# متالورژی فیزیکی
## جلسه سوم : بین نشینی و جانشینی


علی اشرفی

دانشکده مهندسی مواد

دانشگاه صنعتی اصفهان

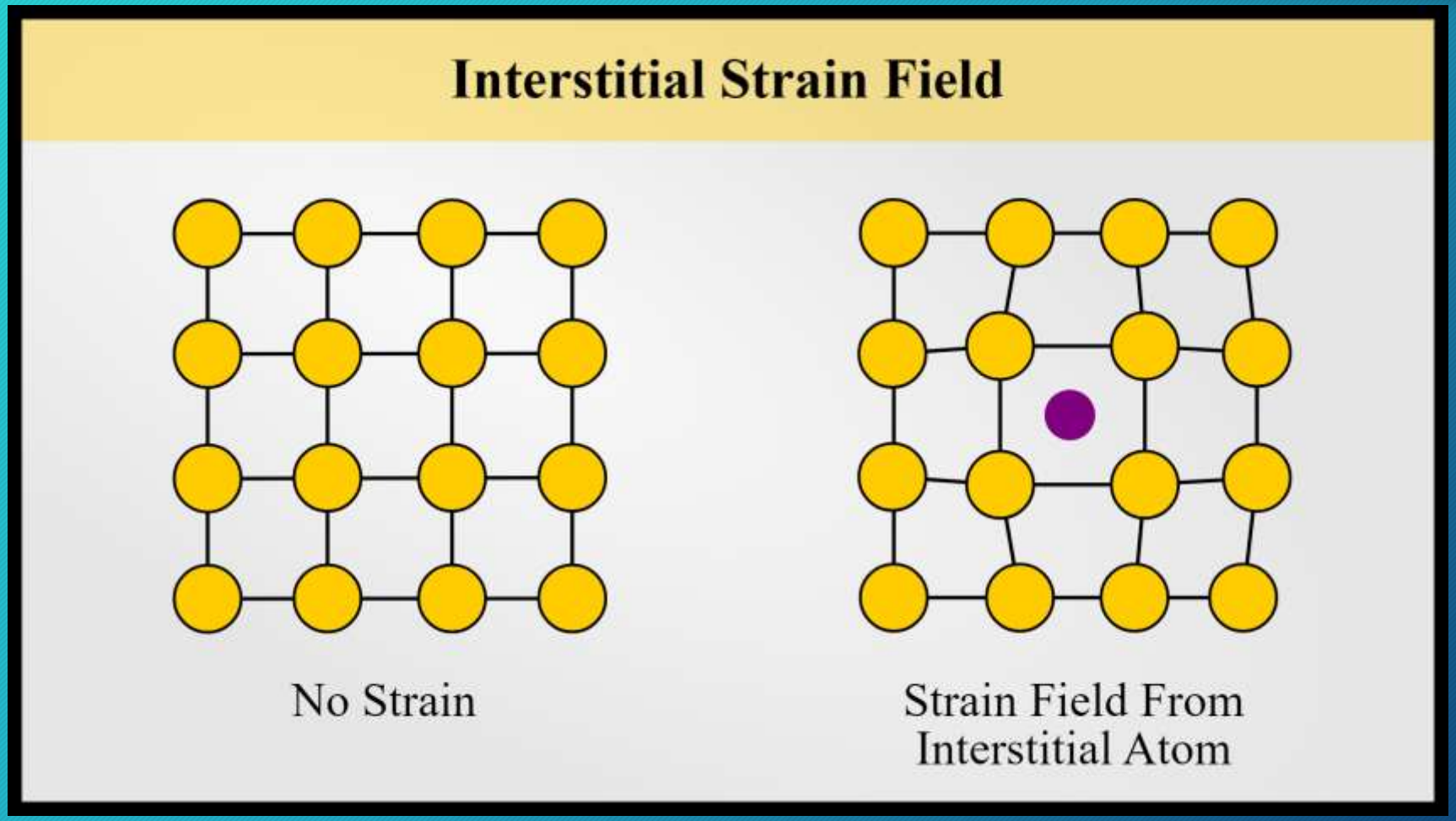
# فضاهای بین نشین

- *فضاهای خالی در شبکه بلوری*

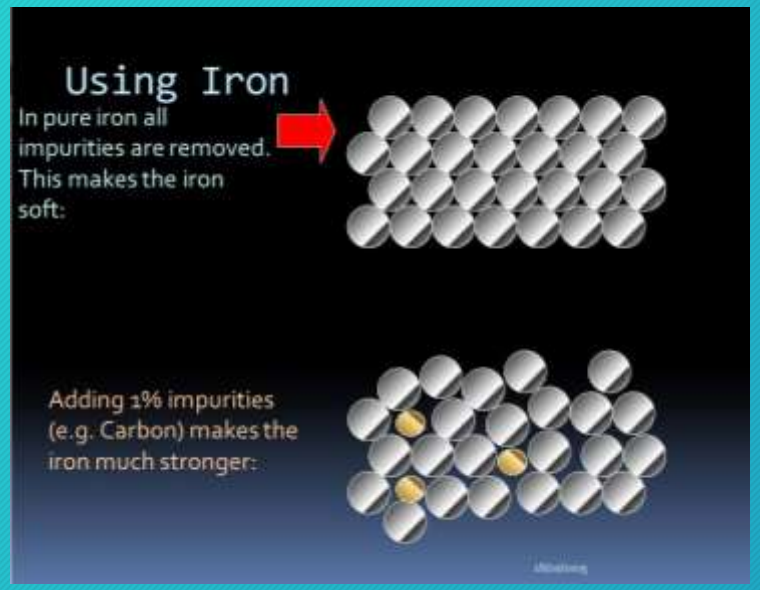
- *با توجه به تعداد اتم احاطه کننده فضای مزبور،*

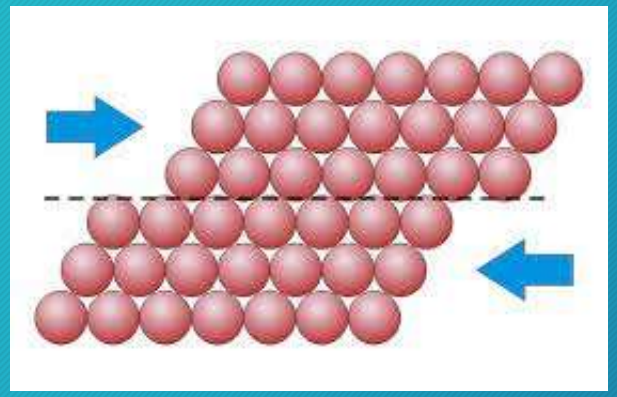
- *فضای مثلثی*
- *فضای تتراهدرال*
- *فضای اکتاهدرال*
- *فضای مکعبی*

