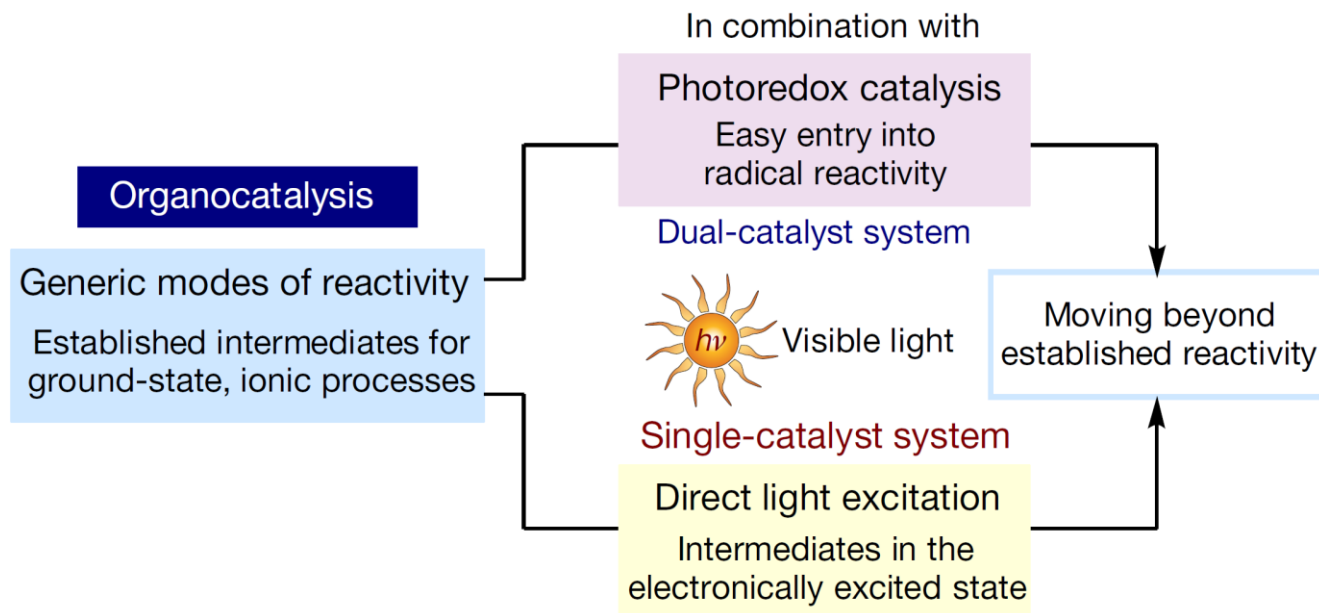


Enhancing the potential of enantioselective organocatalysis with light



Reporter: Xin-Hang Jiang

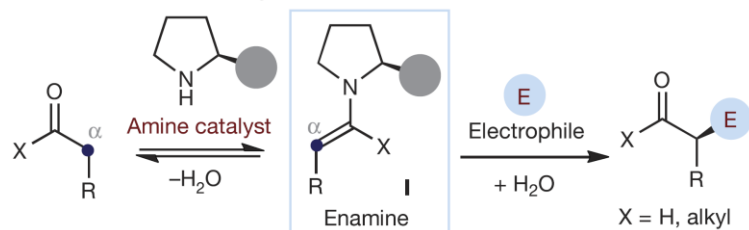
Supervisor: Prof. Yong Huang

Date: 2018. 03. 19

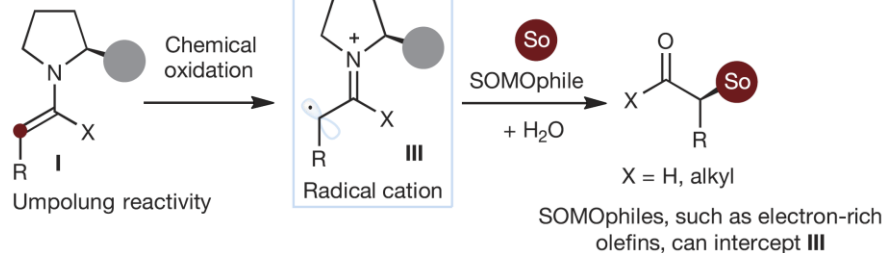
1. Generic mechanisms of organocatalytic reactivity

