UG PART 2
ISOMERISM OF COORDINATION COMPLEXES

(7) Polymerisation Isomerism

This type of isomerism is found in those complex compound whose formulae appear to be polymers of some simple complex compound. All these complex compound have the same ratio of different metal atoms and ligands in them. For example the following complex compound are polymerisation isomers to each other, since (ii) and (iii) complexes appear to be dimer of (i) complex and (iv) complex appears to be the pentamer of (i) complex. The ratio $Co^{3+} : NH_3 : NO_2^-$ in all the complexes is 1 : 3 : 3.

	Complex compound	Number of		
		Co^{3+}	NH_3	NO_2^-
(*i*)	$[Co(NH_3)_3(NO_2)_3]$	1	3	3
(*ii*)	$[Co(NH_3)_6]\ [Co(NO_2)_6]$	2	6	6
(*iii*)	$[Co(NH_3)_4(NO_2)_2]\ [Co(NH_3)_2(NO_2)_4]$	2	6	6
(*iv*)	$[Co(NH_3)_5(NO_2)]_3\ [Co(NO_2)_6]_2$	5	15	15

(8) Summation Isomerism :

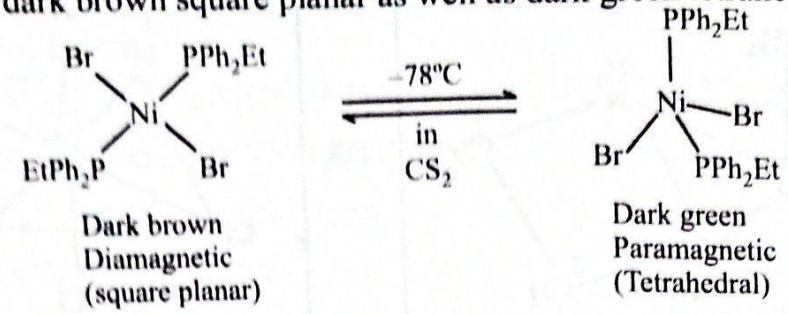
Discovered by Chan in 1967. Here different ligands within coordination sphere have different exchanged atoms. e.g.

cis–$[Co(H_2N.CH_2CH_2.Br)Cl]\ (NO_3)_2$ and

cis–$[Co(H_2N.CH_2CH_2.Cl)Br]\ (NO_3)_2$

(9) Polytopal or Configuration Isomerism:

Sometimes a single complex exist in more than one geometrical forms, which can be separated e.g. $[NiBr_2(PPh_2Et)]$ exists in dark brown square planar as well as dark green tetrahedral form.



Dark brown
Diamagnetic
(square planar)

Dark green
Paramagnetic
(Tetrahedral)

Stereo Isomerism

Stereo isomerism is exhibited by those compounds which have the same position of atoms or groups but these atoms or groups have different arrangement round the central atom. The compunds showing stereo isomerism are called stereo isomers. Stereo isomerism may be of two types viz. geometrical (or cis-trans) isomerism and optical (or d-l or mirror-image) isomerism.

(1) Geometrical (or cis-trans)Isomerism

The complex compounds which have the same ligands in the coordination sphere but the relative position of the ligands round the central metal atom is different are called geometrical isomers and the phenomenon is called geometrical isomerism.

In a given complex compound the two ligands may occupy positions either adjacent to each other or opposite to each other. The complex compound having two ligands occupying the adjacent positions to each other is called *cis-isomer* while that in which the two ligands occupy opposite positions is called *trans-isomer*. Thus geometrical isomerism is also called *cis-trans* isomerism.

Geometrical isomerism is not found in complex compound with coordination number 2 and 3, since in these cases all the positions occupied by the ligands round the central metal atom are adjacent to one another. Geometrical isomerism is most common with the complex compounds having coordination number 4 and 6.

