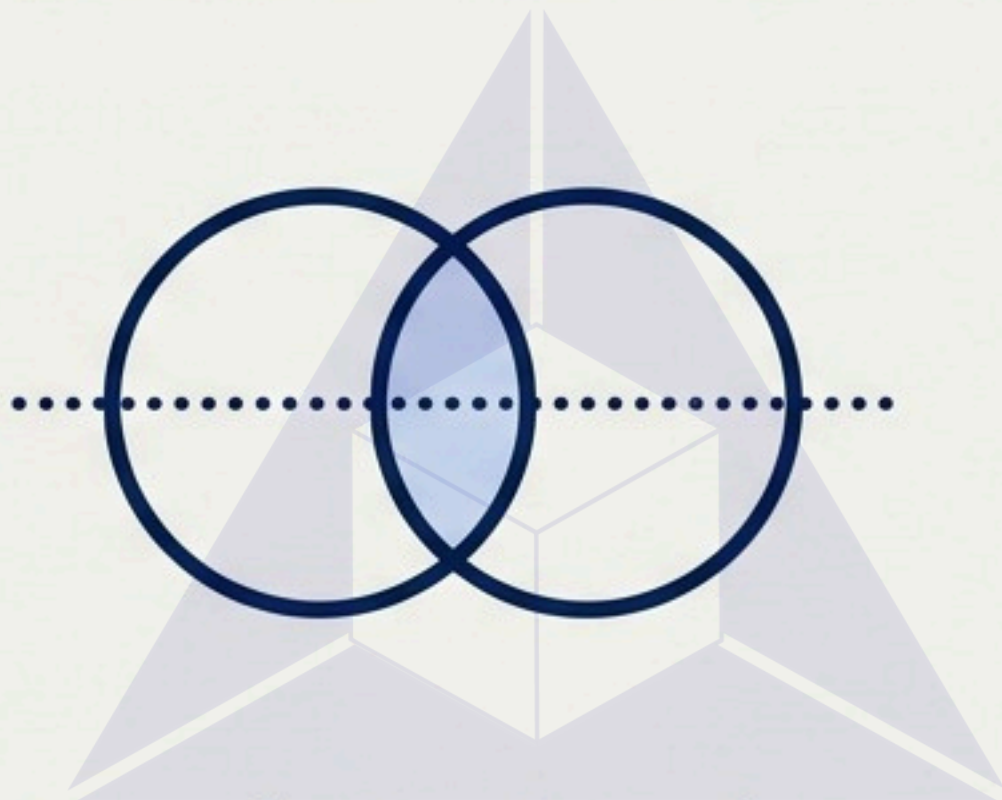


Types of Orbital Overlapping

The spatial orientation of atomic orbitals dictates the nature of the covalent bond.



Head-On Overlap

Results in Sigma (σ) Bonds.
Overlap occurs directly along the
internuclear axis.



