

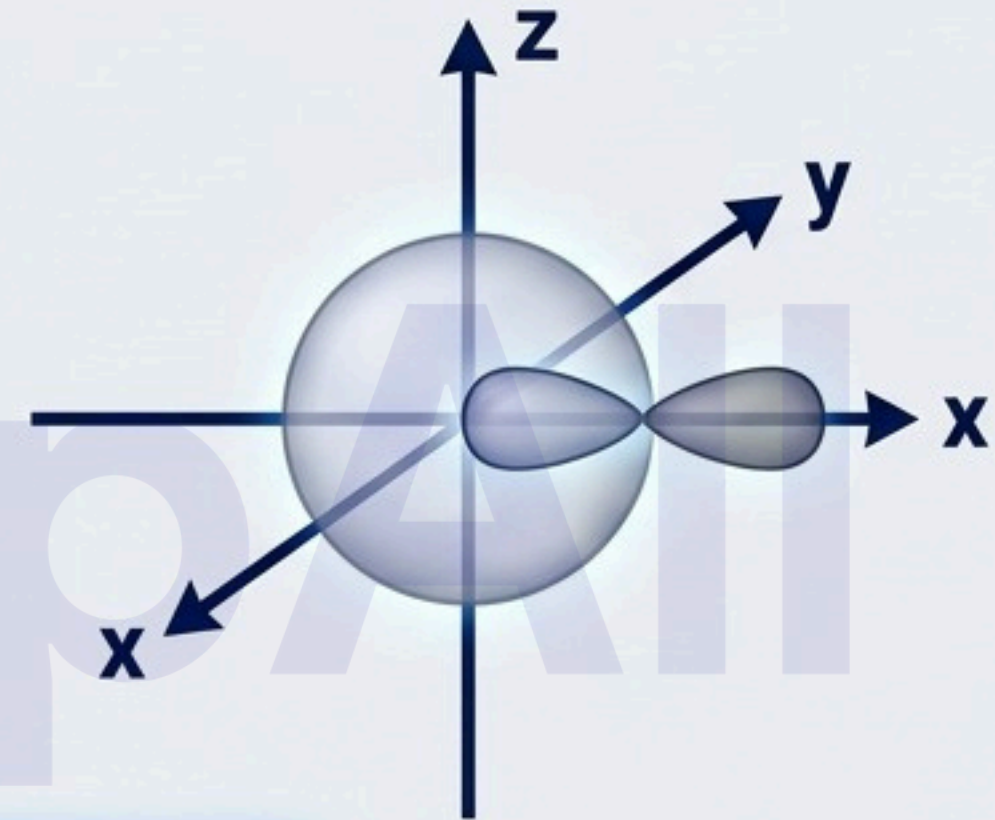
Covalent Bonds are Physical Overlaps in 3D Space

The 2D Abstraction



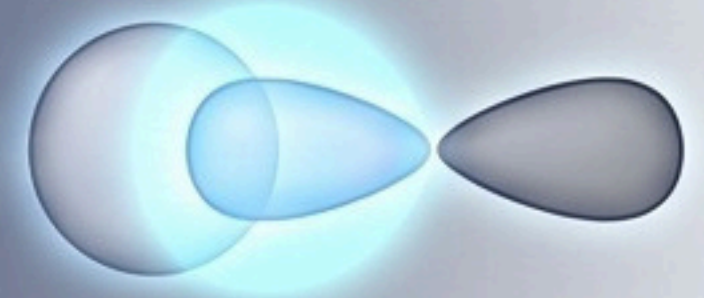
Lewis Model: Tells us *that* atoms bond, but not *how* in 3D space.

