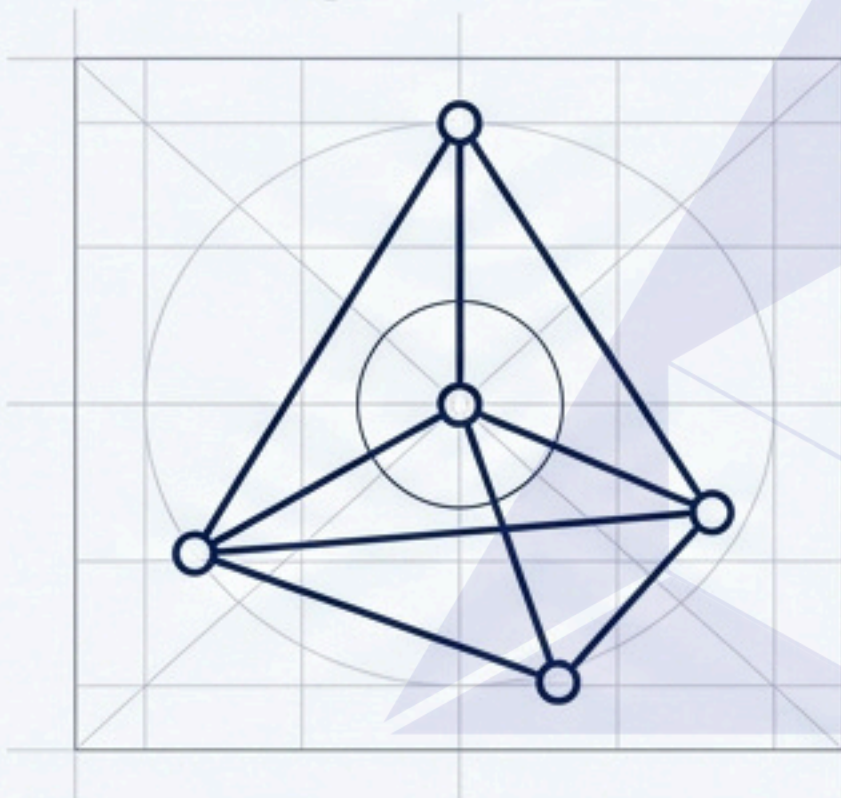


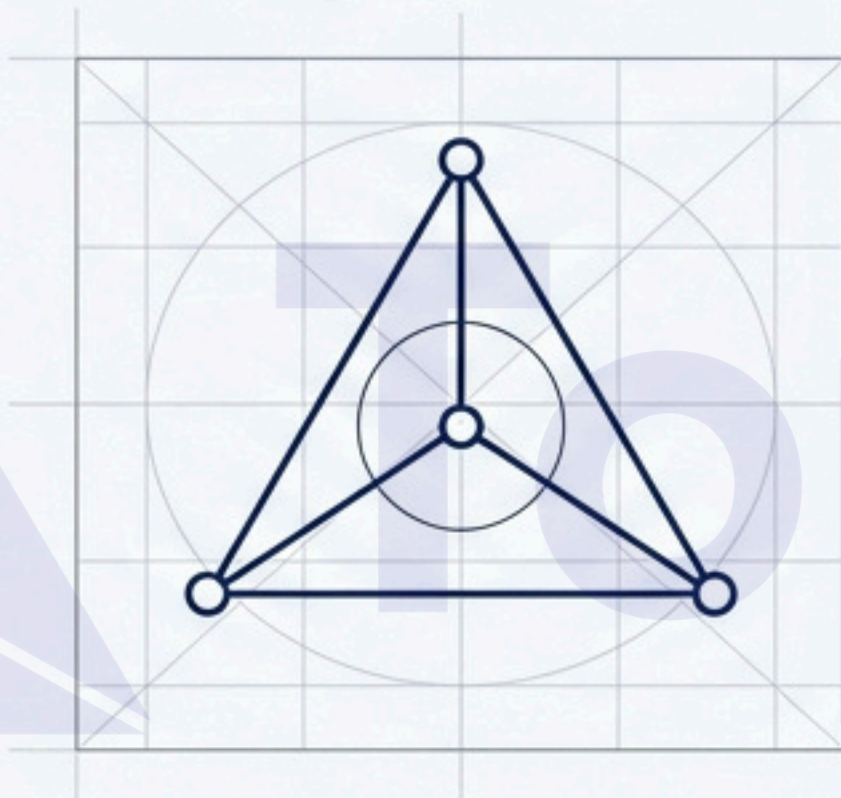
The Architectural Frameworks of Organic Chemistry

