

**LIGAÇÃO COVALENTE:  
TEORIA DA LIGAÇÃO DE VALÊNCIA (TLV)**

**Parte 02**

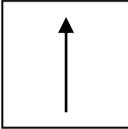
**HIBRIDIZAÇÃO**

**Prof. Gianluca C. Azzellini**

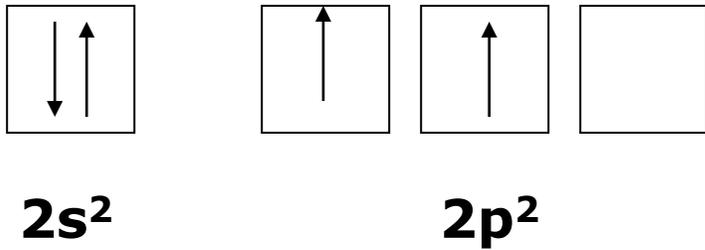
**QFL-1101**

# Compostos C e H Saturados $C_nH_{2n+2}$

Para  $n = 1$  Temos  $CH_4$  (metano)

Configuração do H:  $1s^1$  

Configuração do C:  $1s^2 2s^2 2p^2$



$CH_2$   **Não Existe Como Espécie Estável**

**Existe Como Espécie Instável (Radical)**   $CH_2^\bullet$

## Moléculas Com Mais de 2 átomos

Como explicar:  $\text{BF}_3$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{O}$ ,  $\text{NH}_3$ , etc

??

## Linus Pauling: Hibridização

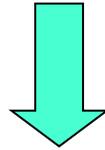


Mistura dos orbitais atômicos do átomo *central* (funções de onda)

**Mistura dos orbitais = Combinação Algébrica das Funções de Onda**

# Linus Pauling: Híbridização

**Mistura dos orbitais atômicos do átomo central (funções de onda)**



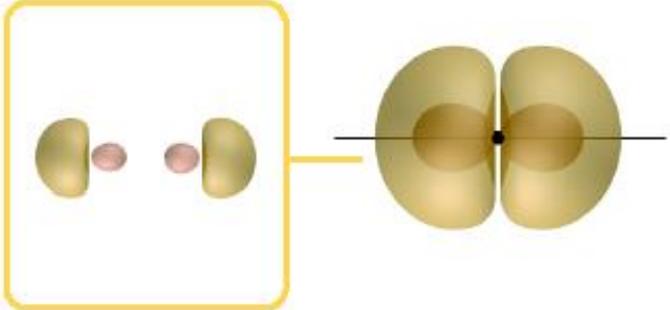
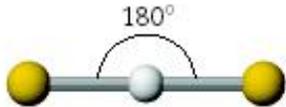
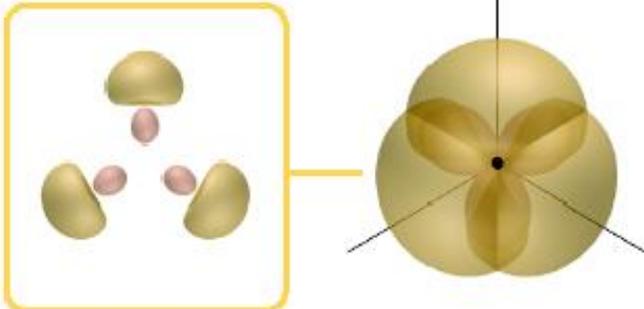
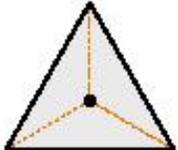
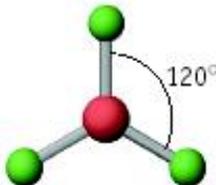
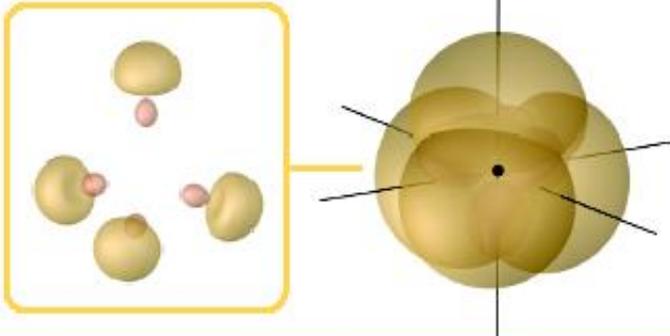
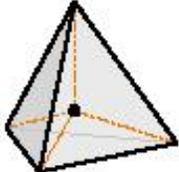
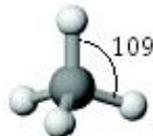
**Novo conjunto de orbitais (híbridos)**



**Nova orientação/Nova Energia**

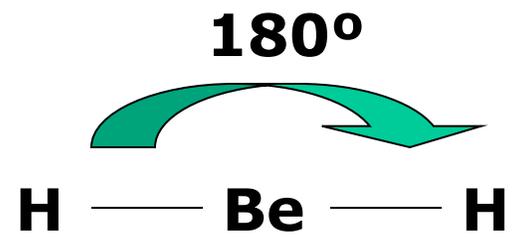


**Maior região de sobreposição orbital**

	Arrangement of Hybrid Orbitals	Geometric figure	Example
<p>Two electron pairs <math>sp</math></p>		 <p>Linear</p>	 <p><math>180^\circ</math> BeCl<sub>2</sub></p>
<p>Three electron pairs <math>sp^2</math></p>		 <p>Trigonal-planar</p>	 <p><math>120^\circ</math> BF<sub>3</sub></p>
<p>Four electron pairs <math>sp^3</math></p>		 <p>Tetrahedral</p>	 <p><math>109.5^\circ</math> CH<sub>4</sub></p>

