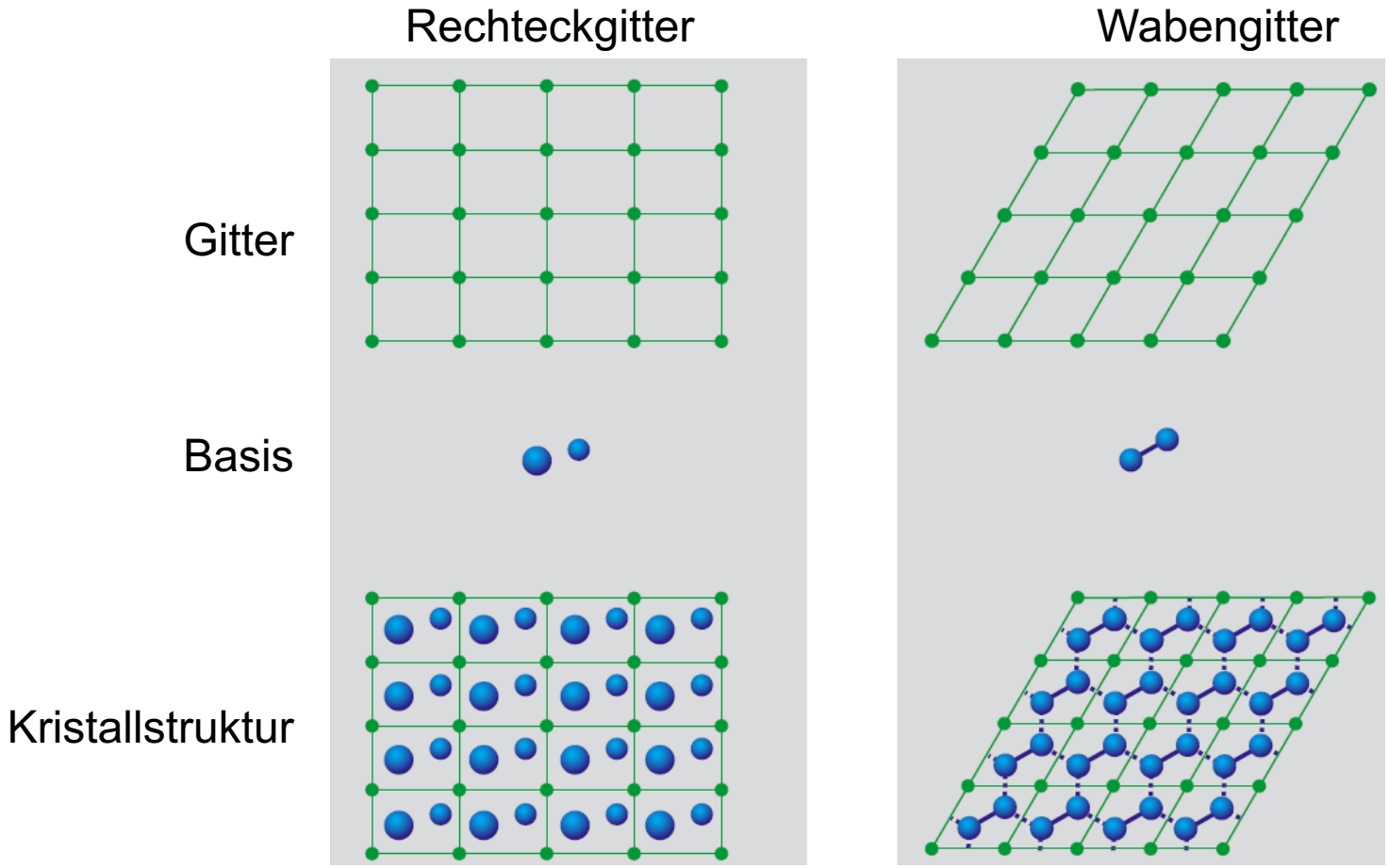
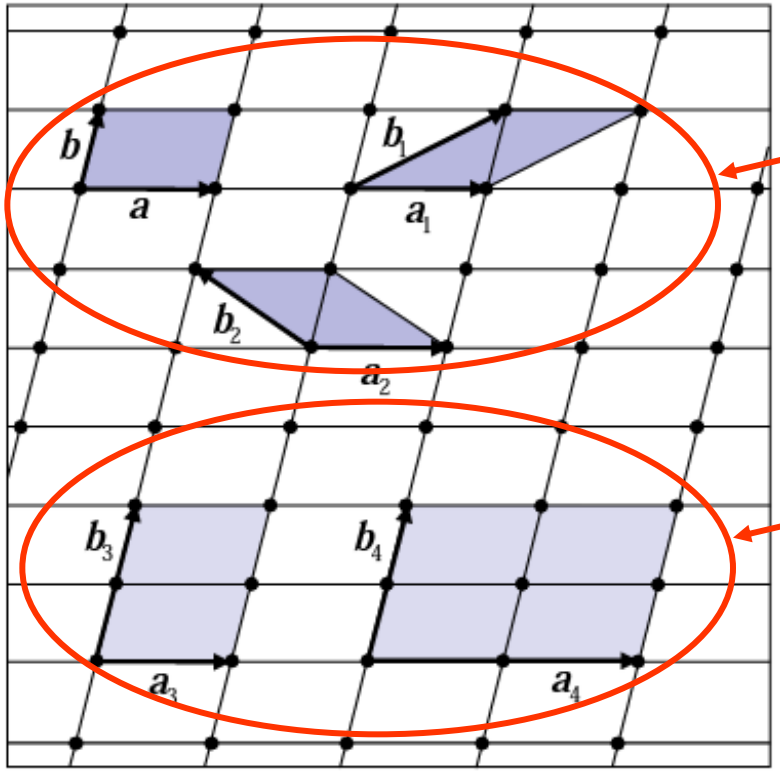
# Kristallstruktur = Gitter + Basis



# Primitive 2D Elementarzellen (EZ)




primitive Elementarzellen

**nicht-**primitive Elementarzellen

# Gitterarten

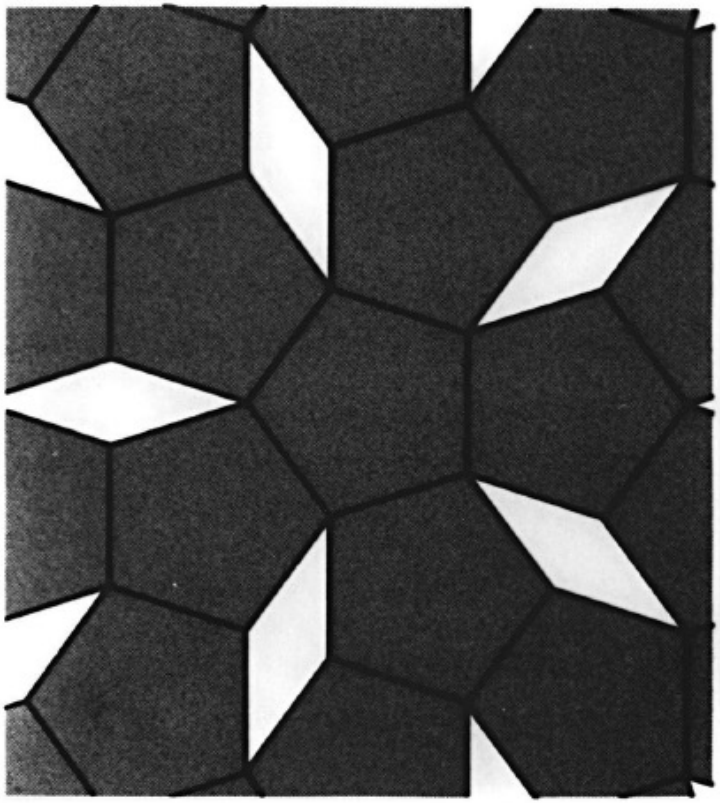


Figure 9a A five-fold axis of symmetry cannot exist in a lattice because it is not possible to fill all space with a connected array of pentagons. In Fig. 32 we give an example of regular pentagonal packing which does not have the translational invariance of a lattice.