The 3D Reality

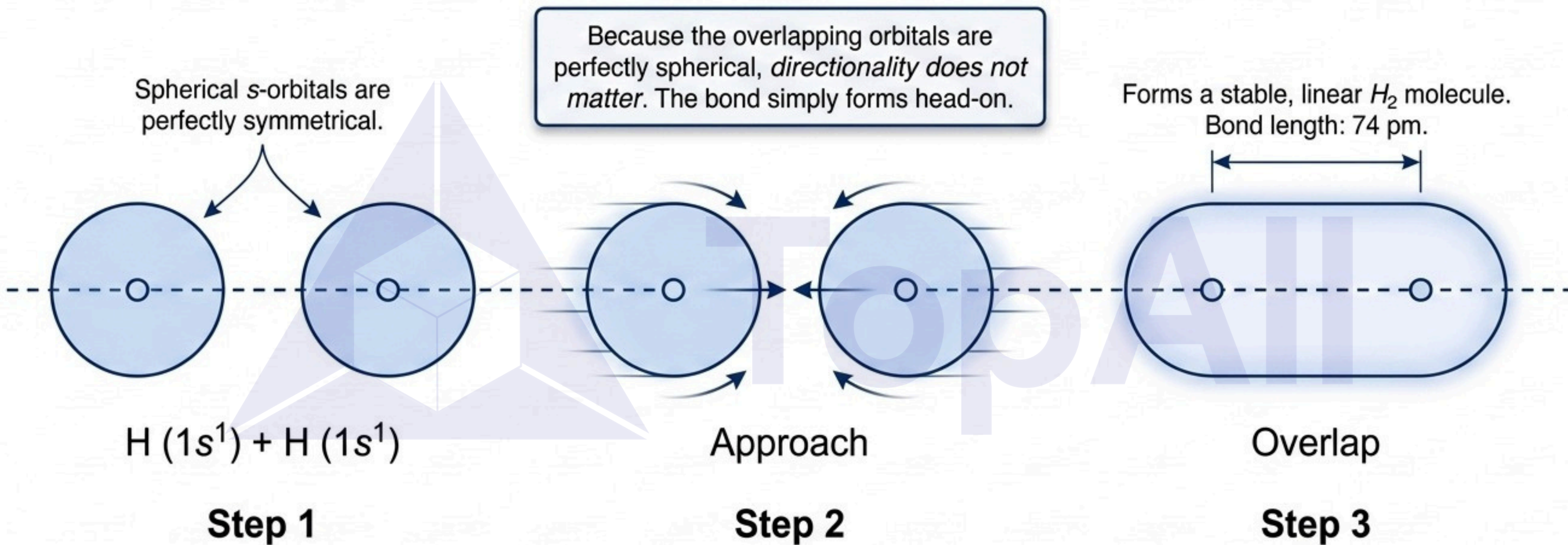


Valence Bond Theory establishes that the **extent and direction** of orbital overlap dictate the physical geometry of a molecule.

Atomic Orbital 1 + Atomic Orbital 2 → Directional Overlap



Simple Overlap Works Perfectly for Spherical Orbitals



For simple diatomic molecules, native atomic orbitals provide everything needed for a perfect structural blueprint.



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$$E=mc^2$$



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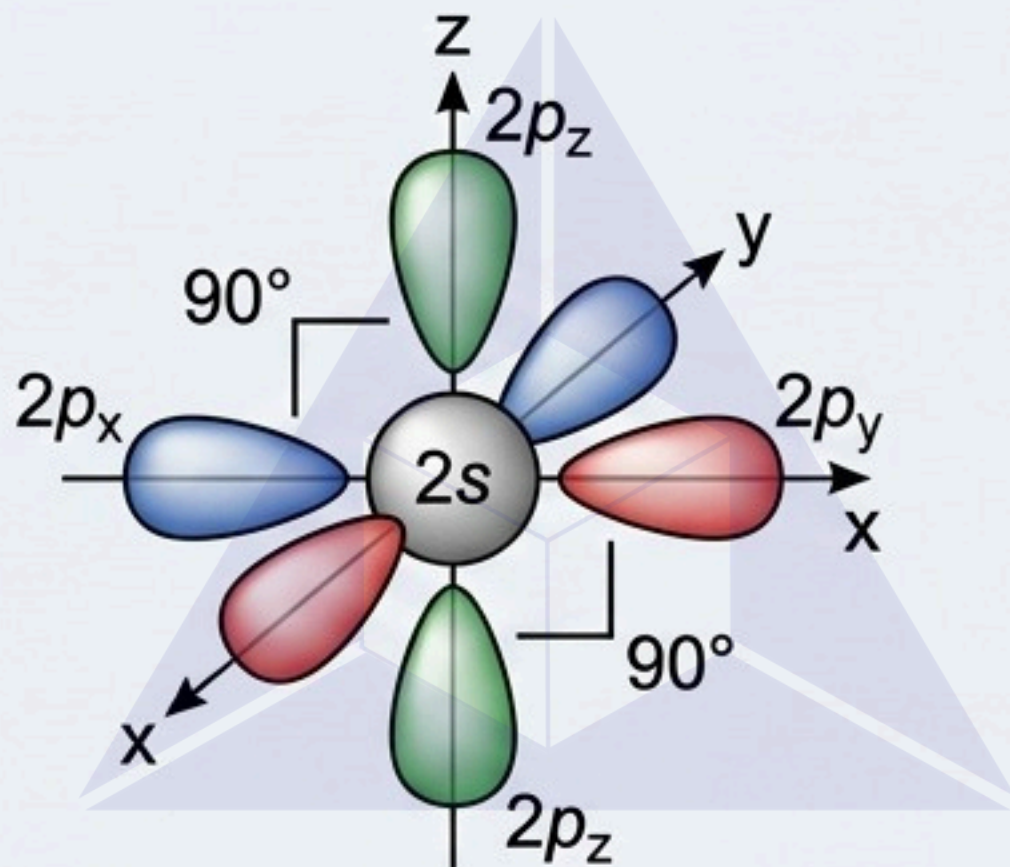
Key Highlights

