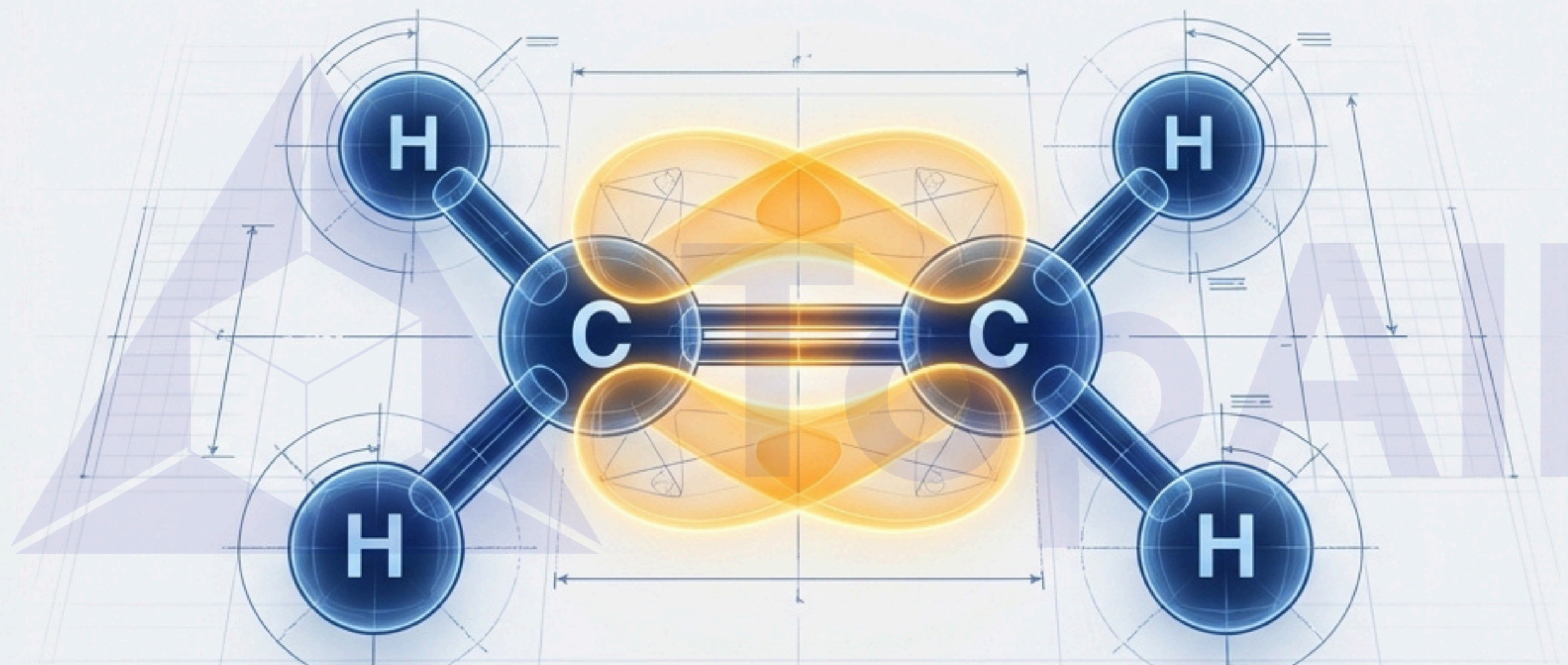


Structure of Double Bond in Alkenes



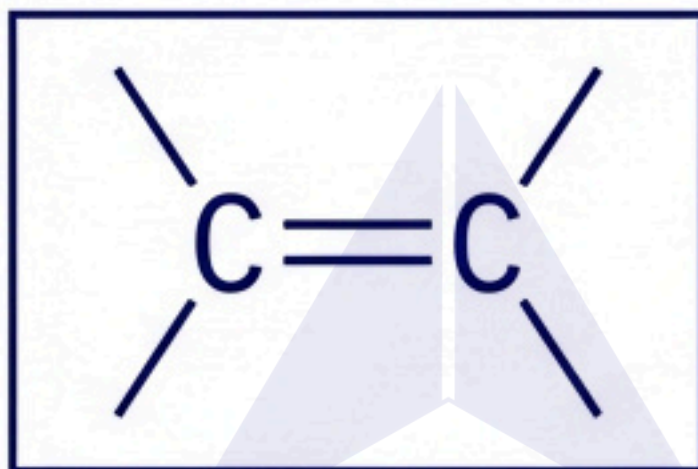
[Exam-Smart Summary]

