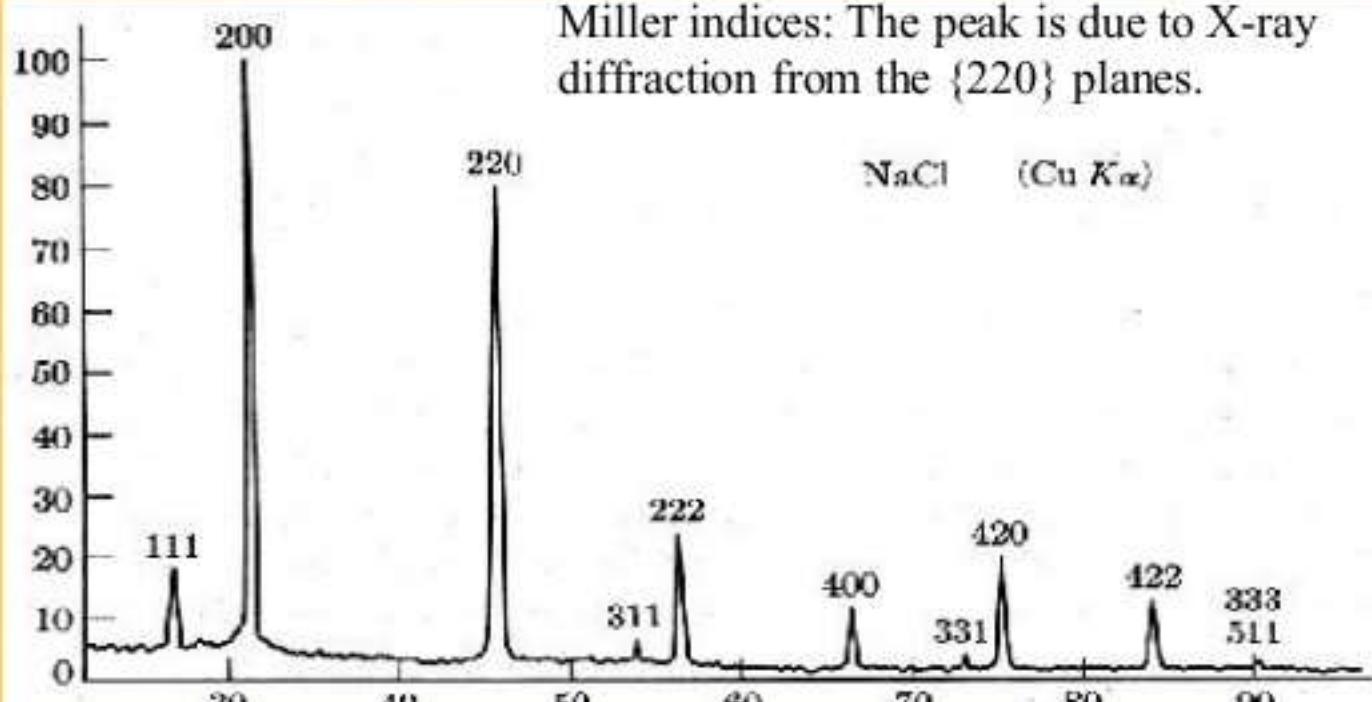


# X-ray Diffraction (XRD)





## XRD Pattern of NaCl Powder



**Diffraction angle  $2\theta$  (degrees)**

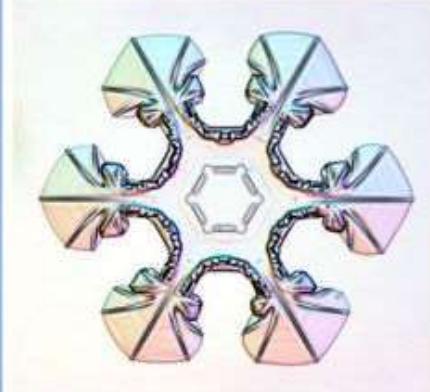
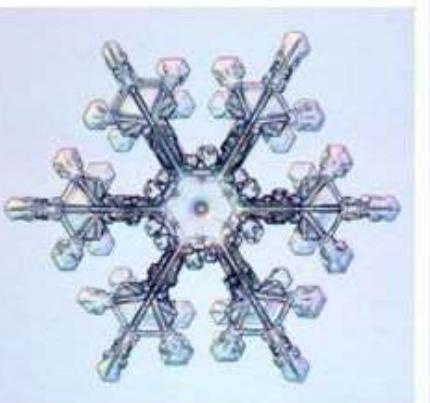
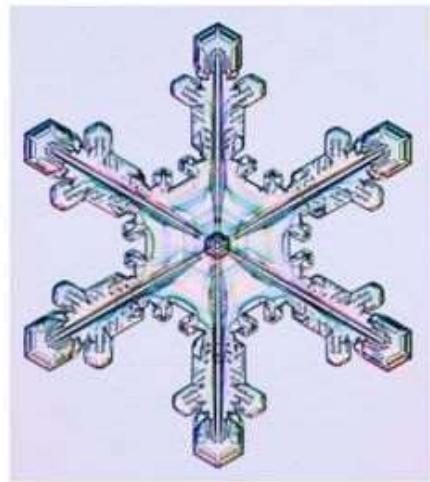
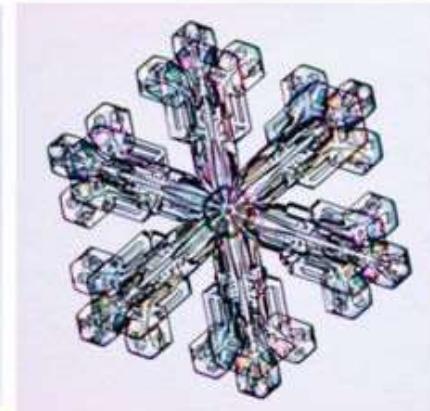
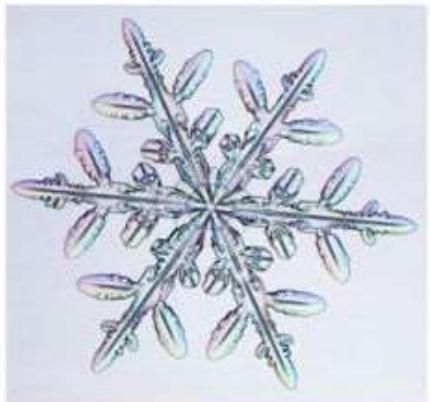
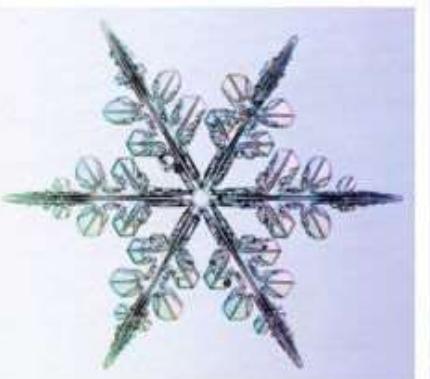
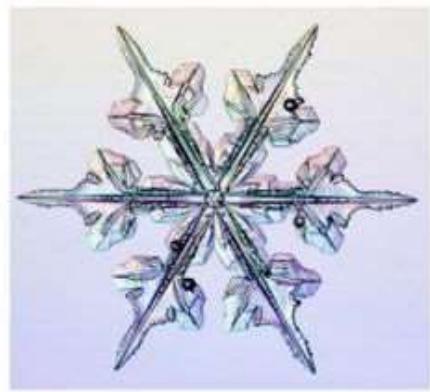
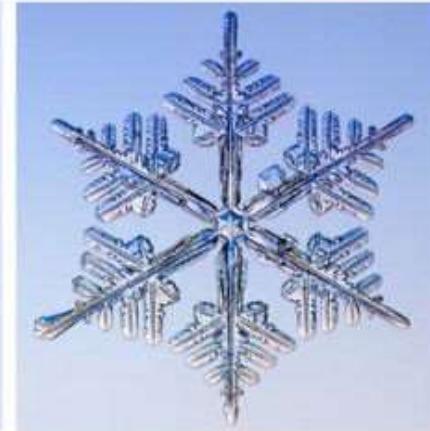