The sp^3 Framework



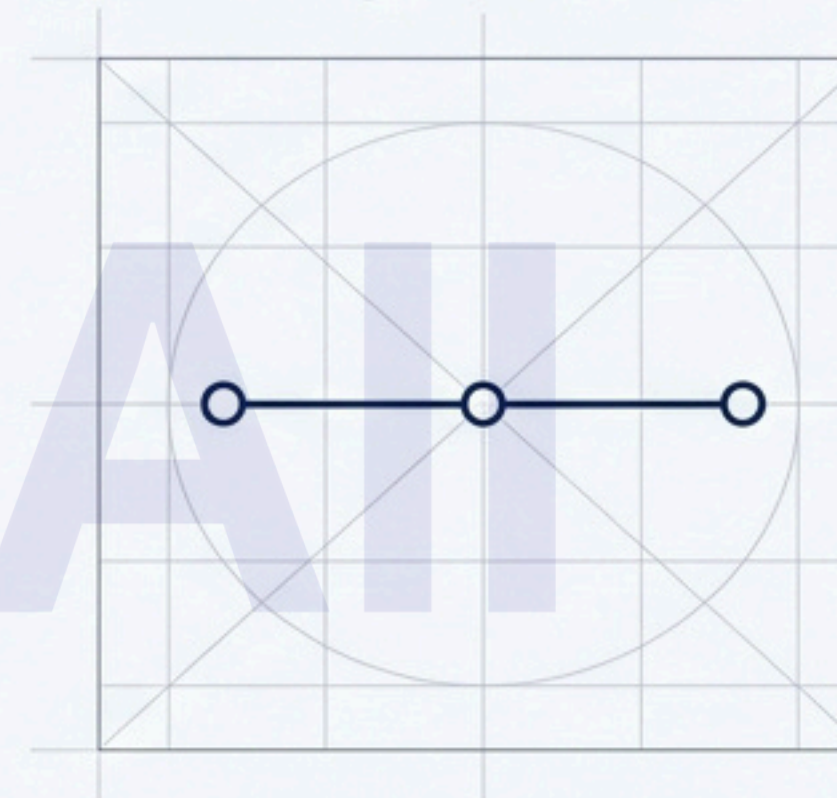
Single Bonds (Saturated)

The sp^2 Framework



Double Bonds (Unsaturated)

The sp Framework



Triple Bonds (Unsaturated)

Hybridization is the mathematical mixing of atomic orbitals to form new, directional hybrid orbitals. The resulting geometry dictates the molecule's physical and chemical reality.

