The Wittig Reaction: Substitution of =O by =C

\[
\begin{align*}
\text{Ph} & \quad \text{Ph}_3P\cdot\cdot\cdot \text{CH}_2 \\
\text{Ph} & \quad \text{Ph}_3P\RightarrowCH_2 \\
\text{(carbon nucleophile)} & \quad \text{a phosphonium ylide}
\end{align*}
\]

This net substitution proceeds by an addition-elimination sequence.

Phosphonium ylides (powerful nucleophiles) add to aldehyde or ketone carbonyl groups via normal \([\text{Ad}_N]\). This tetrahedral intermediate, a betaine, (BAY-tah-een) has no leaving group, yet it’s not stable. Because phosphorous has a high affinity for oxygen, the oxyanion attacks the positively charged P via \([\text{A}_N]\) to make a 4-membered ring (called a phosphaoxetane). This strained phosphaoxetane reacts further to split into \(\text{Ph}_3P=O\) and an alkene. This elimination is a little funky, but you should be able to draw a reasonable set of curved arrows (and identify the frontier orbitals).
Formation of Ylides

\[
\text{Ph}_3\text{P} + \text{CH}_3\text{I} \xrightarrow{[S_N2]} \text{Ph}_3\text{P} = \text{C} = \text{H} \quad \text{I}^-\quad \text{methyltriphenylphosphonium iodide}
\]

\[
\text{Ph}_3\text{P} - \text{CH}_2^- + \text{LiI} \quad \text{butane}
\]

\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \quad \text{butyllithium (strong base)}
\]

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