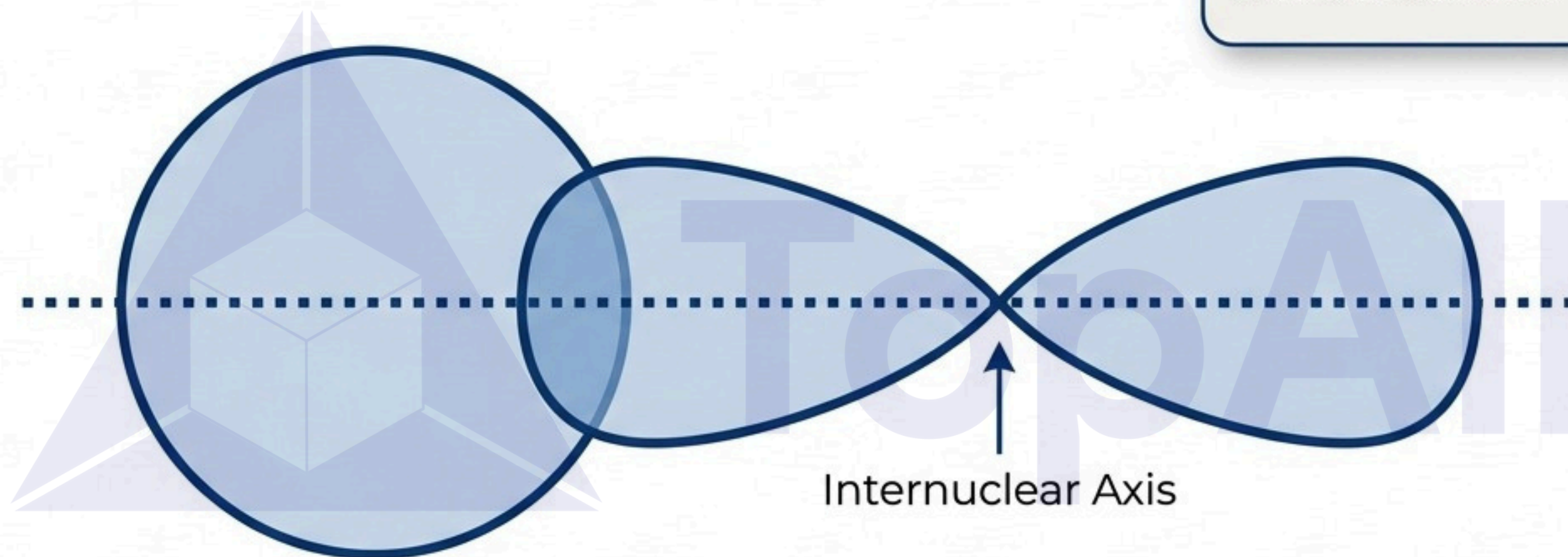
Sidewise Overlap

Results in Pi (π) Bonds. Overlap
occurs parallel to each other,
perpendicular to the axis.

The Sigma (σ) Bond

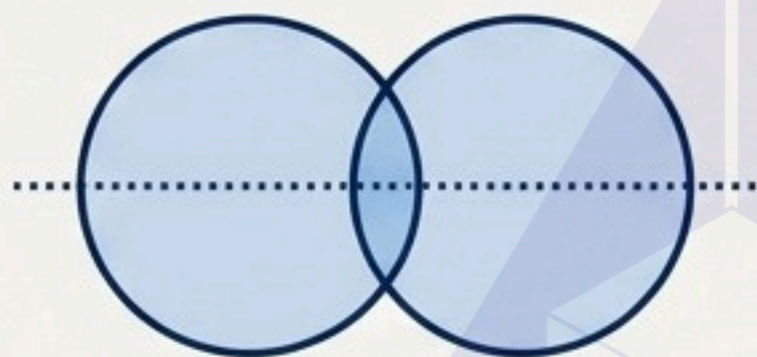
Head-On Axial Overlap

Formed by the end-to-end (head-on) overlap of bonding orbitals directly along the internuclear axis.



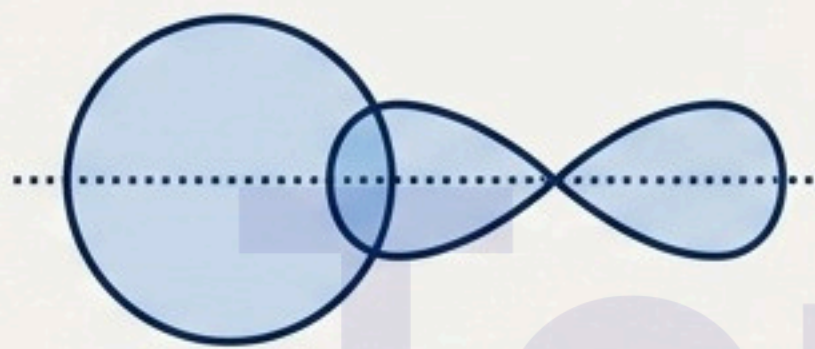
Maximum Overlap = Maximum Strength.
Because this axial overlapping takes place to a larger extent, Sigma bonds are inherently stronger than Pi bonds.