# Hibridização sp

Molécula  $\text{BeH}_2$



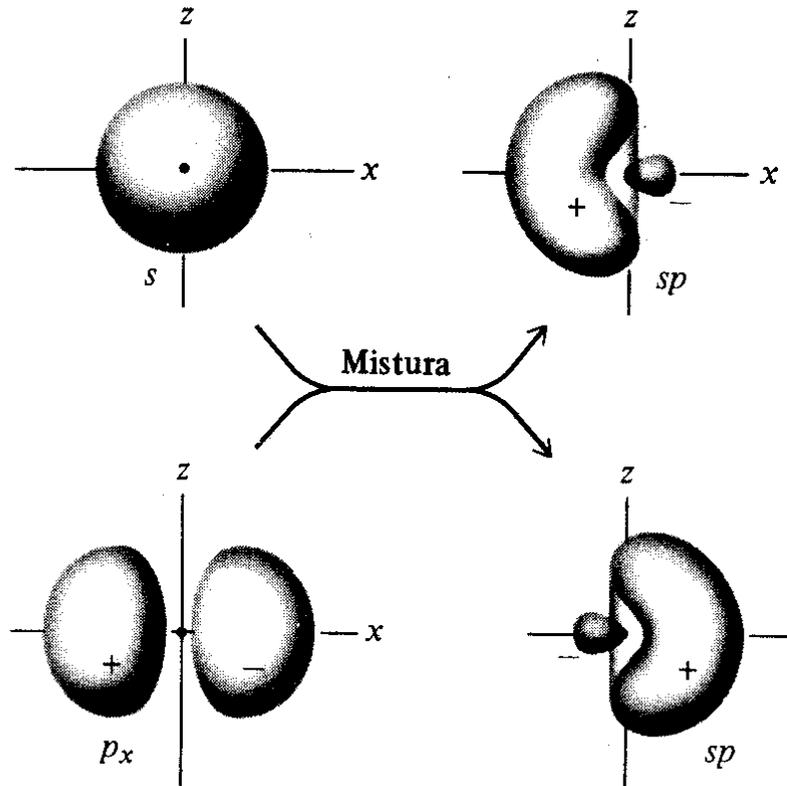
Be:  $1s^2 2s^2$

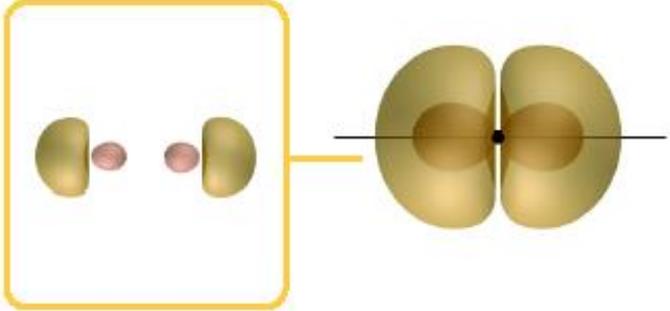
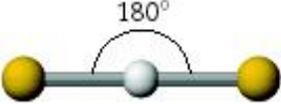


# Combinação de 1 orbital s com 1 orbital p



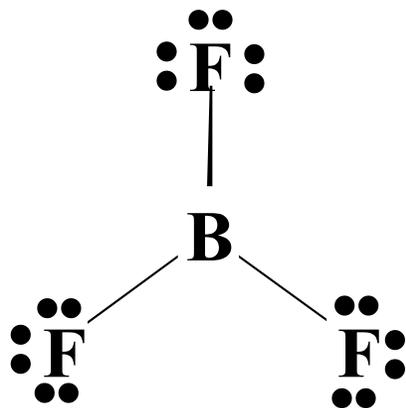
## 2 Orbitais híbridos sp



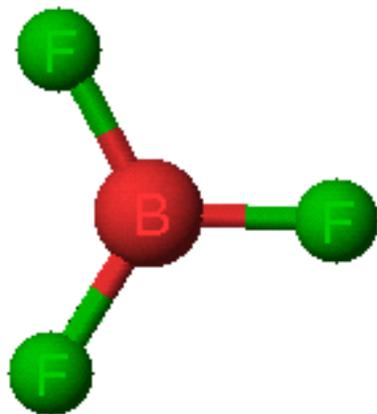
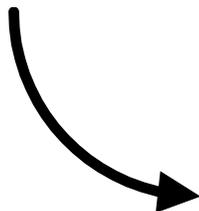
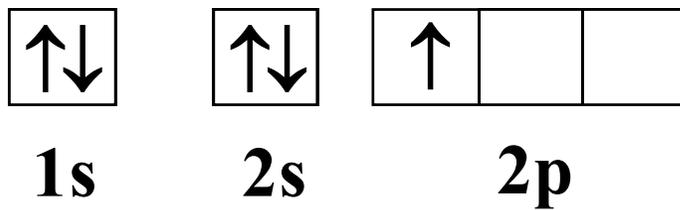
	Arrangement of Hybrid Orbitals	Geometric figure	Example
Two electron pairs <i>sp</i>		 <p><b>Linear</b></p>	 <p><b>BeH<sub>2</sub></b></p>

## Hibridização *sp*

Formação de *dois* orbitais SEMI-PREENCHIDOS *sp*



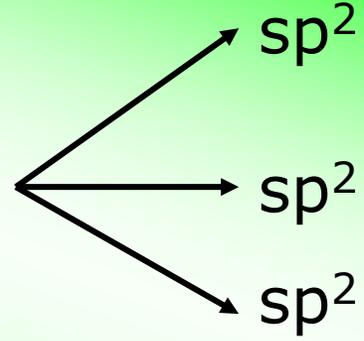
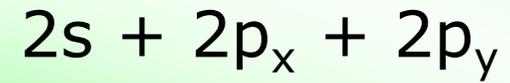
**Boron configuration**



