

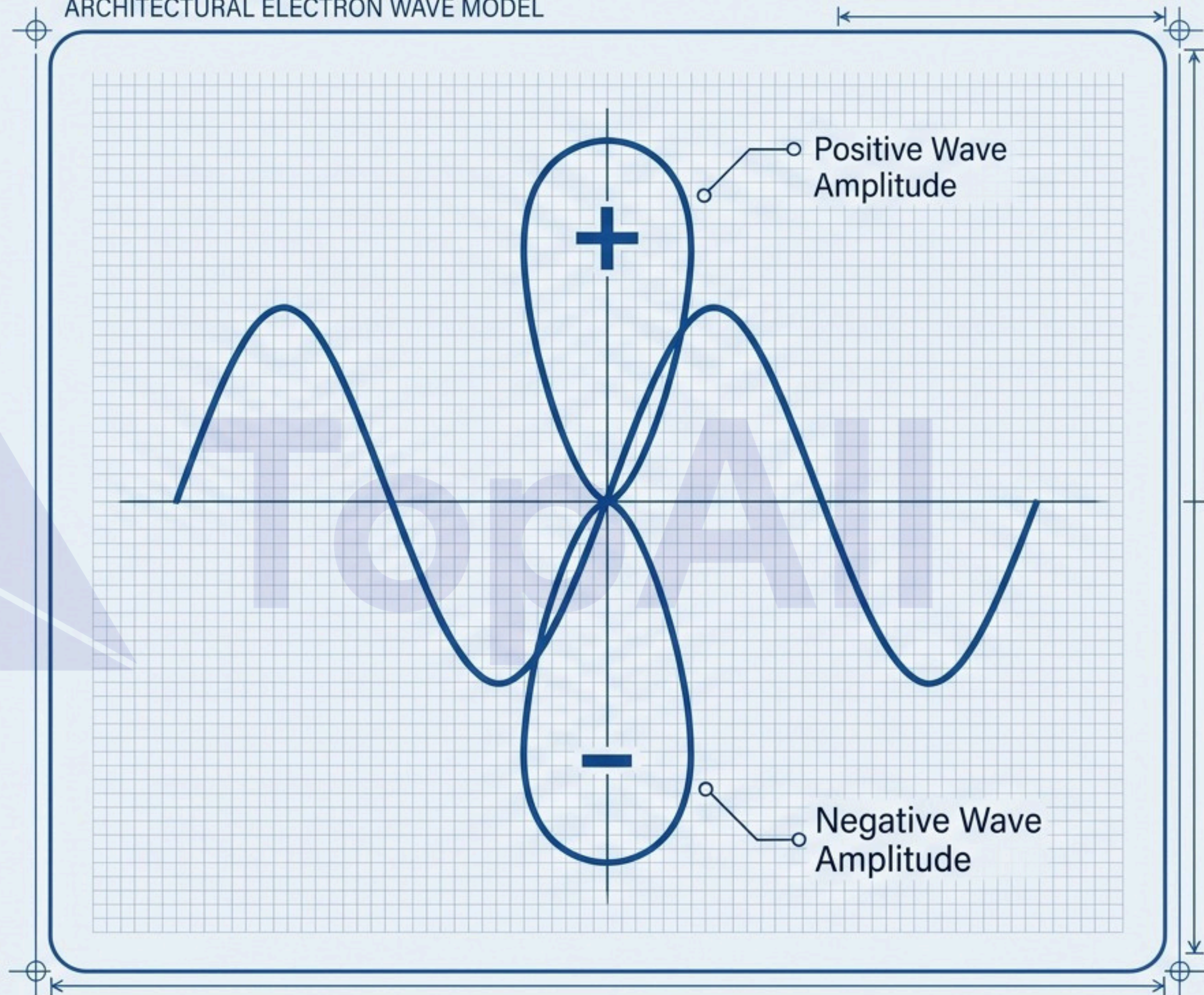
Orbitals are 3D Electron Waves

Covalent bonds are not formed by solid spheres touching.

According to the Orbital Overlap Concept, bonds form through the partial interpenetration of atomic orbitals.

To understand this, we must treat orbitals as precise wave functions (ψ), not physical objects.