[Orbital Mechanisms]

[Reactivity Profiles]

A self-guided visual study module.

The Dual Nature of the Double Bond



One Sigma (σ) Bond

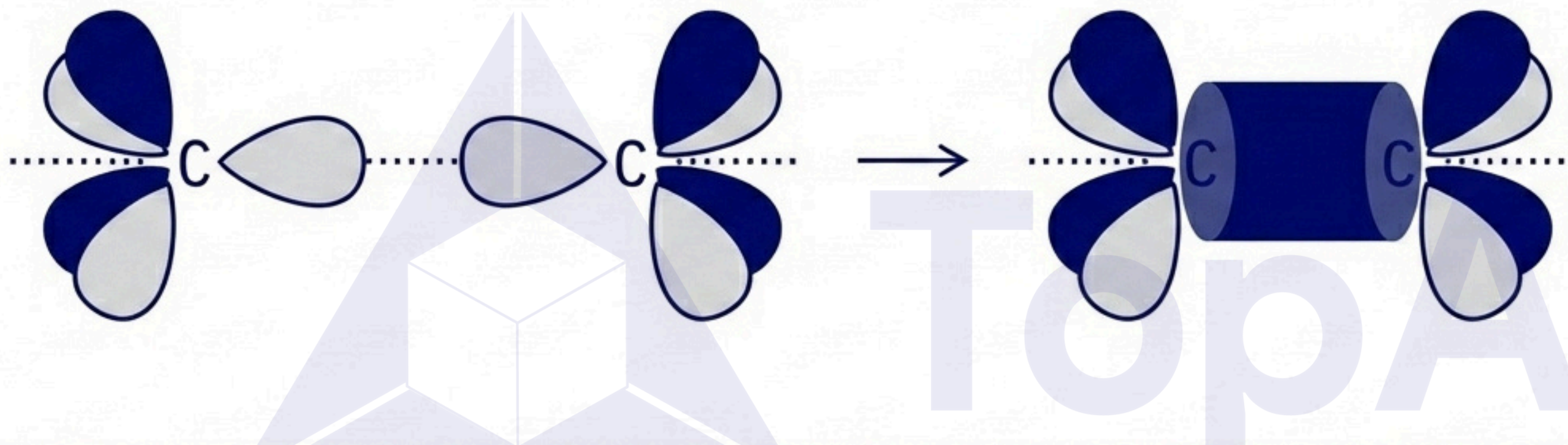
The strong, foundational framework holding the carbon atoms together.

One Pi (π) Bond

The weaker, exposed electron cloud that dictates chemical reactivity.

A double bond is never just two identical single bonds. It is a combination of two fundamentally different types of orbital overlaps.

Head-On Overlap: The Sigma (σ) Bond



Bond Enthalpy:
 $\sim 397 \text{ kJ mol}^{-1}$

Mechanism

Formed by the direct, head-on overlapping of sp^2 hybrid orbitals.

Properties

Because the overlap is deep and directly between the atomic nuclei, this bond is incredibly strong. It forms the rigid, planar geometry of the molecule.