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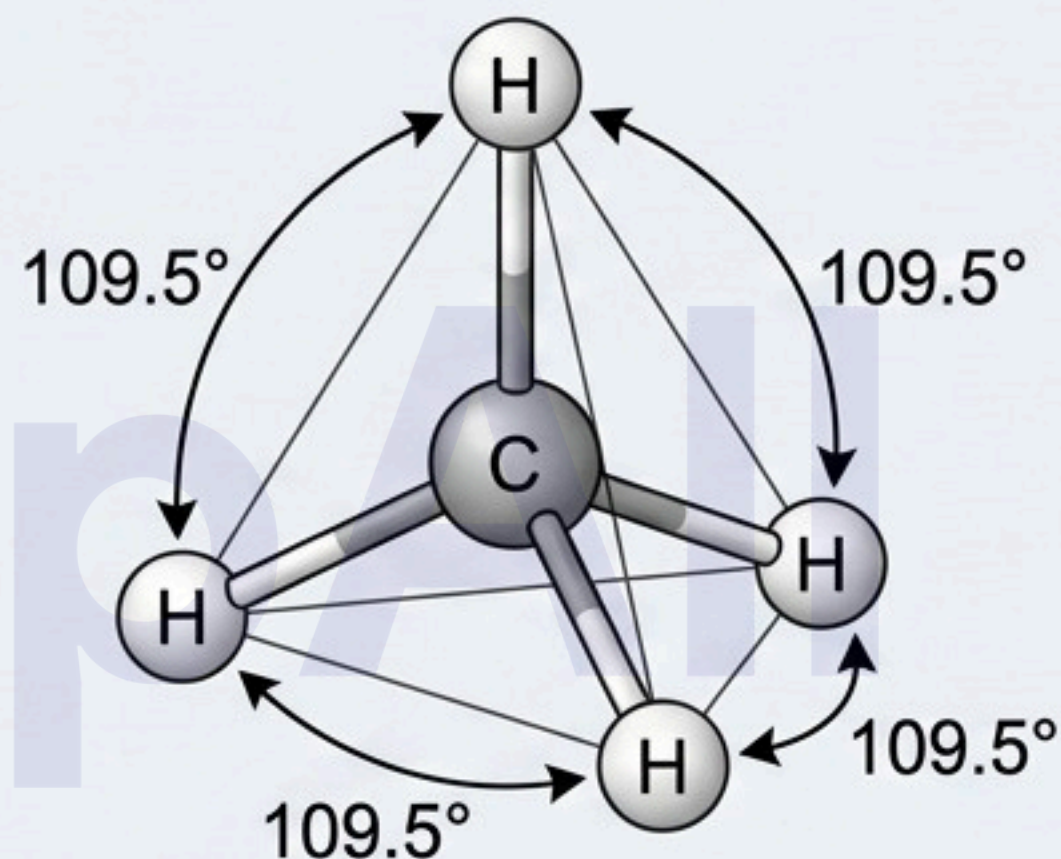
The Methane Anomaly: When the Simple Blueprint Fails

The Expectation (Based on Native Orbitals)



If Hydrogen atoms attached here, we would get three bonds at exactly 90° and one random, directionless s-bond.

