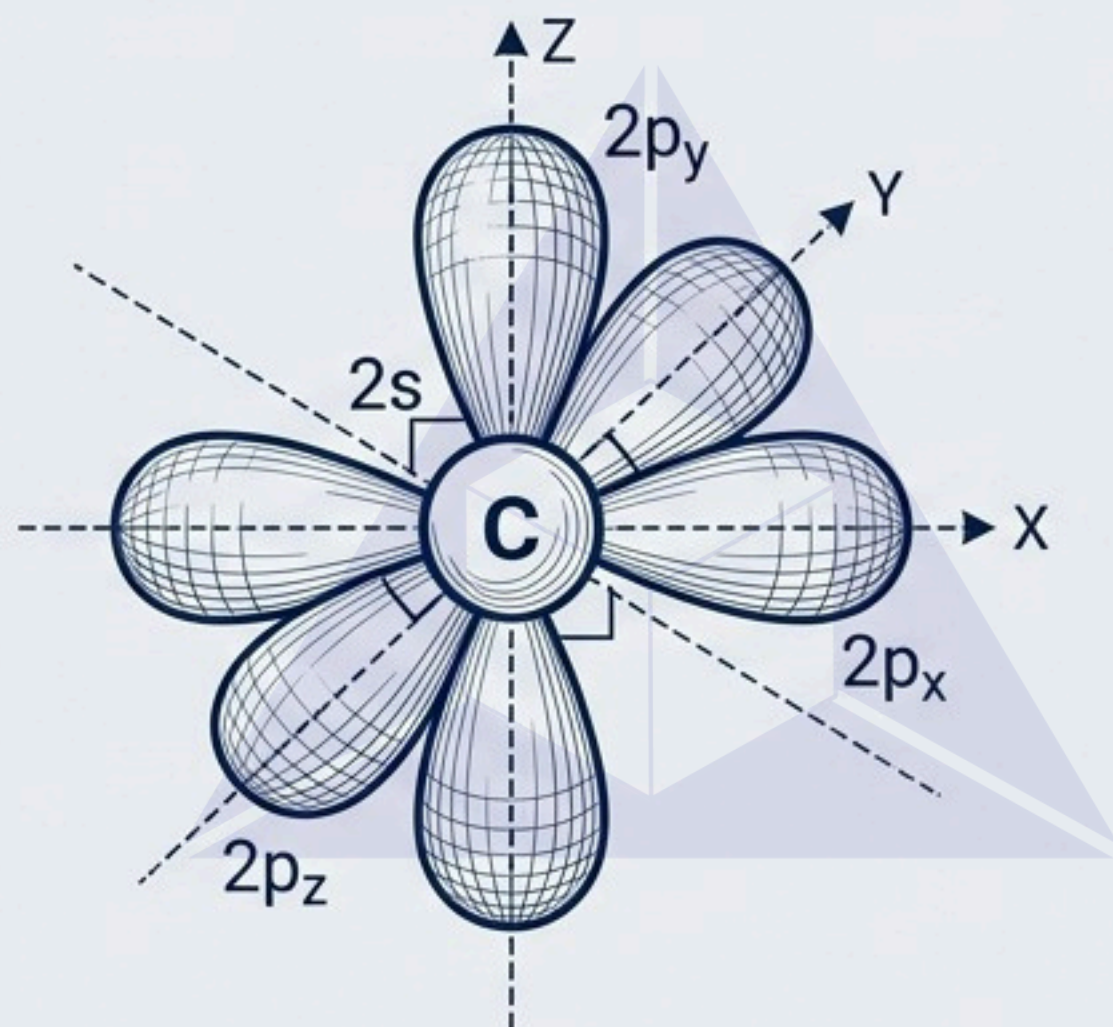


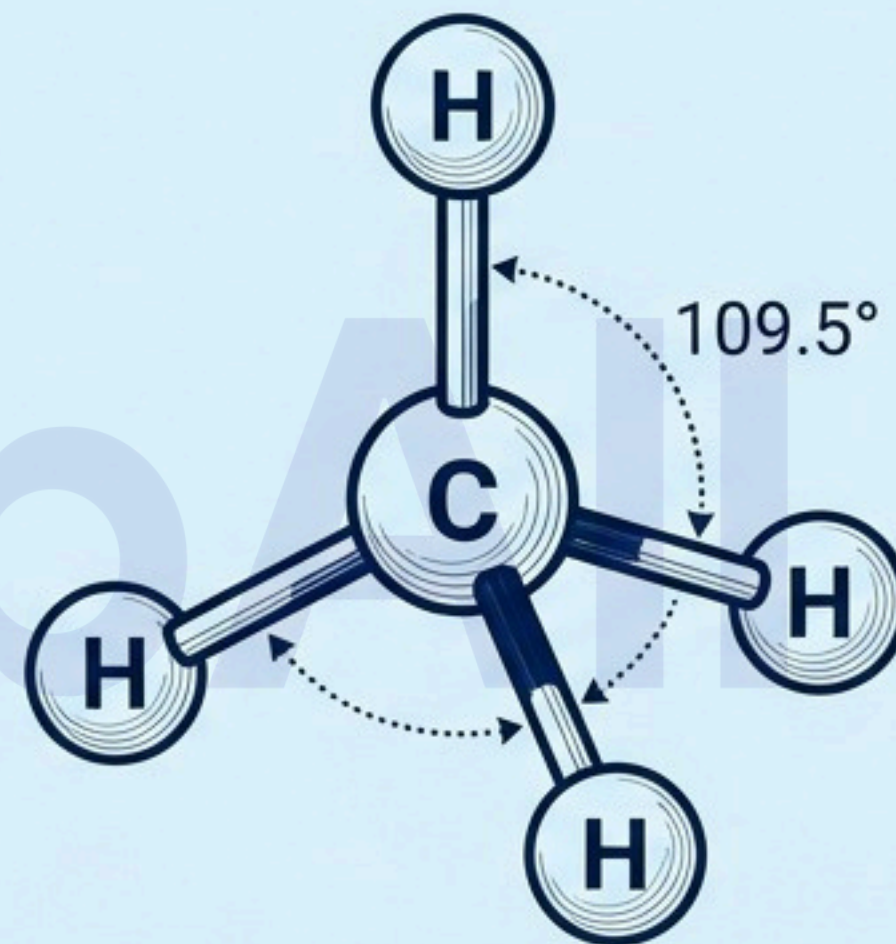
The Geometry Problem: Why Simple Overlap Fails

The Expectation (Simple Overlap)



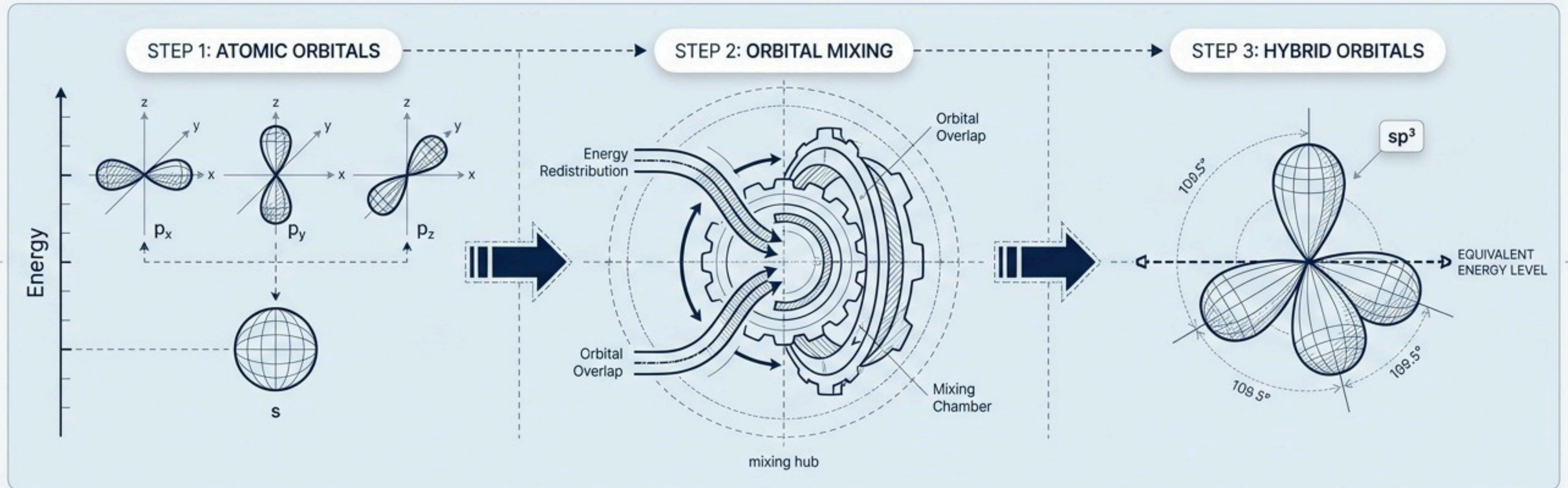
Valence Bond (VB) theory assumes bonds form by the simple overlap of pure atomic orbitals. If true for Carbon ($2s^2, 2p^2$), it would form three bonds at 90° (from p-orbitals) and one directionless bond (from the s-orbital).

