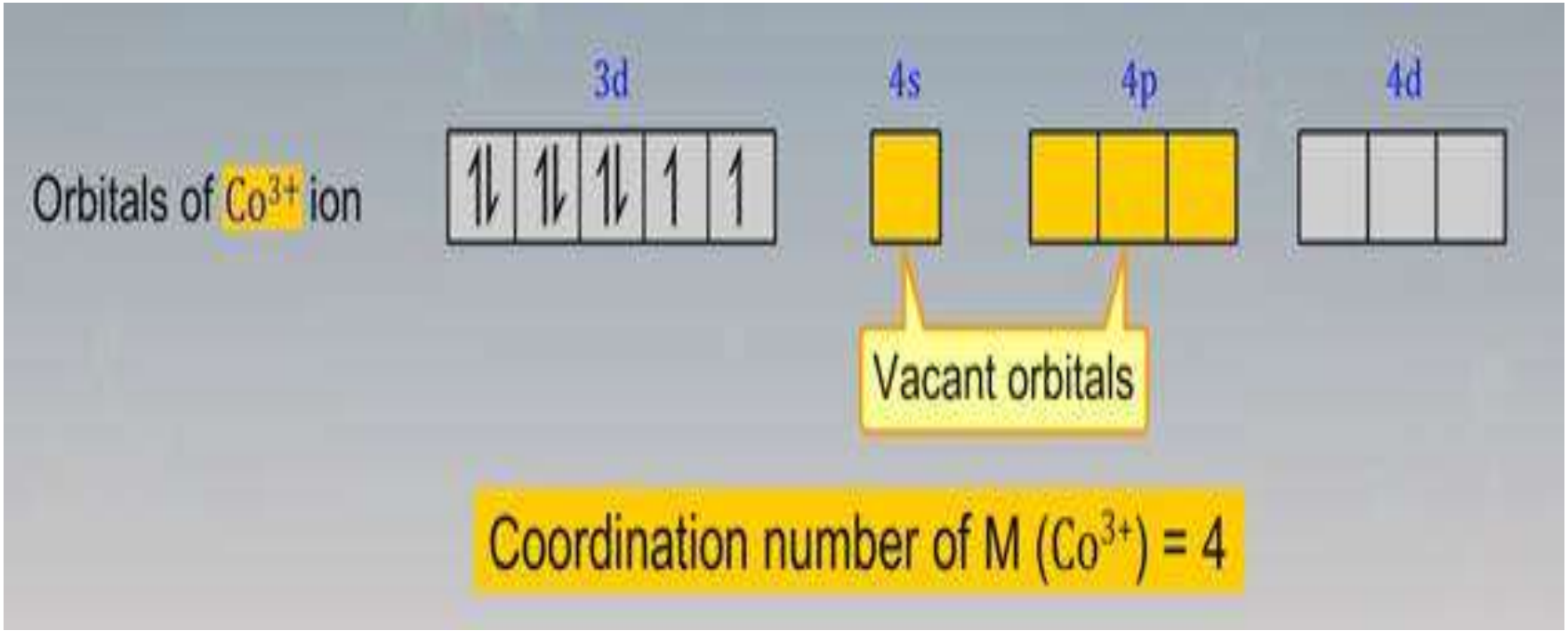
Salient features of the VBT theory:

- This vacant orbital goes hybridization to form same no. of hybrid orbitals.
- Each ligand has at least one orbital containing lone pair of electrons.
- Vacant hybrid orbital filled with ligand to form coordination bond.
- Coordinate bond is stronger if the overlapping between the orbitals is greater.