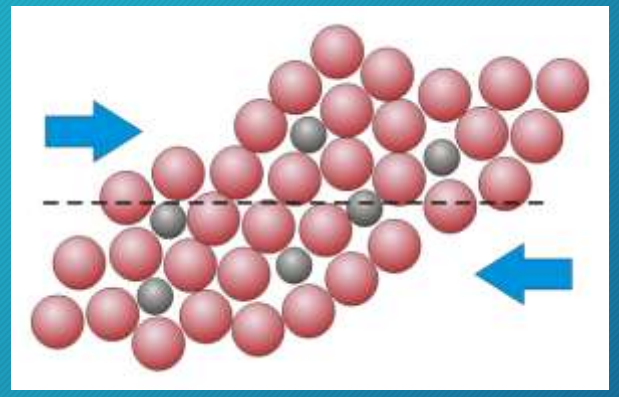
# تاثیر عیب بین نشین بر شبکه بلوری

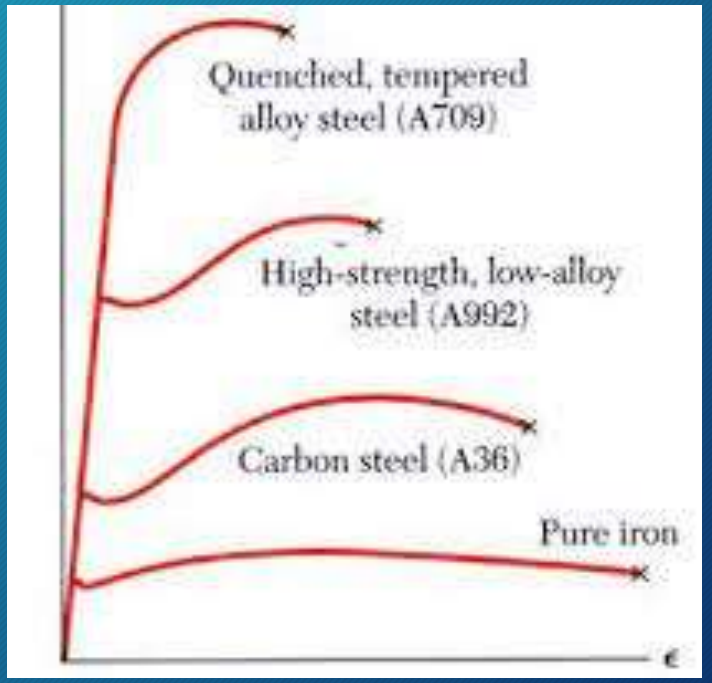


# نقش اتم های بین نشین در ایجاد خواص مکانیکی متفاوت آهن خالص و فولاد

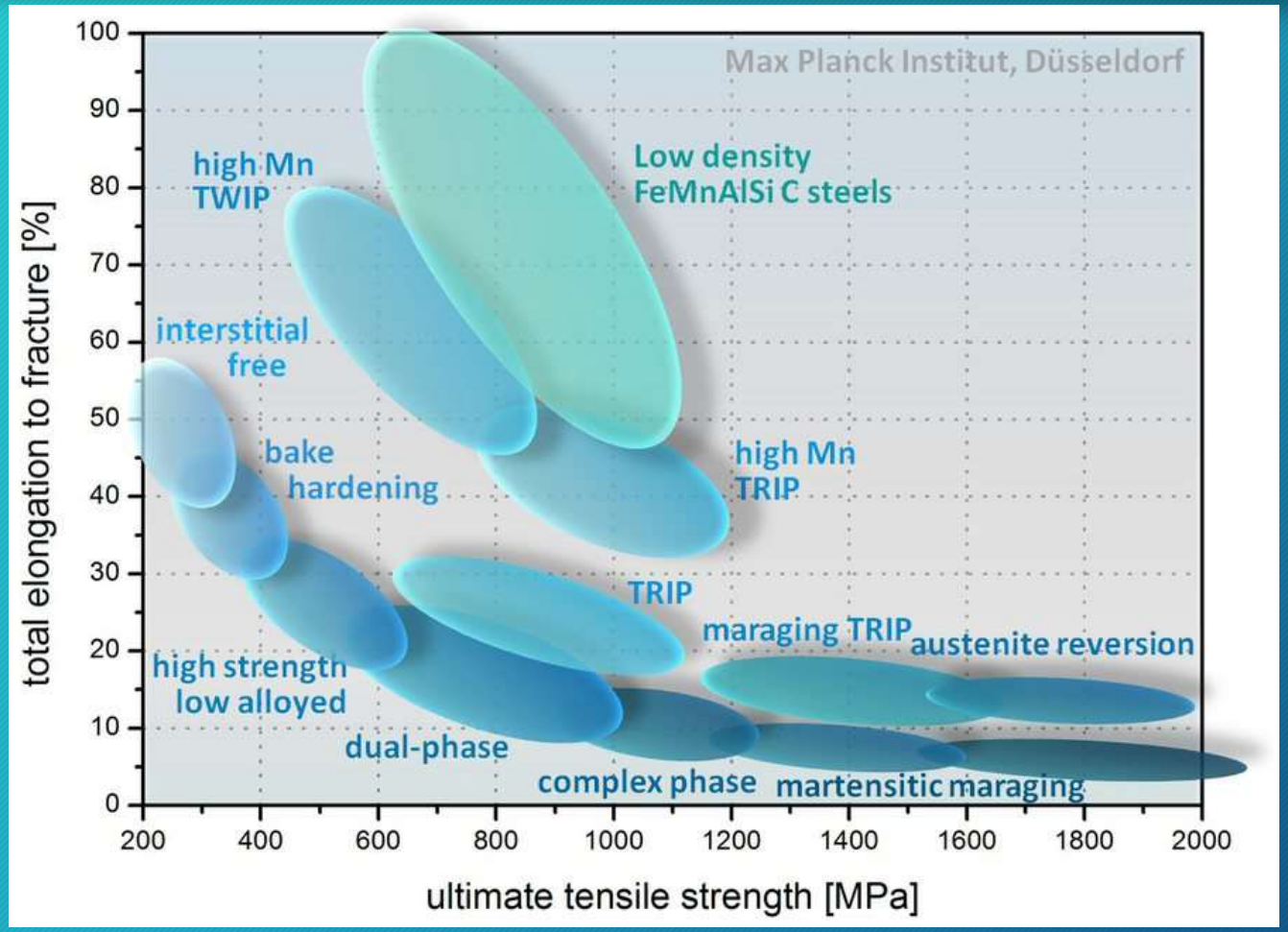


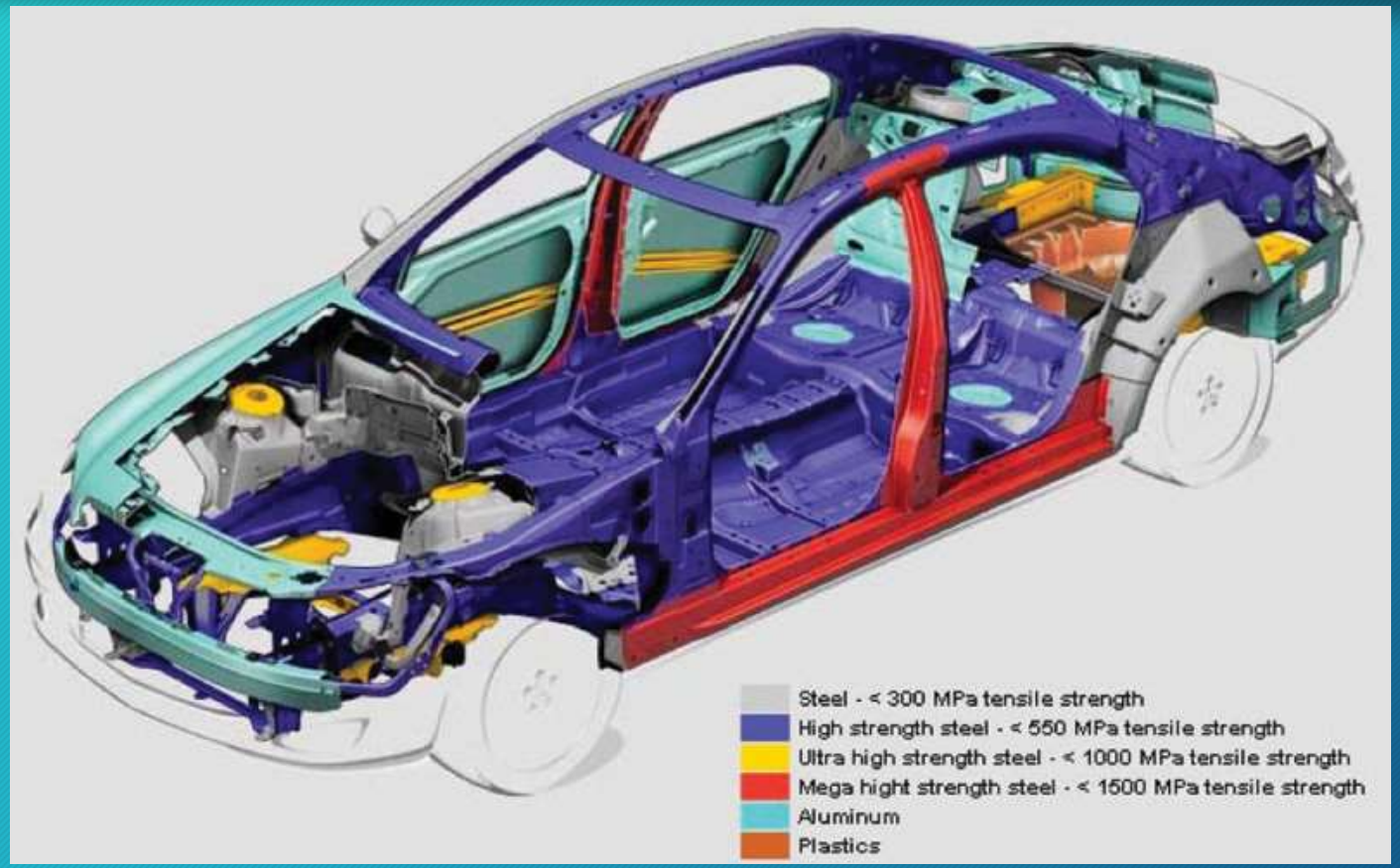




# موقعیت فولادها از نظر خواص مکانیکی

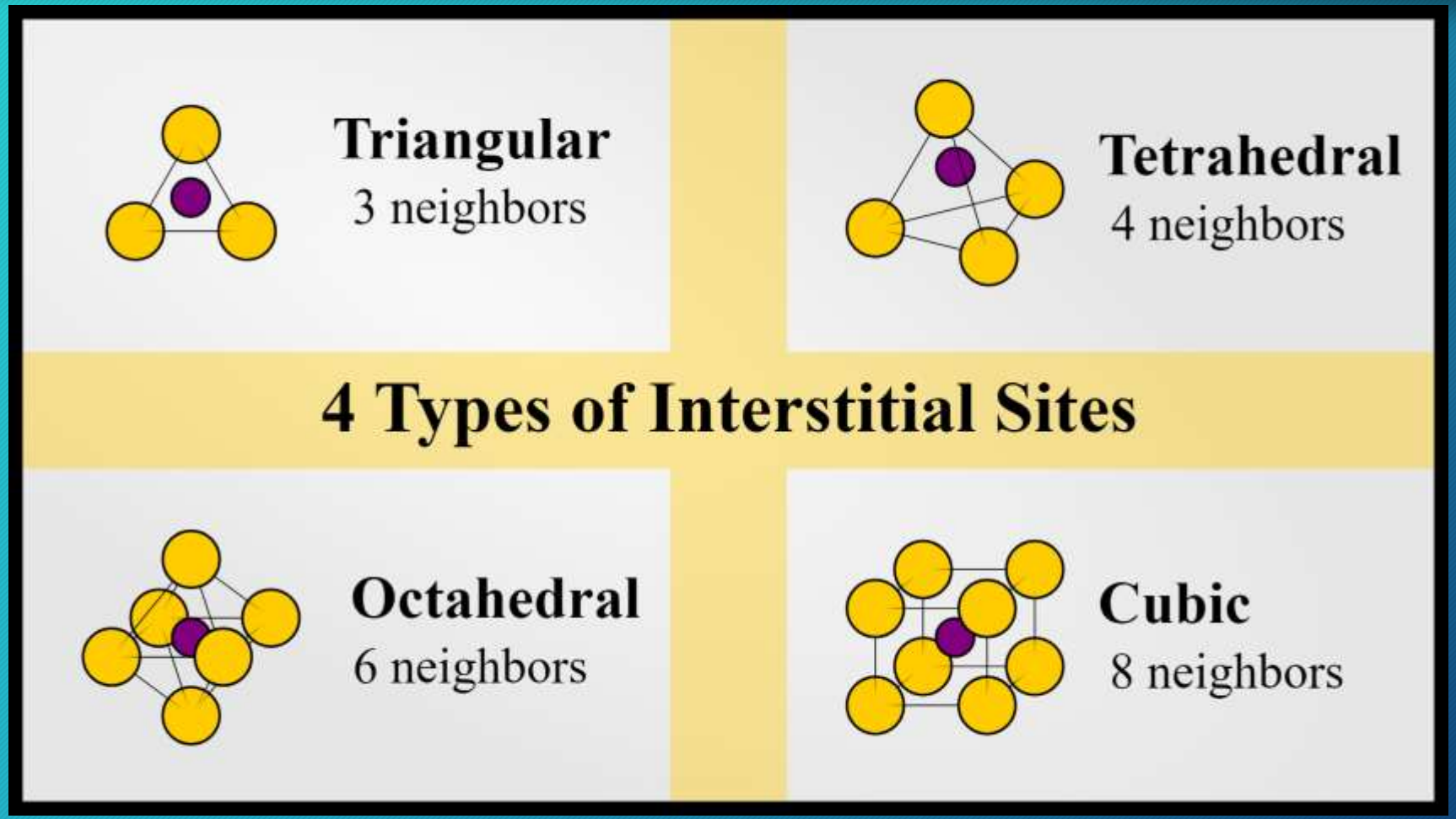


# استفاده از فولادهای مختلف در ساخت بدنه اتومبیل

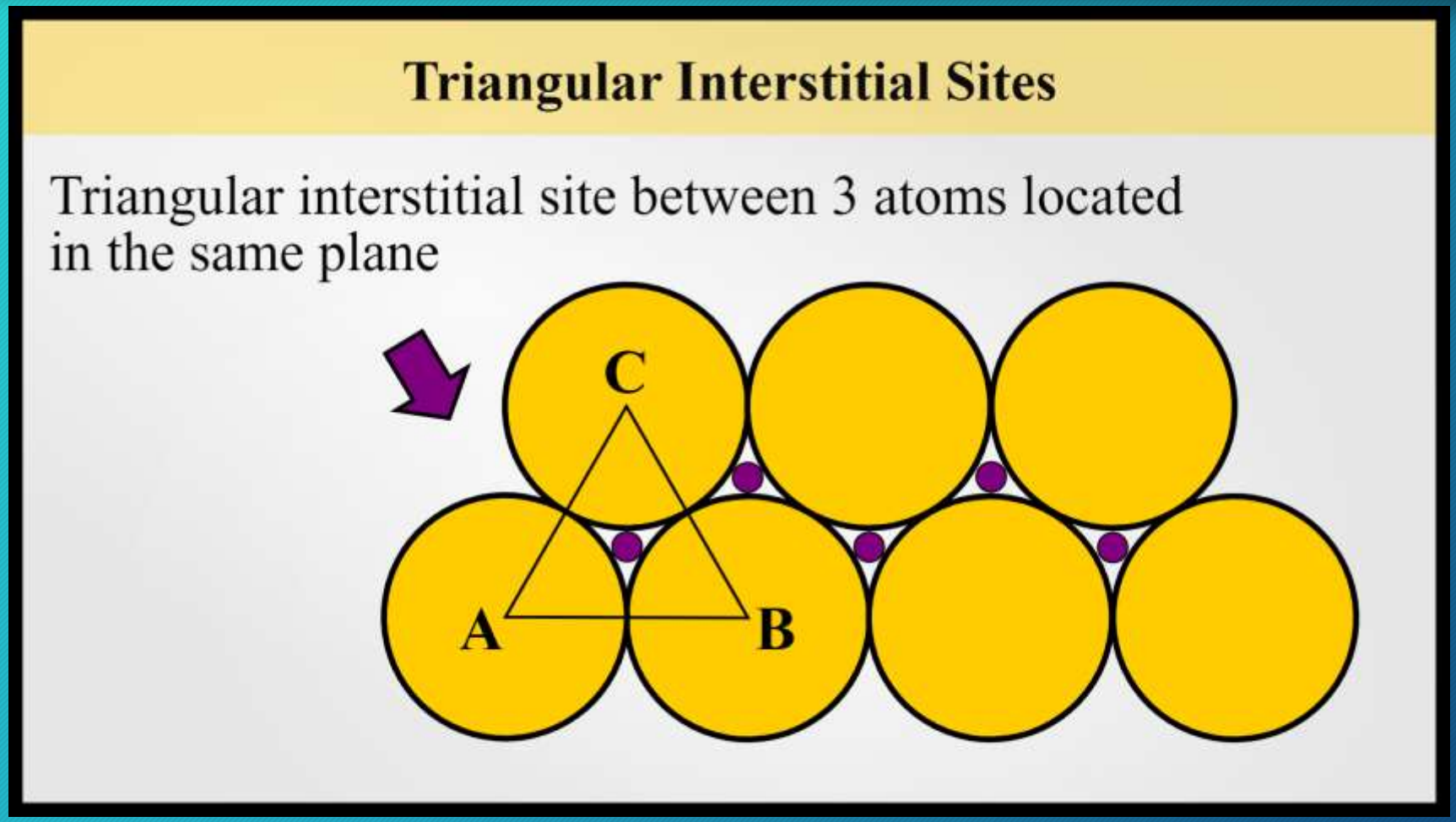