Methane (CH₄) & The sp³ Blueprint

Tetrahedral

109.5°

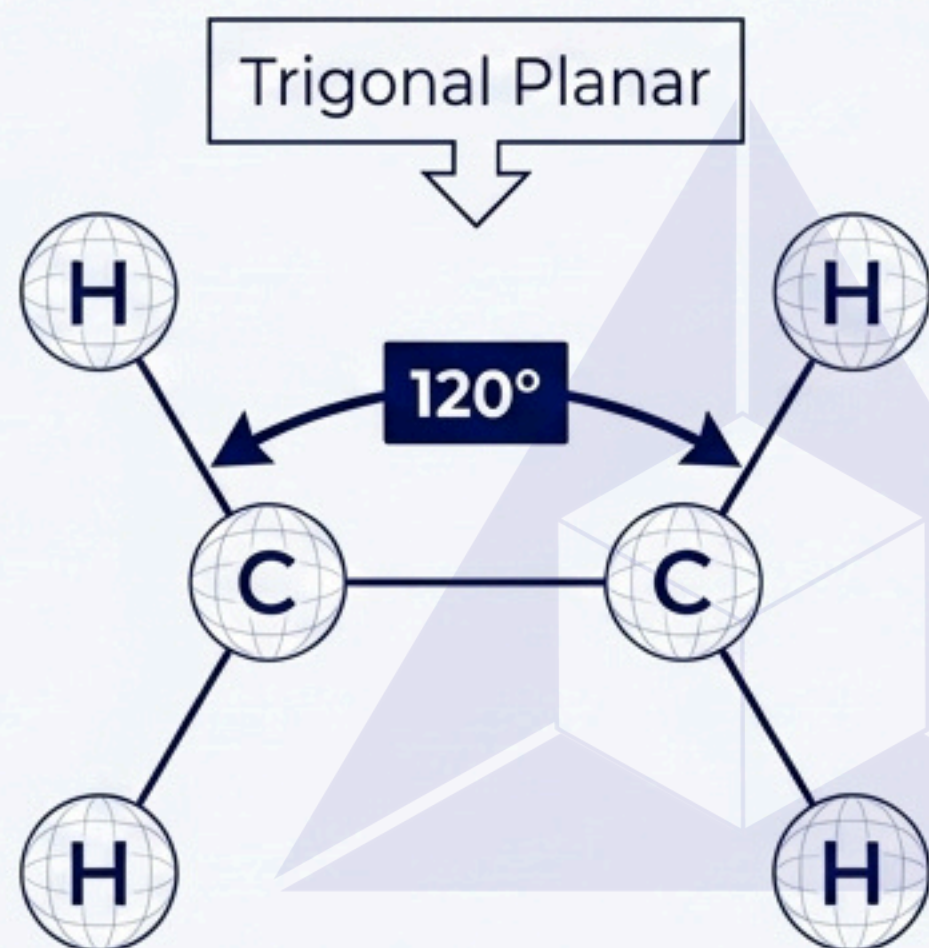
Bond Profile Matrix

• Bonds per Carbon:	4
• Bond Types:	4 identical σ (sigma) bonds
• π (pi) bonds:	0

Key Insight

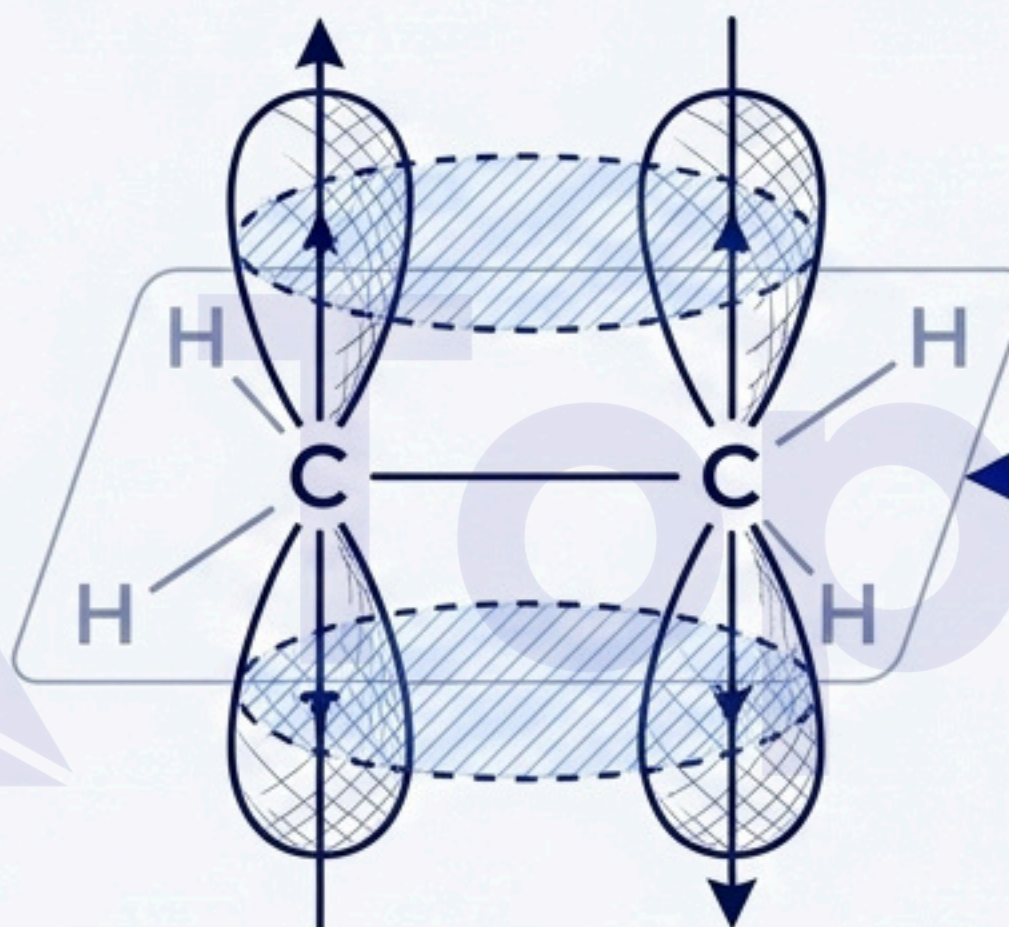
In an sp³ hybridized carbon, all four valence electrons are utilized in forming strong, directional σ bonds. This creates a fully saturated, stable 3D framework with maximum spatial separation between electron pairs.