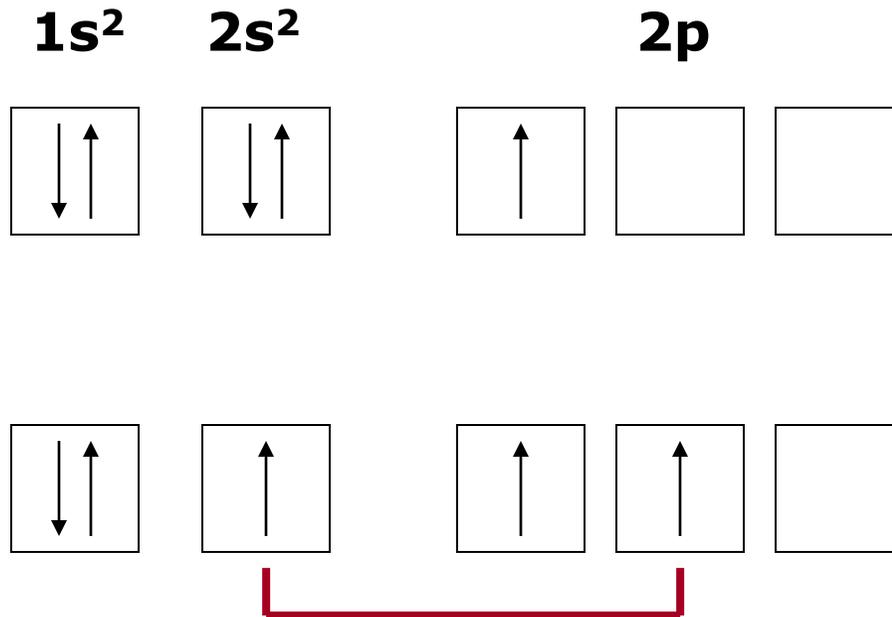
**Triangular Planar**  
**ângulo: 120°**

# Hibridização $sp^2$

**B:**



Orbital:  $p_x$ ;  $2p_z$  inalterado

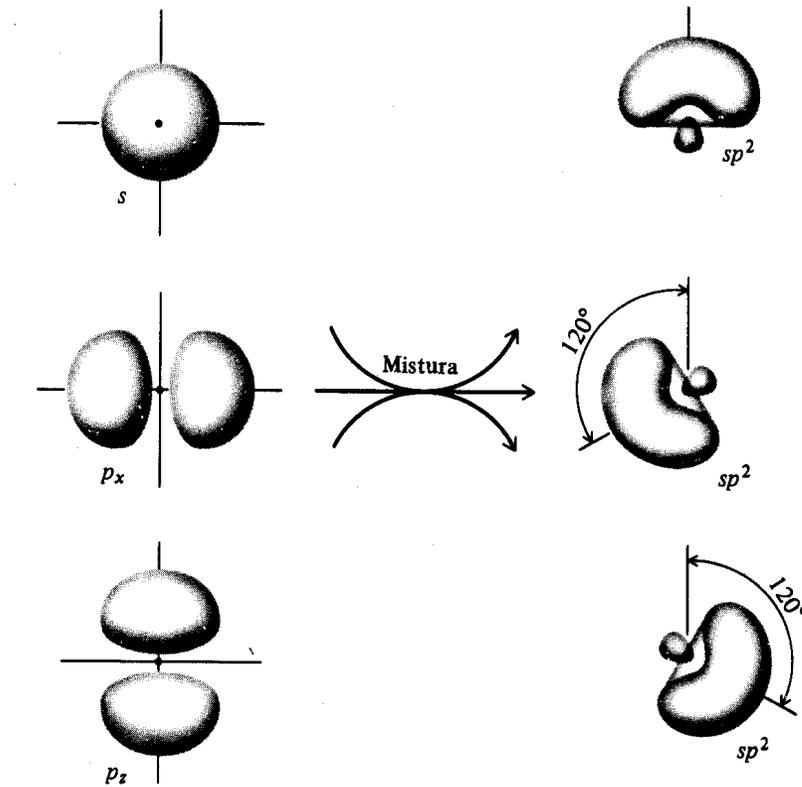


**Rearranjo  
eletrônico**

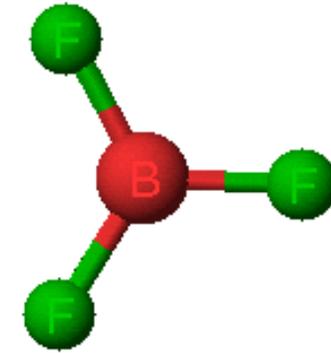
# Combinação de 1 orbital s com 2 orbitais p