— Covalent-based modes of activation

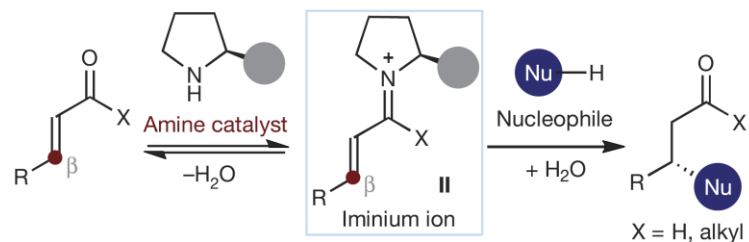
Enamine-mediated catalysis



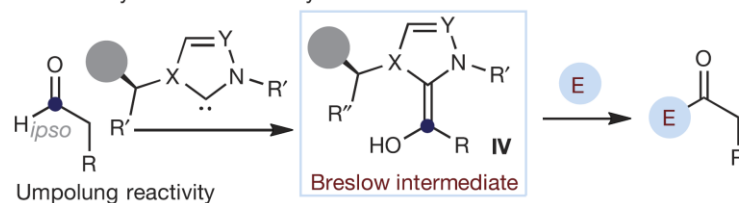
SOMO activation



Iminium-ion-mediated catalysis



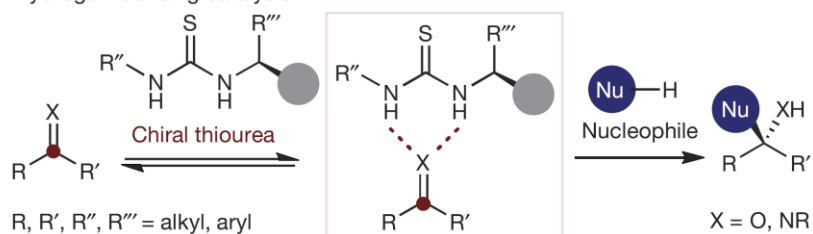
N-heterocyclic-carbene catalysis



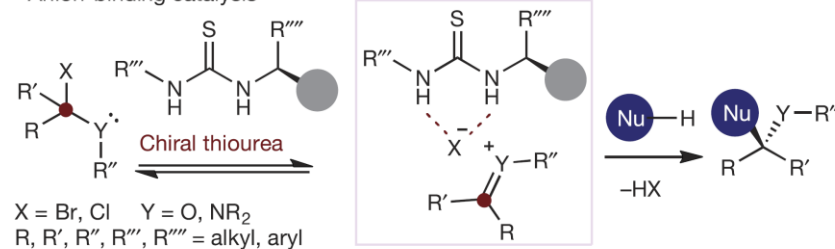
1. Generic mechanisms of organocatalytic reactivity

—Non-covalent approaches

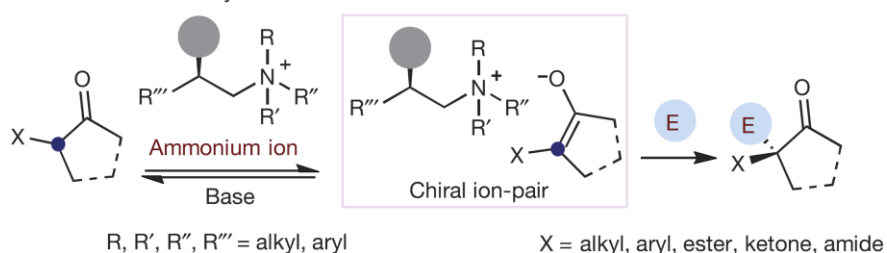
Hydrogen-bonding catalysis



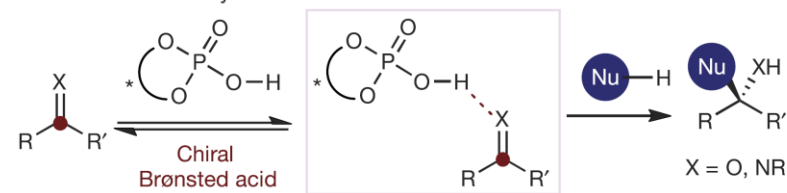
Anion-binding catalysis



Phase-transfer catalysis



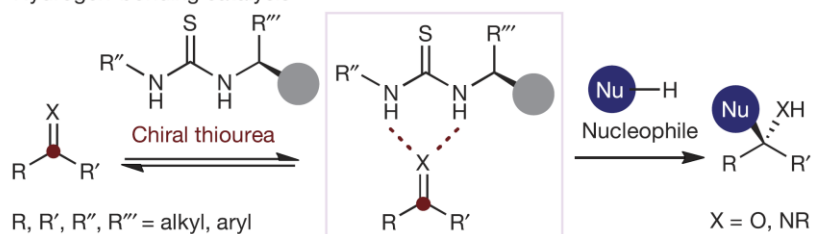
Brønsted acid catalysis



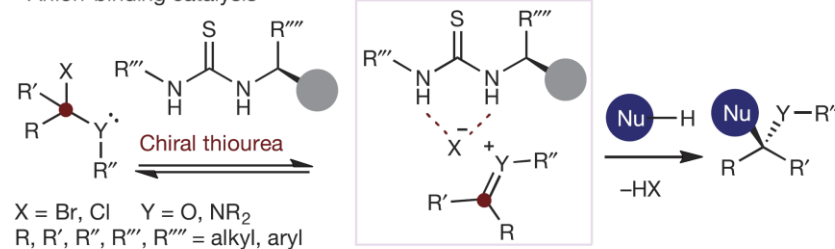
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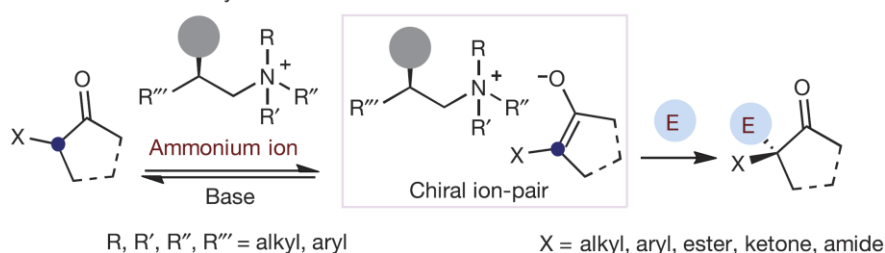
Hydrogen-bonding catalysis