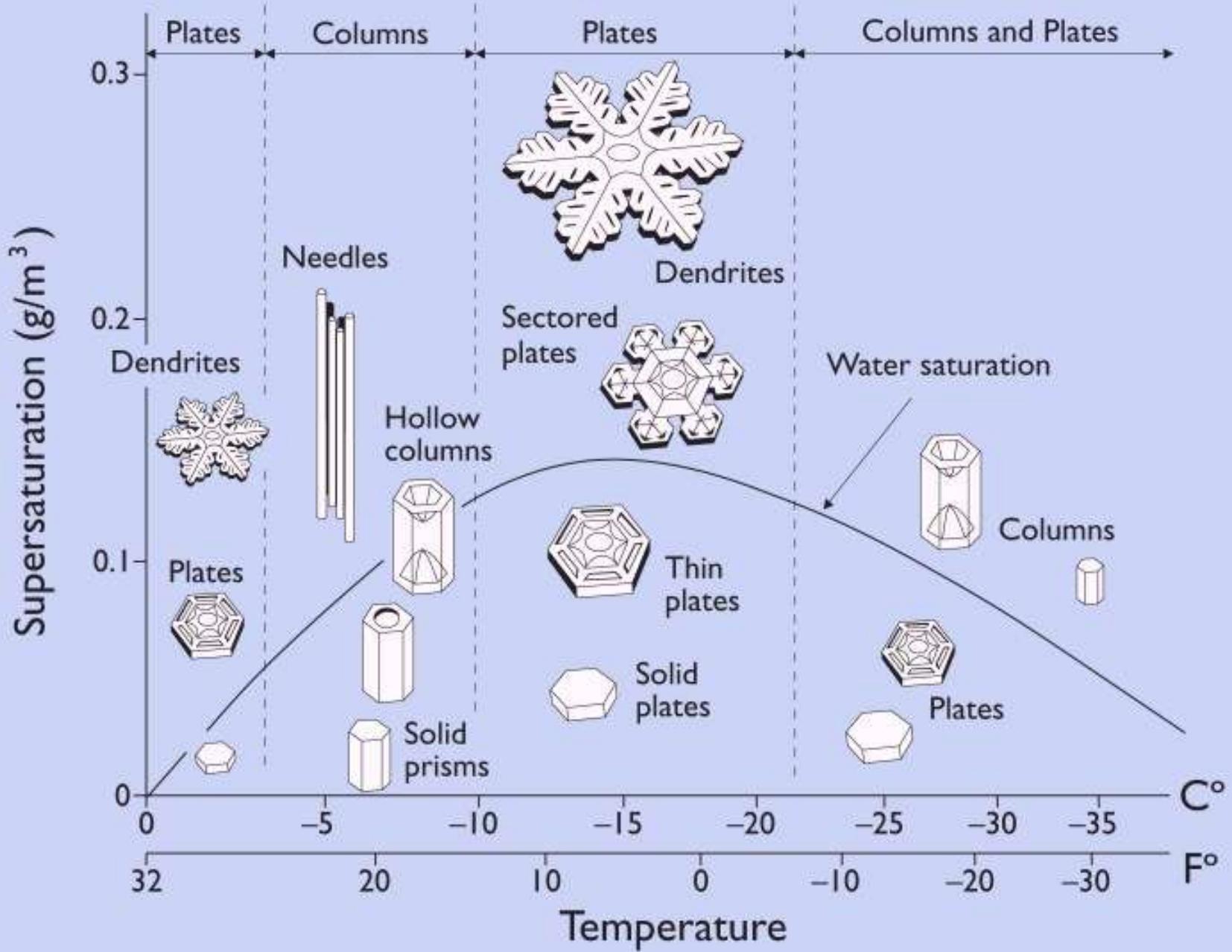


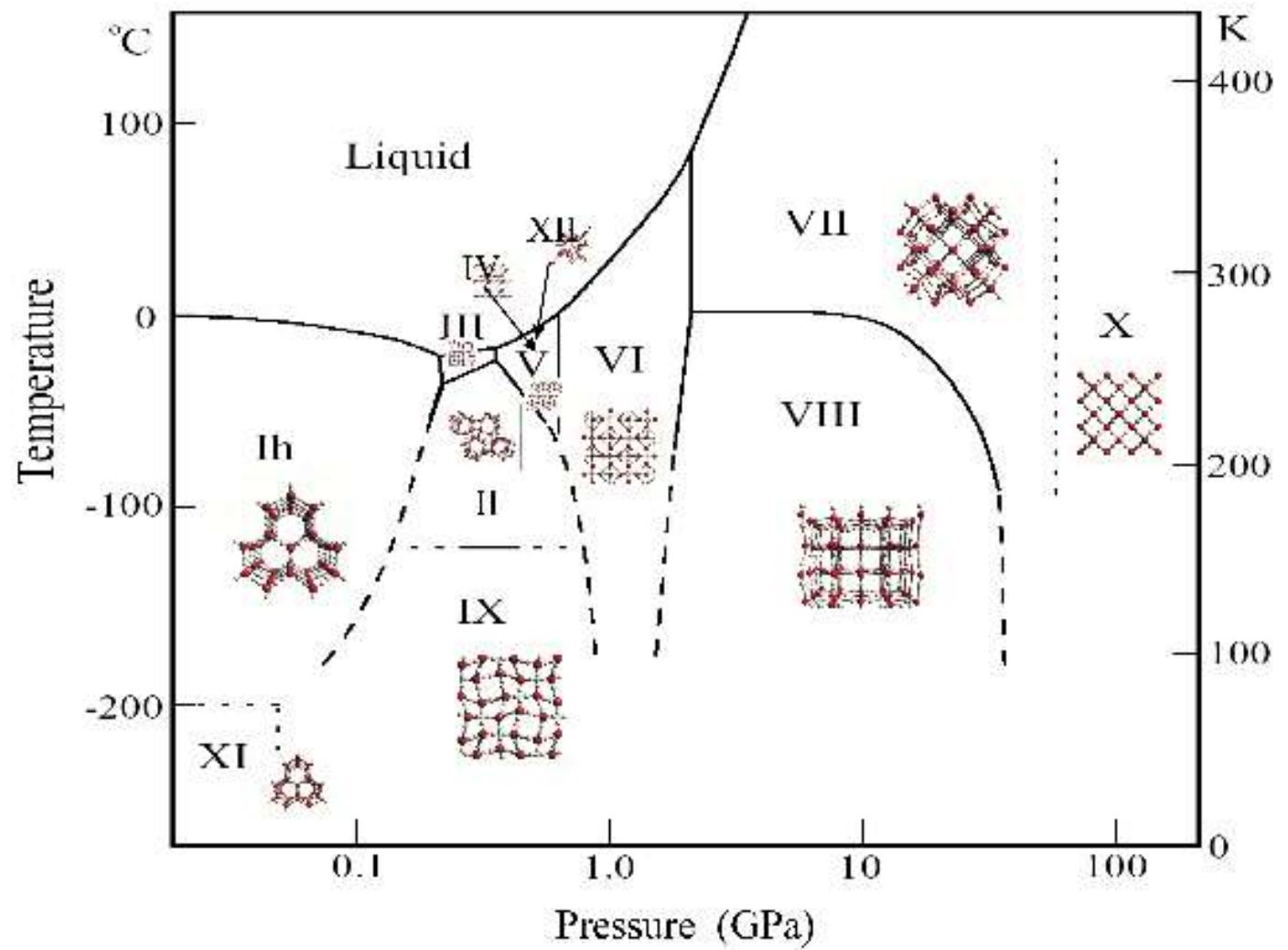