5,7,8 etc. Eck füllen den Raum nicht ohne Lücken

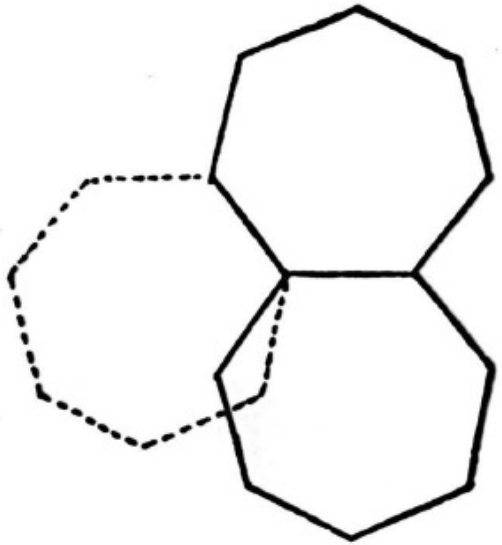
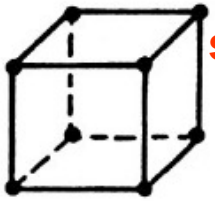
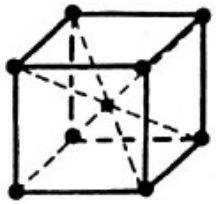


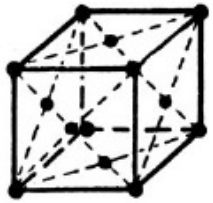
Figure 9b Kepler's demonstration (*Harmonice mundi*, 1619) that a seven-fold axis of symmetry cannot exist in a lattice. (*Gesammelte Werke*, Vol. 6, Beck, Munich, 1940.)

# Die Bravias Gitter 1-9
# Rechtwinklige Kristallsysteme

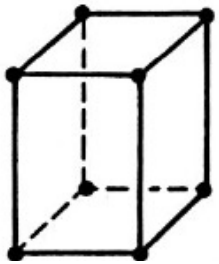
**kubisch**
$a=b=c$
$\alpha=\beta=\gamma=\pi/2$

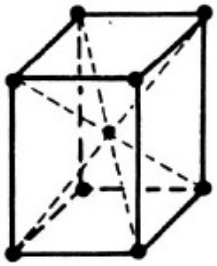

sc primitiv


bcc raumzentriert

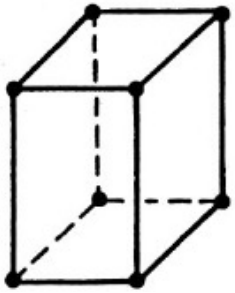

fcc flächenzentriert

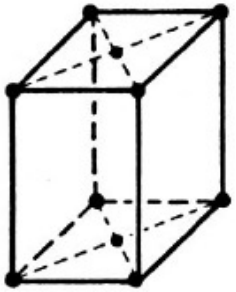
**tetragonal**
$a=b\neq c$
$\alpha=\beta=\gamma=\pi/2$

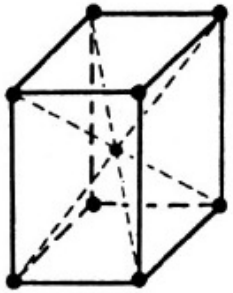

primitiv

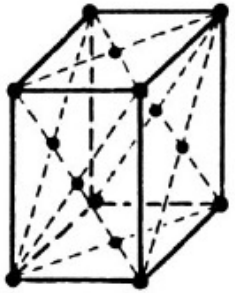

raumzentriert

**orthorhombisch**
$a\neq b\neq c$
$\alpha=\beta=\gamma=\pi/2$


primitiv

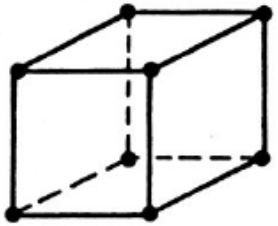

basiszentriert


raumzentriert

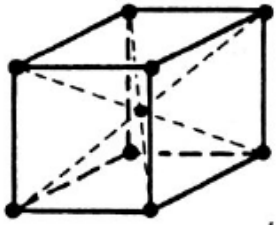

flächenzentriert

# Die Bravias Gitter 10-14
# Schiefwinklige Kristallsysteme

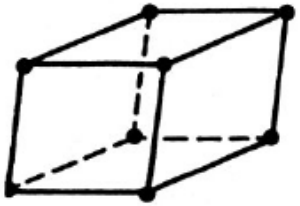
**monoklin**
$a \neq b \neq c$
$\alpha = \beta = \pi/2 \neq \gamma$