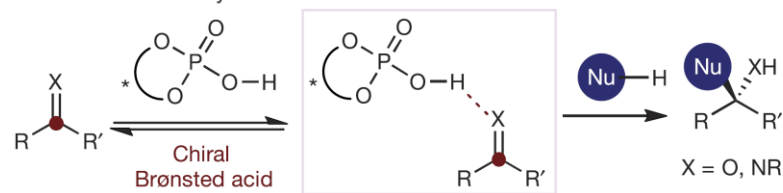
Anion-binding catalysis



Phase-transfer catalysis



Brønsted acid catalysis

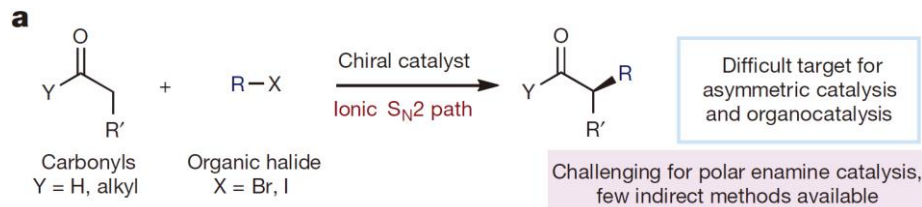


How to further expand the synthetic potential of organocatalysis?

1. Silvi, M. and Melchiorre, P. *Nature* **2018**, 554, 41–49.

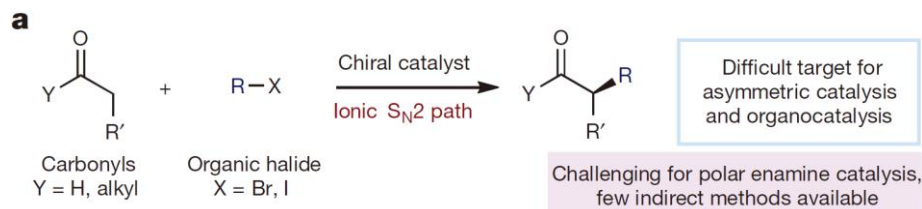
nature

2. Dual-catalyst systems—covalent organocatalysis ——Merging photoredox and enamine catalysis

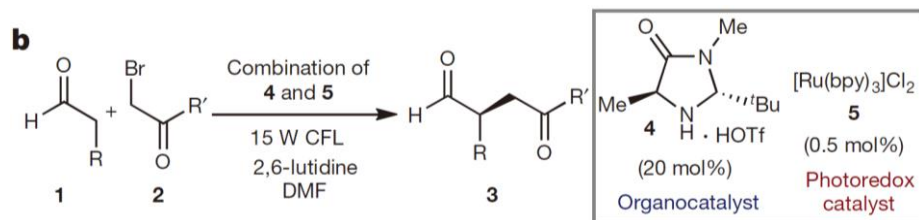


**modest reactivity of alkyl halides:
N-alkylation, self-aldol condensation**

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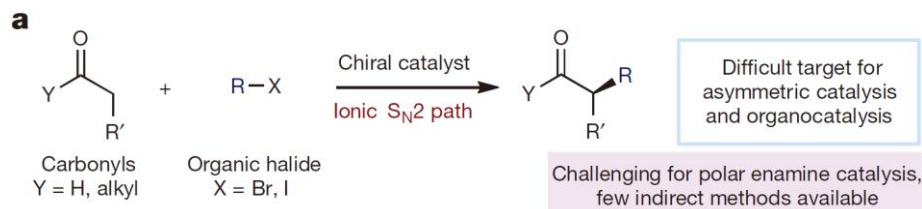


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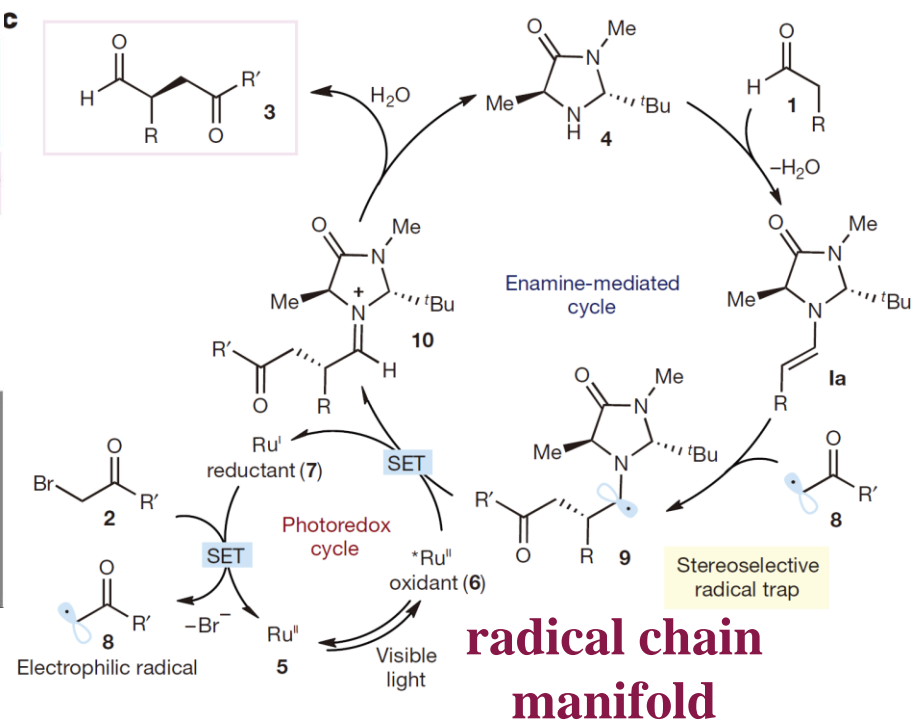
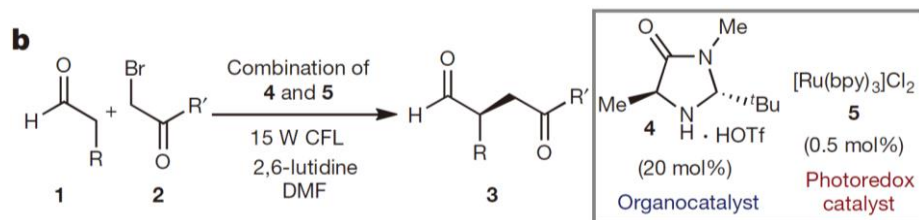