*2020 Mercedes Benz GLE Body Structure*

# انواع فضای بین نشین و تعداد اتم همسایه



# موقعیت بین نشین مثلثی



# روش محاسبه فضای بین نشین مثلثی

## Calculating The Distance To The Center of an Equilateral Triangle

$|AB|=|AC|=|BC|= a$

$|A'B|= \frac{a}{2}$

**Pythagorean Theorem for $\Delta BA'$:**

$$|AB|^2= |AA'|^2 + |A'B|^2$$

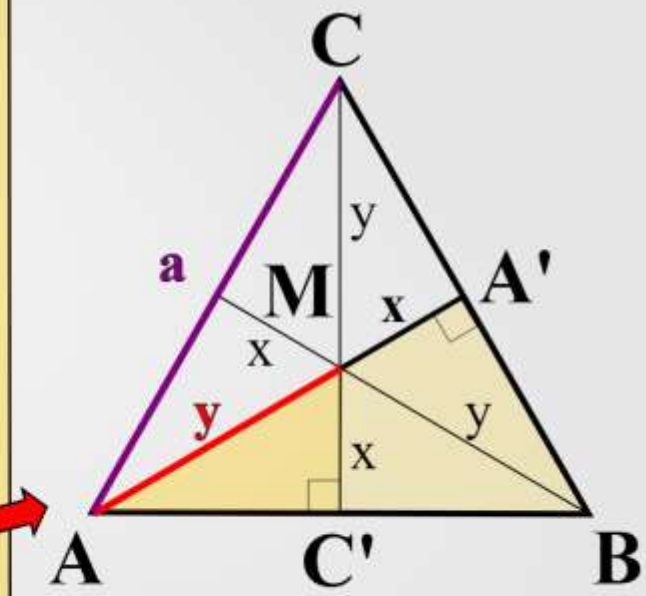
$$|AA'|= \frac{a\sqrt{3}}{2}$$

Also, $|AA'|= x + y$

$$x = \frac{a\sqrt{3}}{2} - y$$