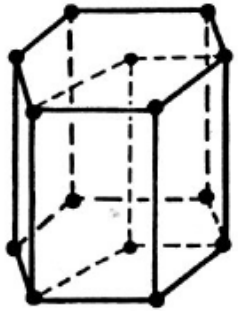
primitiv



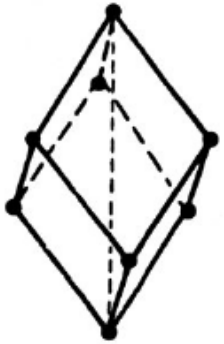
raumzentriert



**triklin**
$a \neq b \neq c$
$\alpha \neq \beta \neq \gamma \neq \pi/2$



**hexagonal**
$a = b \neq c$
$\alpha = \beta = \pi/2, \quad \gamma = 2\pi/3$



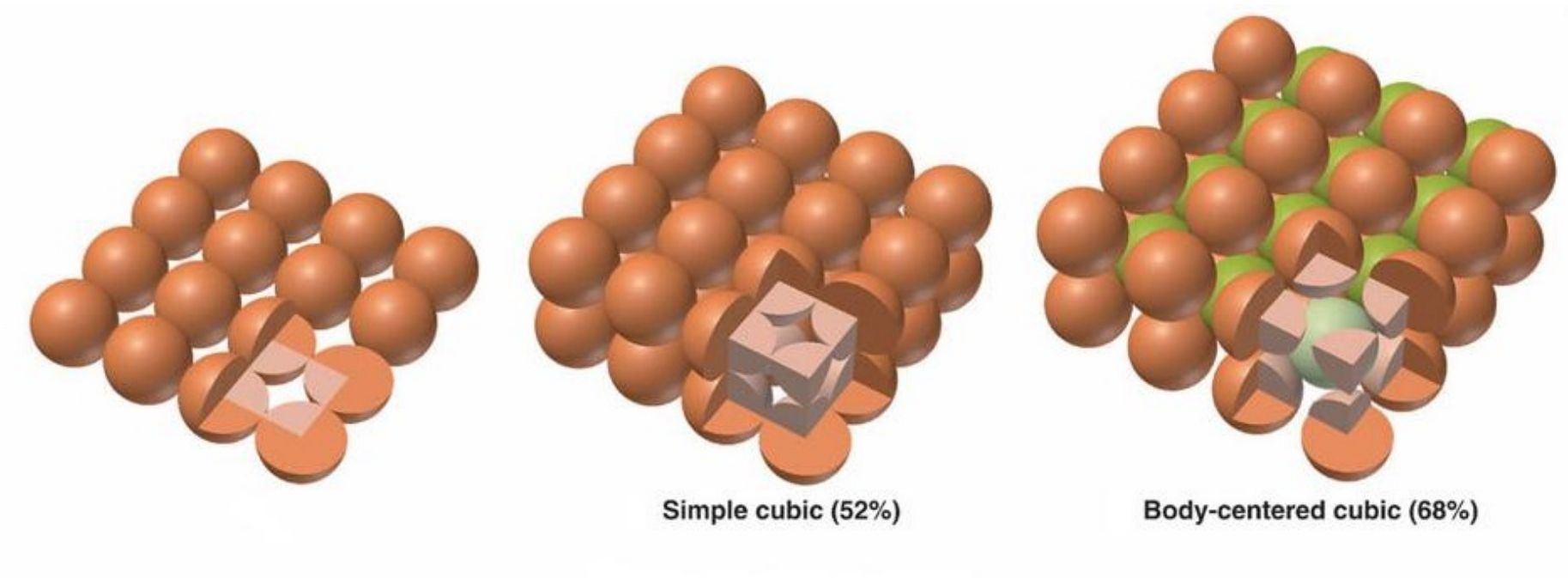
**trigonal**
$a = b = c$
$\alpha = \beta = \gamma \neq \pi/2$

# Einfache Kristallstrukturen

## Kubische Kristalle

sc

bcc

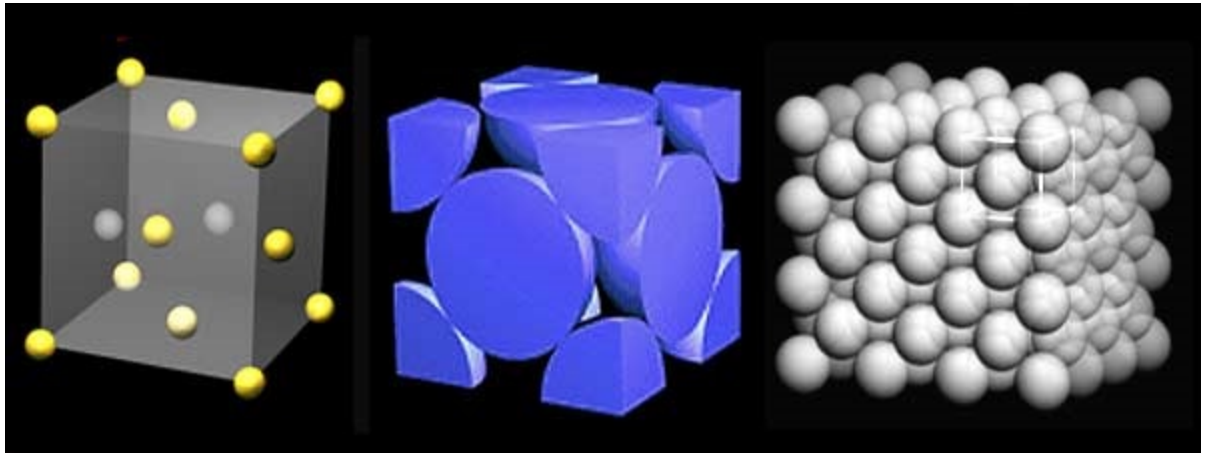



kein Element
CsCl

Li, Na, K, …
V, Ta
Cr, Mo, W

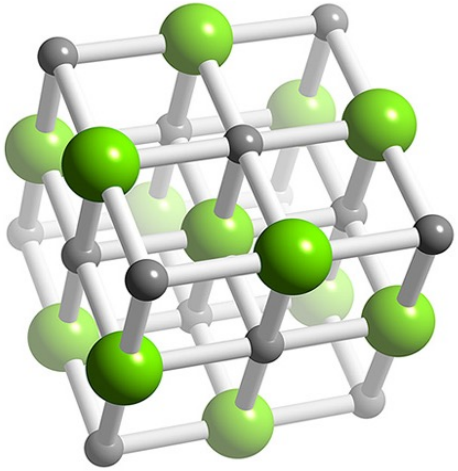
# Einfache Kristallstrukturen

Kubisch flächenzentriert (fcc)
4 Gitterpunkte/EZ



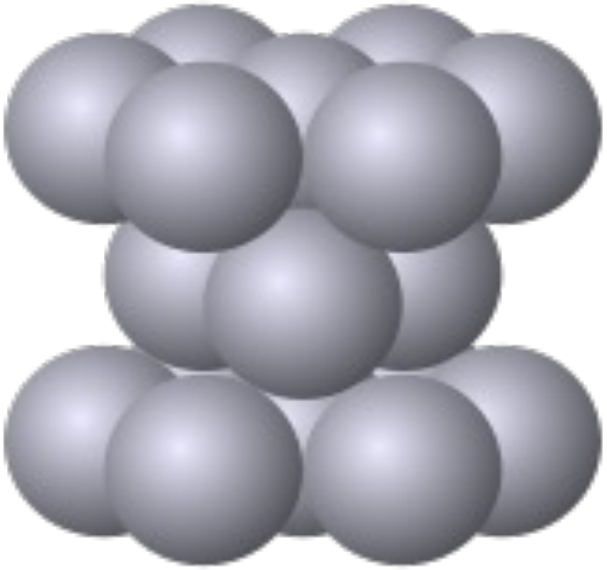
Ne, Ar, Cr, Xe,
…
Cu, Ag, Au, …
Ni, Pd, Pt, …
Rh, Ir, …