ionic $S_N2 \rightarrow$ radical

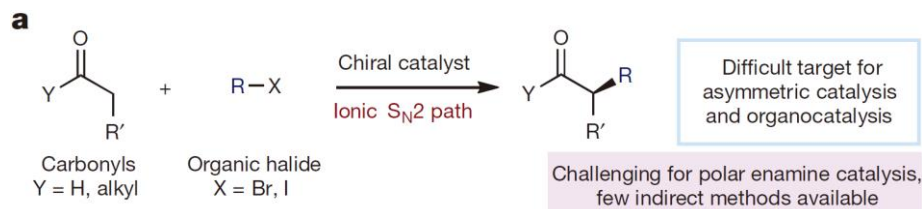
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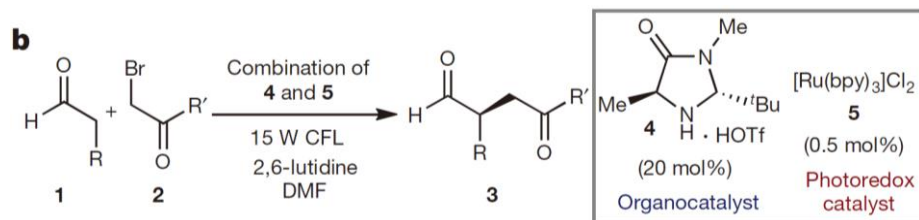
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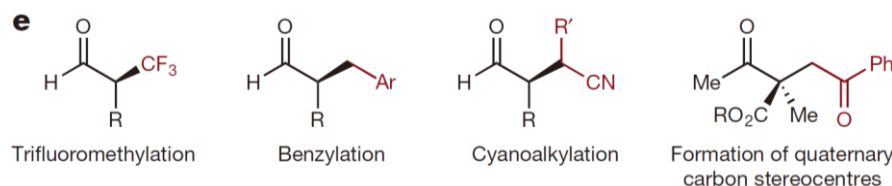
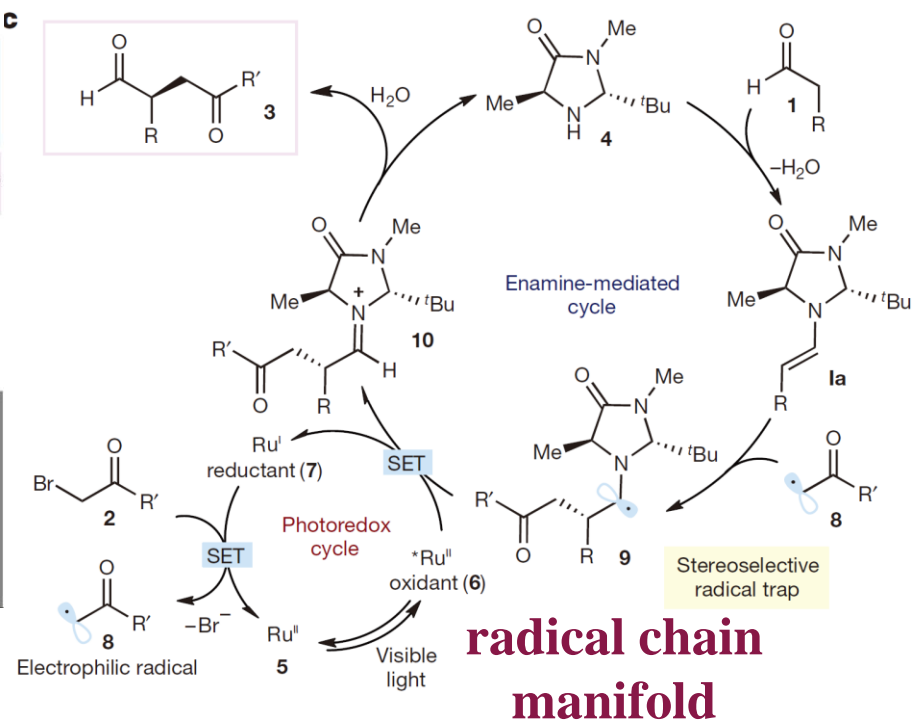
2. Dual-catalyst systems—covalent organocatalysis —Merging photoredox and enamine catalysis



