Stability of coordination compounds

- **Thermodynamic equilibrium constant**.
- **Stability depend upon** the **interaction** between **metal and ligand**.
- If **interaction strong thermodynamic stability strong**.
- **Reaction between metal ion and ligand is based Lewis acid and base**.
- **The greater the value of stability constant**, **more stable is the complex**.

Stability of coordination compounds

$$M + nL \underset{K'}{\overset{K}{\rightleftharpoons}} ML_n$$

Apply law of mass action

$$K = \frac{[ML_n]}{[M][L]^n}$$

K = Formation equilibrium constant

$K \propto$ Stability of complex

$K' = \frac{1}{K}$

K' = Instability constant or the dissociation constant

Stability of coordination compounds

System	Stability
$Cd^{2+} + 4NH_3 \Leftrightarrow [Cd(NH_3)_4]^{2+}$	1.3×10^7
$Ag^{+} + 2NH_3 \Leftrightarrow [Ag(NH_3)_2]^{+}$	1.6×10^7
$Cu^{2+} + 4NH_3 \Leftrightarrow [Cu(NH_3)_4]^{2+}$	4.5×10^{11}
$Ag+ + 2CN^{-} \Leftrightarrow [Ag(CN)_2]^{-}$	5.5×10^{18}
$Cu^{2+} + 4CN^{-} \Leftrightarrow [Co(NH_3)_6]^{3+}$	2.0×10^{33}

CN^- is more stable then ammine complex.

It conclude that cyano is a stronger ligand than ammine.

Stability depend upon

1. **Charge** density of the **central metal** ion(ionic radii)
2. **Nature of ligand**

Crystal field theory (CFT)

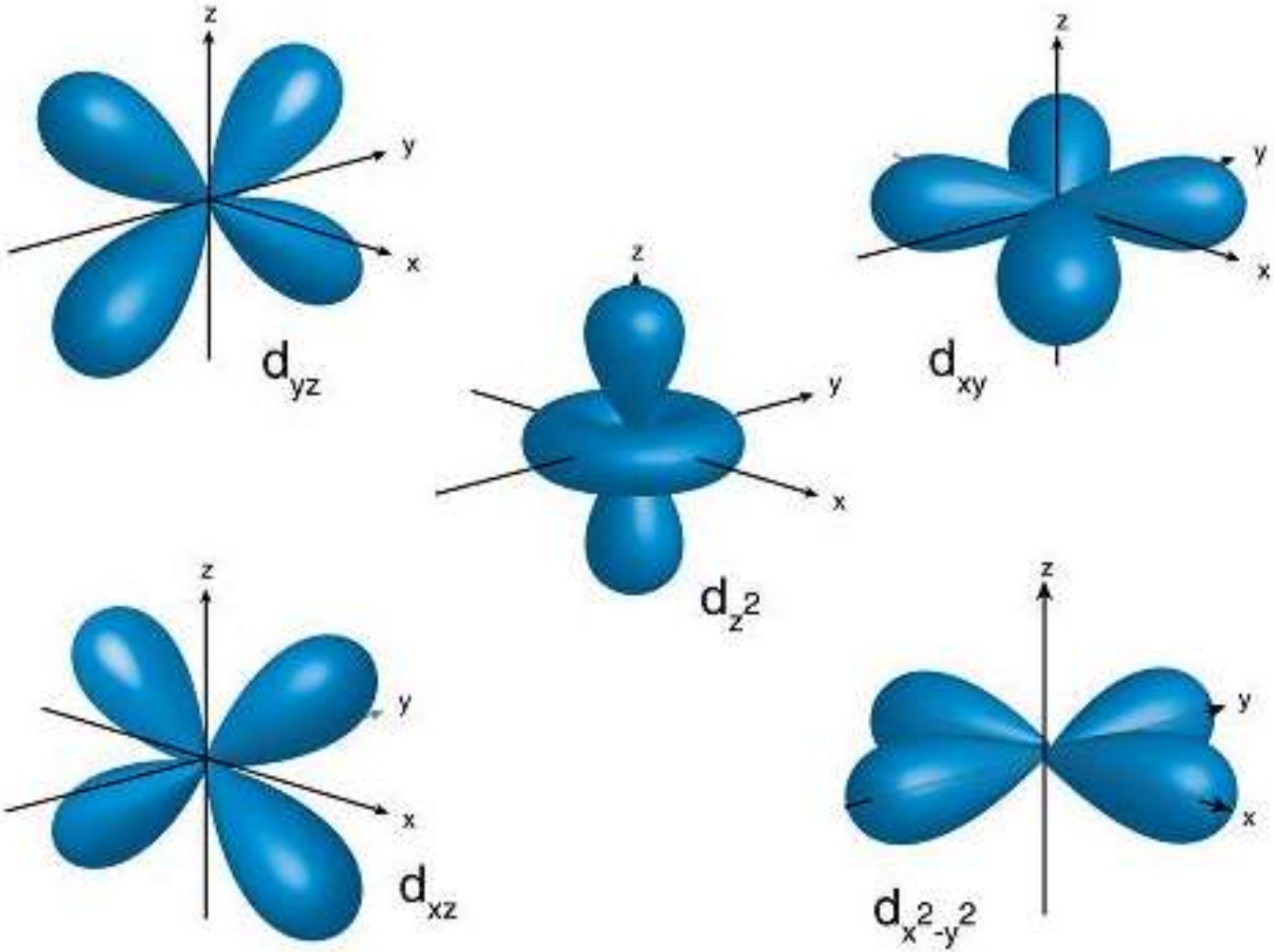
- The **crystal field theory** was proposed by **Hans Bethe and VanVleck**.
- Crystal field theory assumes that the **interaction** between metal ion and the ligand is **purely electrostatic**.