NaCl



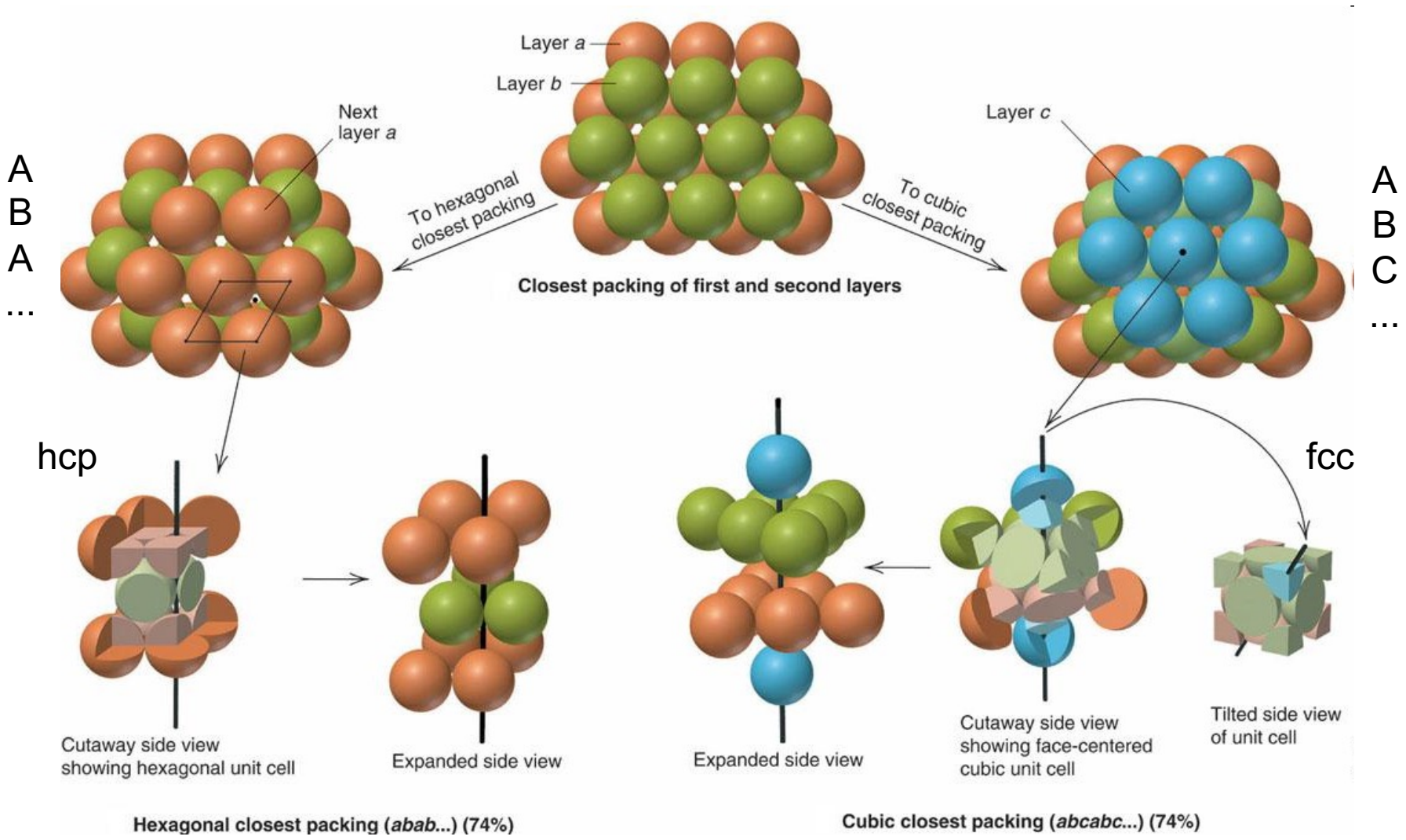
# Einfache Kristallstrukturen

Hexagonal dichteste Packung
(hcp = hexagonal close packed)