Ethene (C_2H_4) & The sp^2 Blueprint



Bond Profile

- Bonds per Carbon: 3 σ bonds, 1 π bond.



The π Bond:

Formed by the lateral overlap of unhybridized p-orbitals. It sits above and below the planar σ framework, locking the molecule into a flat, rigid geometry.



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$$E=mc^2$$



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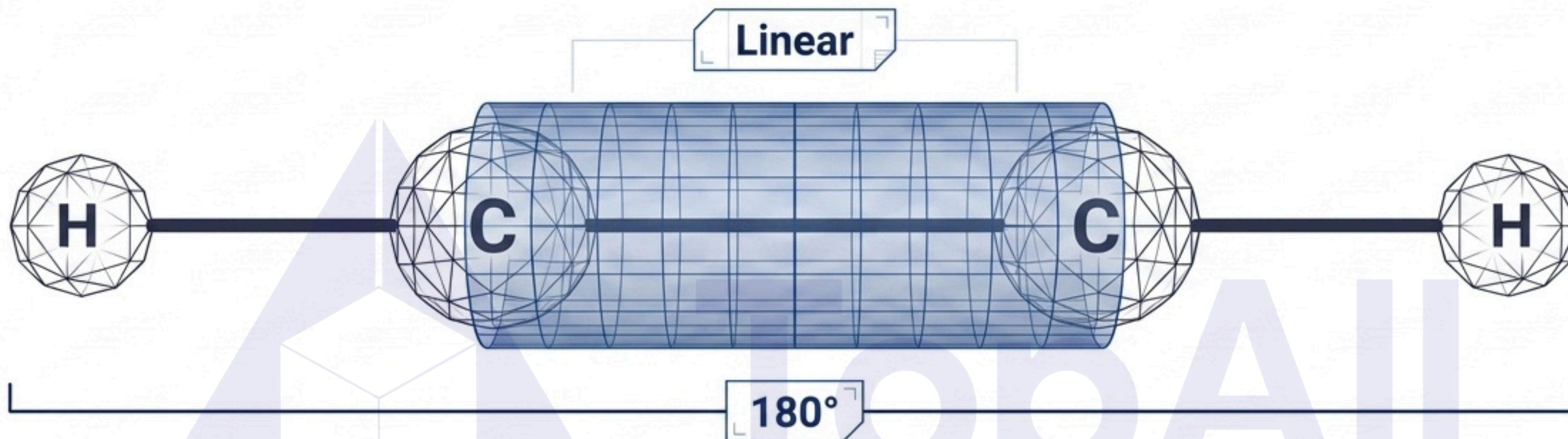
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Ethyne (C_2H_2) & The sp Blueprint



Bond Profile Matrix

- **Bonds per Carbon:** 2 σ bonds, 2 π bonds.