**Pythagorean Theorem for $\Delta MC'$:**

$$y^2= \left[\frac{a}{2}\right]^2 + \left[\frac{a\sqrt{3}}{2} - y\right]^2 \Rightarrow y = \frac{a\sqrt{3}}{3}$$



# محاسبه شعاع اتم بین نشین در موقعیت مثلثی

## Calculating The Size of Triangular Interstitial Site

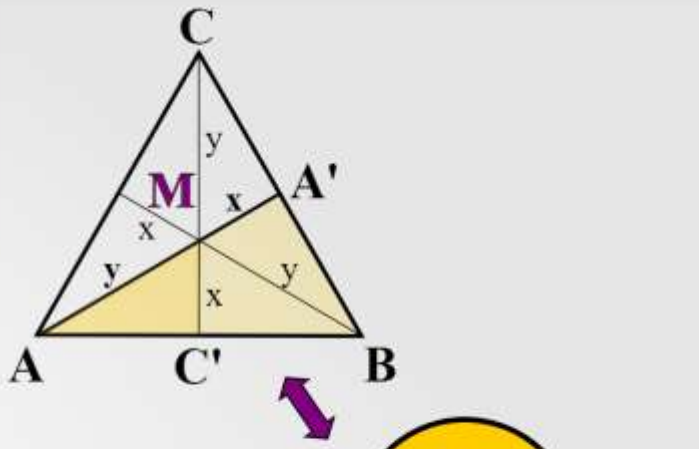
Since $|AM| = y$, and $y = r + R$

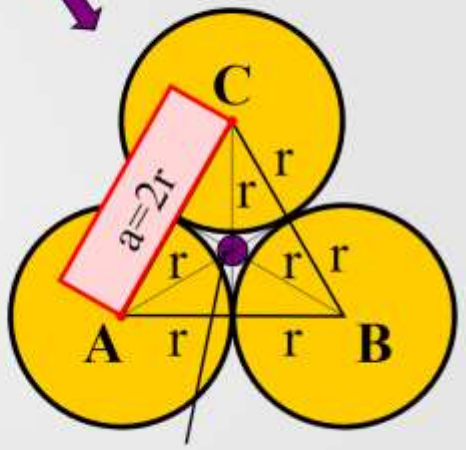
$$y = \frac{a\sqrt{3}}{3} \Rightarrow r + R = \frac{a\sqrt{3}}{3}$$