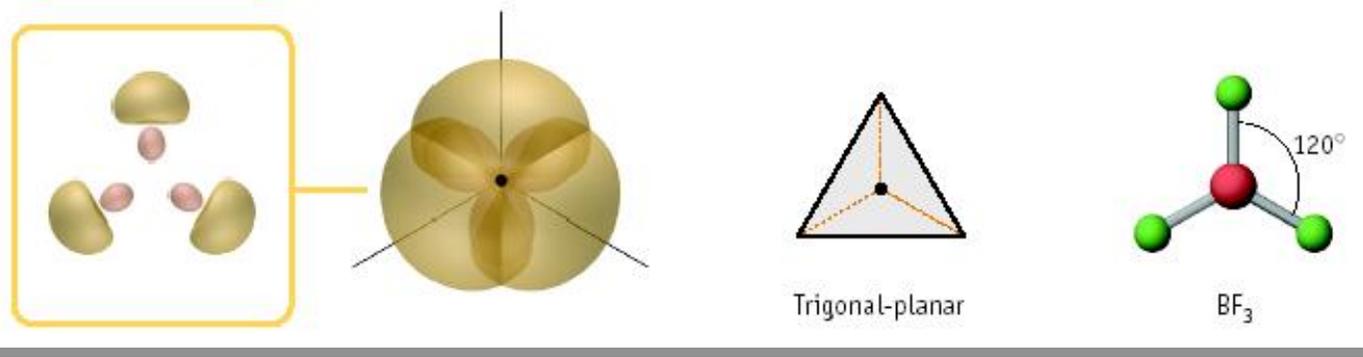
## 3 Orbitais híbridos $sp^2$



# Hibridização $sp^2$

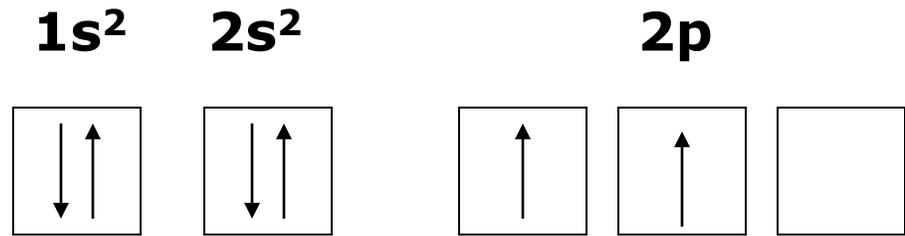


Three electron pairs  
 $sp^2$

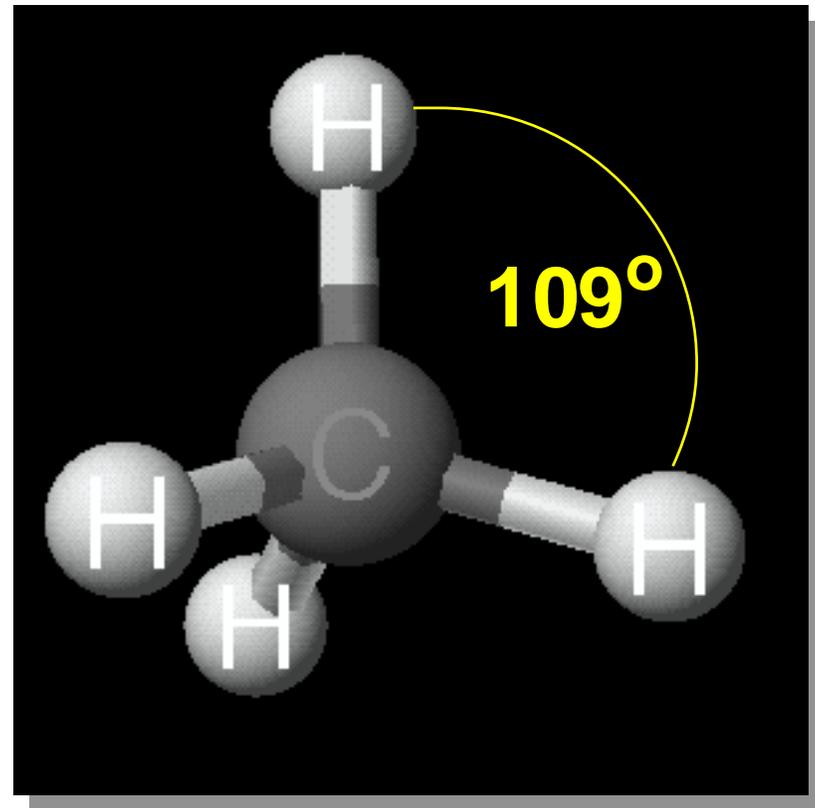


Formação de *três orbitais SEMI-PREENCHIDOS*  $sp^2$

# Hibridização $sp^3$

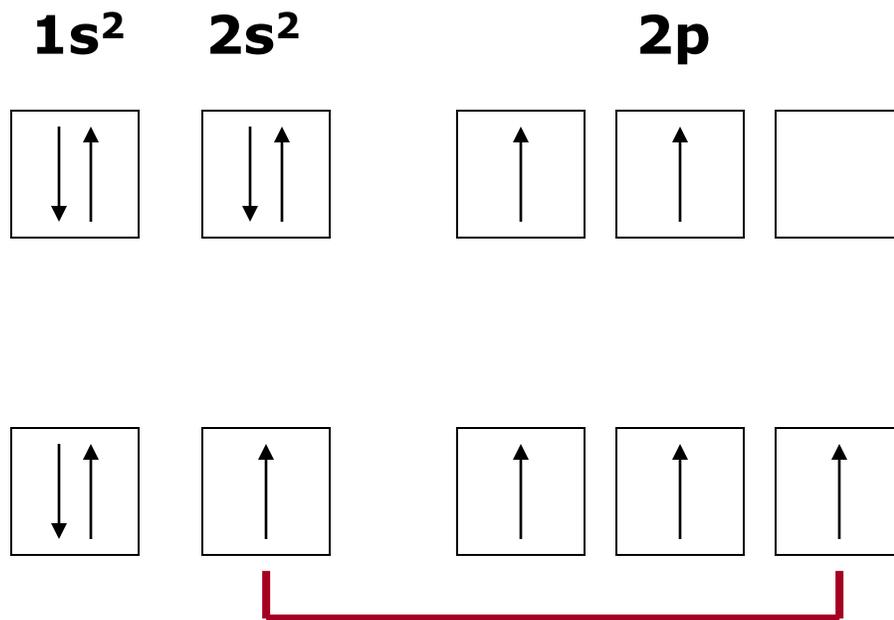
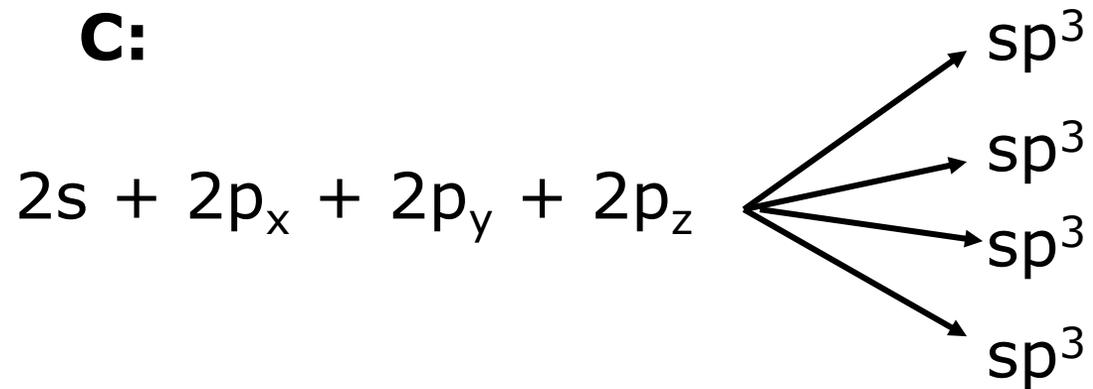