**modest reactivity of alkyl halides:
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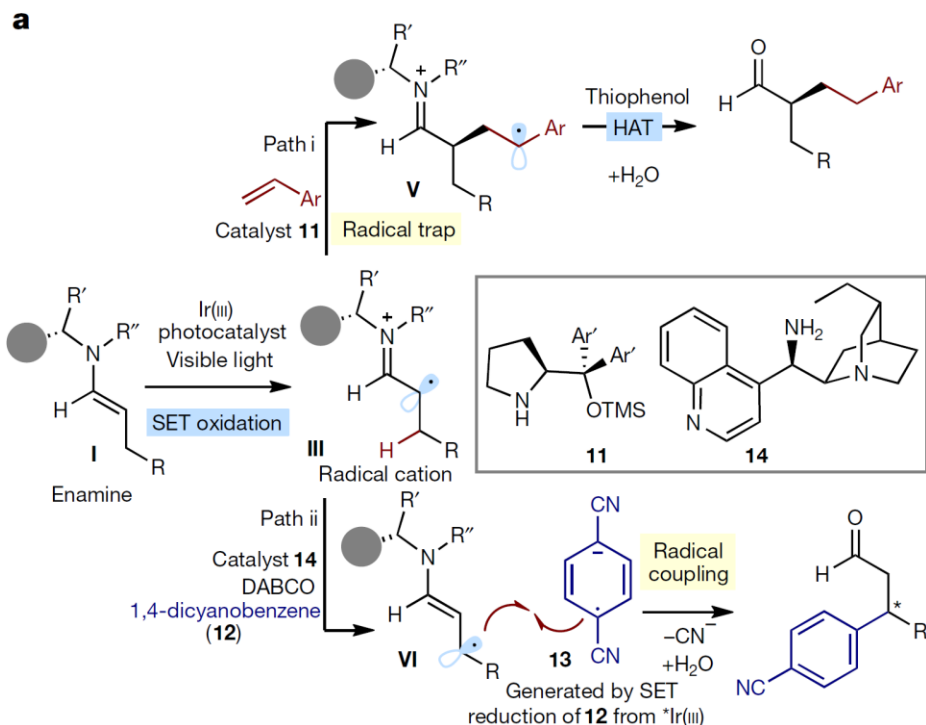
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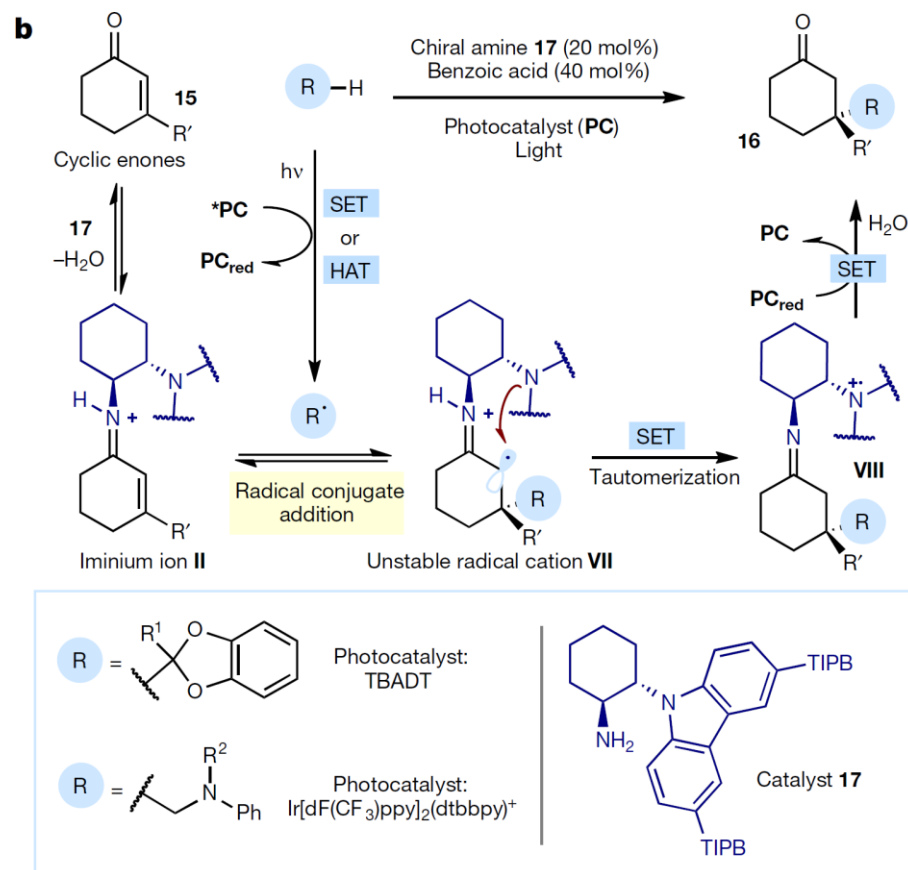
1. Silvi, M. and Melchiorre, P. *Nature* **2018**, 554, 41–49.

nature

2. Dual-catalyst systems—covalent organocatalysis —Merging SOMO activation / iminium-ion and photoredox catalysis



**weakened allylic C-H of VI:
DABCO → proton abstraction**

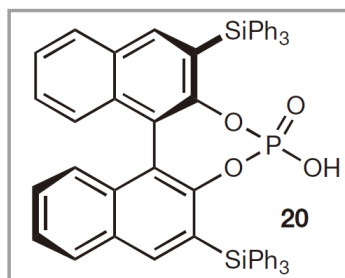
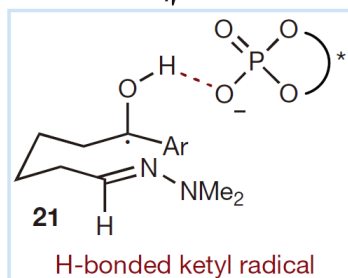
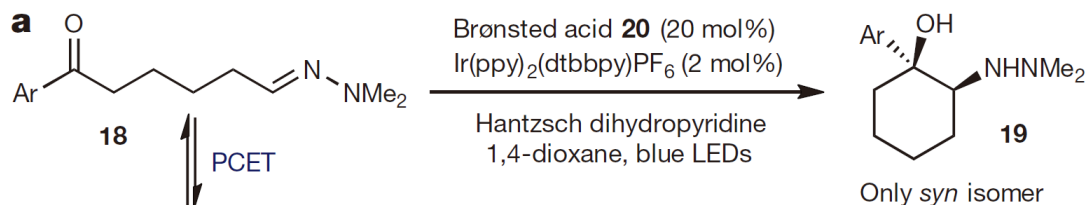


