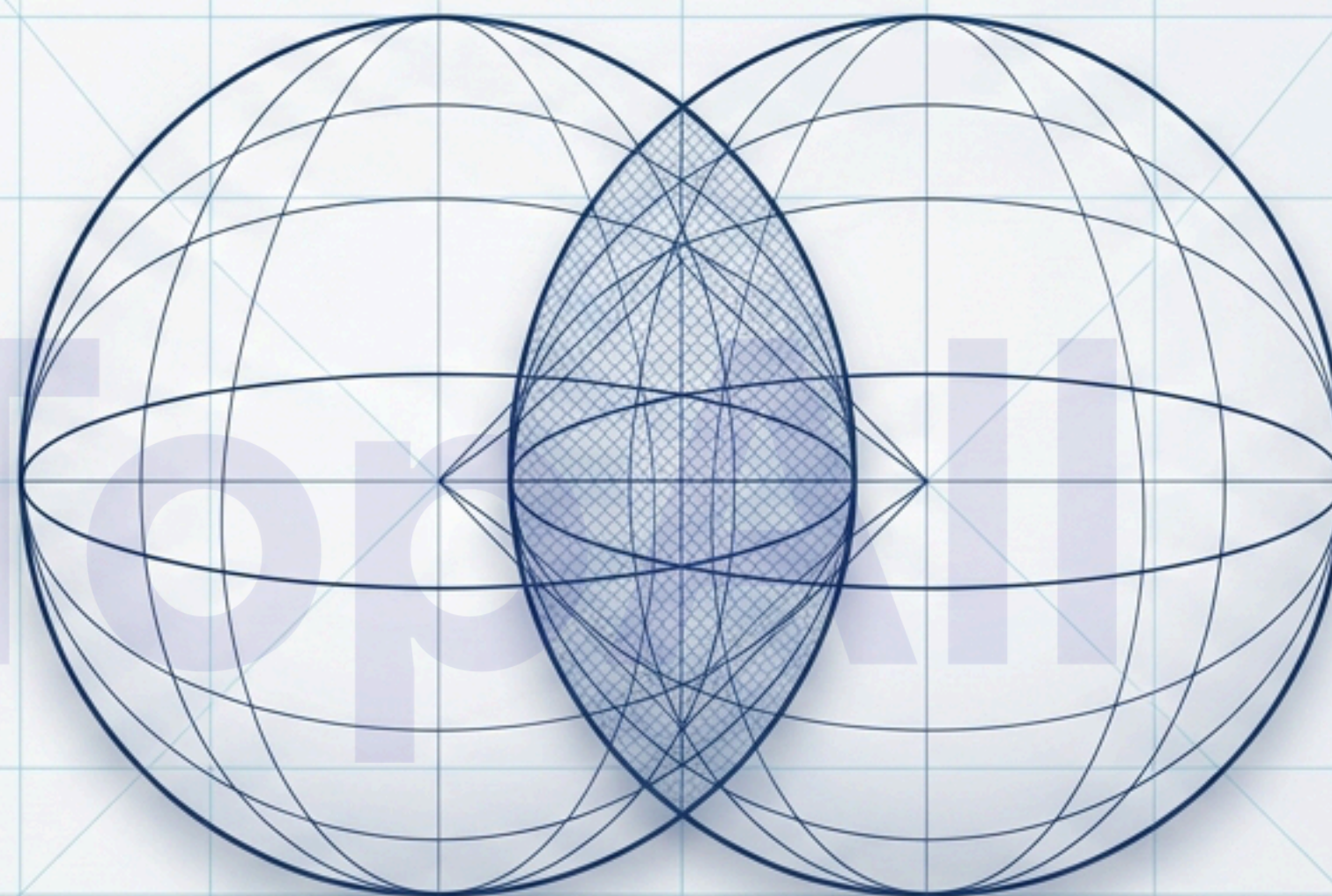


## UNIT 4: CHEMICAL BONDING



# 4.5.5 Strength of Sigma and Pi Bonds



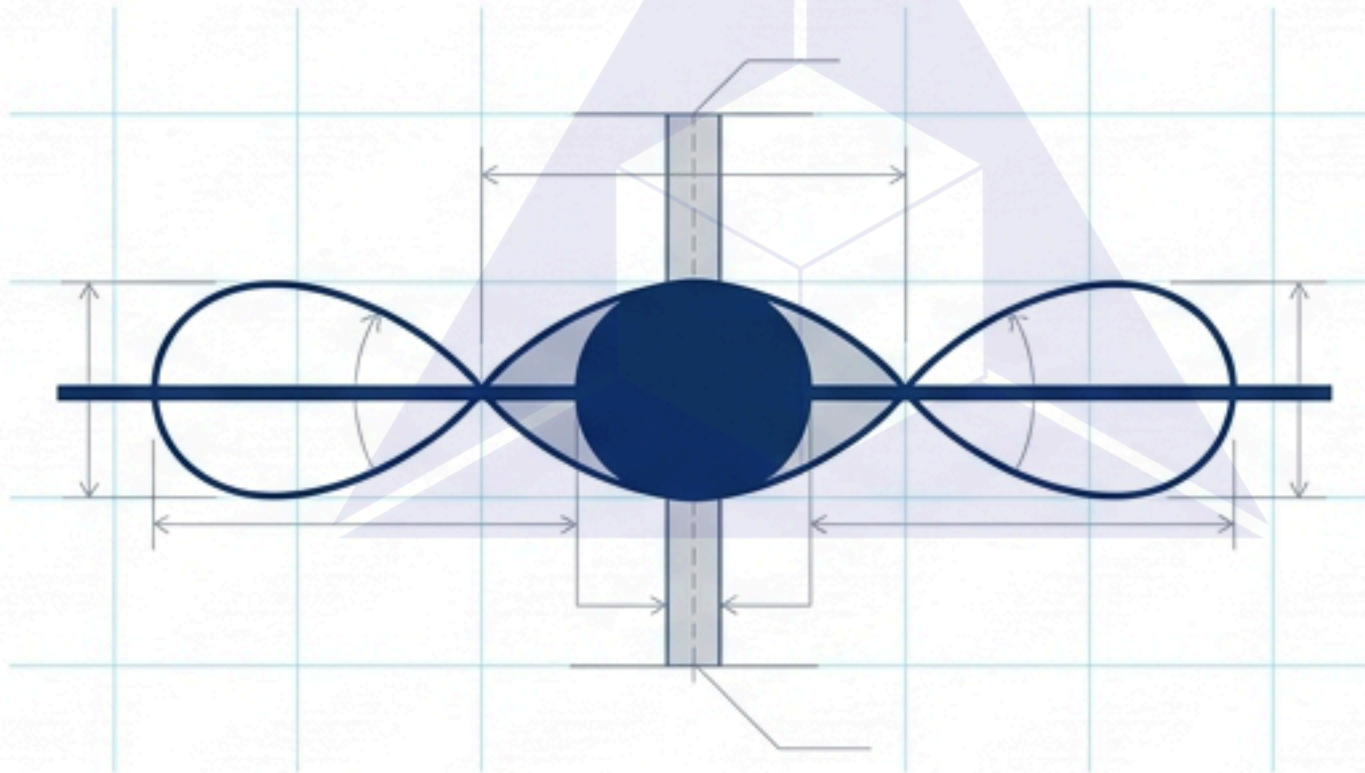
Valence Bond Theory