**Configuração do C**

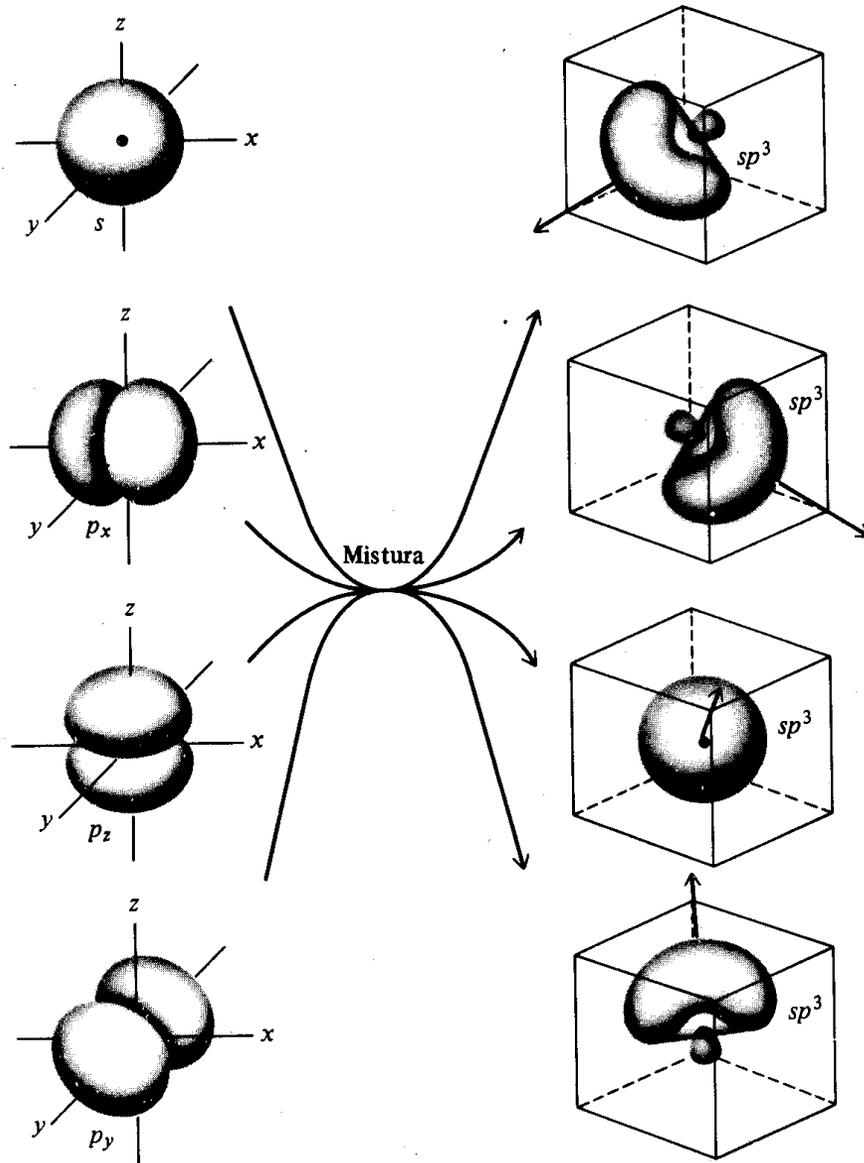


# Hibridização $sp^3$

**C:**



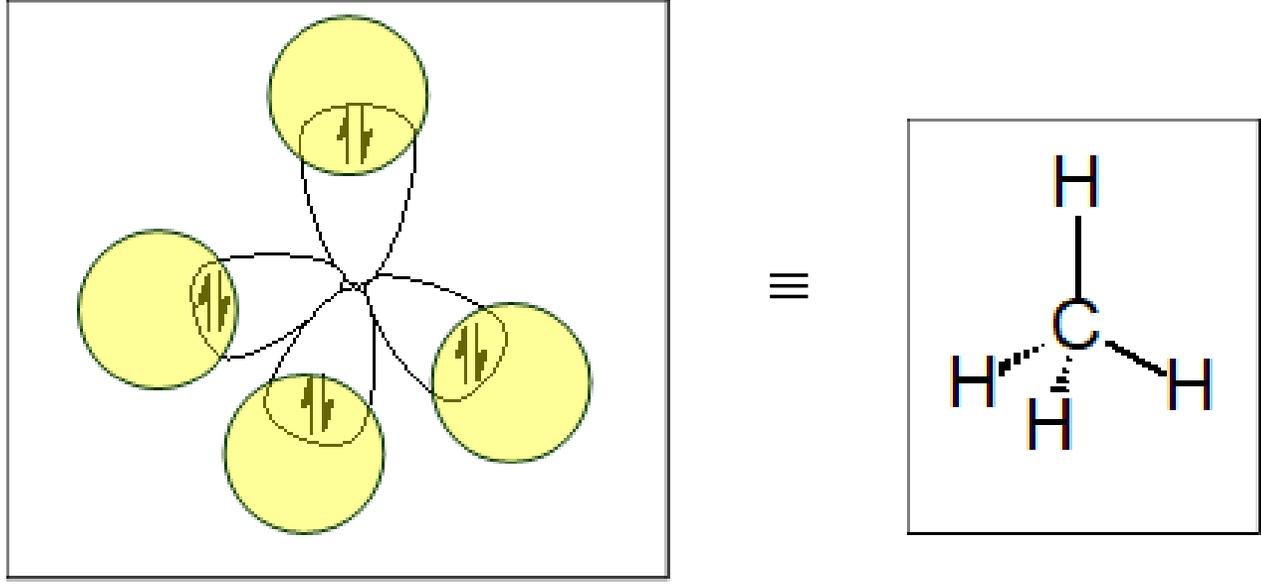
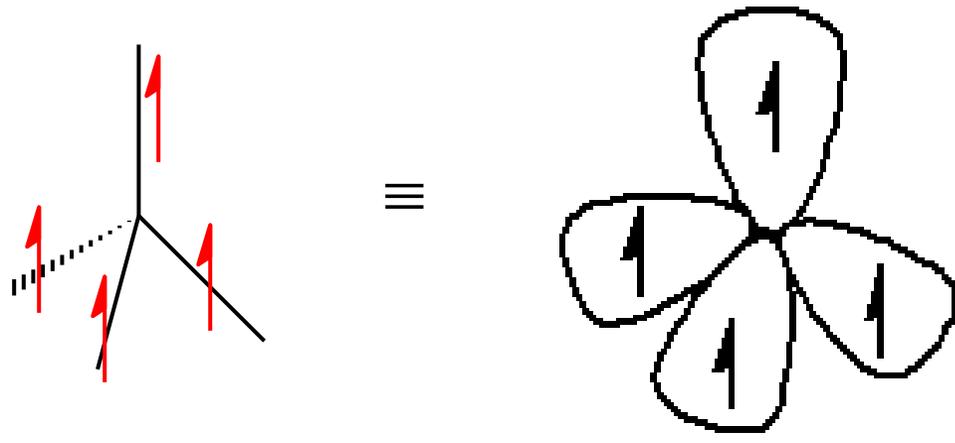
**Rearranjo  
eletrônico**