**reactive α-iminyl radical cation VII:
β-scission → intra. SET red.**

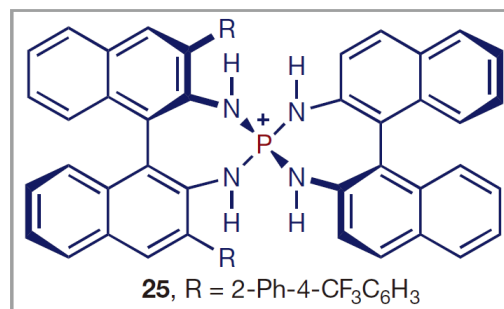
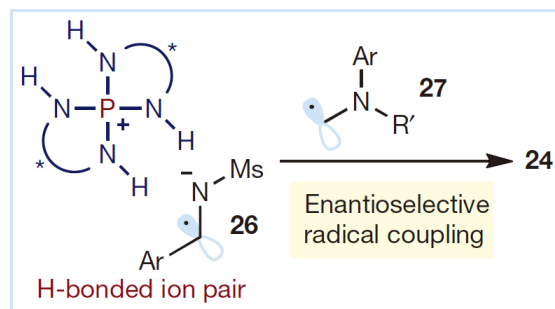
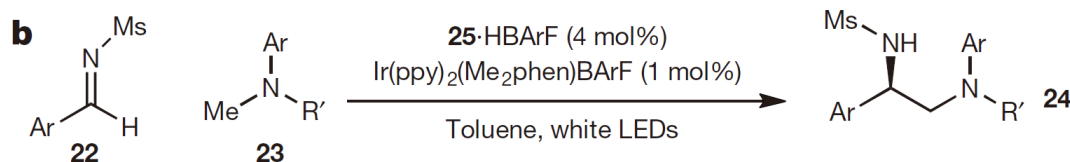
nature

2. Dual-catalyst systems—non-covalent organocatalysis

—Merging Brønsted acid / ion-pair and photoredox catalysis



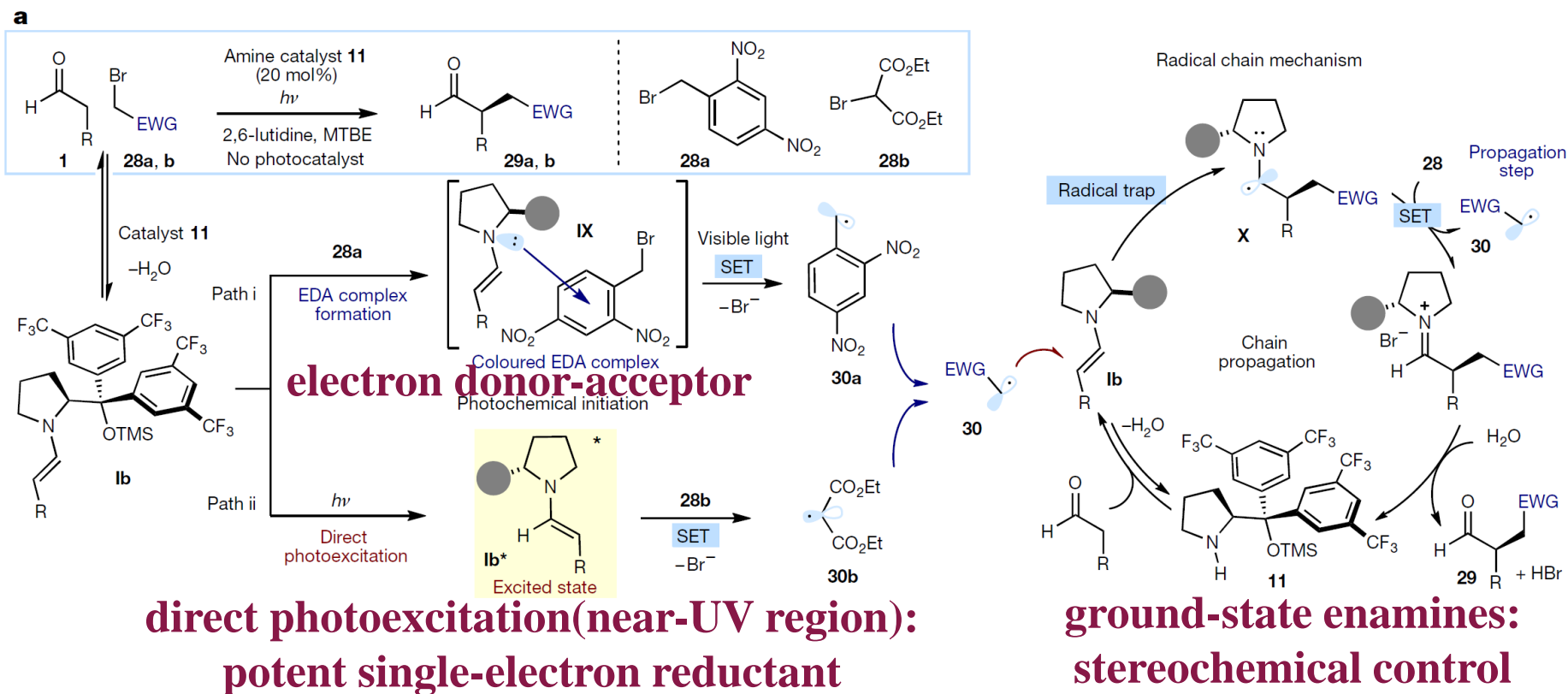
tight hydrogen-bonding → PCET:
 aza-pinacol cyclization