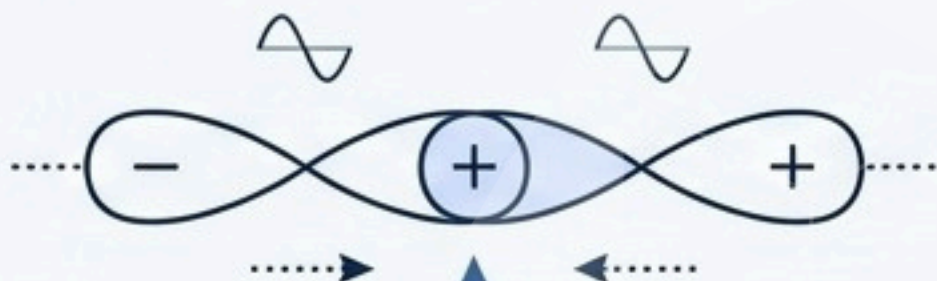
ARCHITECTURAL ELECTRON WAVE MODEL



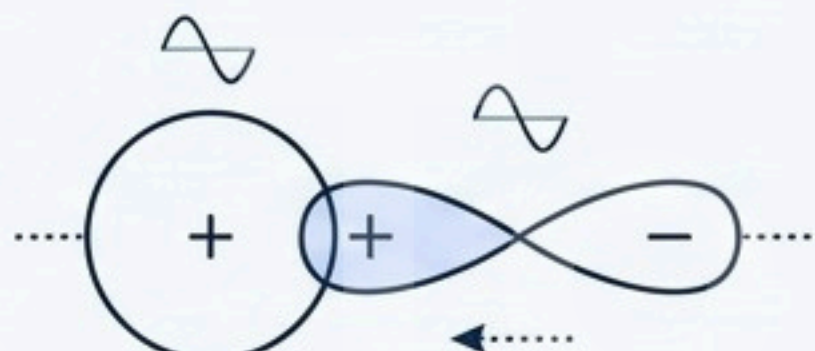
Positive Overlap: Constructive Interference

Bonding occurs when orbitals with the same phase and spatial orientation interpenetrate.