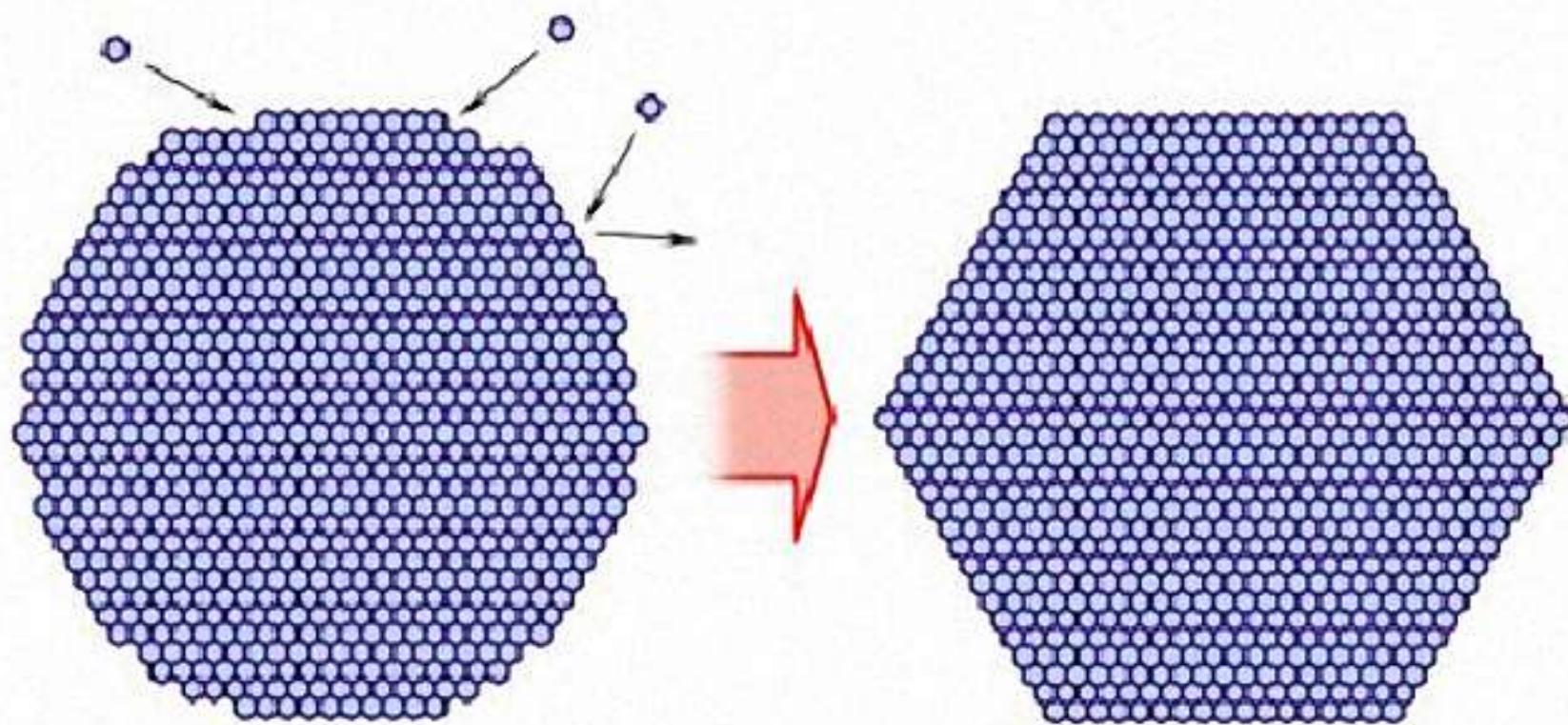




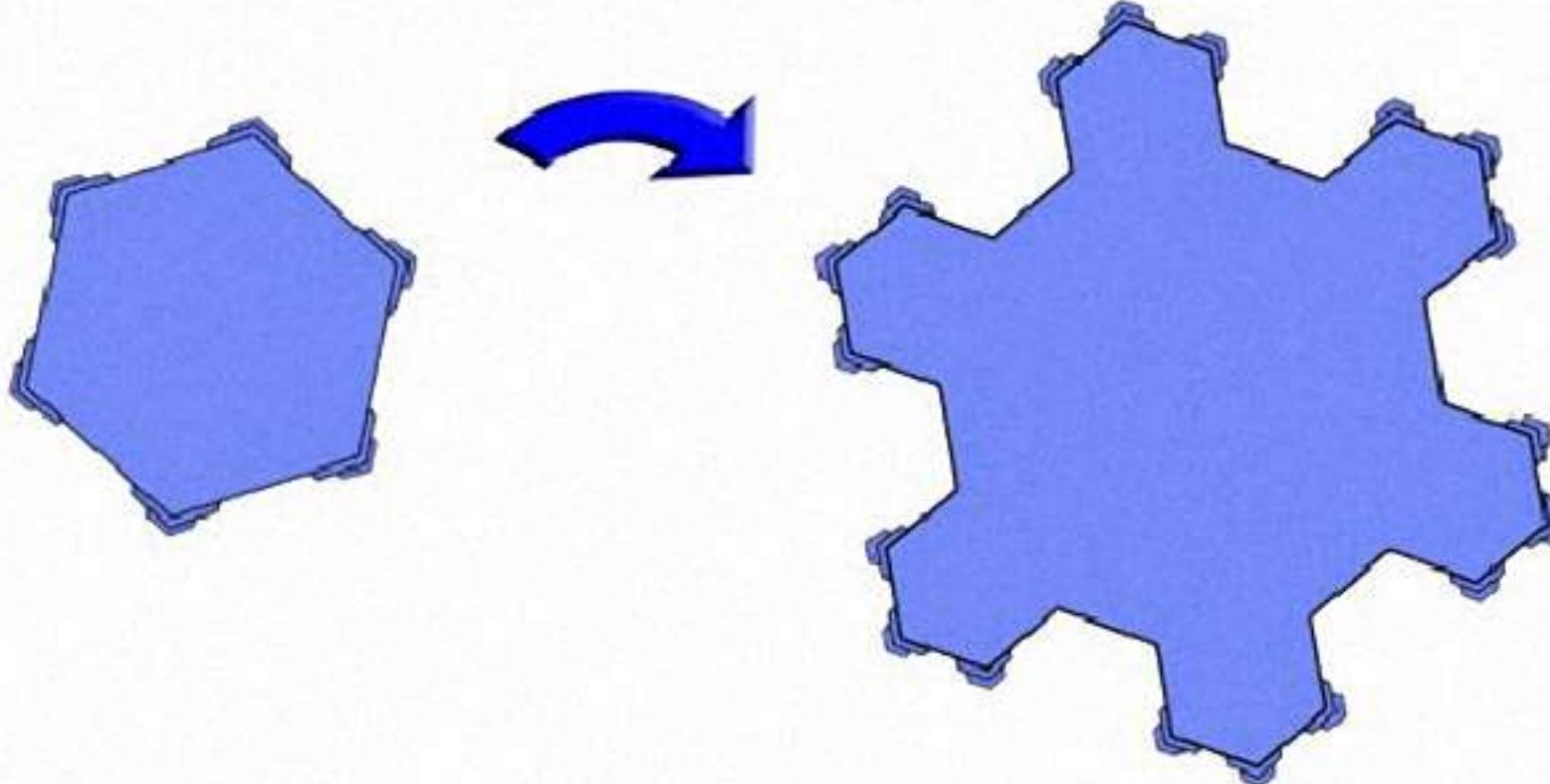


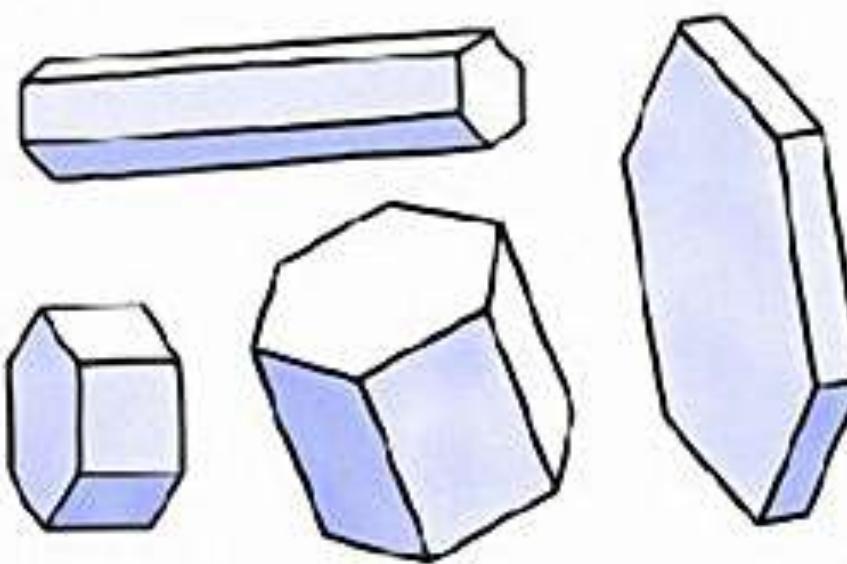


