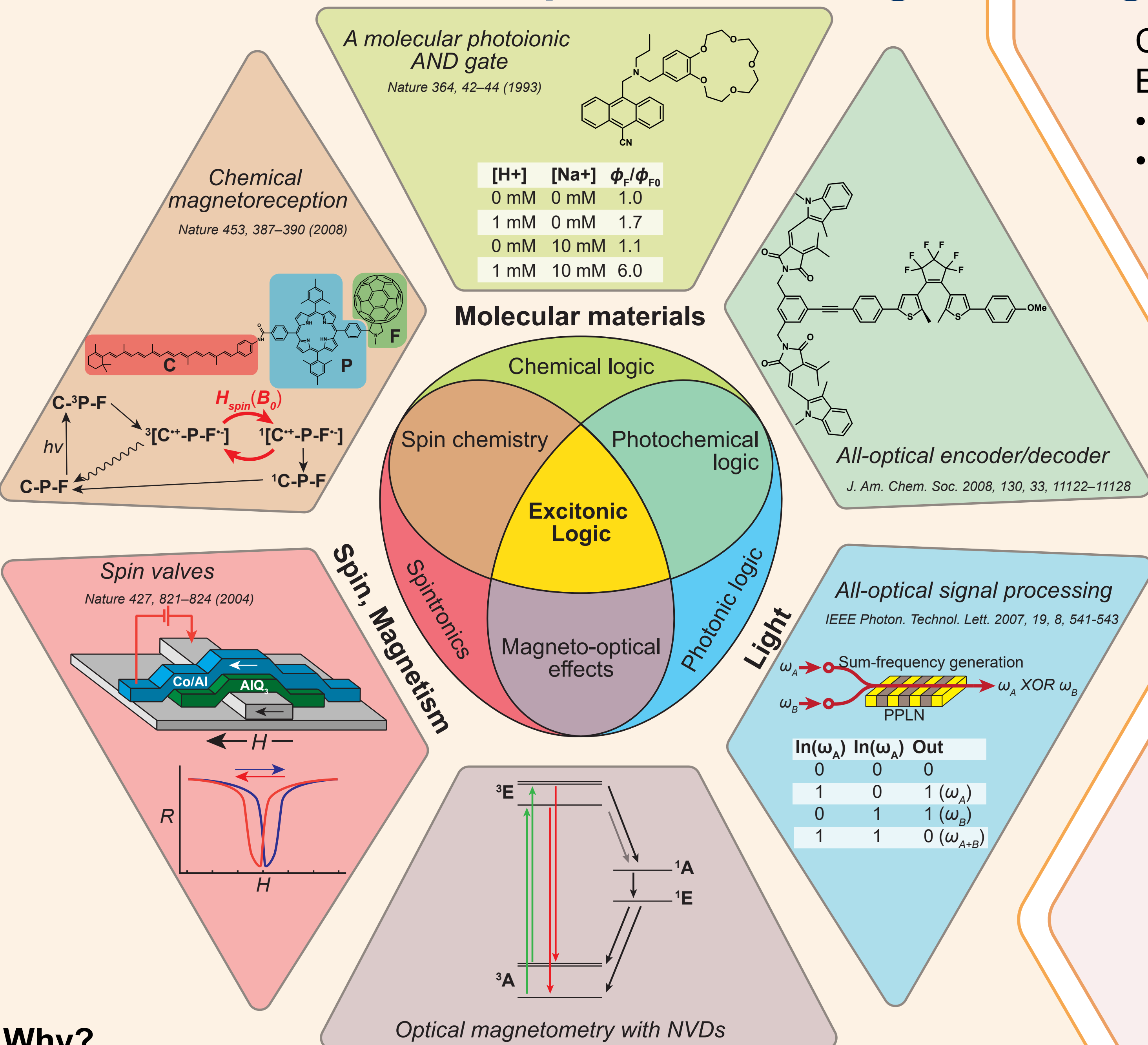




Exciton Logic

Thomas S. C. MacDonald, Rohan