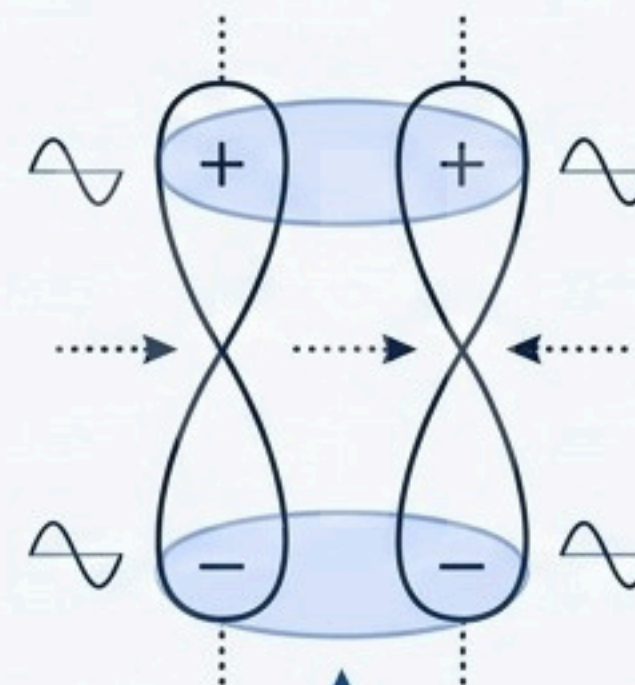
1 p-p axial



2 s-p axial



3 p-p sidewise

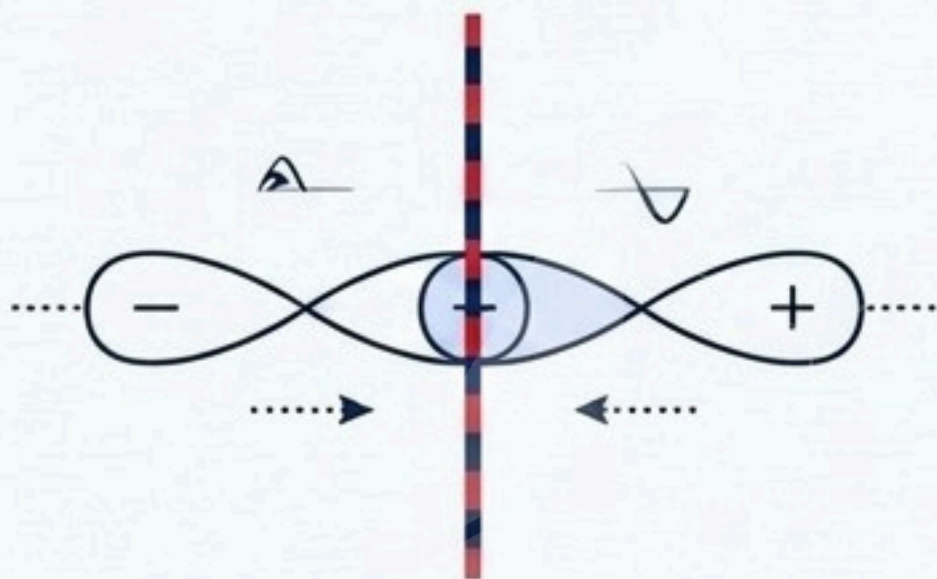


Constructive Interference $\rightarrow$ σ or π bond forms

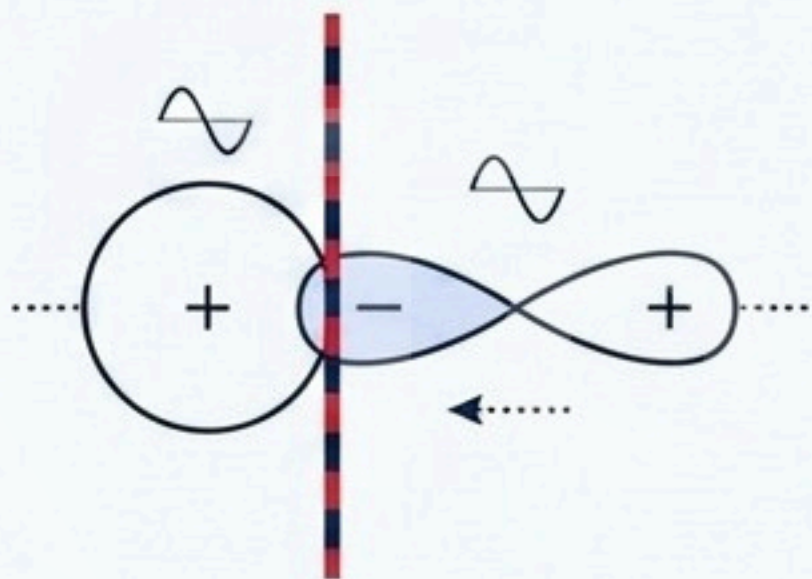
Negative Overlap: Destructive Interference

Bonds fail to form when opposite phases overlap, canceling the wave function.

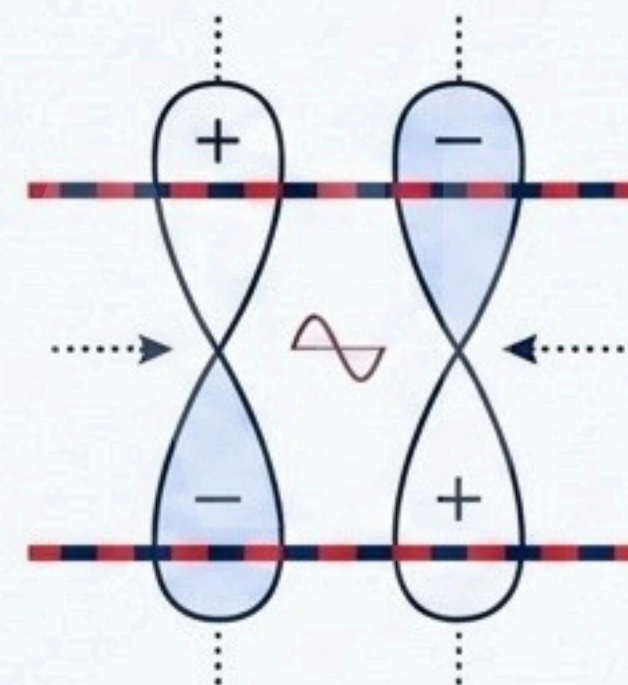
1 p-p axial



2 s-p axial



3 p-p sidewise



Wave Cancellation (Node) → Zero electron probability. No bond.