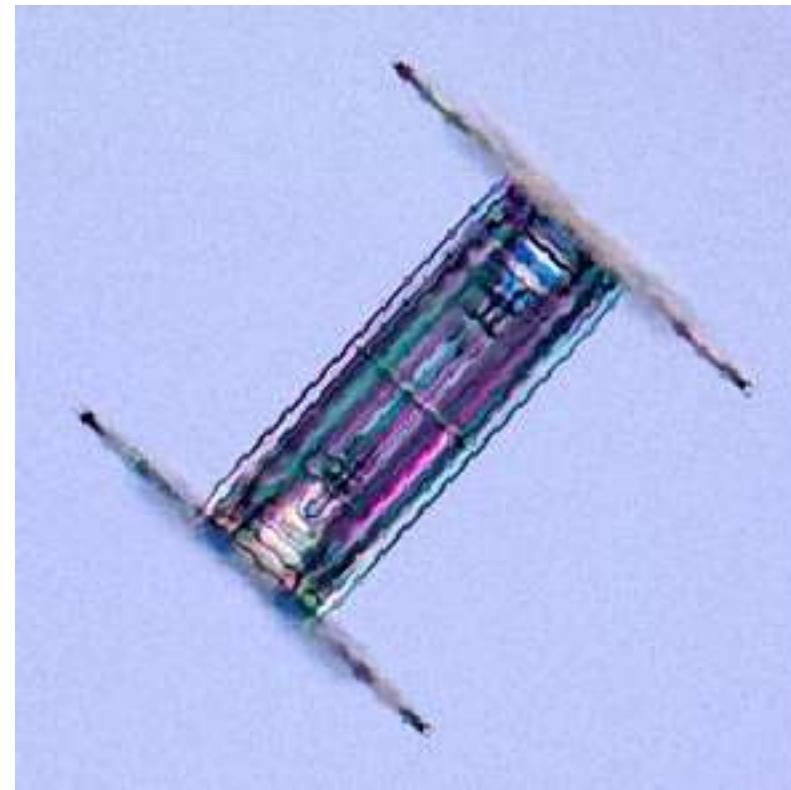


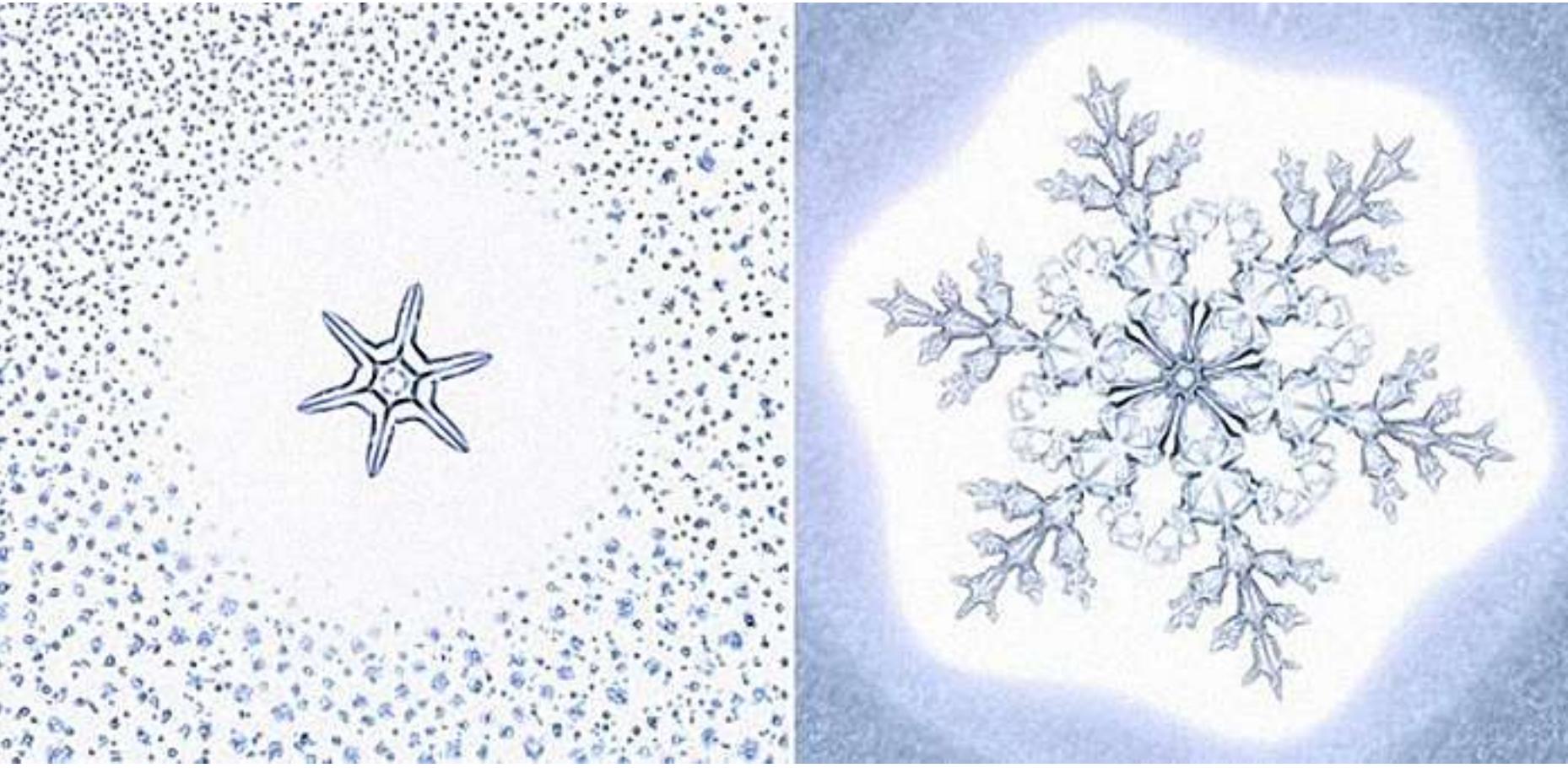