The Reality (Experimental)



However, molecules like CH_4 exhibit highly characteristic, symmetric geometries. Methane possesses four perfectly equivalent bonds at precisely 109.5° . Linus Pauling introduced a new framework to explain this directional symmetry.

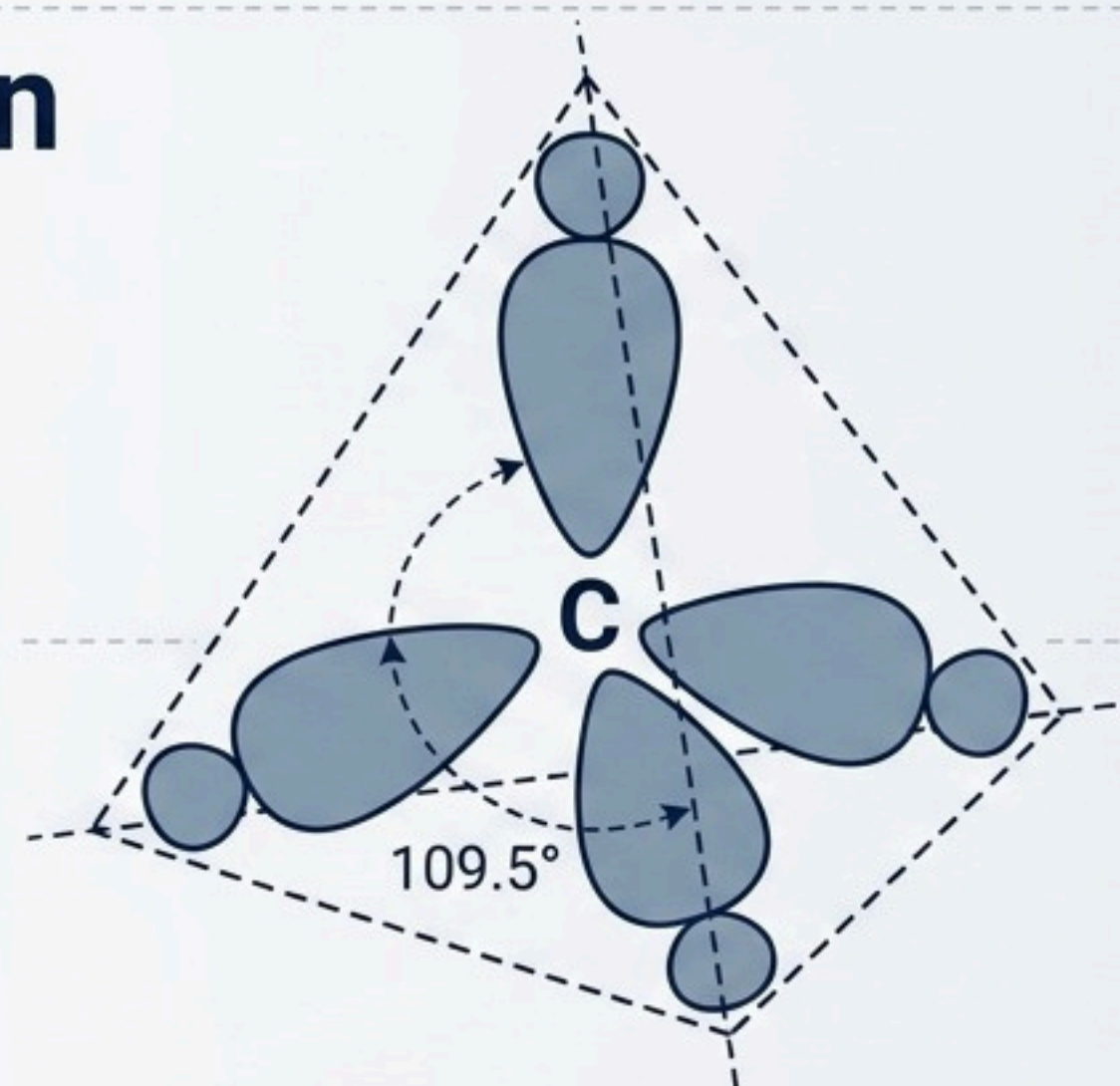
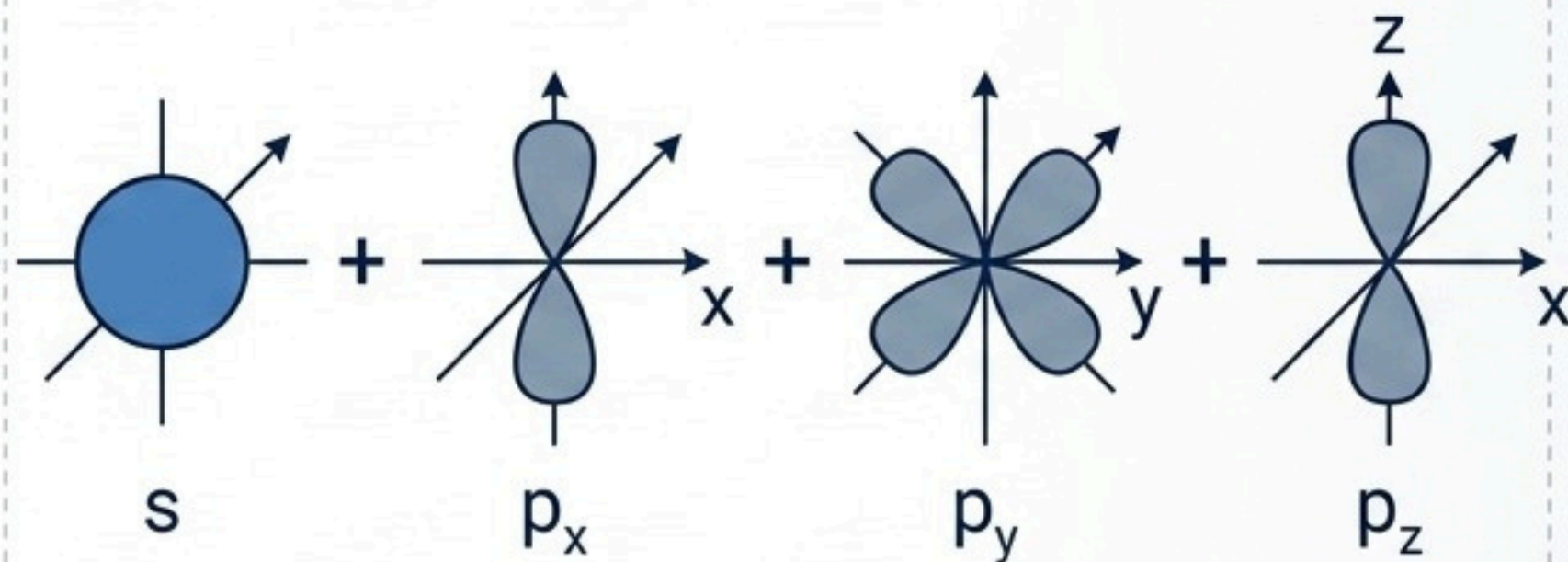
Defining Hybridisation: The Redistribution of Energy



The process of intermixing orbitals of slightly different energies to redistribute their energies, resulting in the formation of a new set of orbitals of equivalent energies and shape.

Unlike pure atomic orbitals, these new hybrid orbitals are the exclusive tools used in bond formation.

The Mechanics of sp^3 Hybridisation



The Input

One s-orbital + Three p-orbitals intermix from the valence shell.

The Output

Four entirely new, perfectly equivalent sp^3 hybrid orbitals are generated.

The Character

Each resulting hybrid orbital mathematically contains 25% s-character and 75% p-character.