(i) Geometrical Isomerism in 4-coordinated Complex Compounds

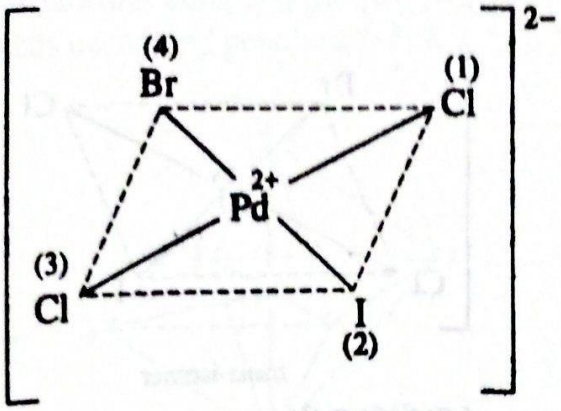
Complexes having central atom with 4-coordination number may have either tetrahedral or square planar geometry.

(ii) Geometrical Isomerism in Tetrahedral complexes

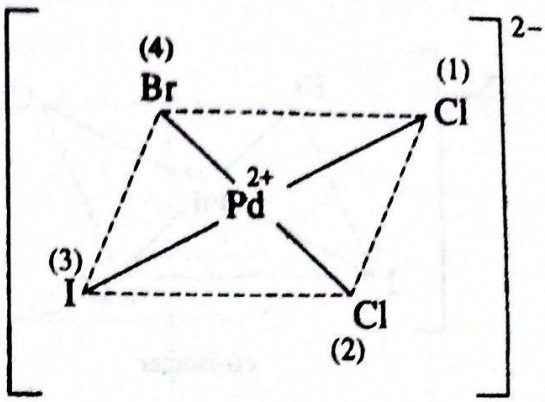
Geometrical isomerism cannot be shown by tetrahedral complexes, since all the four ligands in this geometry have adjacent position (i.e., *cis* position) to one another and all the four bond angles are the same (= 109.5°).

(iii) Geometrical Isomerism in Square Planar Complexes

A square planar complex having similar ligands at adjacent positions (90° apart) is called *cis*-isomer while a square planar complex having two similar ligands at opposite positions (180° apart) is called *trans*-isomer. Thus a square planar complex having two similar ligands at 1-2, 2-3, 3-4 and 1-4 positions is called *cis*-isomer while that having two similar ligands at 1-3 and 2-4 positions is called *trans*-isomer.



(a) cis-dichlorobromoiodopalladium(II) ion or 1, 2-dichlorobromoiodopalladium(II) ion, $[Pd^{2+}Cl_2BrI]^{2-}$

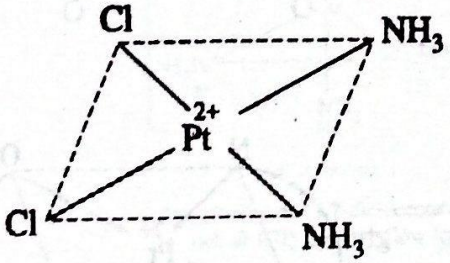


(b) trans-dichlorobromoiodopalladium(II) ion or 1, 2-dichlorobromoiodopalladium(II) ion, $[Pd^{2+}Cl_2BrI]^{2-}$

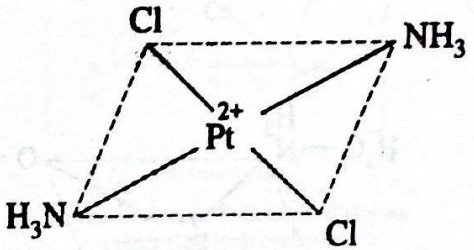
Nomenclature of geometrical (*cis*-and *trans*) isomers of a square planar complex.

(1) $[Ma_4]$, $[Ma_3b]$ type complexes : Square planar complexes of this type do not show geometrical isomerism, since all the possible spatial arrangement of four ligands round the central metal atom is the same.