Key Insight

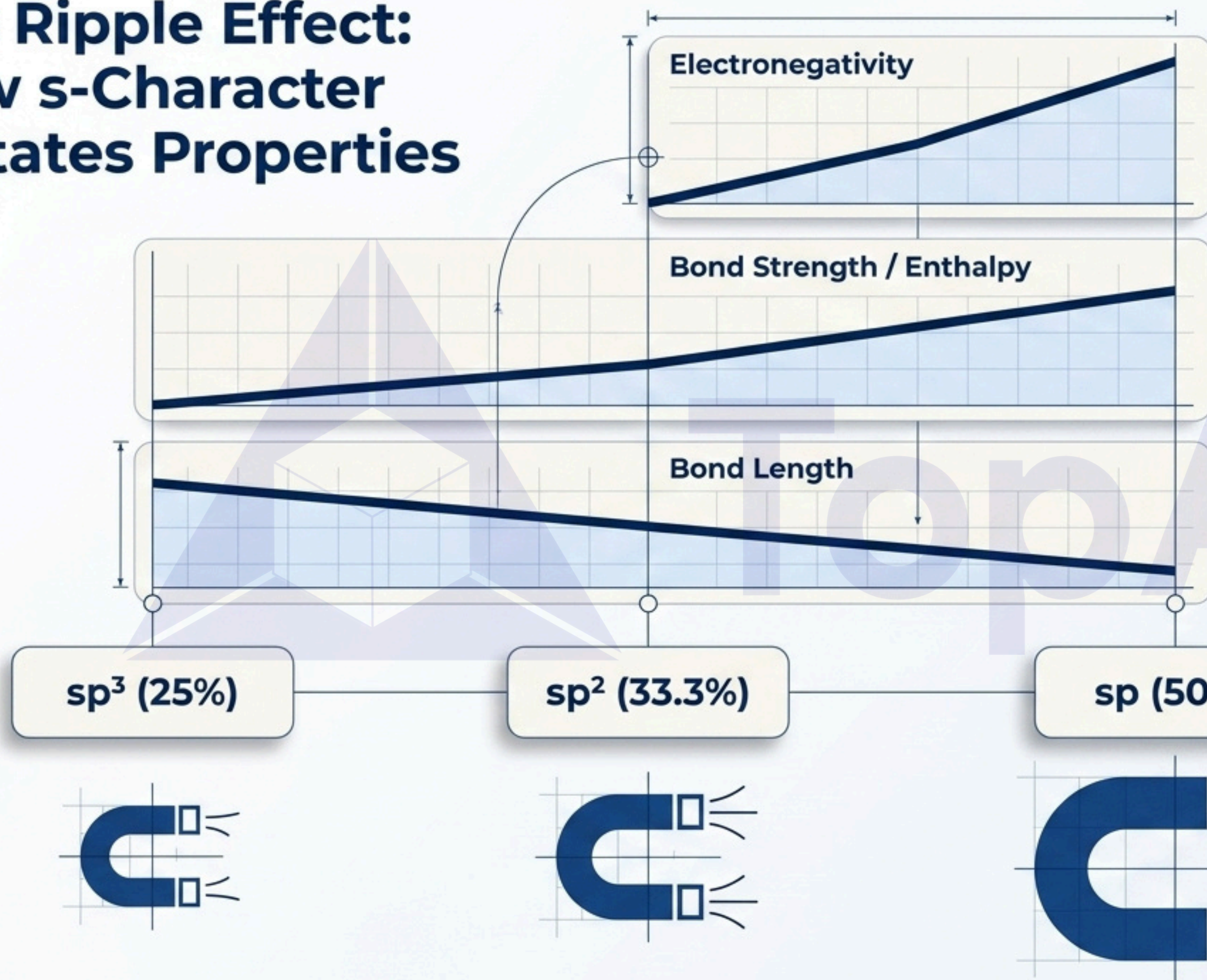
Two unhybridized p-orbitals on each carbon overlap mutually. This creates two distinct π bonds perpendicular to each other, merging into a continuous cylinder of electron density around the inter-nuclear axis.

The Master Variable: Percentage s-Character



What does s-character mean? 's' orbitals are spherical and sit closer to the atomic nucleus than highly directional 'p' orbitals. As s-character increases, the hybrid orbital becomes bulkier, rounder, and closer to the positively charged carbon nucleus.

The Ripple Effect: How s-Character Dictates Properties



Higher s-character means electrons are held tighter by the nucleus. Therefore, an sp carbon is highly electronegative compared to an sp^3 carbon.

Greater nuclear pull and π bond reinforcements require more energy to break.

Tighter orbital pull physically shortens the inter-nuclear distance (C-C single > C=C double > C $\equiv$ C triple).

Master Diagnostic Matrix: Carbon Hybridization



Property	sp^3 (Alkane)	sp^2 (Alkene)	sp (Alkyne)
3D Geometry	Tetrahedral	Trigonal Planar	Linear
Bond Angle	109.5°	120°	180°
$\sigma : \pi$ bonds (per C)	4 : 0	3 : 1	2 : 2
% s-Character	25%	33.3%	50%
Electronegativity	Lowest	Intermediate	Highest
C-C Bond Length	Longest	Intermediate	Shortest





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