The Geometry

The four orbitals project toward the corners of a regular tetrahedron (109.5° angle) to minimize repulsion. (e.g., CH₄).



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4 Salient Features of Hybrid Orbitals



Conservation of Orbitals

The number of hybrid orbitals generated is always exactly equal to the number of pure atomic orbitals that were intermixed.



Total Equivalence

The newly formed hybridized orbitals are always perfectly equivalent to each other in both energy and shape.



Superior Bond Strength

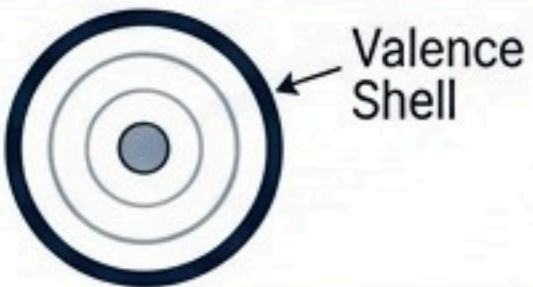
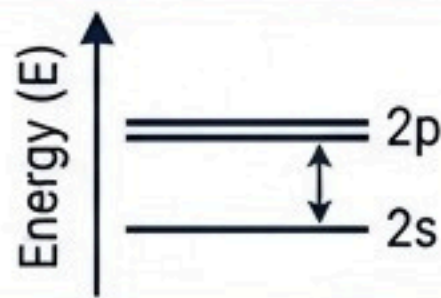
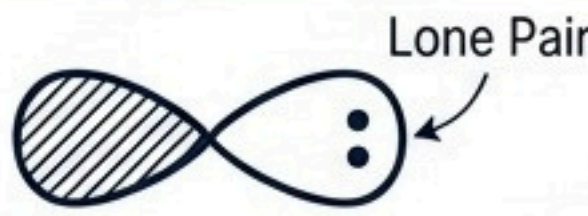
Hybrid orbitals are significantly more effective at forming stable, strong chemical bonds than their pure atomic orbital counterparts.



Directional Geometry

Hybrid orbitals are directed in space to ensure minimum repulsion between electron pairs, ultimately dictating the molecule's stable geometry.

Essential Conditions for Hybridisation

✓		Valence Shell Only. Only the orbitals present in the outermost (valence) shell of the atom undergo hybridisation. Inner core electrons remain protected and uninvolved.
✓		Comparable Energy. The atomic orbitals intermixing must have almost equal energy levels (e.g., 2s and 2p). A 1s cannot effectively hybridize with a 3p.
✓		Promotion is Optional. The promotion or excitation of an electron to a higher energy state is not a strict prerequisite for hybridisation to occur.
✓		Filled Orbitals Can Participate. It is a misconception that only half-filled orbitals hybridise. Fully filled orbitals in the valence shell can also participate, resulting in lone pairs (e.g., NH3 or H2O).

Revision Frame: Hybridisation

The Core Concept

Intermixing of atomic orbitals (different energy/shape) $\longrightarrow$ Energy Redistribution $\longrightarrow$ Formation of hybrid orbitals (equivalent energy/shape)

Purpose: Solves the failure of simple overlap theory to predict the exact directional properties and geometry of polyatomic molecules.

Key Rules & Conditions



Features:

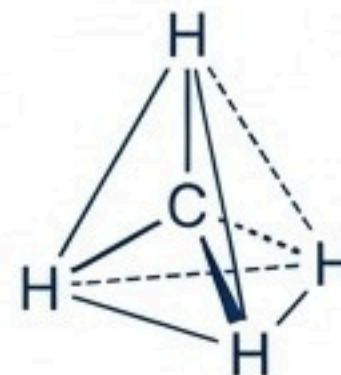
- Hybrids formed = Atomic orbitals mixed.
- Equivalent in energy/shape.
- Forms stronger bonds.
- Minimizes electron repulsion to dictate molecular geometry.



Conditions:

- Requires valence orbitals only.
- Must have comparable energy.
- Electron promotion is not mandatory.
- Fully filled orbitals can participate.

sp³ Deep Dive



$s \rightarrow$ $p \rightarrow$	Reaction	$1s + 3p \rightarrow 4 sp^3 \text{ hybrids}$
	Ratio	25% s-character / 75% p-character
	Angle	Tetrahedral geometry
	Example	109.5° bond angle



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