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$$E=mc^2$$



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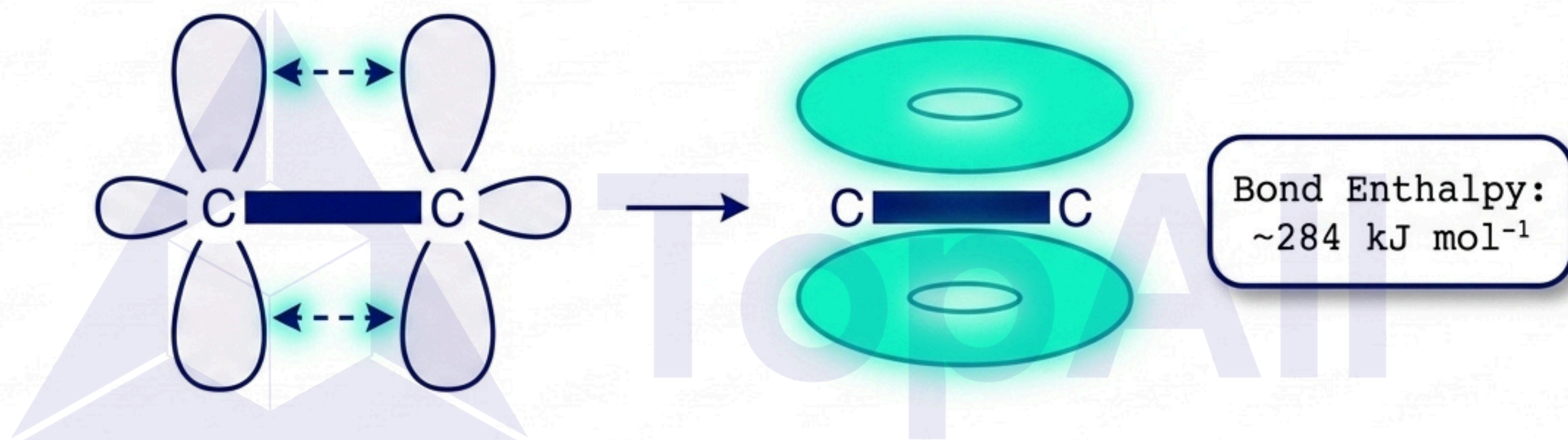
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STEP 2: THE CLOUD

Sideways Overlap: The Pi (π) Bond



Mechanism

Formed by the **lateral (sideways)** overlap of **unhybridized 2p** orbitals.

Properties

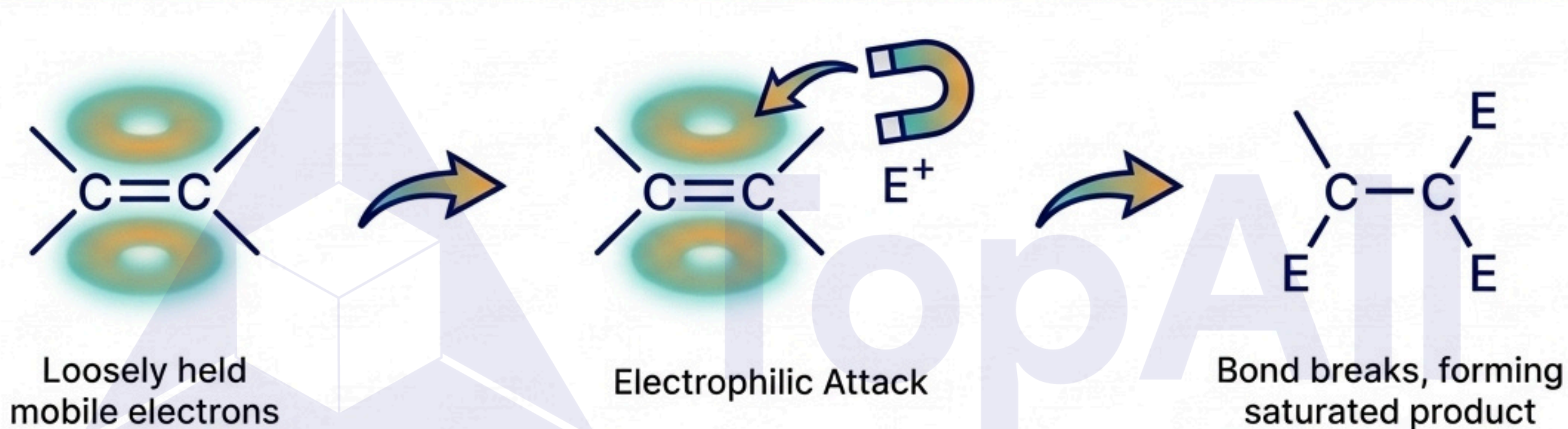
Because the overlap is poor compared to a head-on collision, the π **bond is significantly weaker** than the σ bond.