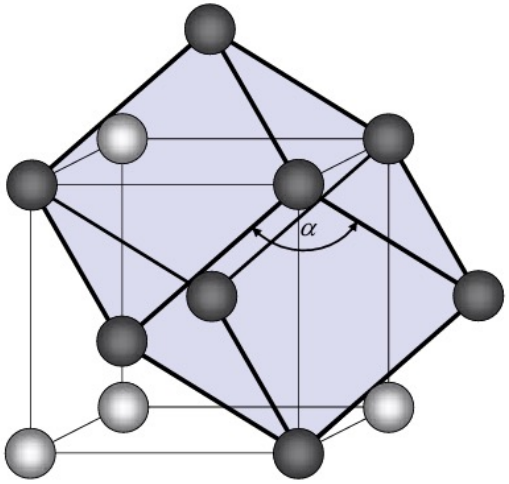


Ti, Zr, Hf
Be, Mg, Co

# Kugelpackung: hexagonal oder kubisch? hcp und fcc

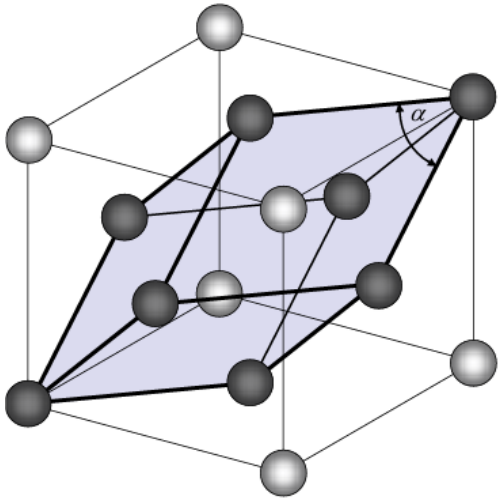


# Primitive 3D Elementarzellen (EZ)



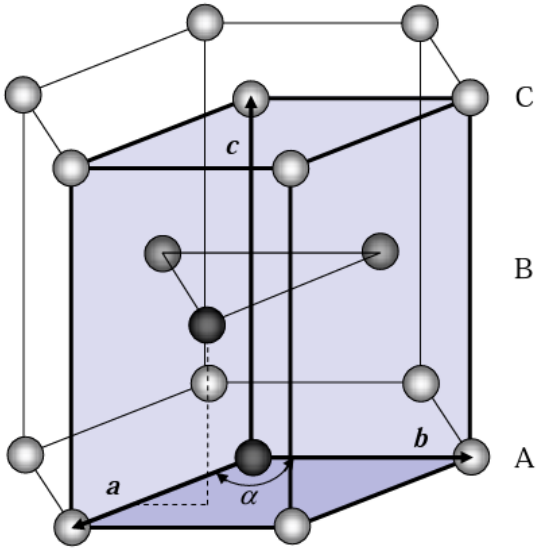

bcc

kubisch raumzentriertes Gitter




fcc

kubisch flächenzentriertes Gitter



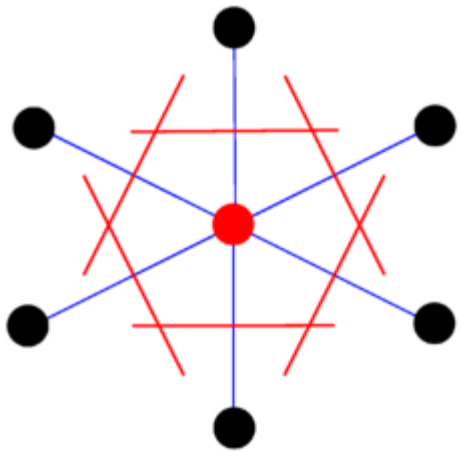

hcp

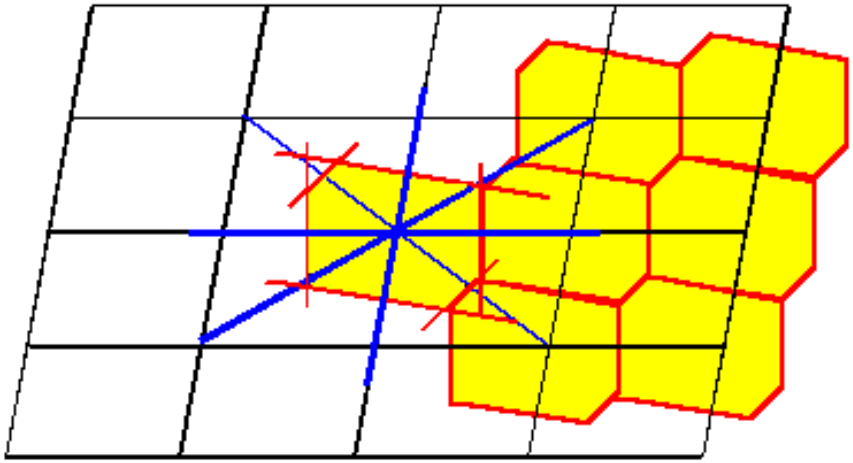
hexagonal dichtesten Kugelpackung

© S.Hunklinger

# Die Wigner-Seitz Zelle

Zur 2D Konstruktion einer Wigner-Seitz-Zelle



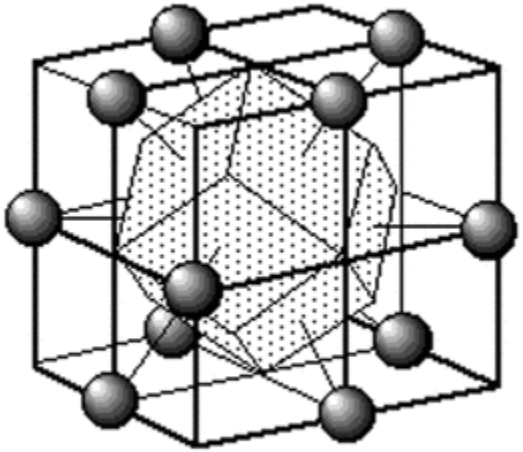