ion pair:
 radical coupling

3. Single-catalyst systems— organocatalysis in the excited state —Merging Enamine and photoredox catalysis

control experiment of α -alkylation \rightarrow light promoted chain propagation

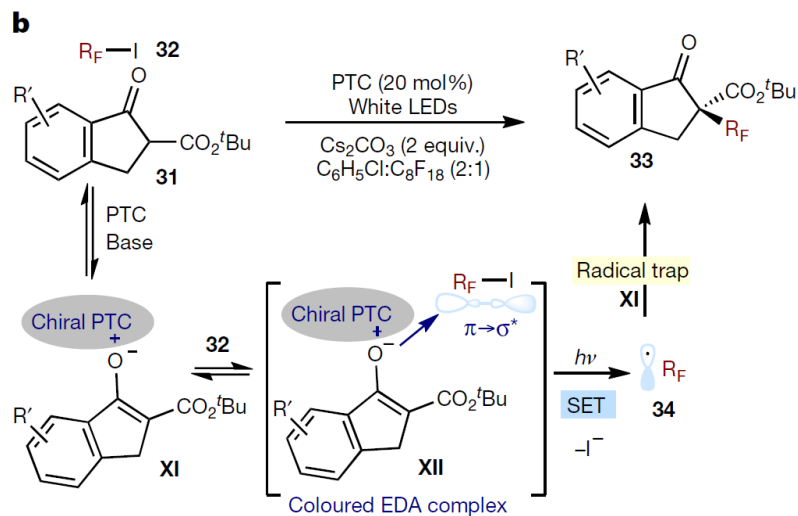


α -functionalization: phenacyl alkylation, amination, and arylsulfonyl alkylation of aldehydes and the alkylation of cyclic ketones

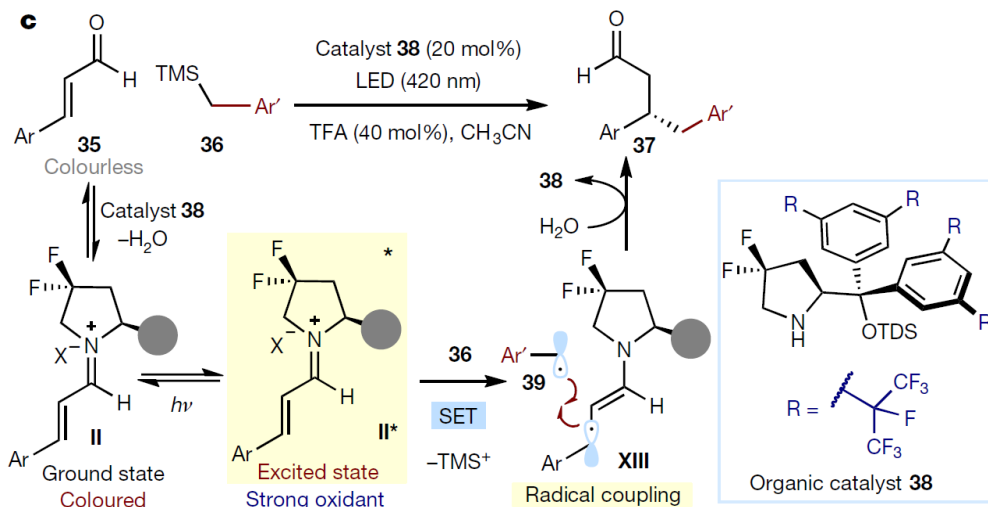
1. Silvi, M. and Melchiorre, P. *Nature* **2018**, 554, 41–49.

nature

3. Single-catalyst systems— organocatalysis in the excited state —Merging PTC / iminium and photoredox catalysis



**electronic similarities
with enamines:**
 π (donor) $\rightarrow \sigma^*$ (acceptor)
cinchonine-derived phase-
transfer catalyst



violet light excitation:
strong oxidant II*
organic silanes: non-
nucleophilic substrates