- The **vacant orbitals** of the metal atom (or) ion

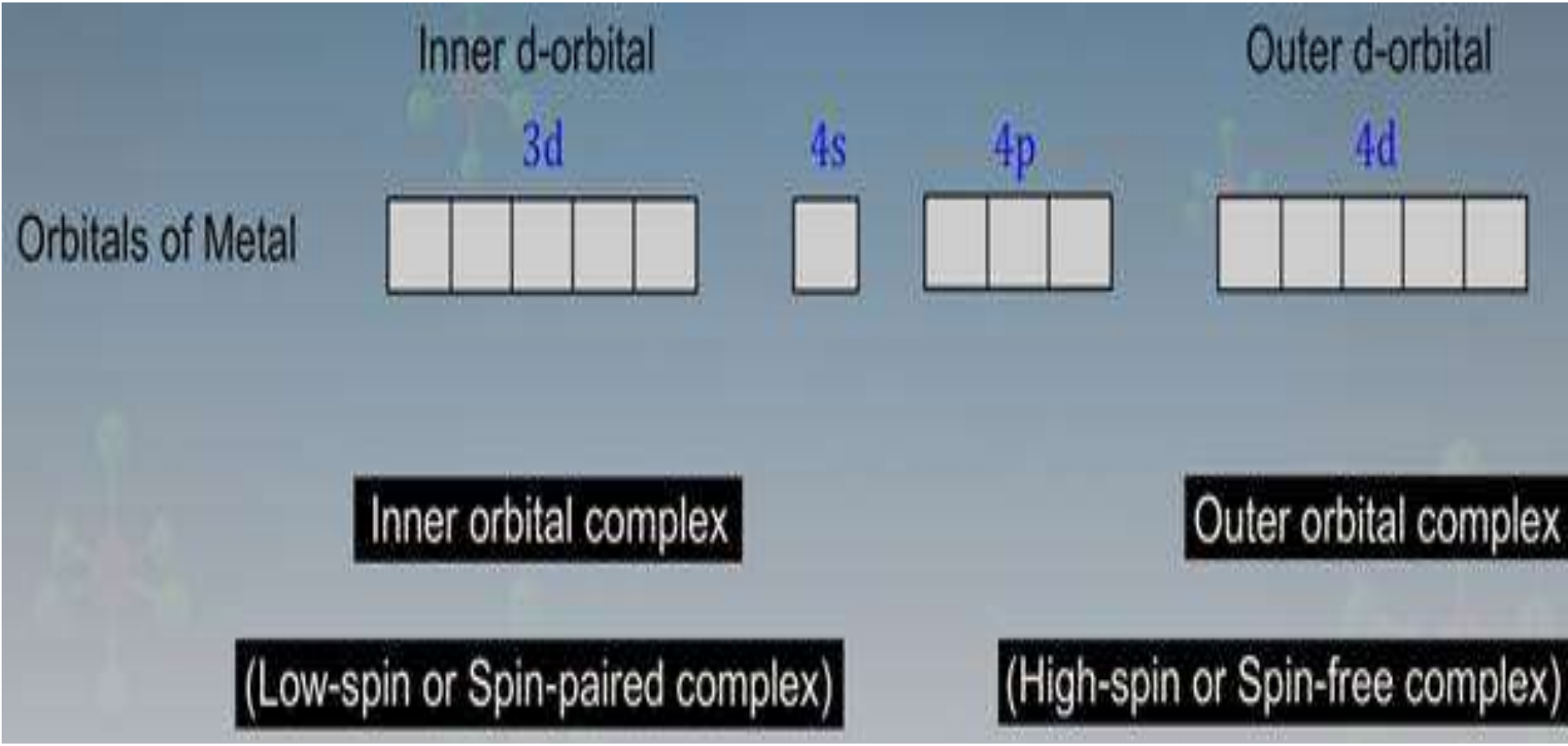
undergo suitable hybridisation to yield a set of equivalent **hybrid orbitals** of definite geometry



Geometrical shape depend upon the hybridization of the metal orbital.

C.N.	Hybridised orbitals	Molecular geometry	Example
2	sp	Linear	$[Ag(NH_3)_2]^+$, $[Ag(CN)_2]^-$
3	sp^2	Trigonal planar	$[HgI_3]^-$
4	sp^3	Tetrahedral	$[Ni(CO)_4]$, $Zn[(NH_3)_4]^{2+}$ $[NiX_4]^{2-}$, $[MnX_4]^{2-}$ $[Cd(CN)_4]^{2-}$, $[FeCl_4]^{2-}$, $[CuCl_4]^{2-}$
4	dsp^2 d-orbital used is $d_{x^2-y^2}$	Square planar	$[Ni(CN)_4]^{2-}$, $[Ni(NH_3)_4]^{2+}$, $[Pt(NH_3)_4]^{2+}$ $[Pt(Cl_4]^{2-}$, $[PdCl_4]^{2-}$, $[Pt(NH_3)_2Cl_2]$, $[PdCl_4]^{2-}$, $[Cu(NH_3)_4]^{2+}$
5	dsp^3 d-orbital used is d_{z^2} of inner *i.e.* $(n-1)^{th}$ shell	Trigonal bipyramidal	$[CuCl_5]^{3-}$, $[Fe(CO)_5]$

If (n-1)d orbitals are used for hybridization, the complexes is called inner complexes and nd called outer complexes.