Also, $a = 2r$, hence: $r + R = \frac{2r\sqrt{3}}{3}$

**Triangular Interstitial Site Radius**

$$R = r\left(\frac{2\sqrt{3}}{3} - 1\right)$$



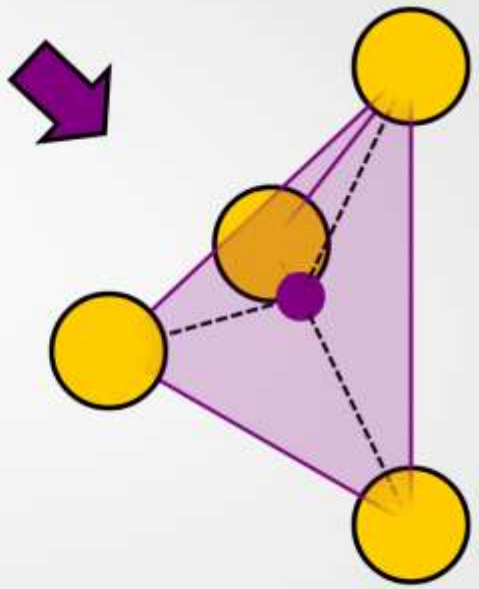




Interstitial Site Radius, R

# موقعیت بین نشین تتراهدرال

## Tetrahedral Interstitial Sites

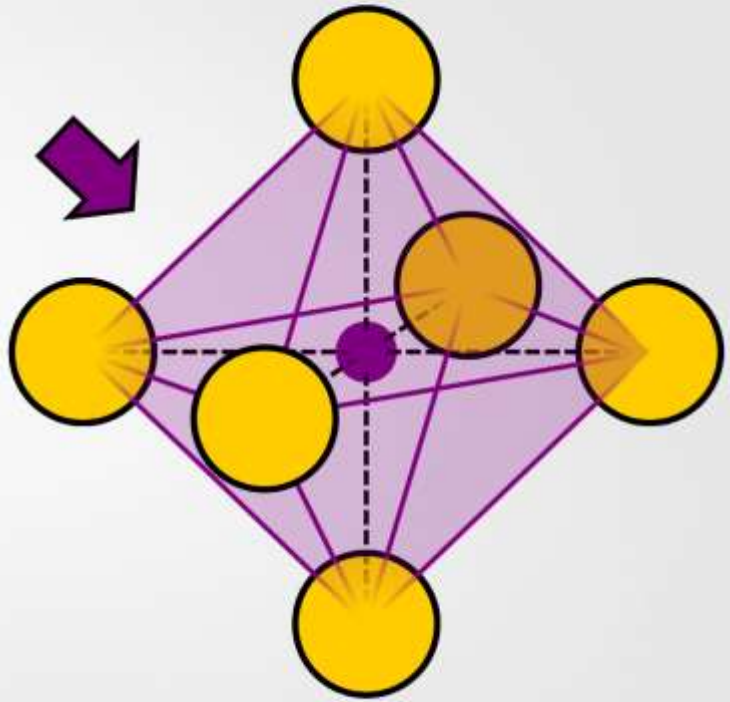
Tetrahedral interstitial site between 4 atoms



# موقعیت بین نشین اکتاهدرال

## Octahedral Interstitial Sites

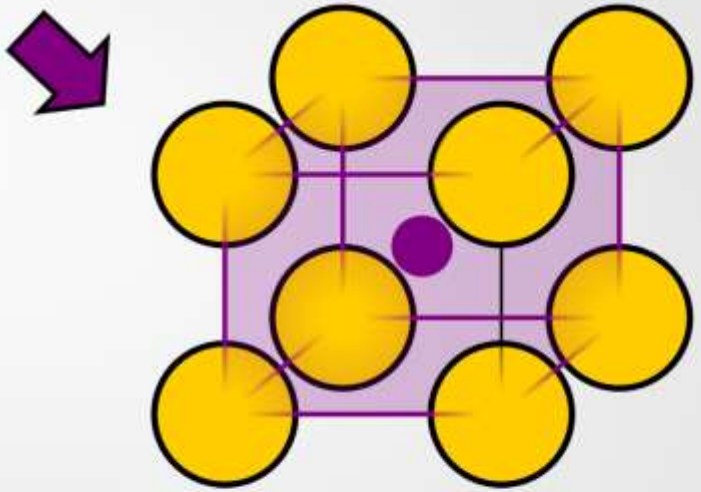
Octahedral interstitial site between 6 atoms

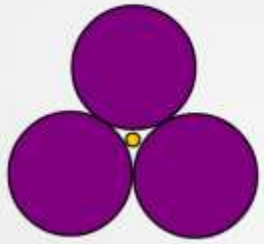


# موقعیت بین نشین مکعبی

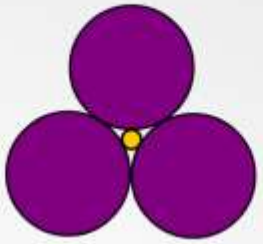
## Cubic Interstitial Sites

Cubic interstitial site
between 8 atoms

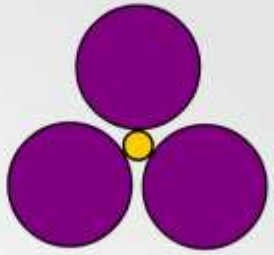




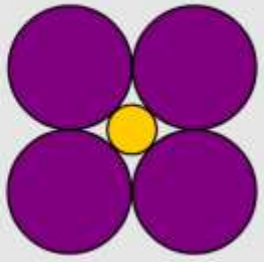
Cation too small:
CN=3 unstable



Cation barely touches anion
CN=3 stable

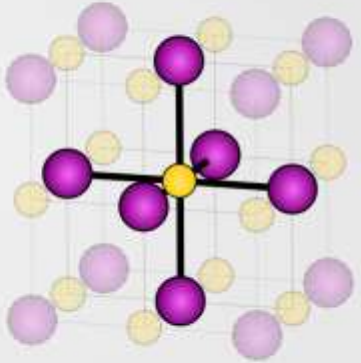


Cation more than touches anion
CN=3 still stable



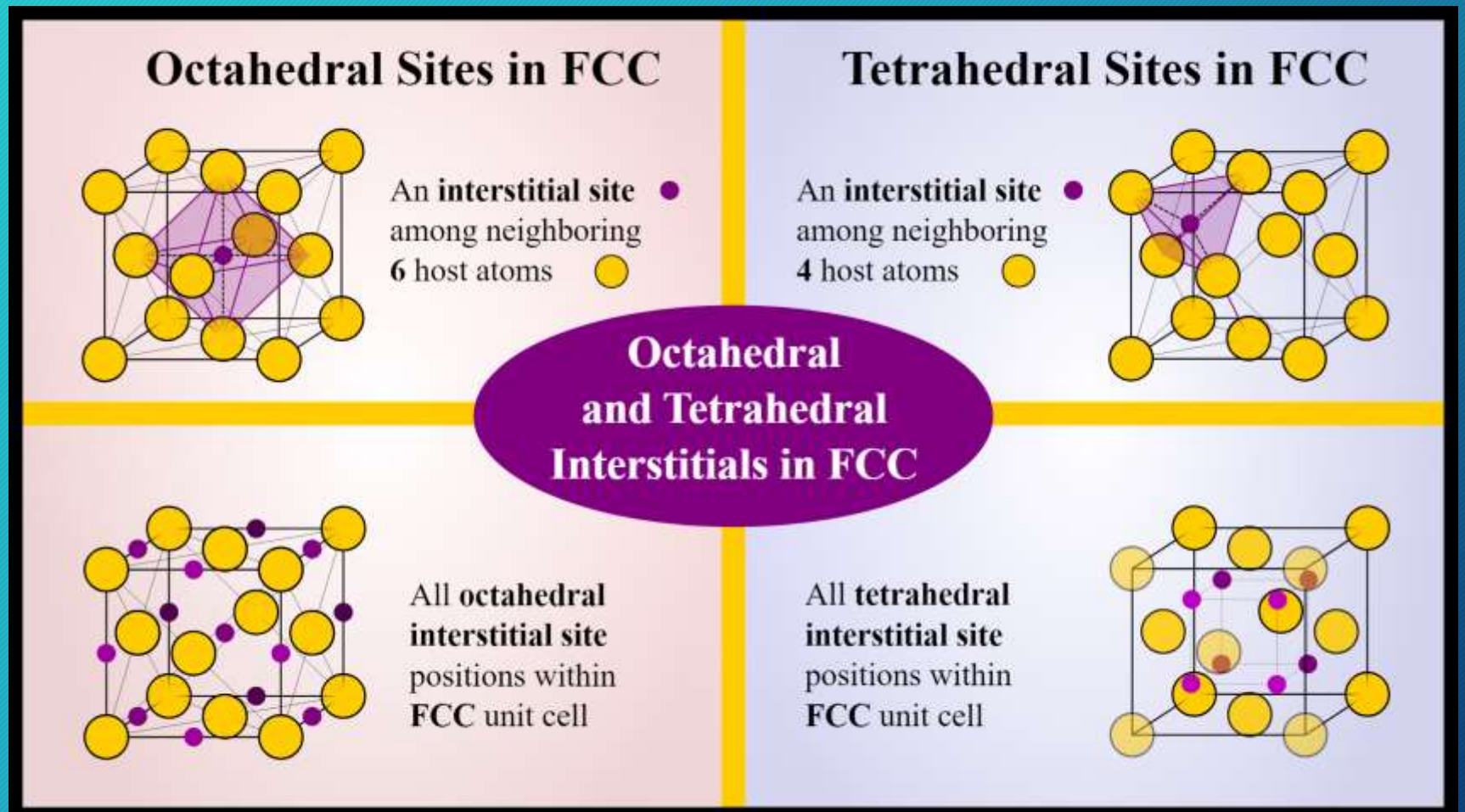
Cation barely touches anion
CN=4 now stable