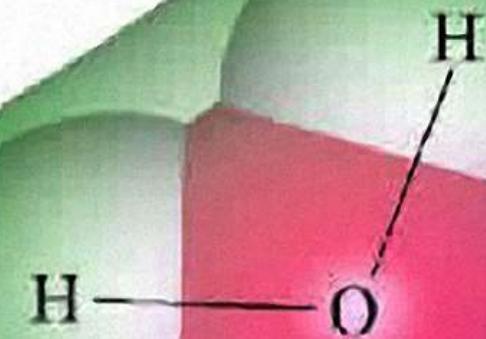
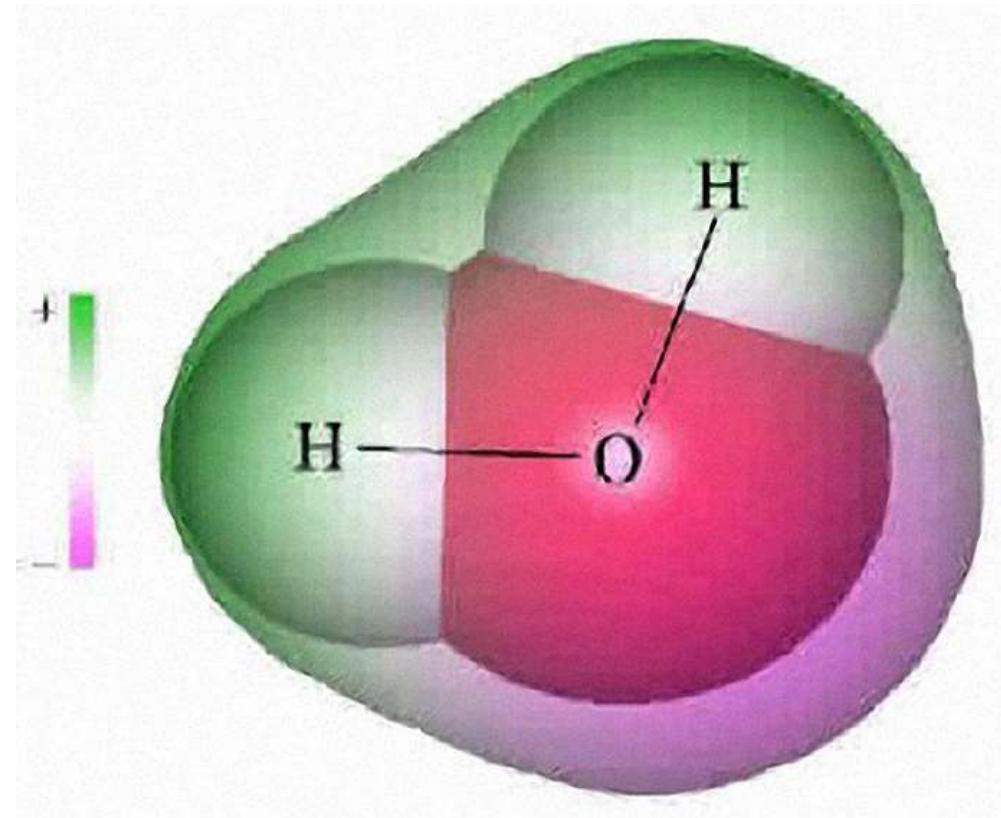
desorption