(2) $[Ma_2b_2]$ type complexes : Important examples of square planar complexes of this type are $[Pt(NH_3)_2Cl_2]^0$, $[Pt(py)_2Cl_2]^0$, $[Pd(NH_3)_2(NO_2)_2]^0$ etc. These complexes exist in *cis*- and *trans*-isomers.



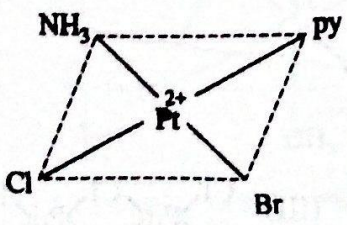
cis-isomer

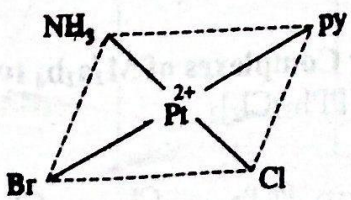


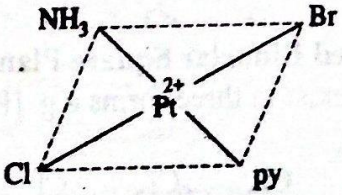
trans-isomer

***cis*-and *trans*-isomers of $[Pt^{2+}(NH_3)_2Cl_2]^0$**

(3) [Mabcd] type complexes : Square planar complexes of this type exist in three isomeric forms. For example $[Pt^{2+}(NH_3)(py)(Cl)(Br)]$ exists in three isomeric forms shown below. These isomeric forms can be obtained by selecting one ligand, say NH_3, and then placing the remaining three ligands, one by one, *trans* to NH_3.



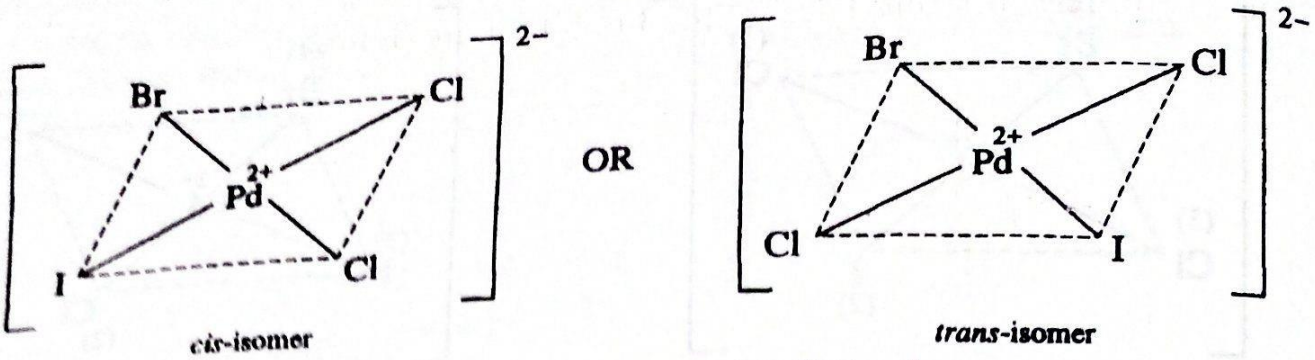




Three isomeric forms of $[Pt^{2+}(NH_3)(py)(Cl)(Br)]$

$[Pt^{2+}(NO_2)(py)(NH_3)(NH_2OH)]^+$ and $[Pt^{2+}(C_2H_4)(NH_3)(Cl)Br]$ are other examples of square planar complexes which exist in three isomeric forms.

(4) $[Ma_2bc]$ type complexes : Square planar complexes of this type also show *cis-trans*isomerism. For example $[Pd^{2+}Cl_2BrI]^{2-}$ ion exists in *cis* and *trans* isomers as shown below.