$$\frac{r_{Na^+} = 116\ pm}{r_{Cl^-} = 167\ pm} = 0.69$$

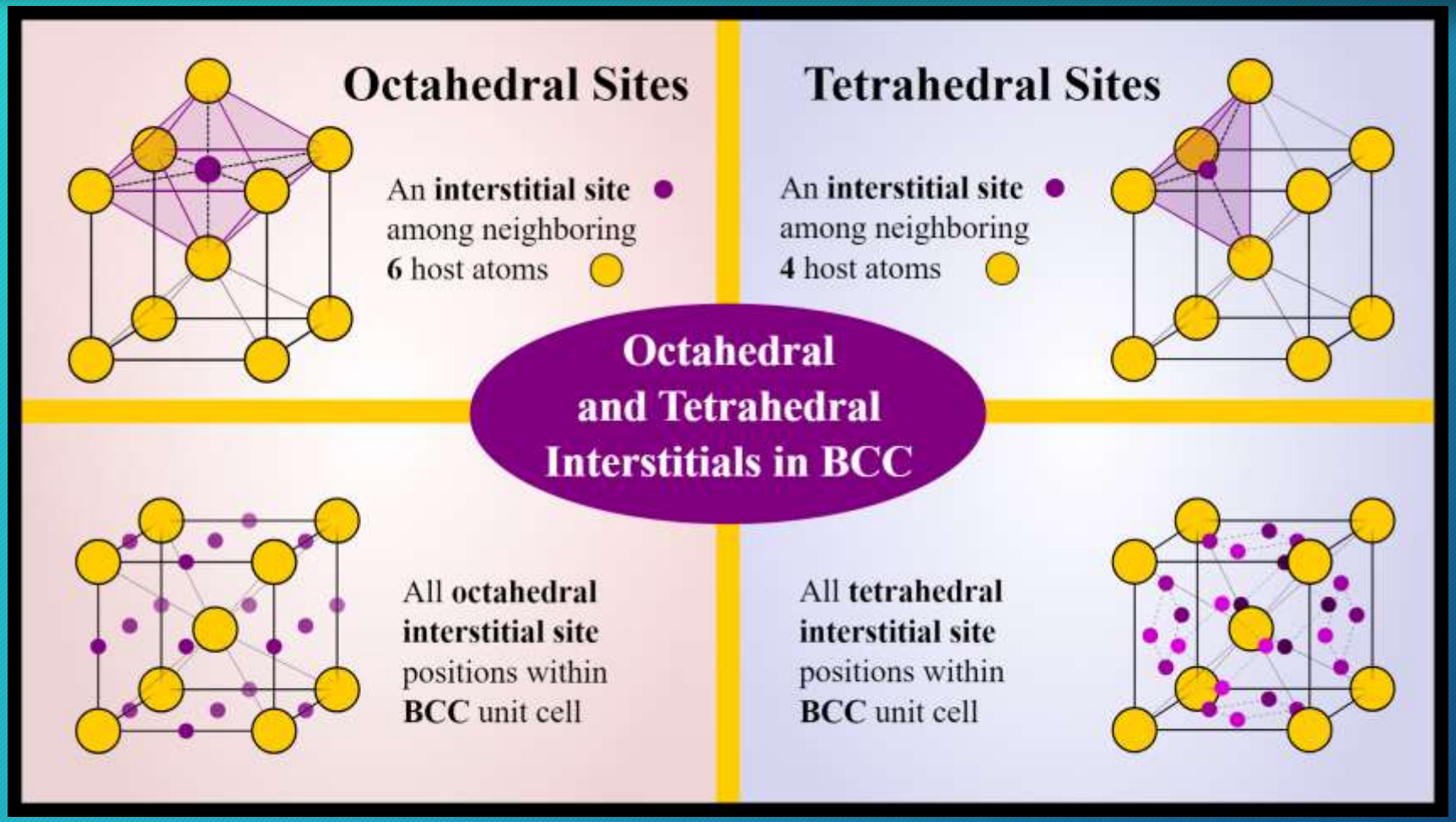


CN = 6

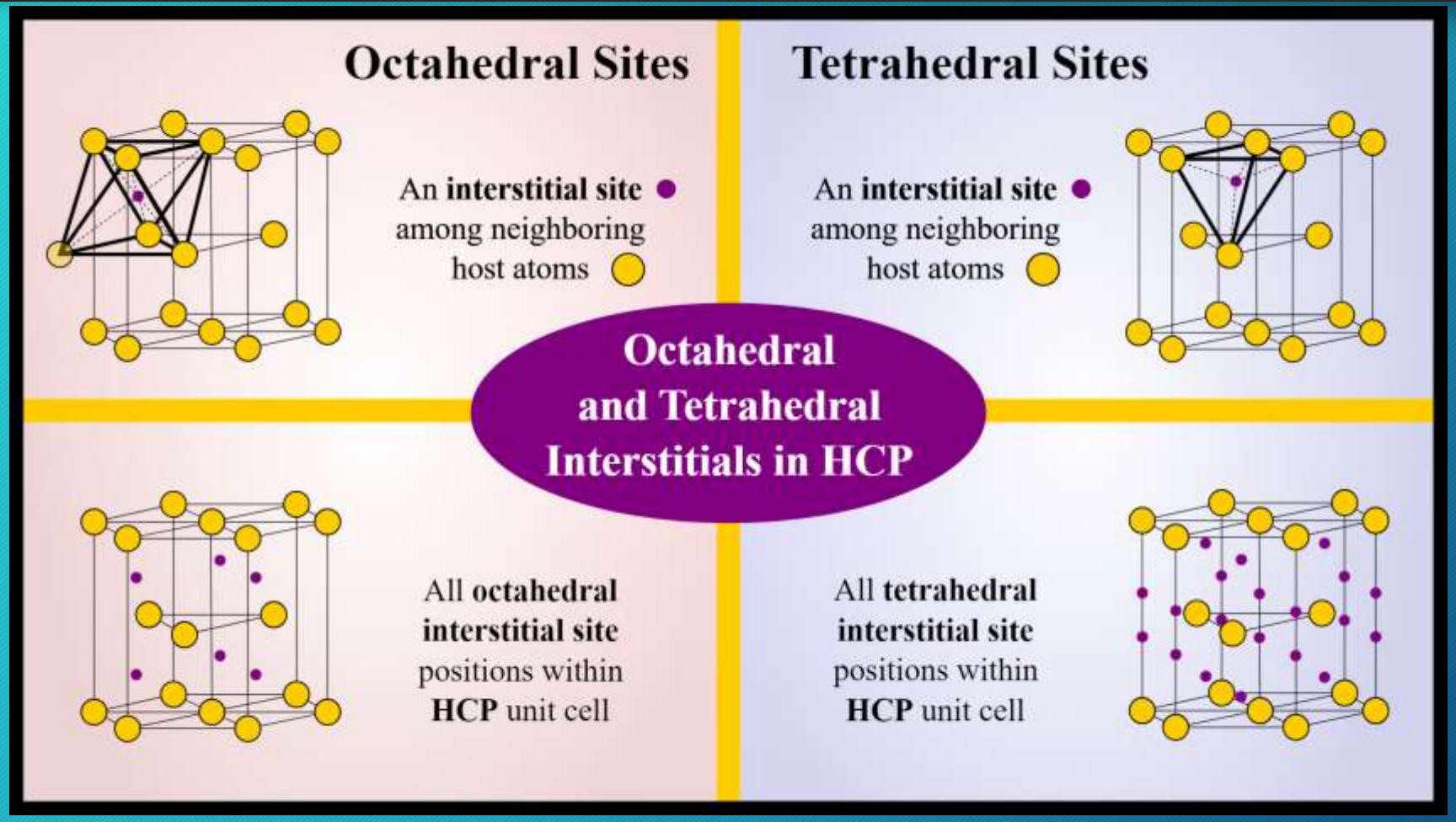
# موقعیت های بین نشینی اکتاهدرال و تتراهدرال در FCC