Double vs. Single Bonds

Property	Ethane (C–C)	Ethene (C=C)
Composition	1 σ	1 σ + 1 π
Bond Length	154 pm	134 pm
Total Enthalpy	348 kJ mol ⁻¹	681 kJ mol ⁻¹

The double bond is shorter (atoms are pulled tighter together) and stronger overall (681 > 348). However, the additional π bond (284) is weaker than a standard single σ bond (348).

The Vulnerability of the Pi Bond



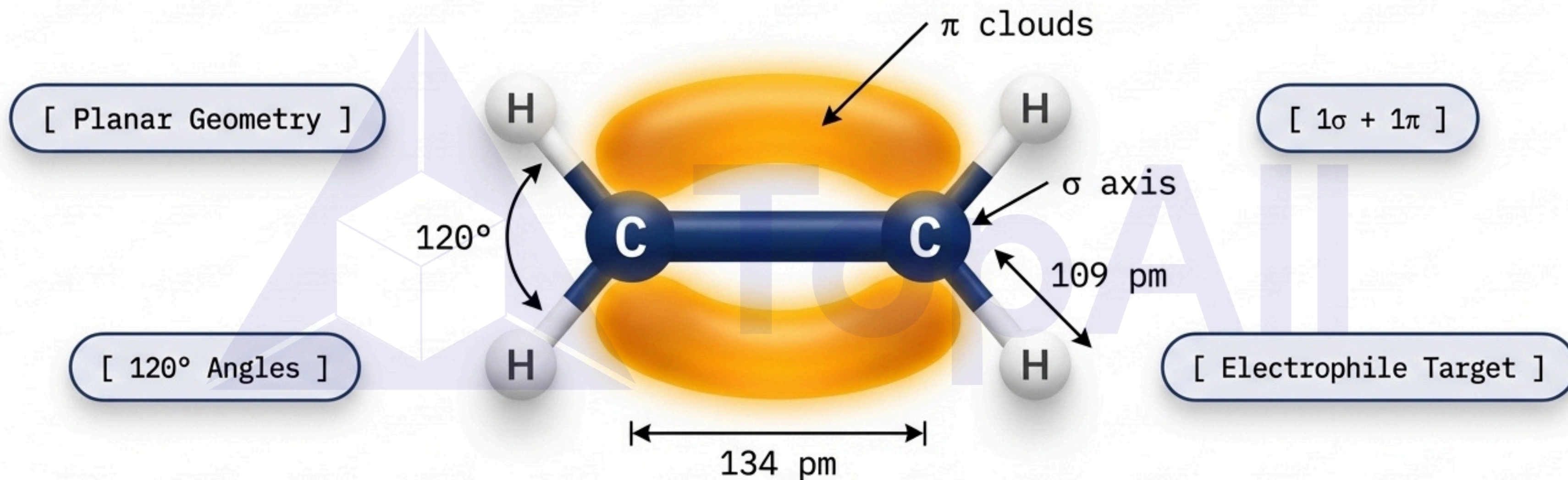
Exposed Electrons

π electrons sit above and below the carbon nuclei, leaving them exposed and highly mobile.

Electrophilic Reagents

Molecules in search of electrons easily break the weak π bond, which is why alkenes readily undergo addition reactions while alkanes do not.

Ethene (C_2H_4): The Complete Picture



Memorize this blueprint. The rigid geometry restricts rotation, while the exposed π -cloud dictates the molecule's signature chemical reactivity.



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