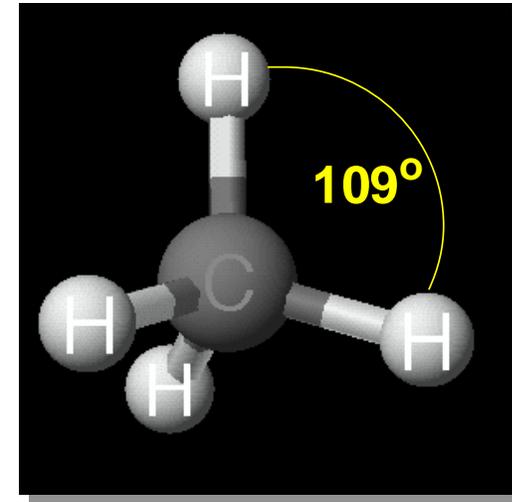
**Combinação de 1  
orbital s com 3  
orbitais p**



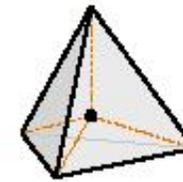
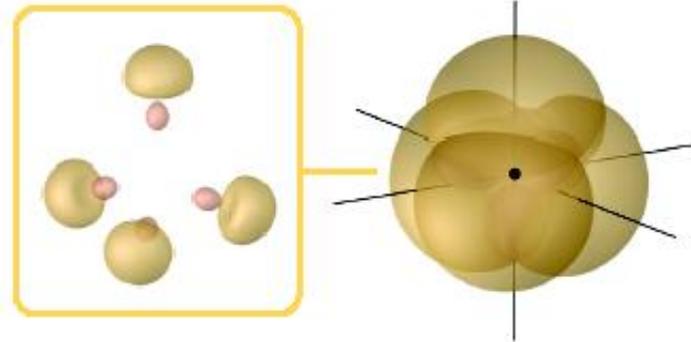
**4 Orbitais híbridos  $sp^3$**



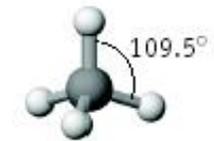
# Hibridização $sp^3$



Four electron pairs  
 $sp^3$

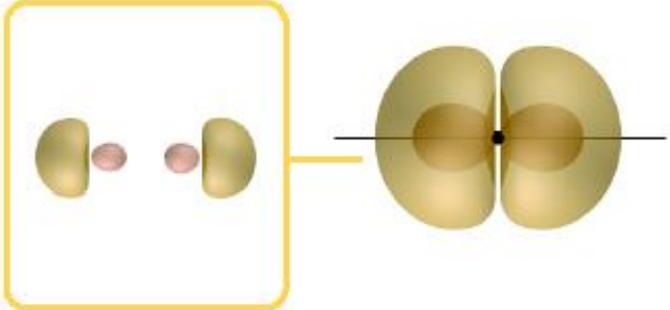
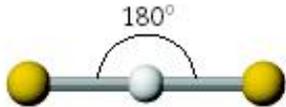
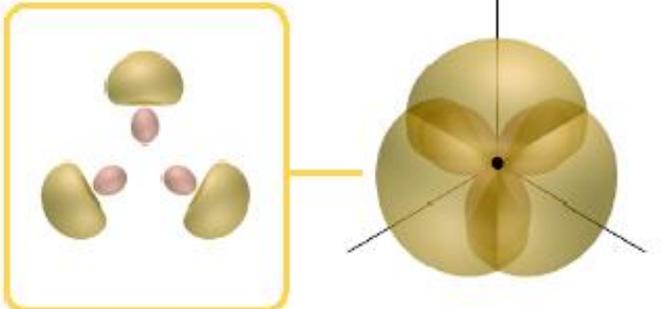
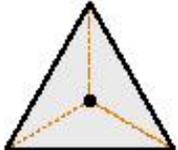
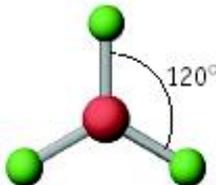
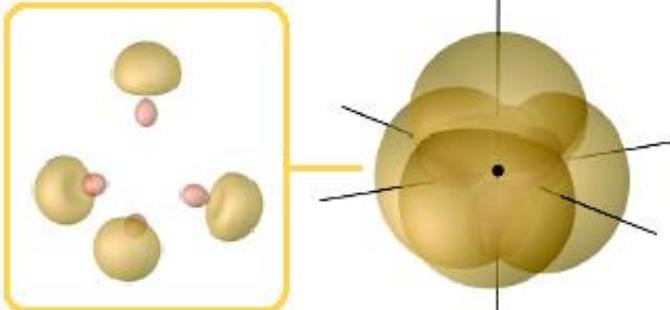
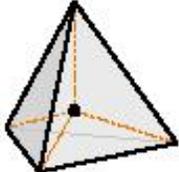
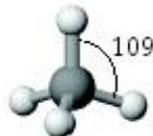