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$$E=mc^2$$



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Key Highlights

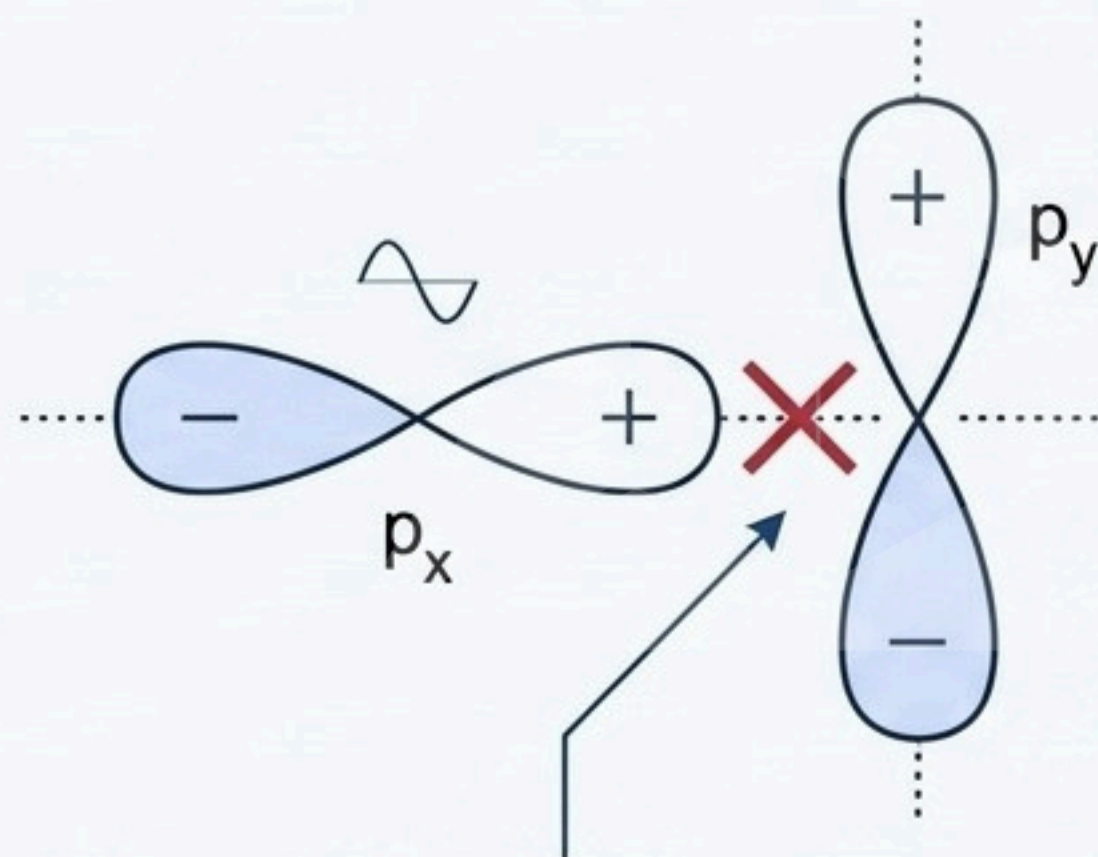
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Zero Overlap: Spatial Misalignment