# Die Wigner-Seitz Zelle

## 3D Wigner-Seitz-Zellen

**fcc**

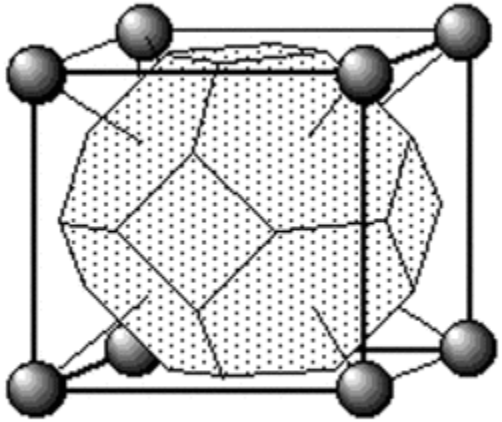
kubisch flächenzentriertes Gitter



rhombic dodecahedron

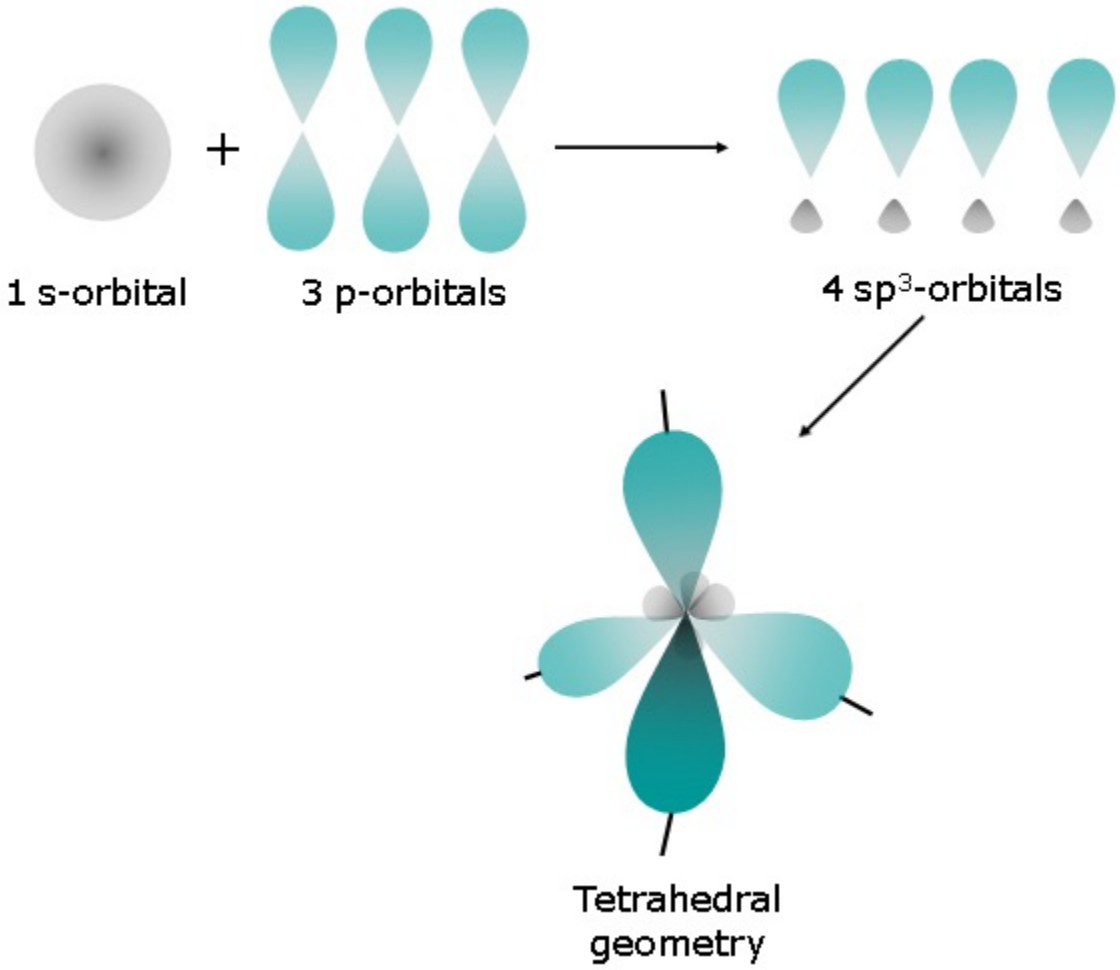
**bcc**

kubisch raumzentriertes Gitter

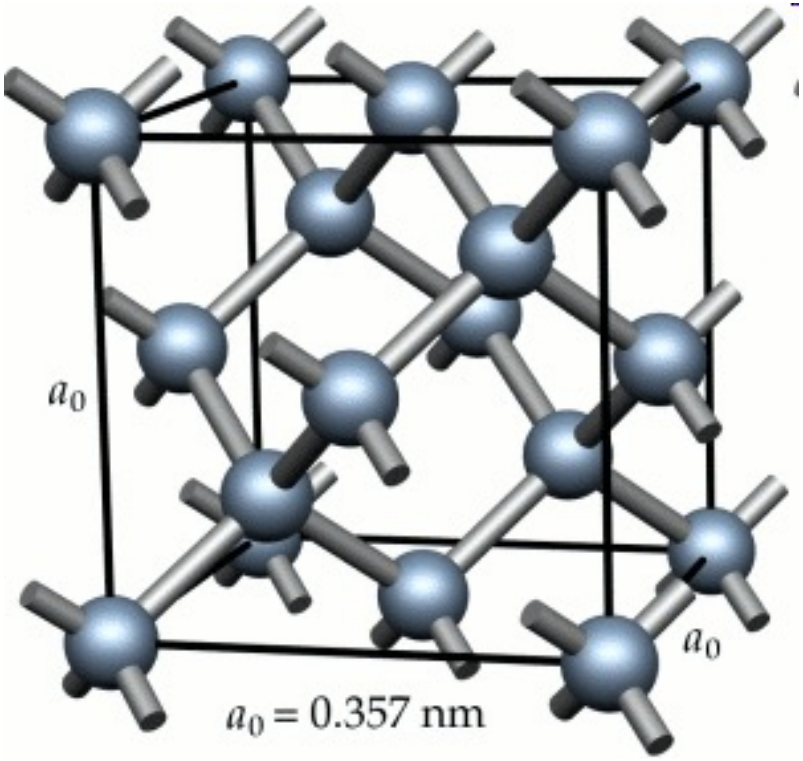


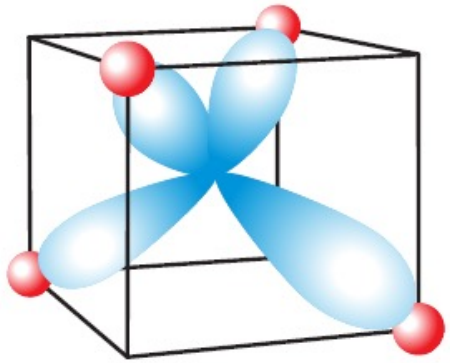
truncated octahedron

# Die kovalente Bindung: $sp^3$ -Hybridisierung

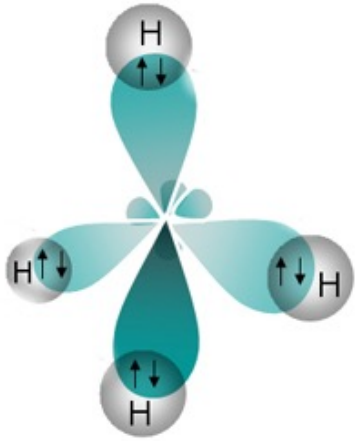


# Diamant-Struktur



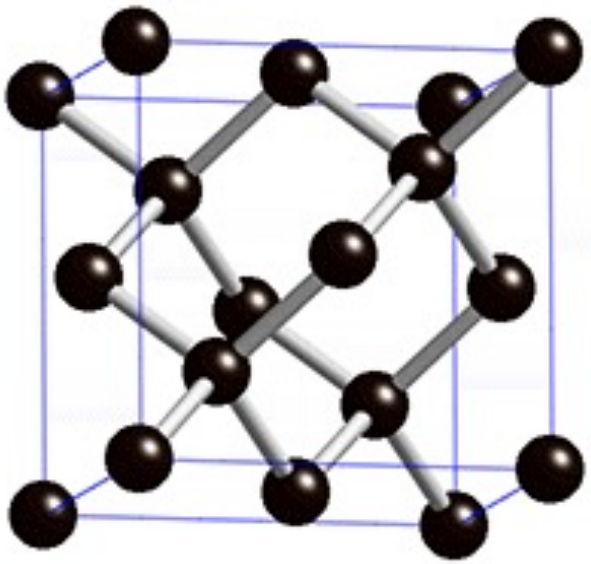



$sp^3$-Hybridbindung
"Tetraeder-Bindung"