Three Pathways to Sigma Overlap



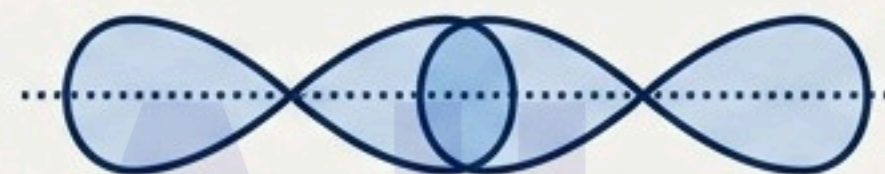
s-s Overlap

Overlap of two half-filled s-orbitals along the internuclear axis.



s-p Overlap

Occurs between a half-filled s-orbital of one atom and a half-filled p-orbital of another.



p-p Overlap

Takes place between half-filled p-orbitals of two approaching atoms facing end-to-end.



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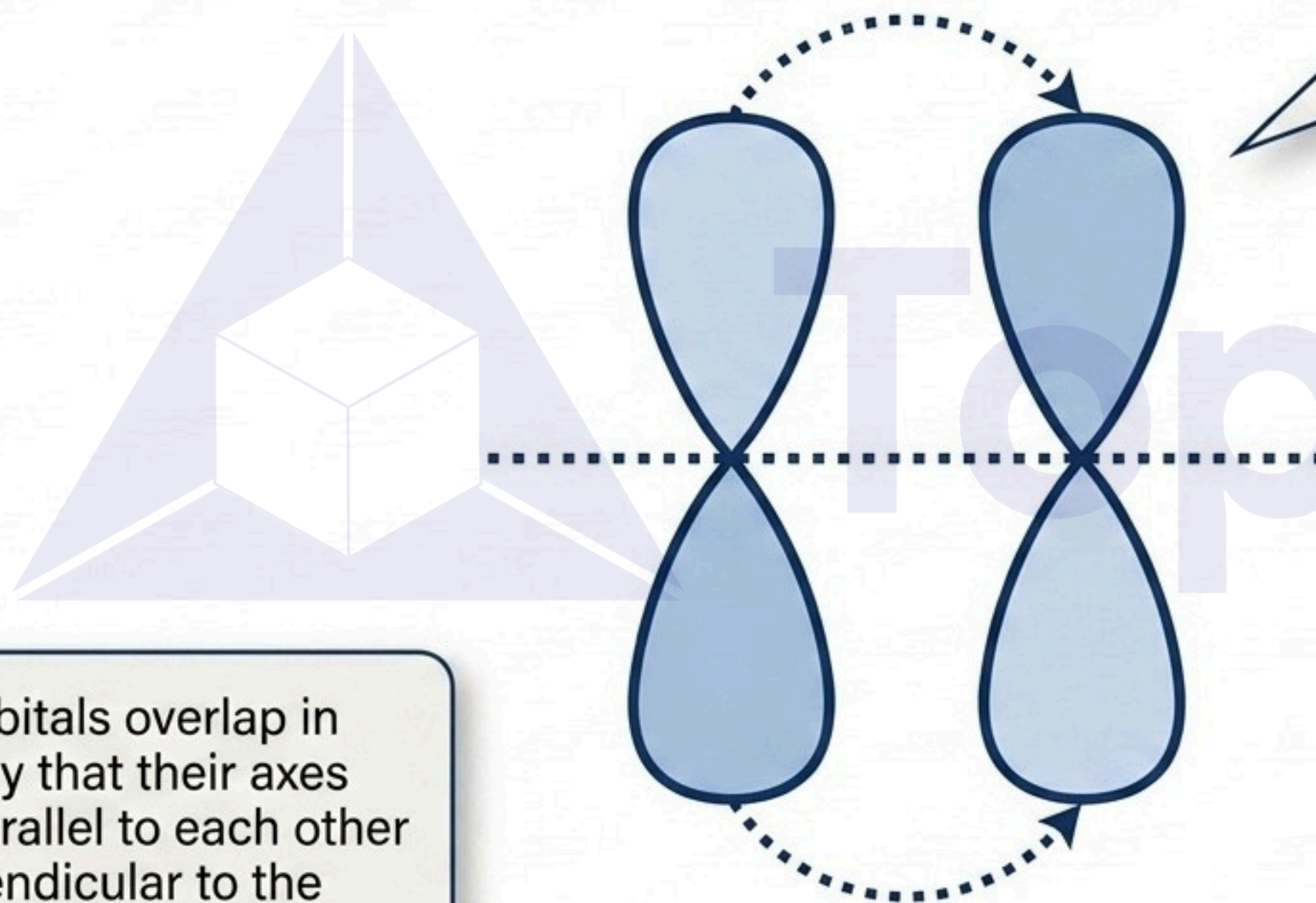
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The Pi (π) Bond