Orbital Overlap

# Why Sigma Bonds Are Stronger

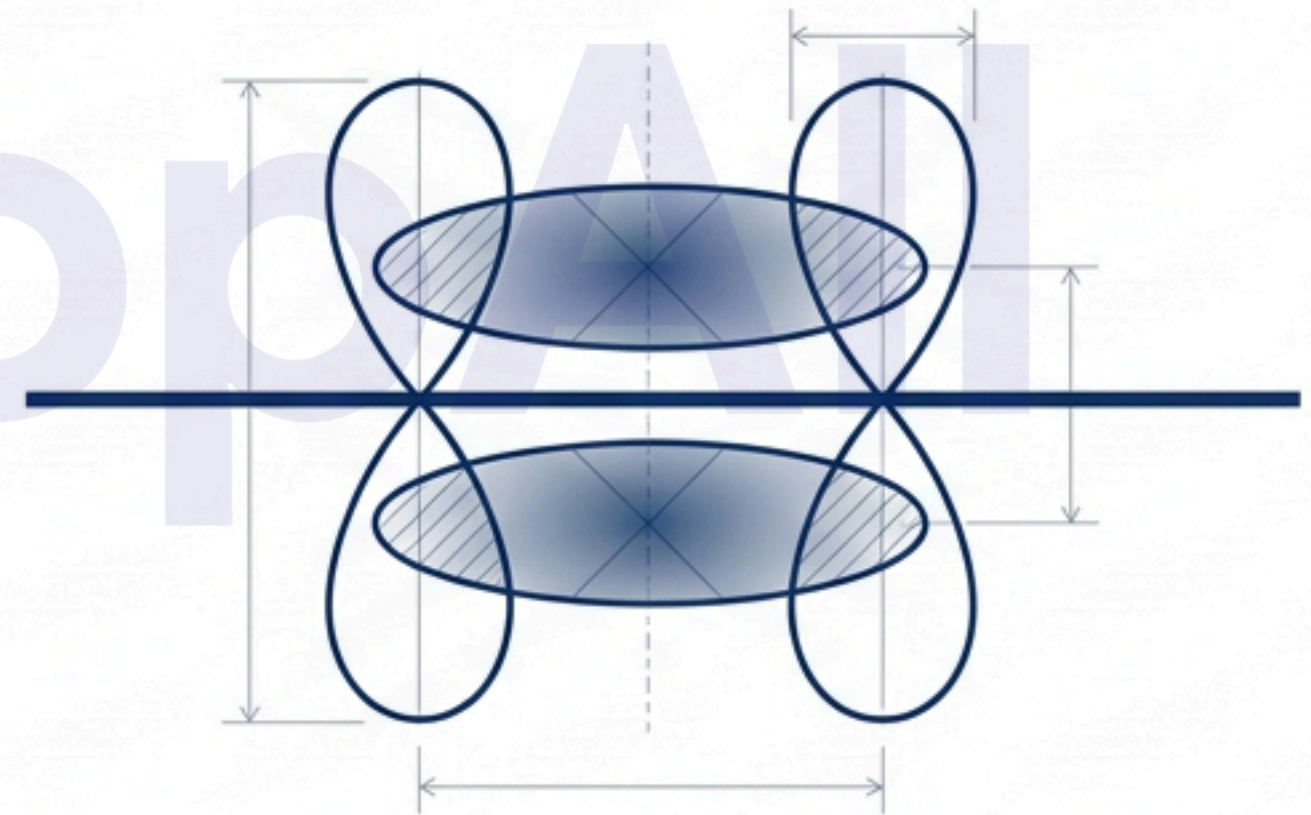
Orientation  $\rightarrow$  Extent of Overlap  $\rightarrow$  Bond Strength

$\sigma$  (Sigma)



Head-On / Axial Collision  $\rightarrow$  Deep penetration, maximum overlap.

$\pi$  (Pi)



Sidewise / Parallel Alignment  $\rightarrow$  Shallower intersection, dispersed electron cloud.