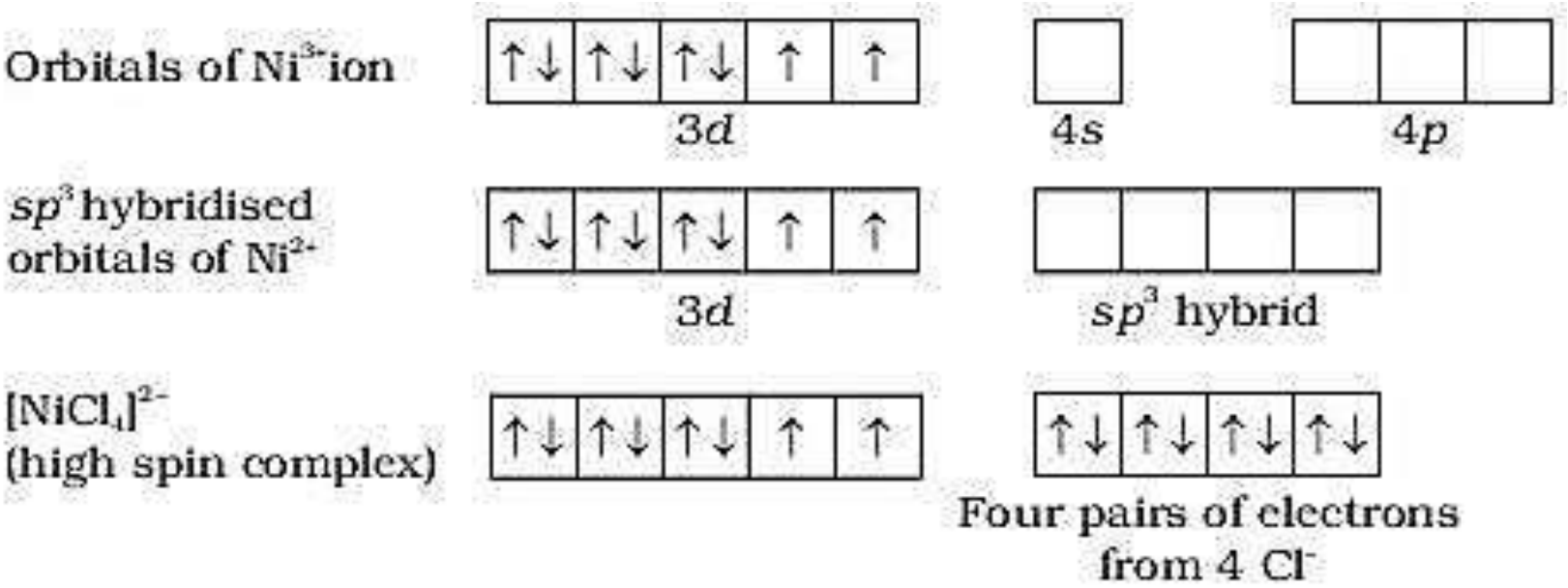
- When **strong field ligands like NH_3** and **CN^-** are **involved** in the formation of complexes, they causes **pairing electrons** present in metal ions. This process is called as **spin pairing**.