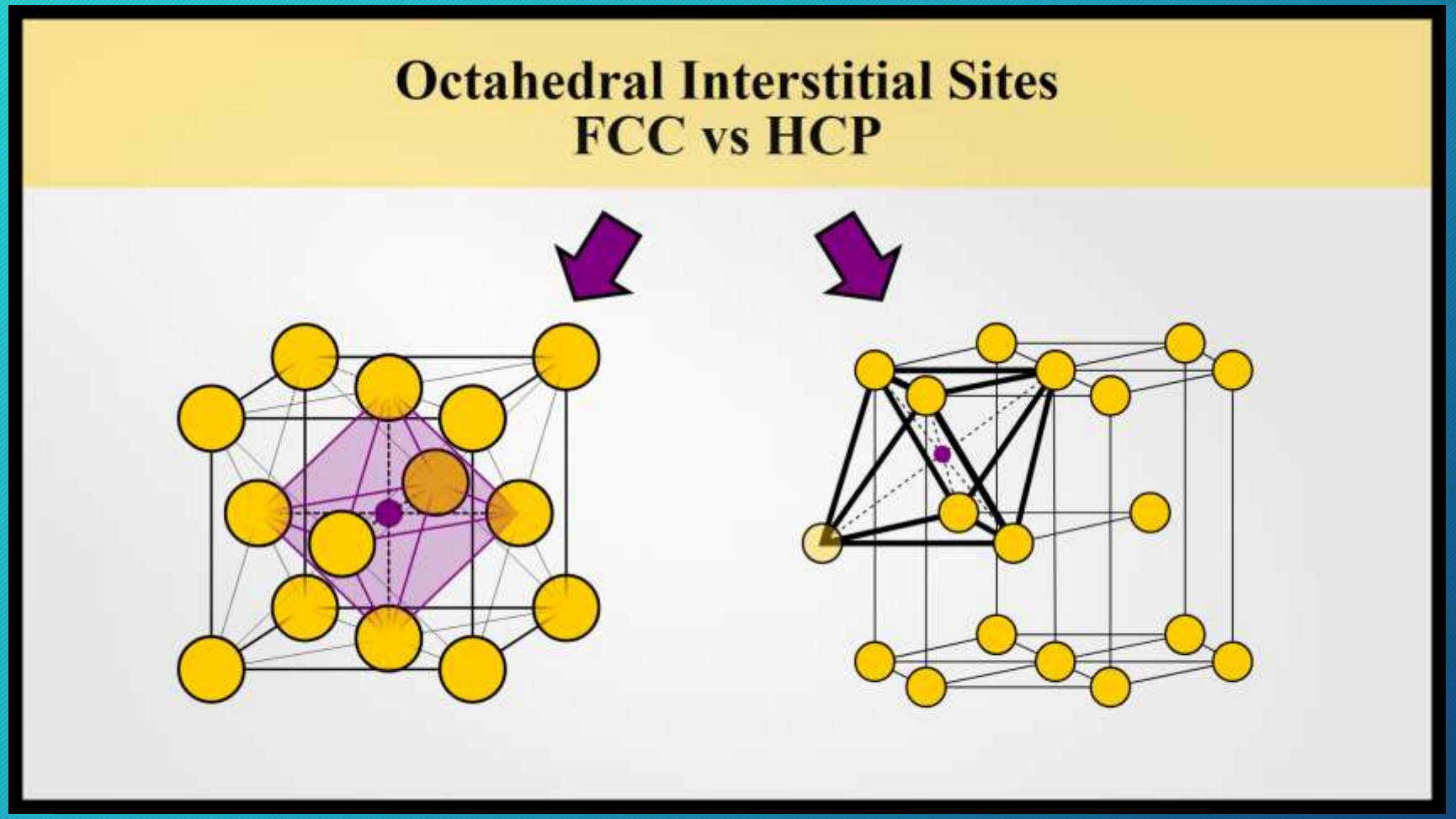
# موقعیت های بین نشینی اکتاهدرال و تتراهدرال در BCC



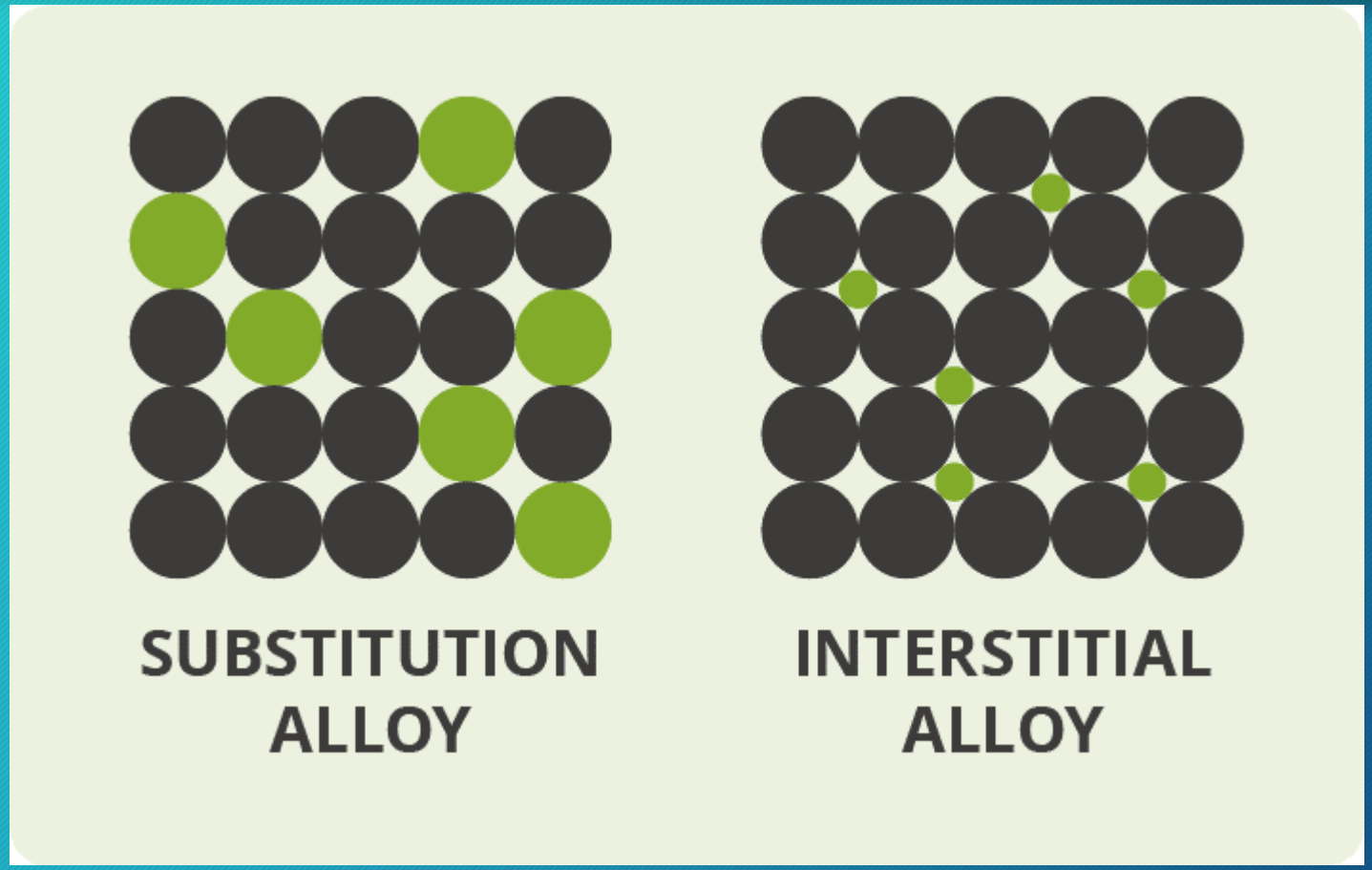
# موقعیت های بین نشینی اکتاهدرال و تتراهدرال در HCP