Methan

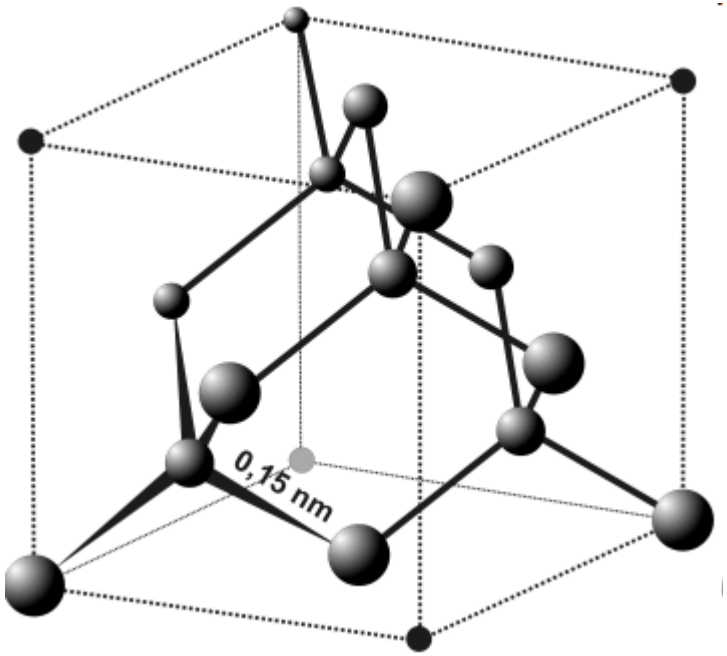
# Diamant-Struktur



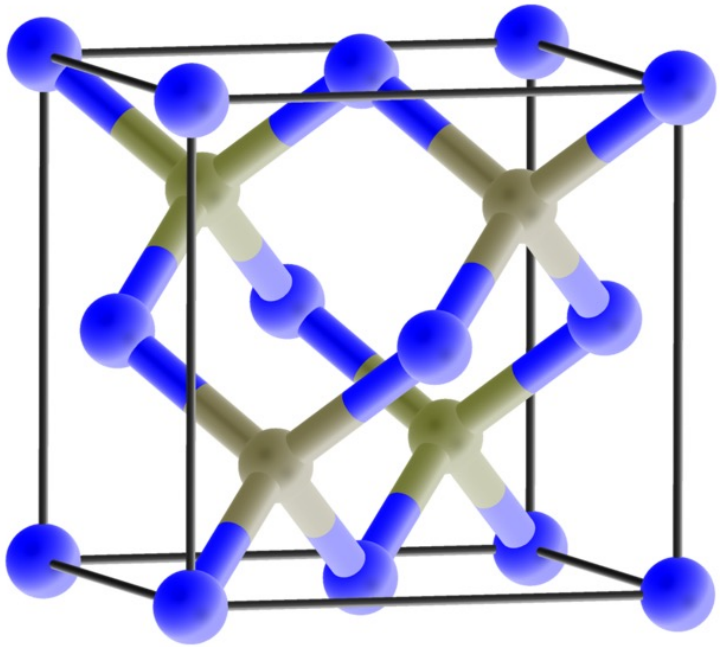
# Einfache Kristallstrukturen

Diamant- und Zinkblende-Strukturen  fcc

Diamant  C




Zinkblende ZnS



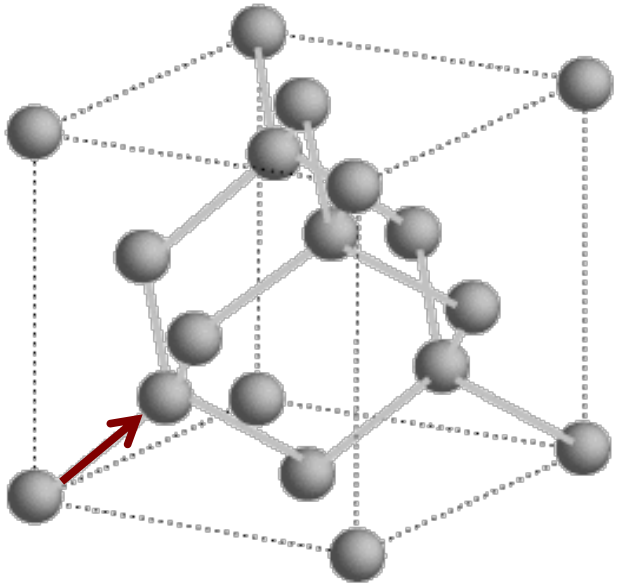
# Einfache Kristallstrukturen

Diamantstruktur

Diamant

C,Si,Ge

elementare Halbleiter



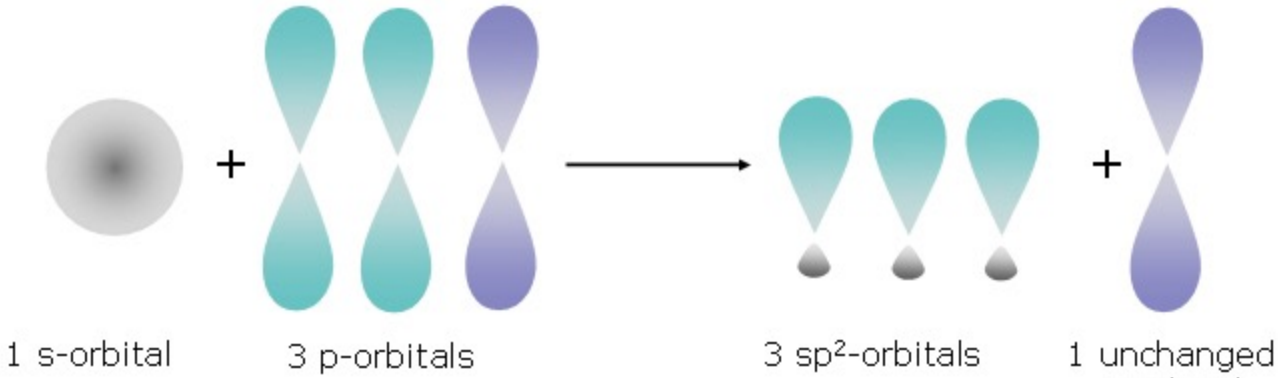
Zinkblende

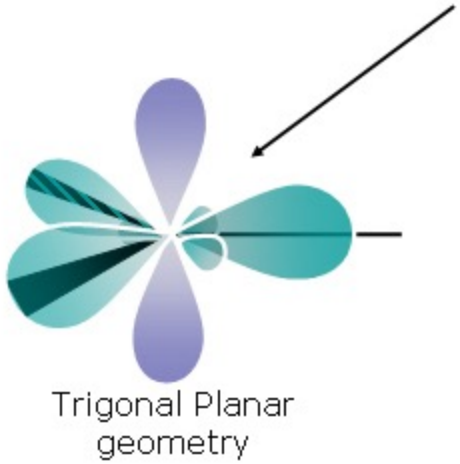
ZnS, GaAs, InP

III-V Halbleiter

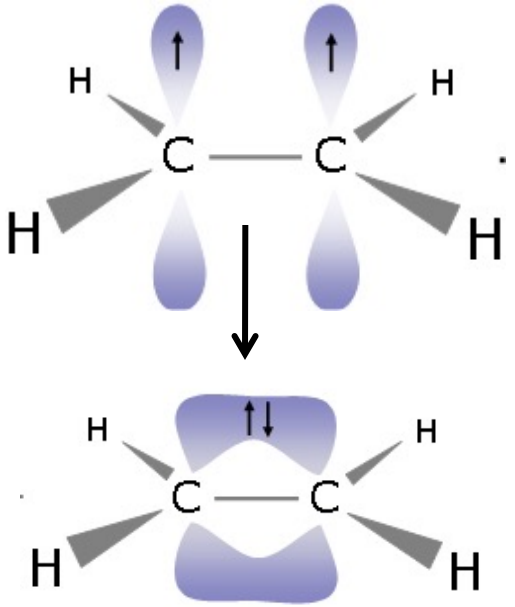
2 fcc Gitter um [1/4,1/4,1/4] gegeneinander verschoben.
Jedes Atom ist eingebettet in einen Tetraeder von nächsten Nachbarn.
Bindungsachsen entsprechen einer $sp^3$ Hybridisierung.
In der Zinkblende Struktur sind die Atome beider fcc Gitter unterschiedliche.