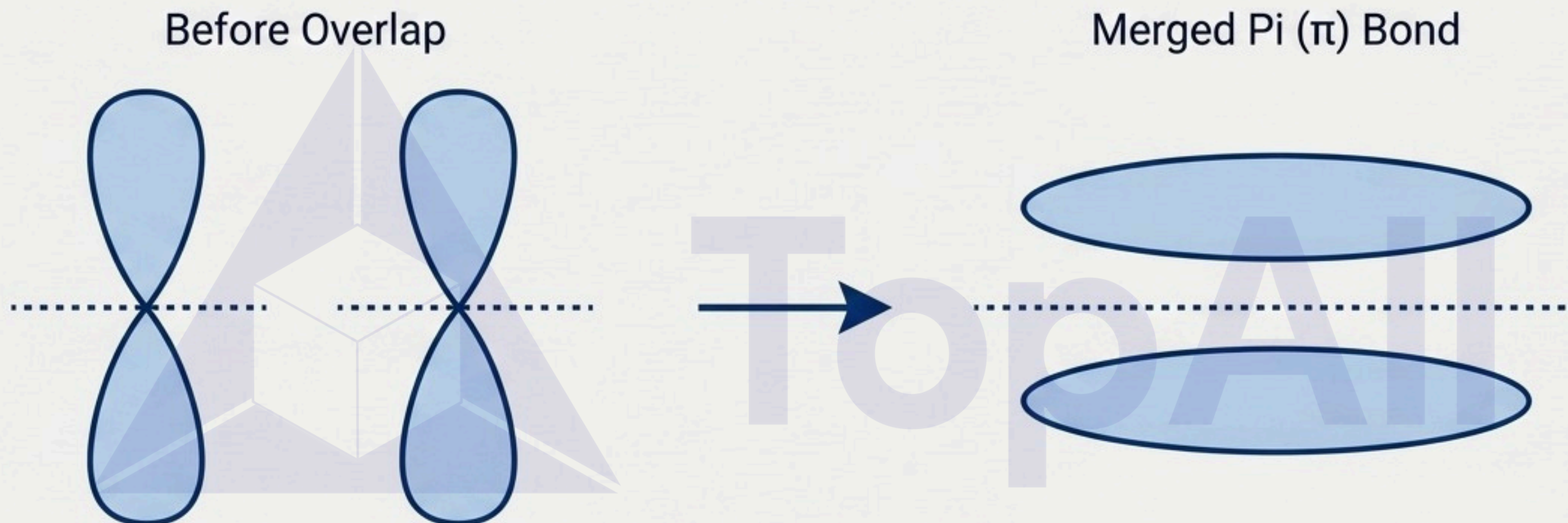
Parallel and Perpendicular



Saucer-Type Clouds. The sidewise overlapping produces two distinct saucer-type charged clouds located above and below the plane of the participating participating atoms.

Atomic orbitals overlap in such a way that their axes remain parallel to each other and perpendicular to the internuclear axis.

p-p Sidewise Overlap



Formed by the lateral (sidewise) overlap of half-filled p-orbitals. Overlapping occurs to a smaller extent than in a Sigma bond, making the Pi bond comparatively weaker.

Pi bonds are never solitary; they are formed in addition to a Sigma bond in molecules featuring double or or triple bonds.

Revision Frame: Sigma vs. Pi Bonds

Feature	Sigma (σ) Bond	Pi (π) Bond
Type of Overlap	Head-on / Axial	Sidewise / Lateral
Orientation	Along the internuclear axis	Perpendicular to the internuclear axis
Electron Cloud	Symmetrical around the bond axis	Two saucer clouds above and below the plane
Extent & Strength	Larger overlap / Stronger bond	Smaller overlap / Weaker bond
Orbital Types	s-s, s-p, p-p (axial)	p-p (sidewise)



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