**β -enaminyll
radical XIII**

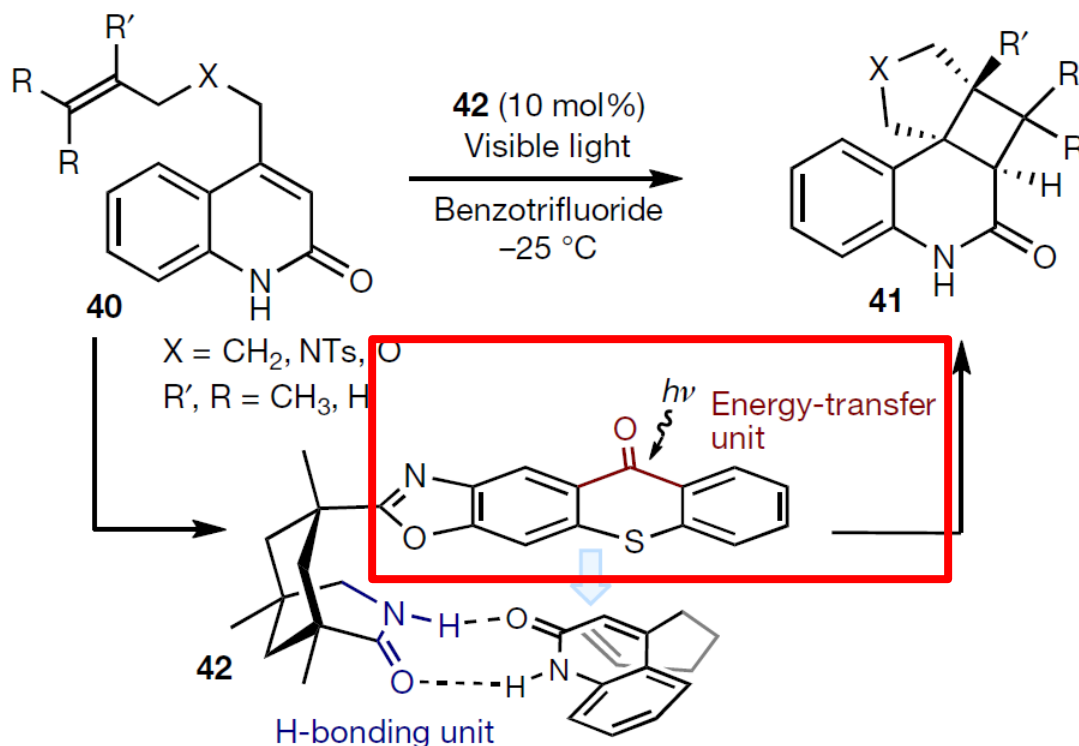
1. Silvi, M. and Melchiorre, P. *Nature* **2018**, 554, 41–49.

nature

3. Single-catalyst systems— organocatalysis in the excited state ——Hydrogen-bonding catalysis in asymmetric photochemistry

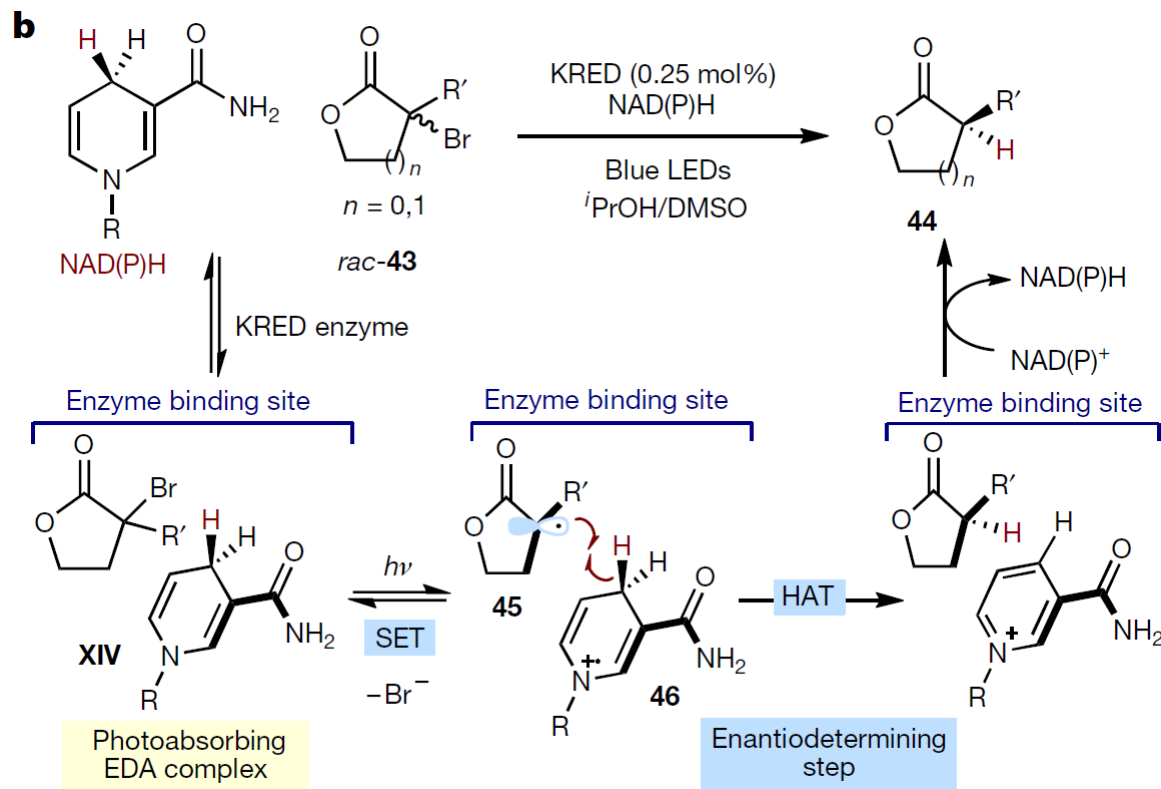
It's hard to require the catalytic stereocontrol of a photochemical process in a high-energy hypersurface

a



light-triggered stereocontrolled [2 + 2] cyclization

3. Single-catalyst systems— organocatalysis in the excited state ——Enzyme cofactors in asymmetric photochemistry



native polar reactivity of enzyme: ketone \rightarrow chiral alcohol;
native polar reactivity of NADH: hydride source \rightarrow strong reducing agent;

Thank you for your attention!