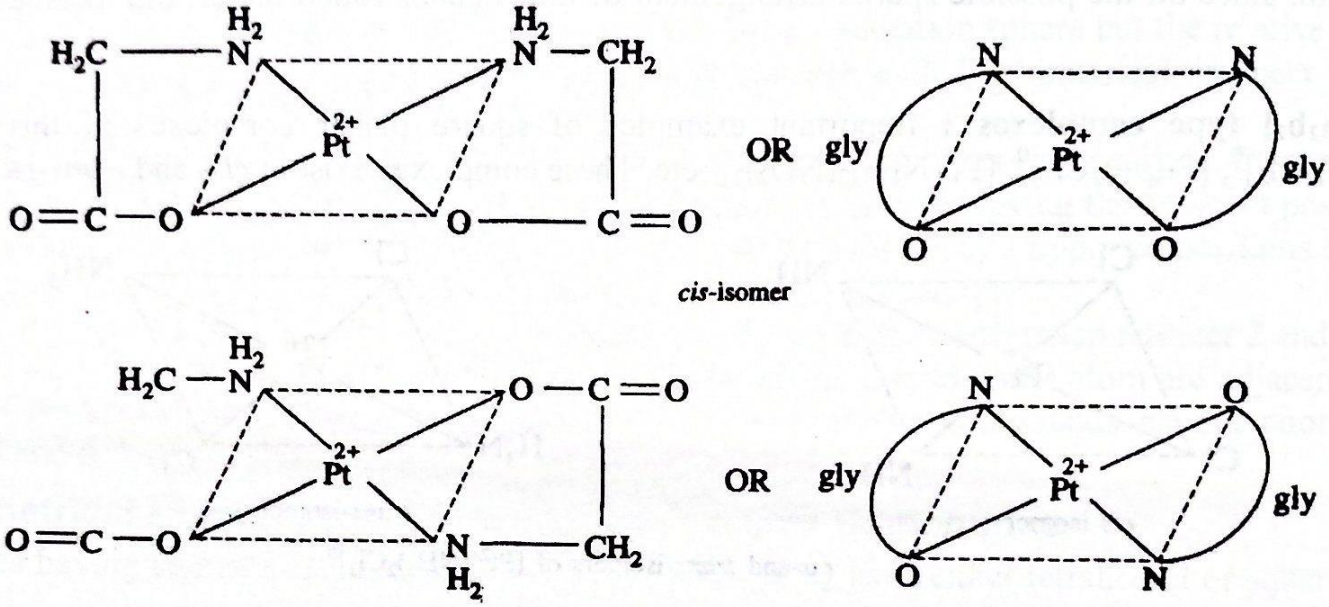


cis-isomer *trans*-isomer

Cis-and *trans*-isomers of $[Pd^{2+}Cl_2Br]^{2-}$ ion.

$[Pt^{2+}(py)_2(NH_3)Cl]^+$ is another example of square planar complex of $[Ma_2bc]$ type which exists in *cis*-*trans*-isomers.

(5) $[M(AB)_2]$ type complexes :



cis-isomer

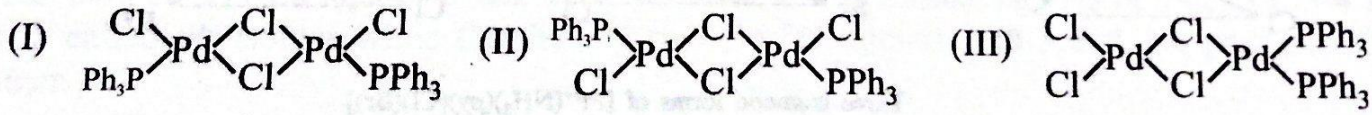
trans-isomer

cis- and *trans*-isomers of $[Pt^{2+}(gly)_2]$

$[Cu^{2+}(gly)_2]^0$ is also an example of square planar complex of $[M(AB)_2]$ type. This complex also exhi *cis-trans*-isomerism.

(6) Bridged Binuclar Square Planar Complexes of $M_2a_2b_4$ type.

They exist in three forms e.g. $[Pd(PPh_3)Cl_2]_2$



cis– trans unsymmetric