Tetrahedral

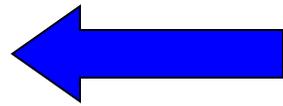
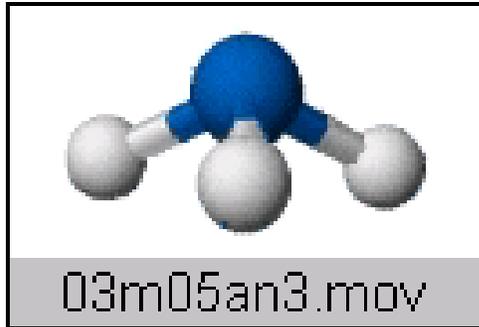


CH<sub>4</sub>

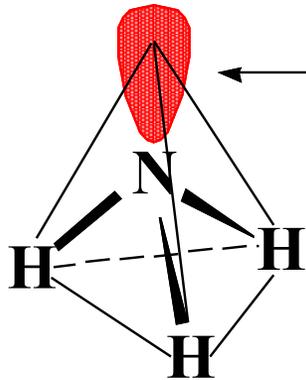
Formação de *quatro* orbitais SEMI-PREENCHIDOS  $sp^3$

	Arrangement of Hybrid Orbitals	Geometric figure	Example
<p>Two electron pairs <math>sp</math></p>		 <p>Linear</p>	 <p><math>180^\circ</math> BeCl<sub>2</sub></p>
<p>Three electron pairs <math>sp^2</math></p>		 <p>Trigonal-planar</p>	 <p><math>120^\circ</math> BF<sub>3</sub></p>
<p>Four electron pairs <math>sp^3</math></p>		 <p>Tetrahedral</p>	 <p><math>109.5^\circ</math> CH<sub>4</sub></p>