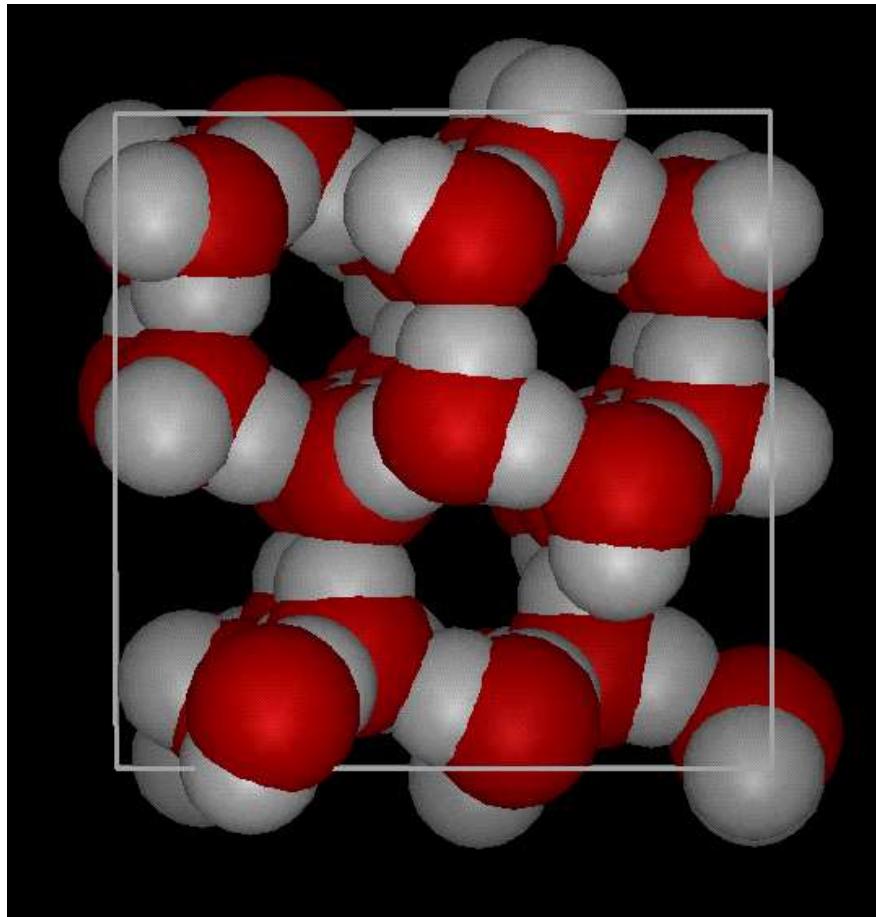


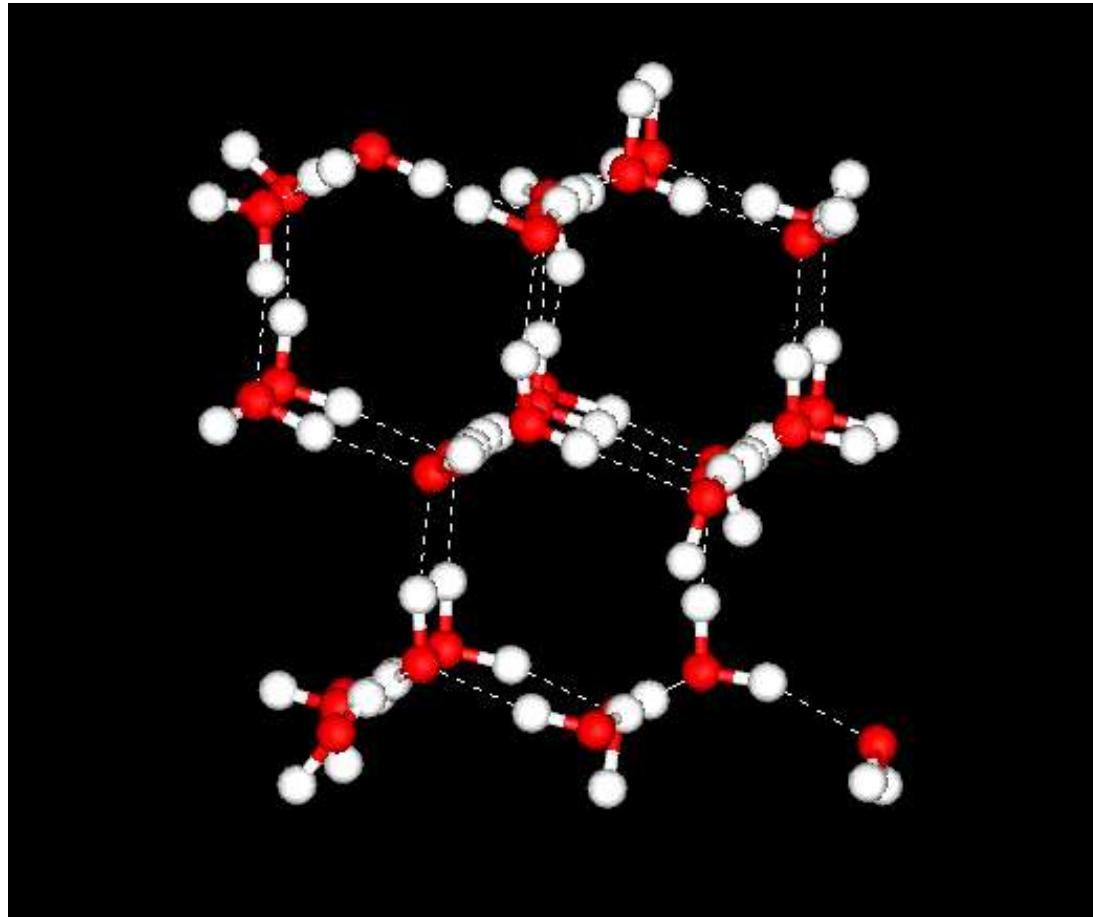




































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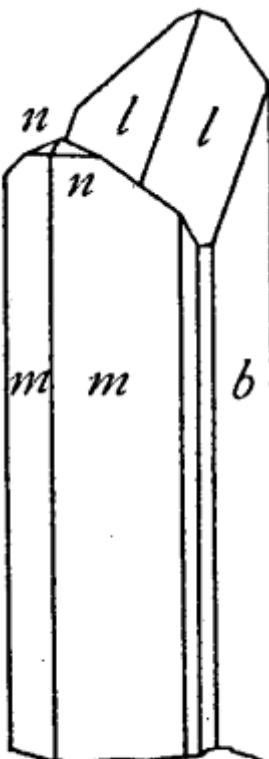
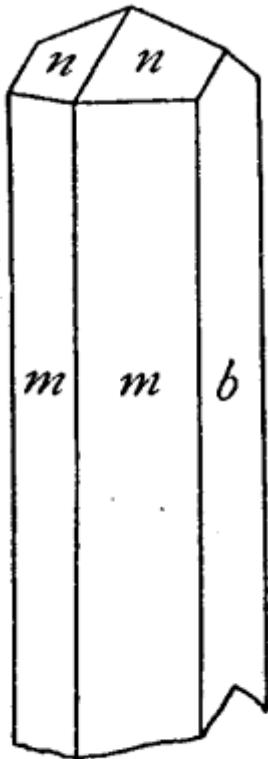