# Die kovalente Bindung: $sp^2$ -Hybridisierung

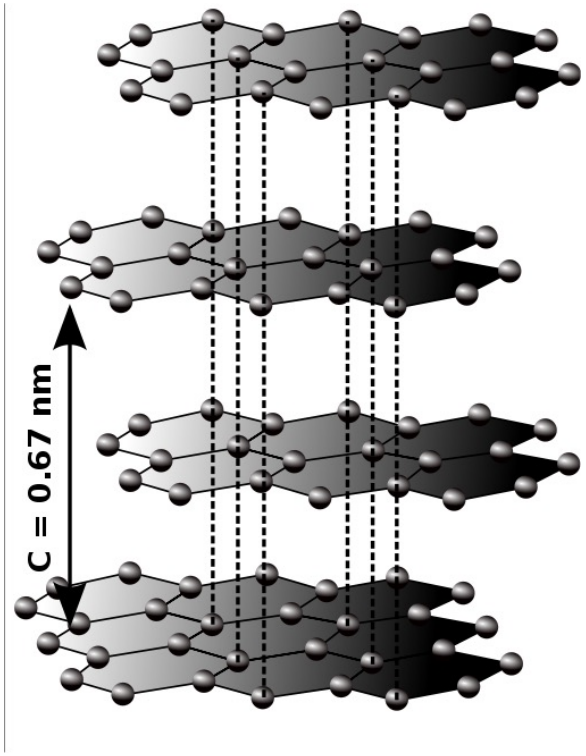


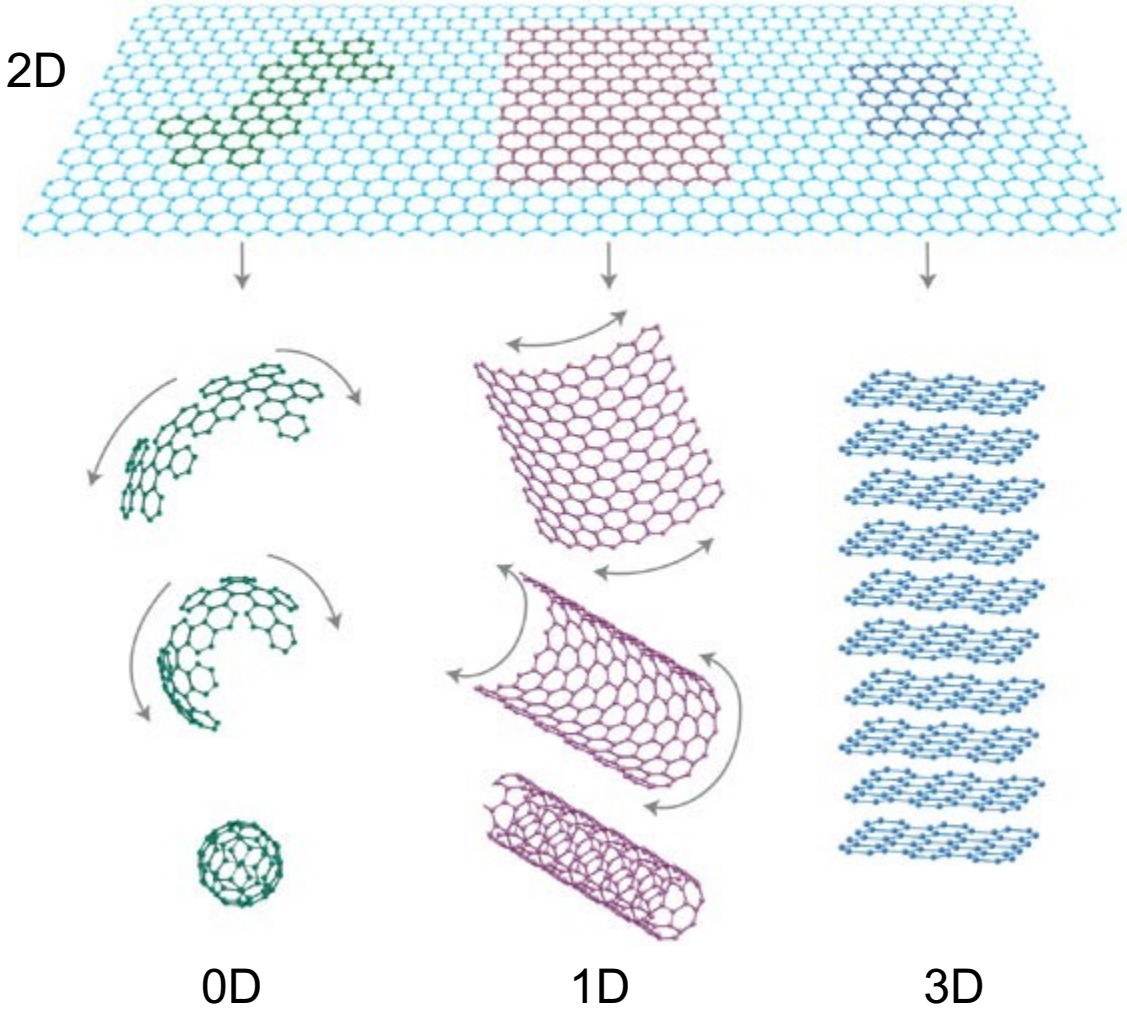




Ethen

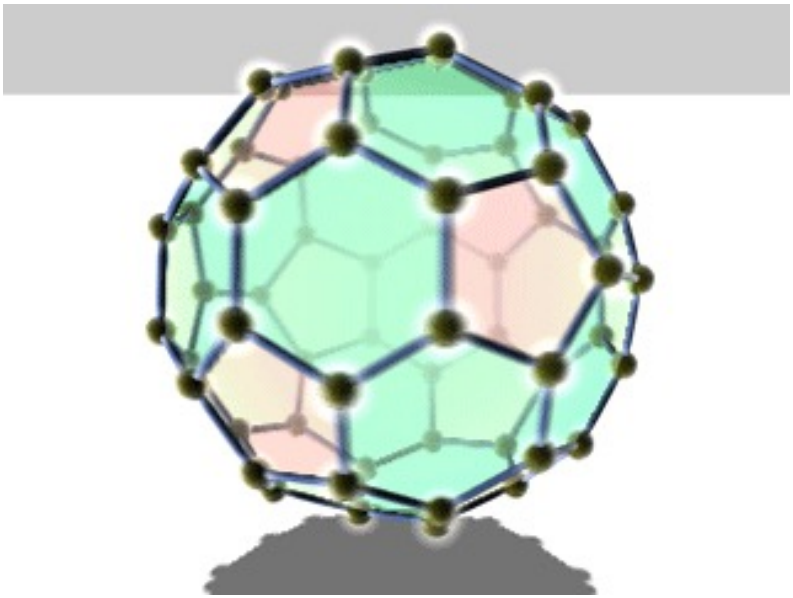


# Carbon Materials: Graphit, Graphene, Nanotube, Fullerene

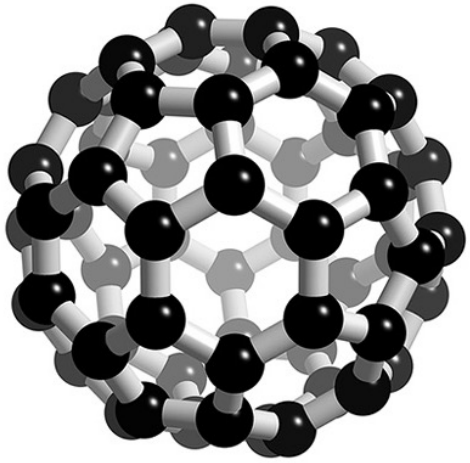


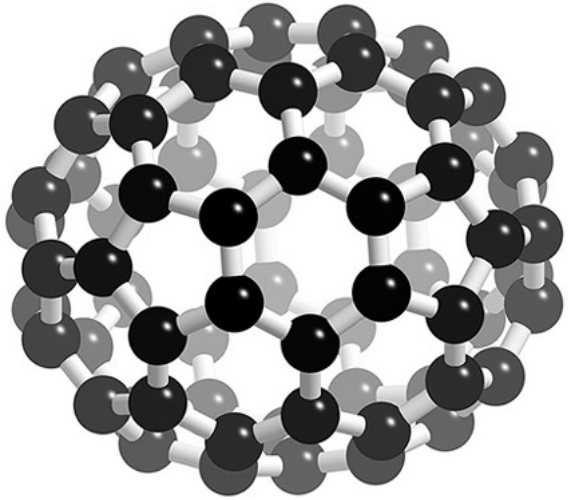
# Fullerene $C_{60}$ und $C_{70}$



$C_{60}$



$C_{70}$



# Graphene