Silent features of CFT

- **Central metal atom or ion is surrounded** by various **ligands** which are **either negative charge** or **neutral molecule.**
- **Electrostatic interaction** between **ML**.

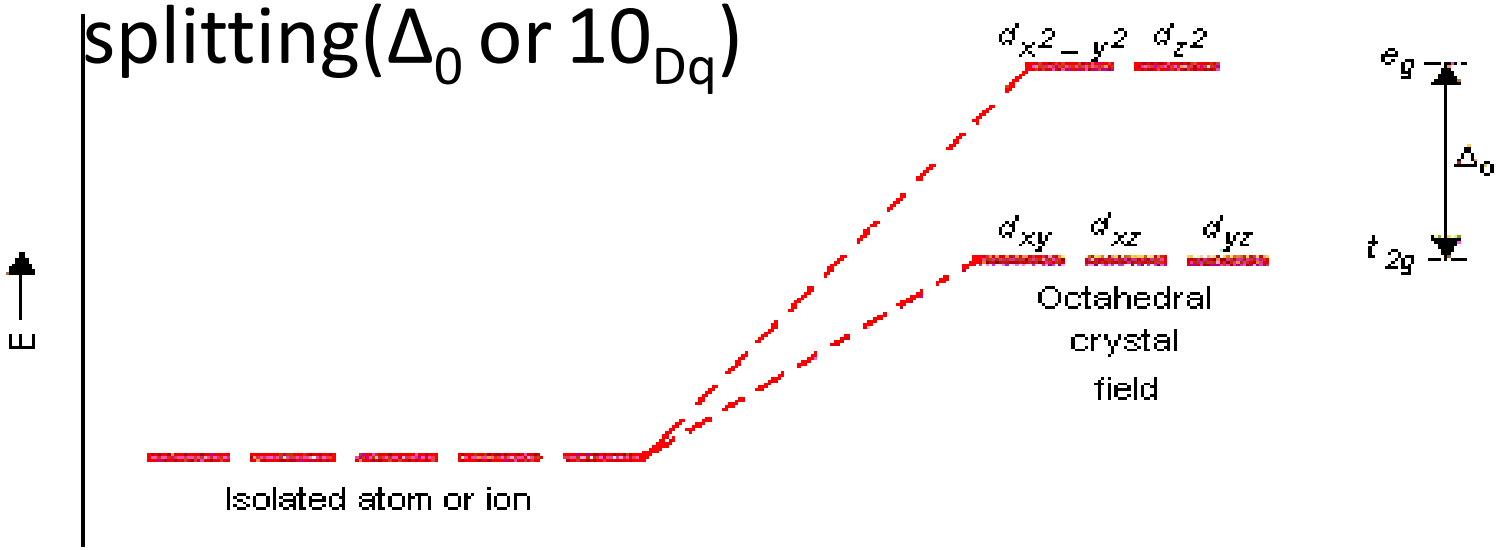
Eg. Fe^{-} and Co^{3+}.

- Central metal atom have **5 degenerated** orbital d_{xy}, d_{yz}, d_{xz}, $d_{(x2-y2)}$, d_{z2}.


z
y
x
d_{yz}
z
y
x
d_{xy}
z
y
x
d_{z^2}
z
y
x
d_{xz}
z
y
x
$d_{x^2-y^2}$

Silent features of CFT

- When the **ligands approach the metal ion**, due to **repulsion forces**, the **degeneracy of d** – orbitals is **destroyed and they split into two** groups of **different energy** level t_{2g} and e_g orbital. This effect is **called crystal field** splitting(Δ_0 or 10_{Dq})



Silent features of CFT

- **Due to repulsion**, the orbitals **along the axes** of **ligands acquire higher energy while those lying in between the ligands** acquire less energy.
- It **doesnt** show the **overlapping**.
- From the **Crystal field stability energy** the stability of the complexes **can be known**.

Defination

- **Crystal field splitting-**

Splitting of **5 degenerated** d-orbital.

- **Crystal filed stabilization energy(CFSE)-**

Change in energy achieved by filling up electron in orbital in complex metal atom.

Definition

- **High spin complex-(spin free)**

Greater no. of **unpaired electrons** and hence **higher value** of resultant spin and magnetic moment is called.

- **Low spin complex-**
- **Pairing energy-**

The energy required to **pair 2 electron** against the electron electron **repulsion** in the same orbital of a metal atom.

Application of CFT to tetrahedral complexes

- In the tetrahedral complex, $[MX_4]^n$, the metal atom or **ion is placed at** centre of the regular **tetrahedron** and the **4 ligands, are placed at four corners of the tetrahedron**.
- Ligand **approach the central**

Metal atom in between 3 cordinate x, y, z.