Estelle Balet

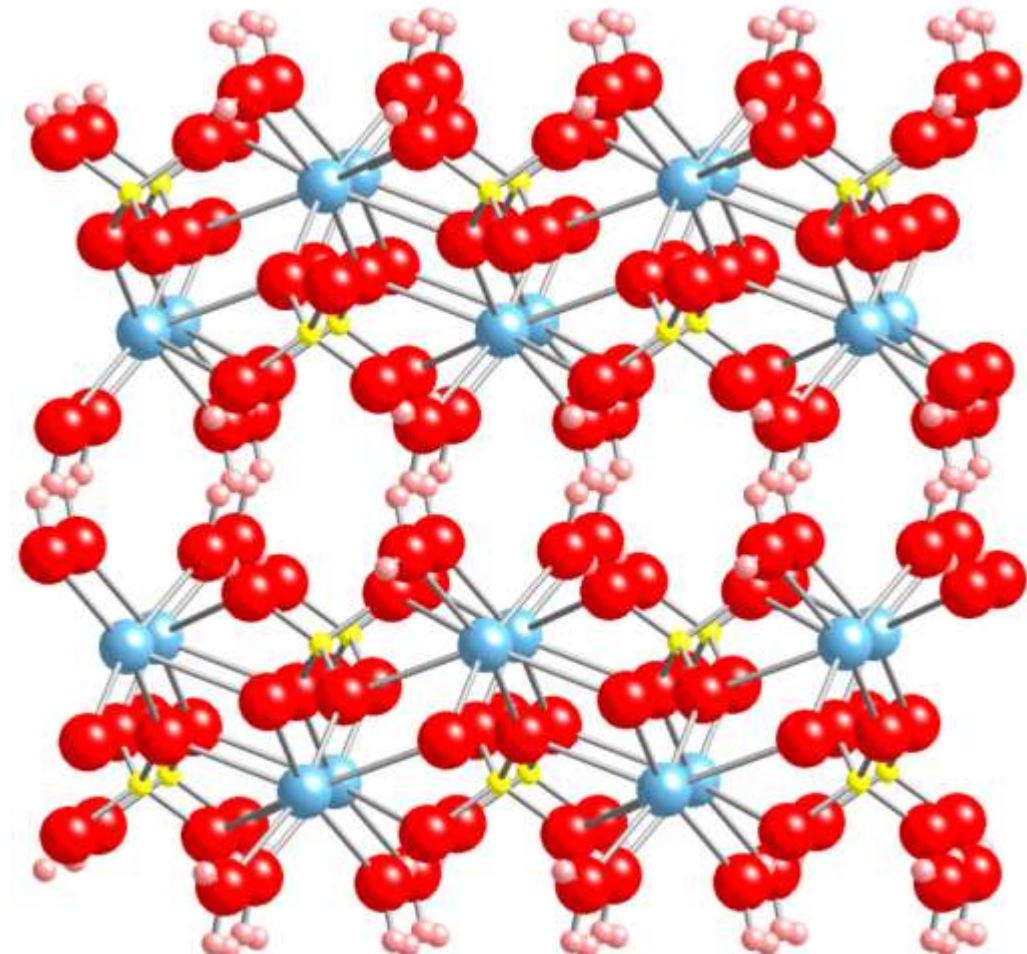


# Gifs/Selenít $\text{CaSO}_4$



*A*

*B*

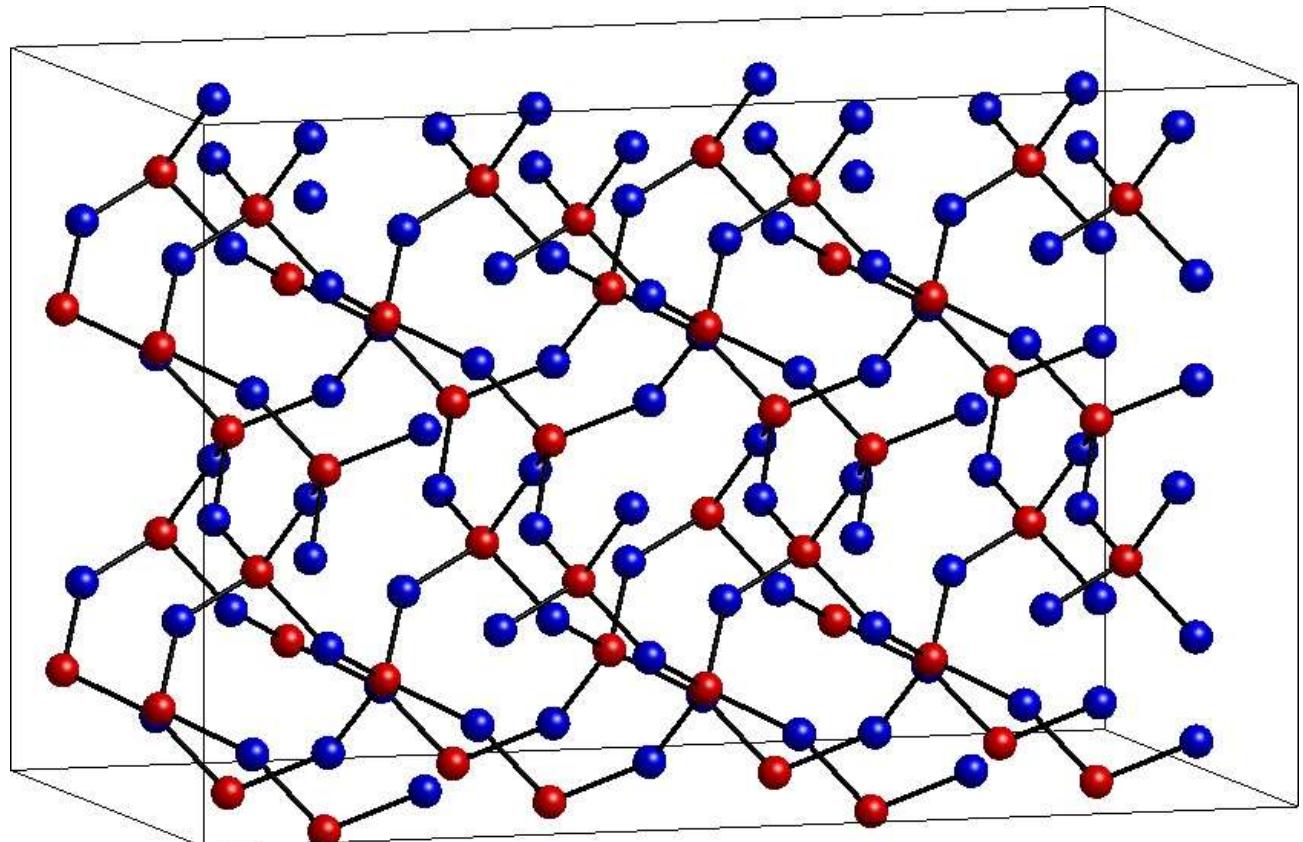
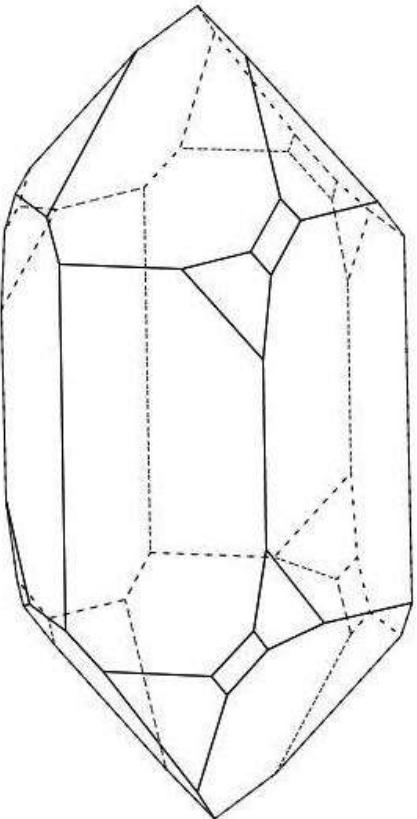








# Kvars $\text{SiO}_2$

















## VOGEL - PHI FUNCTION

Coherent Phi Energy Beam ( Yellow Arrow )

Requisite Phi  
Angle - 51.51



Diamond-Chi Plasmic Braid ( Black )

INPUT

FEMALE ♀

UNIVERSAL  
RECEIVING END

52° ANGLE  
(51 degrees 51 minutes)



OUTPUT

♂ MALE

PERSONAL  
PROJECTING END

MORE ACUTE  
ANGLE ± 60°