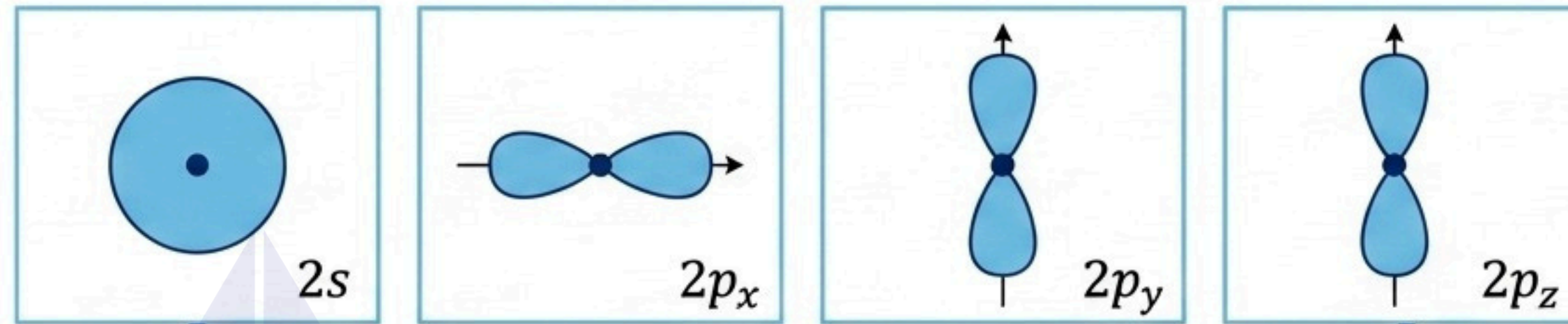
The Reality (Experimental Data)



Reality: CH₄ forms a perfect symmetrical tetrahedron with identical 109.5° angles across all four bonds.

Native atomic orbitals alone cannot account for the directional geometry of polyatomic molecules.

Hybridisation: Engineering New Directional Orbitals

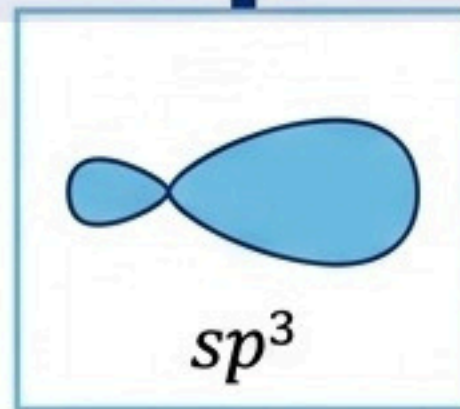


The Inputs

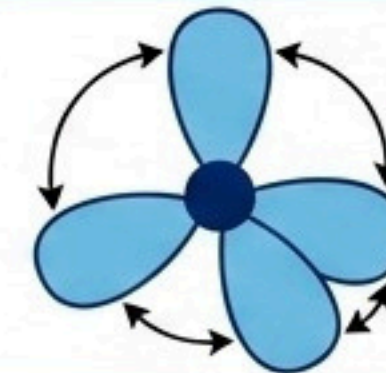
Pauling's Hybridisation Process

Orbitals of slightly different energies intermix and redistribute to minimize electron pair repulsion.

The Process



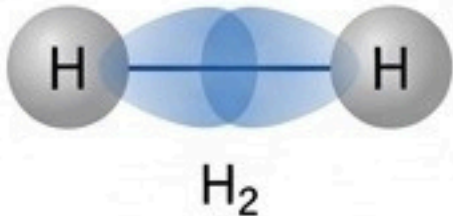
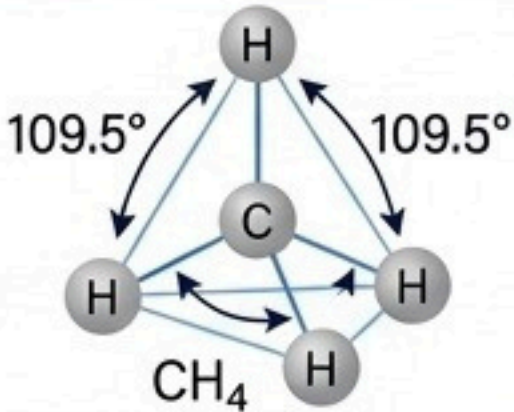
Four equivalent sp^3 orbitals spaced perfectly at 109.5°



The Output

Atoms do not bond using their raw orbitals. They engineer custom, equivalent hybrid orbitals precisely directed in space to form optimal molecular shapes.

Molecular Geometry Reference Matrix

	Pure Orbital Overlap	Hybridised Overlap
Core Mechanism	Direct merging of native atomic orbitals.	Pre-mixing of orbitals to create custom bonding tools.
Orbital Types Used	Standard s and p orbitals.	Custom sp , sp^2 , sp^3 hybrid orbitals.
Resulting Geometry	Dictated by native orbital shapes (spheres or 90° axes).	Optimized for minimal repulsion (Linear, Trigonal Planar, Tetrahedral).
Key Example		

While simple molecules rely on direct orbital merging, complex molecular geometries **require** the directional properties of hybridised orbitals.



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