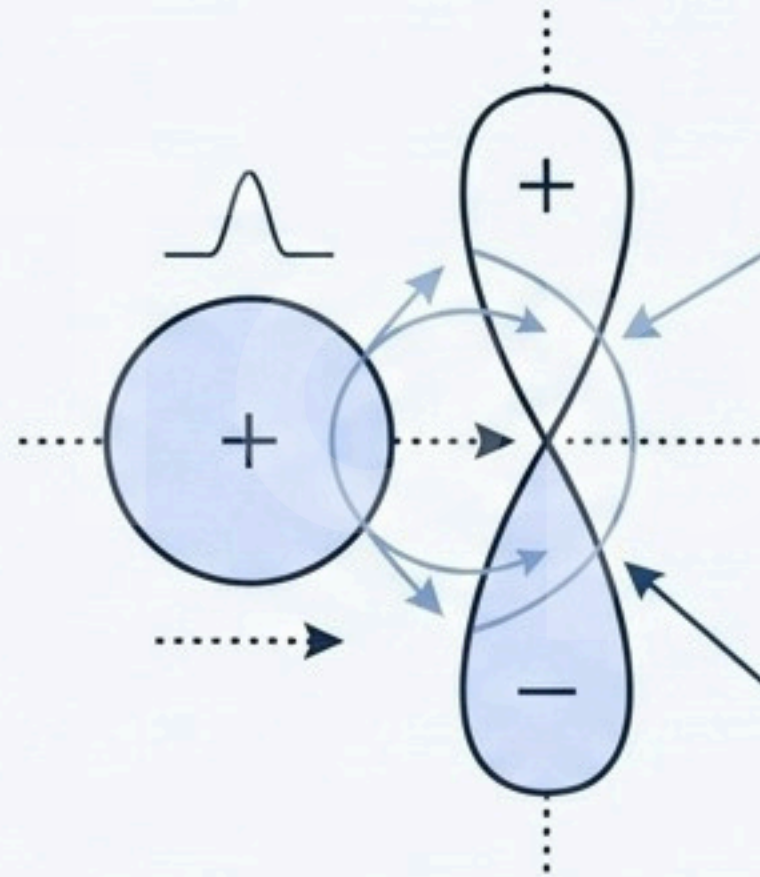
Net-zero interaction occurs when orbitals lack proper geometric orientation or symmetry.

Wrong Orientation



Orthogonal vectors cannot constructively interfere.

Symmetry Cancellation



Mathematical Mechanism:

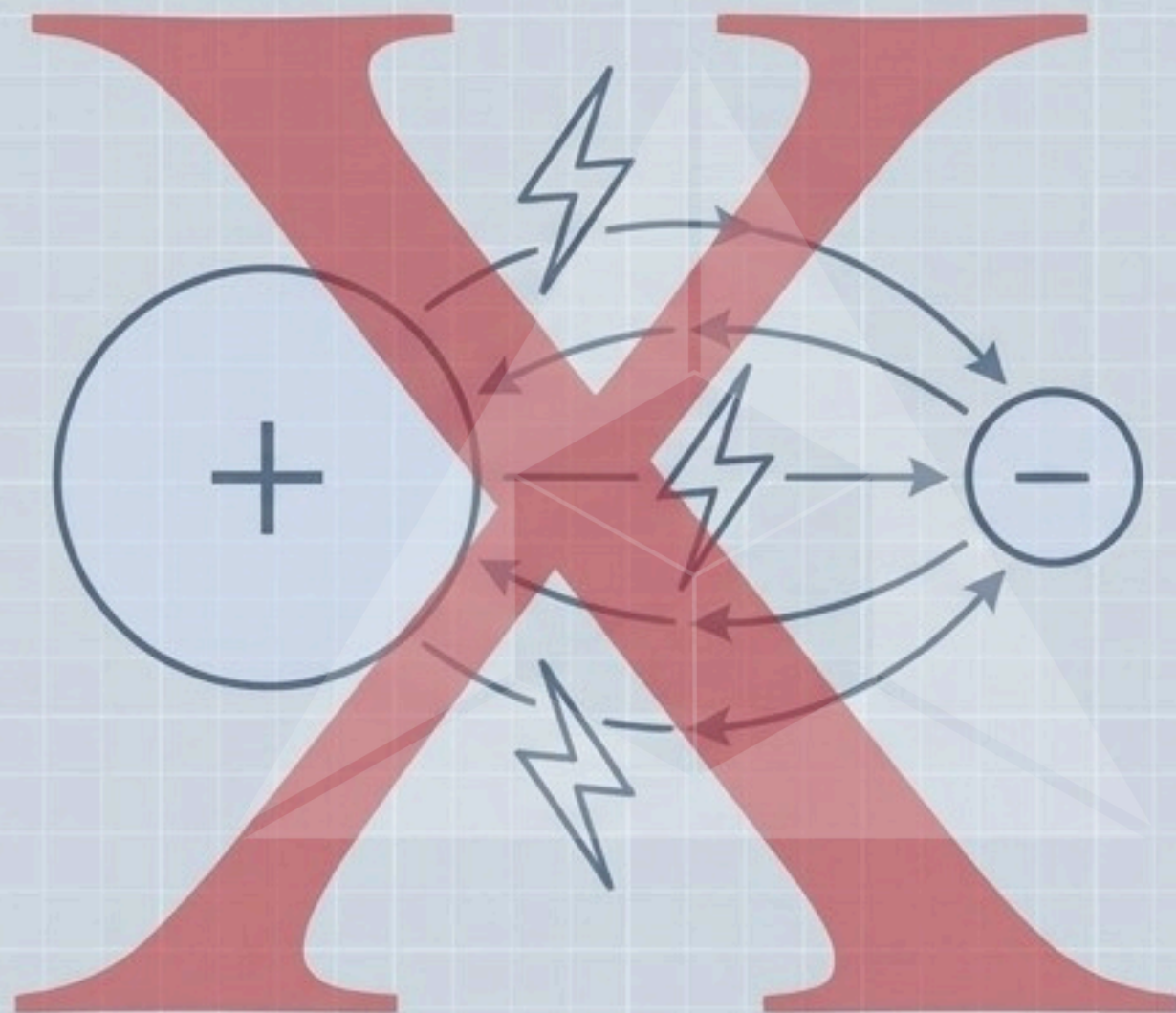
$+(s) + +(p) = \text{Bonding}$

$+(s) + -(p) = \text{Antibonding}$

Simultaneous constructive and destructive overlap results in a net-zero interaction.

The Critical Distinction: Phase vs. Charge

Classical Charge (Incorrect Model)



These signs do NOT represent electrostatic attraction or positive/negative electrical charges.

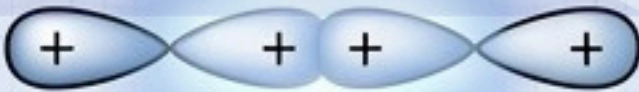
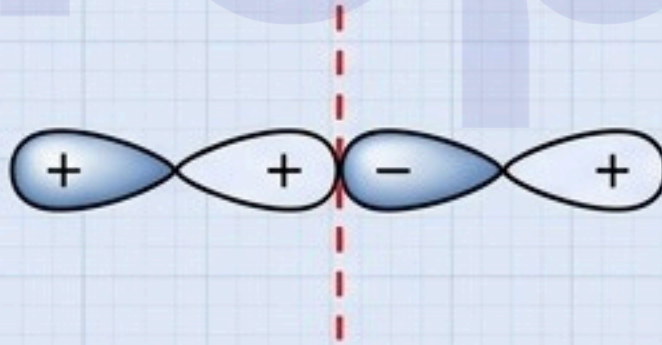
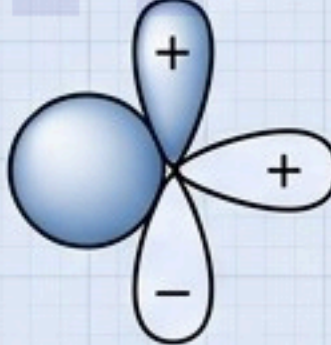
Quantum Phase (Correct Model)



The signs represent the mathematical sign of the orbital wave function's amplitude in space. They solely dictate whether approaching waves will amplify (bond) or cancel (node).

Orbital Overlap Diagnostics

The Wave Interference Matrix

	Positive Overlap	Negative Overlap	Zero Overlap
Phase Alignment	In-Phase	Out-of-Phase	Misaligned / Asymmetrical
Wave Result	Constructive Interference	Destructive Interference	Net-Zero Interference
Visual Signature			
Bond Status	σ or π Bond Forms	Anti-bonding Node (No Bond)	No Bond

Remember: Orbitals forming a bond must have the same sign (phase) AND proper spatial orientation.



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