Structure of complex compounds based on VBT

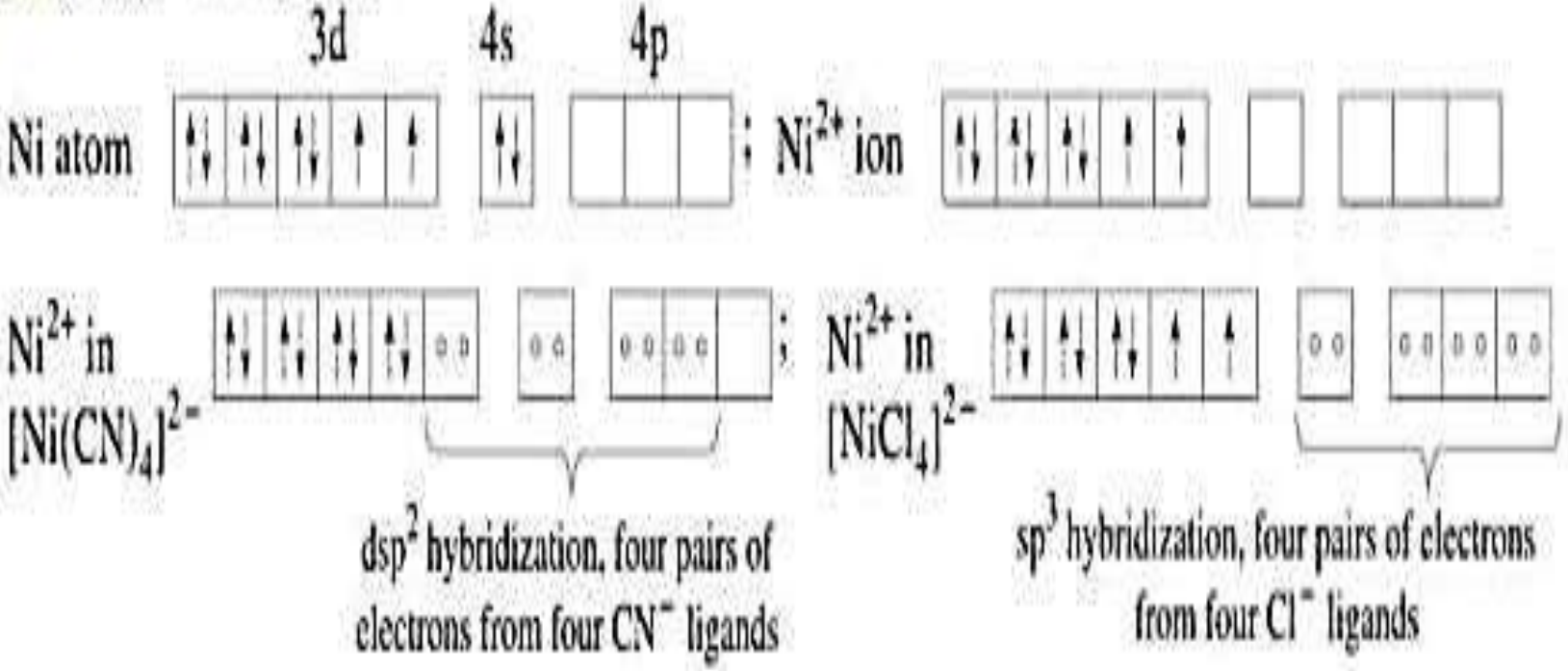
1. Structure of nickel tetracarbonyl $[Ni(CO)_4]$
2. Formation of $[NiCl_4]^{2-}$
3. Structure of $[Ni(CN)_4]^{2-}$
4. Structure of $[CoF_6]^{3-}$
5. Structure of $[Co(NH_3)_6]^{3+}$

Formation of $[NiCl_4]^{2-}$

- Oxidation is +2. each chlorine ion **donate 2** electron. Ni- $3d^8\ 4s^2$.
- **Paramagnetic** contain **2 unpaired electron**.



$[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$



$[Ni(CN)_4]^{2-}$ is a square planar (dsp^2 hybridization) and diamagnetic (no unpaired electrons) while $[NiCl_4]^{2-}$ is tetrahedron (sp^3 hybridization) and paramagnetic (two unpaired electrons). The CN^- ligand is strong and it forces the two unpaired electrons to pair up.

Drawbacks of the valence bond theory:

a) Does **not explain** the **colour** of **coordination compound.**

b) **cannot explain magnetic behavior based on geometry**.

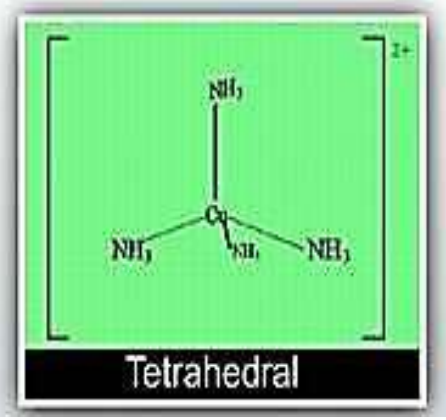
c) **does not explain why some called inner and outer** complex **same metal ion in the same oxidation state**.

d) **Fails to predict** the exact geometry of the complexes with the coordination **number four**.

Example:

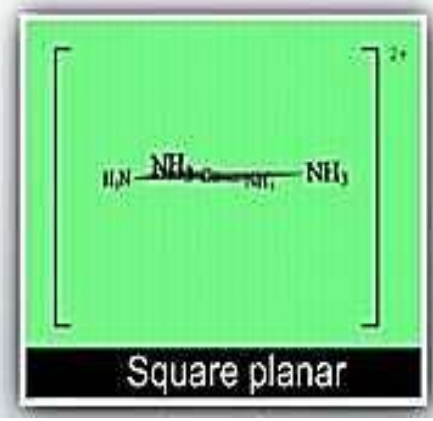
According to valance bond theory:

$[Cu(NH_3)_4]^{2+}$



According to X-ray analysis:

$[Cu(NH_3)_4]^{2+}$



Drawbacks of the valence bond theory:

e) Doesnot distinguish weak field and strong field of ligand.

f) It cannot predict exactly the tetrahedral and square planar structure of 4cordinate.

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**.