# Extent of Overlap Comparison

|                   | Sigma ( $\sigma$ ) Bond                            | Pi ( $\pi$ ) Bond                                     |
|-------------------|----------------------------------------------------|-------------------------------------------------------|
| Orientation       | <b>Axial (Head-on)</b> along the internuclear axis | <b>Parallel (Sidewise)</b> perpendicular to the axis  |
| Extent of Overlap | <b>Larger Extent</b> (deep penetration)            | <b>Smaller Extent</b> (shallow interaction)           |
| Relative Strength | <b>STRONGER</b>                                    | <b>WEAKER</b>                                         |
| Electron Cloud    | <b>Symmetrical</b> (cylindrical around the axis)   | <b>Dispersed</b> (saucer-type clouds above and below) |



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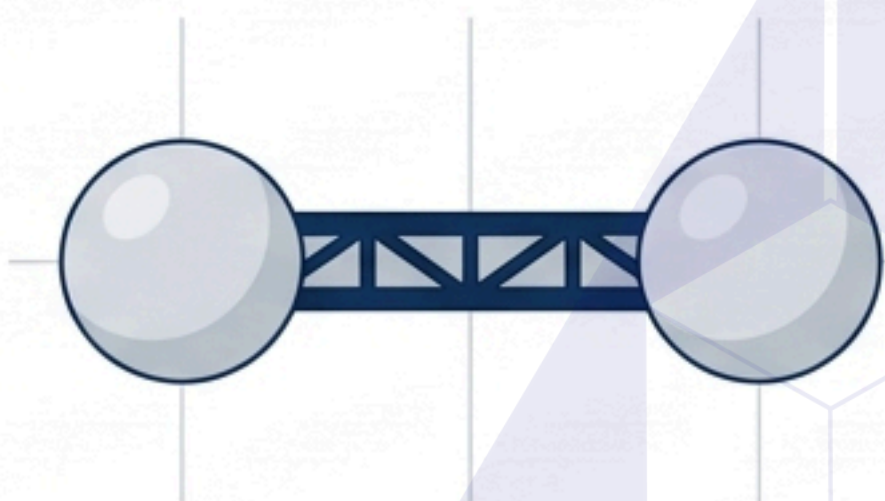
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# Sigma as the Backbone of Multiple Bonds

Single Bond



$1\sigma$

The foundational structure.  
Always forms first.

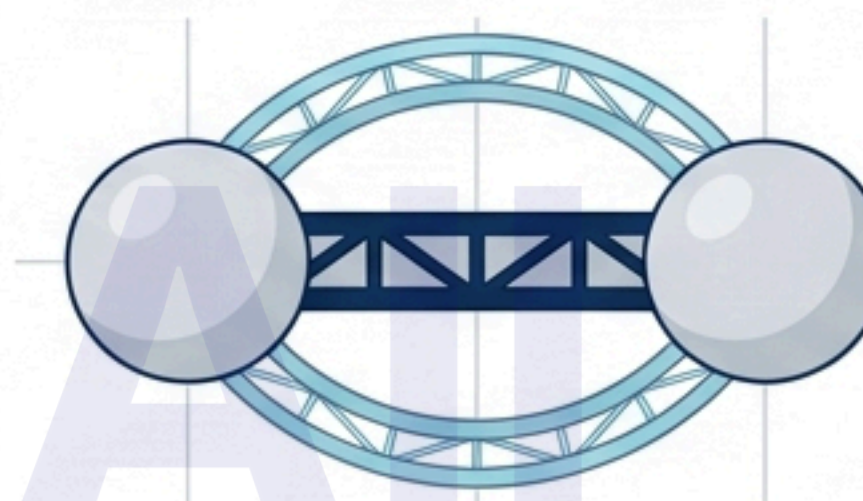
Double Bond



$1\sigma + 1\pi$

Pi bonds are only formed *in addition* to an existing sigma bond.

Triple Bond



$1\sigma + 2\pi$

Maximum structural reinforcement.

Because  $\sigma$  is stronger and lies on the internuclear axis, it forms the permanent skeletal backbone of the molecule.

# The Law of Orbital Overlap

**GREATER OVERLAP = STRONGER BOND**

“Basically the strength of a bond depends upon the extent of overlapping. In case of sigma bond, the overlapping of orbitals takes place to a larger extent.”

Section 4.5.5

$\sigma$  overlapping  $>$   $\pi$  overlapping  $\rightarrow$   $\sigma$  bond is stronger than  $\pi$  bond



# You've Learned the Theory.

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