# Hibridização $sp^3$

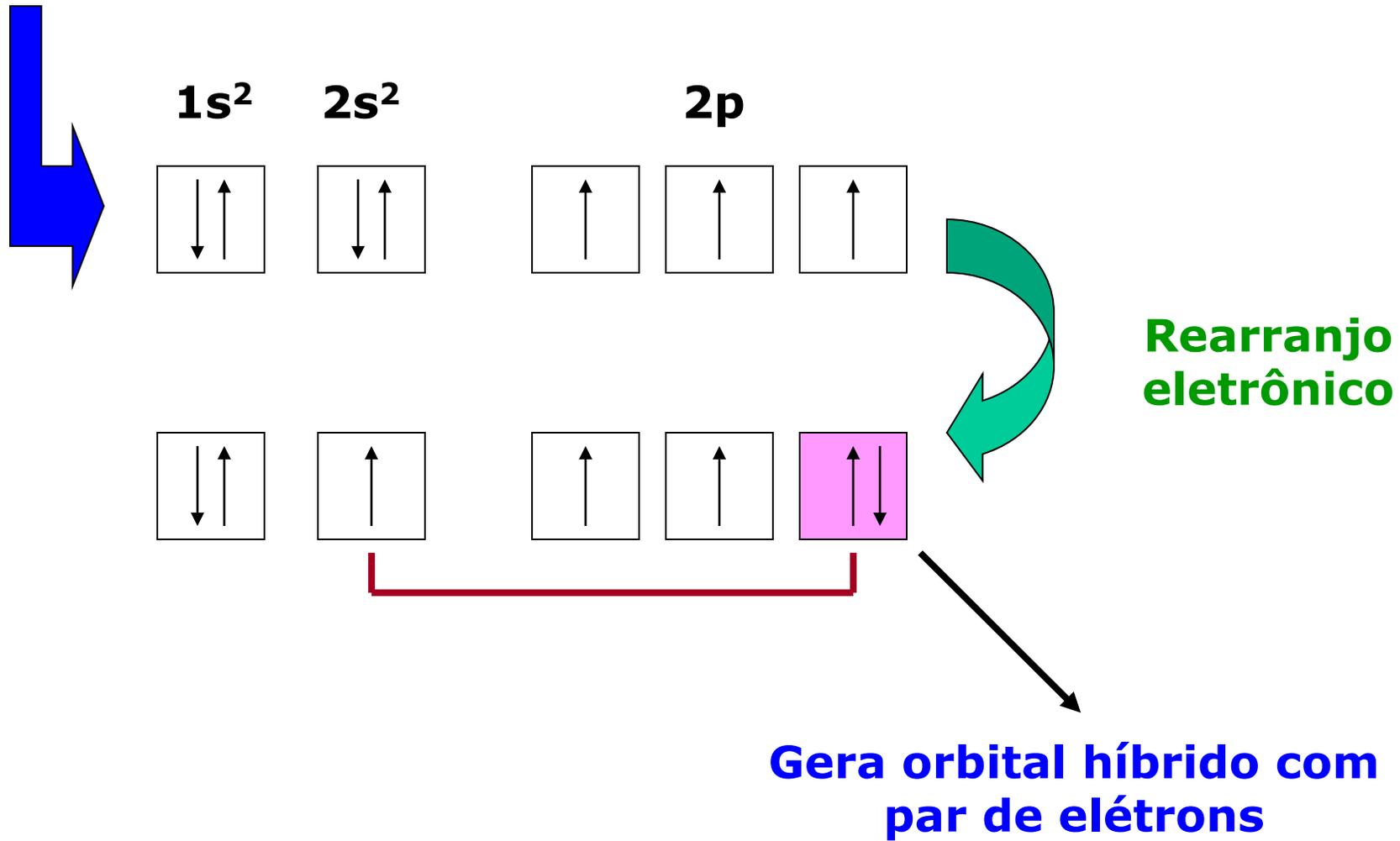


**Posição dos Átomos:  
Geometria Piramidal**



**Par de elétrons  
livres na posição  
tetraédrica**

# Configuração do N



## Hibridizações Utilizando Orbitais d



**Freqüente nos elementos do terceiro período**

Conjunto de orbitais atômicos

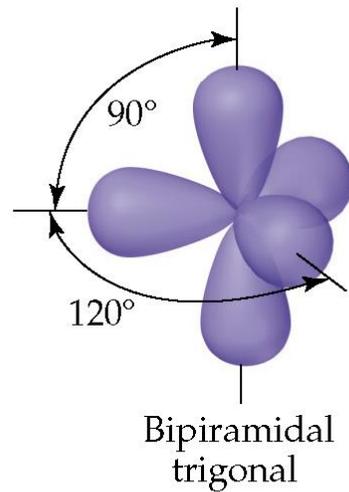
Conjunto de orbitais híbridos

Geometria

Exemplos

$s, p, p, p, d$

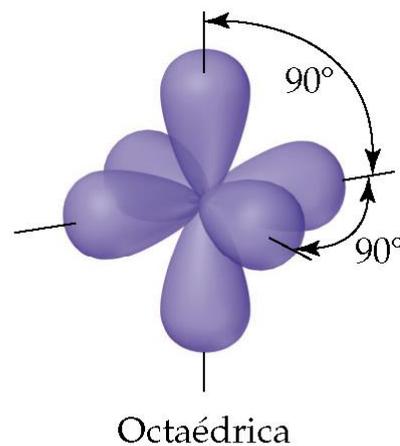
Cinco  $sp^3d$



**Ex:  $PCl_5/SF_4$**

$s, p, p, p, d, d$

Seis  $sp^3d^2$



**Ex:  $SF_6/ClF_5$**

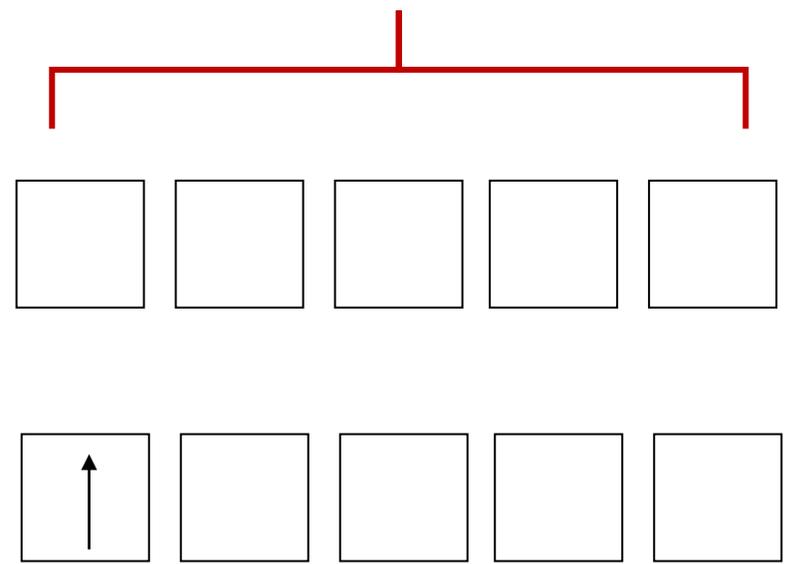
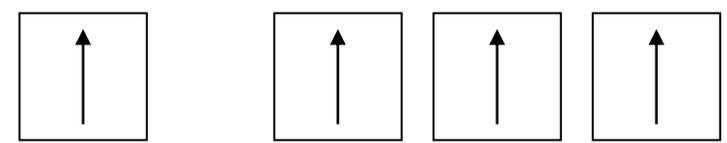
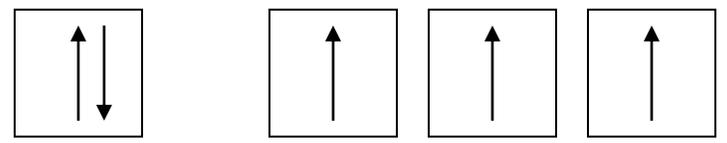
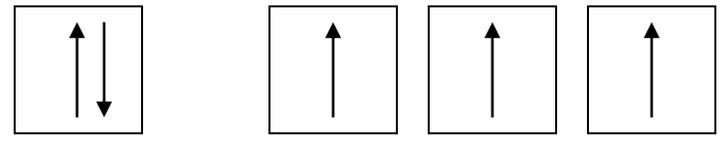
# Configuração do P

# PCl<sub>5</sub>

3s<sup>2</sup>

3p<sup>3</sup>

3d

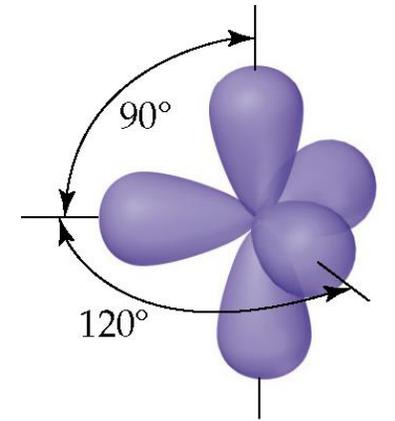


sp<sup>3</sup>d



Rearranjo eletrônico

Cinco sp<sup>3</sup>d



Bipiramidal trigonal