# مقایسه موقعیت اکتاهدرال در FCC و HCP



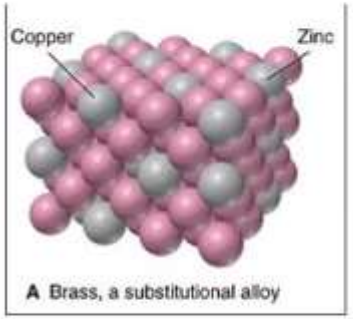
# انواع آلیاژ ؟



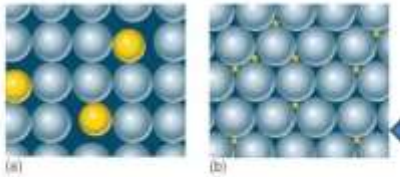
# مثال هایی از انواع آلیاژ

## Classification of Alloys.

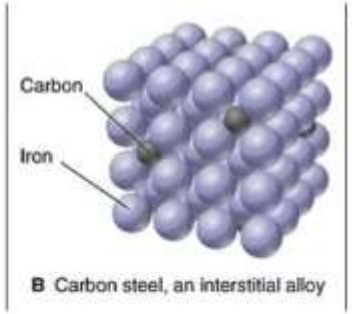
**Substitutional Alloys** are where the metals combining have atoms of the same size. Brass is an example.




**Substitutional Alloy.**



**Interstitial Alloy.**




**Interstitial Alloys** are where one of the alloying elements combining has atoms of smaller size. Steel is an example. Carbon atoms are much smaller and fit into the gaps in the Iron atoms.

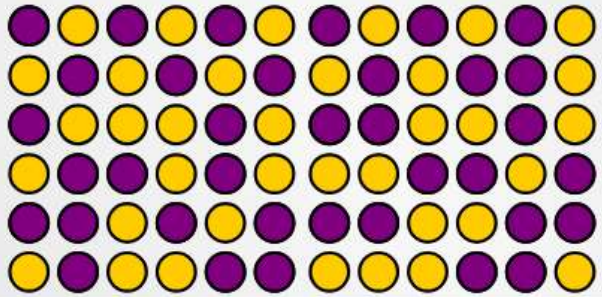
# دسته بندی کامل

## Substitutional Alloy
(solid solution)

and

like each other equally.

They can randomly replace each other.

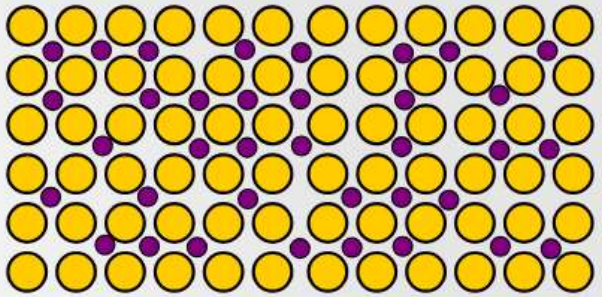


## Interstitial Alloy
(solid solution)

and

like each other equally.

Small atoms randomly squeeze between big atoms.

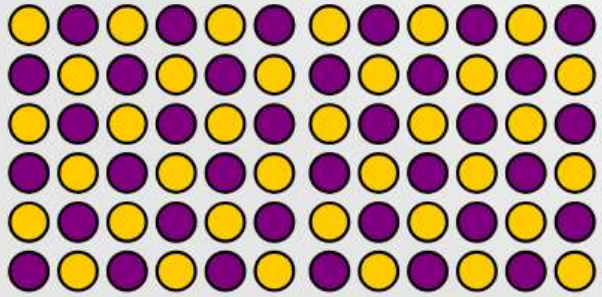


## Intermetallic Compound

and

like each other more than themselves

They must be arranged in a specific order to maximize contact.

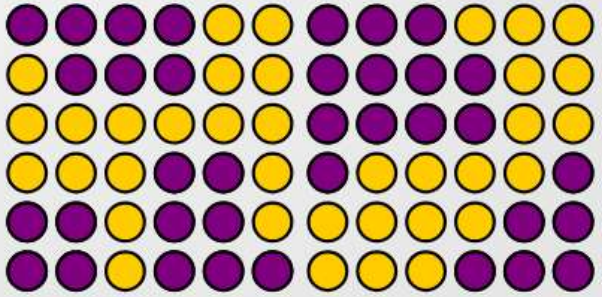


## Two-Phase Alloy

and

like each other less than themselves

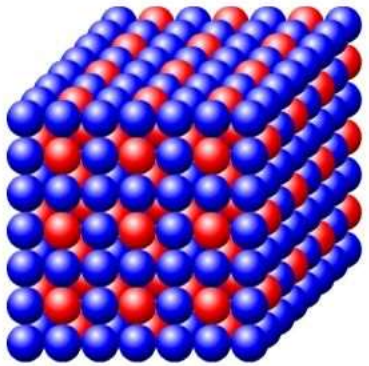
They stay in distinct phases to minimize contact



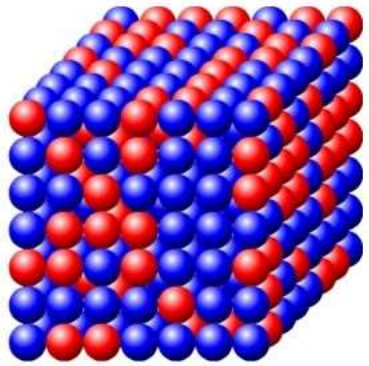
# مفهوم آلیاژ و ترکیب بین فلزی

## What are Intermetallic Compounds

1. Compounds consist of a fixed ratio of atom, e.g. Nickel aluminide ($Ni_3Al$)
2. Compounds show long range ordering, in other words they have a regularly repeating pattern.



Intermetallics



Standard Alloy