J. Hudson, Jared H. Cole, Dane R. McCamey

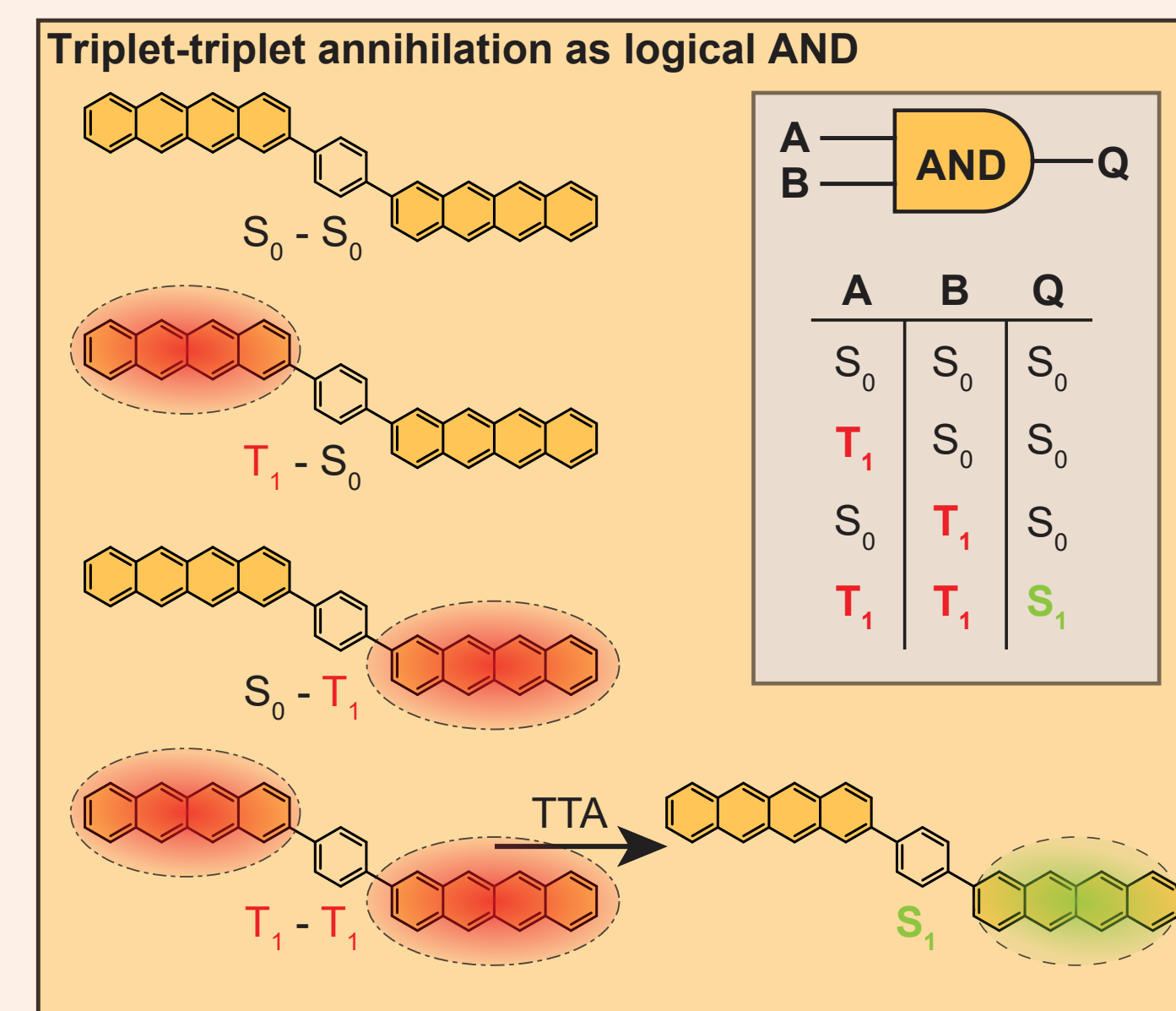
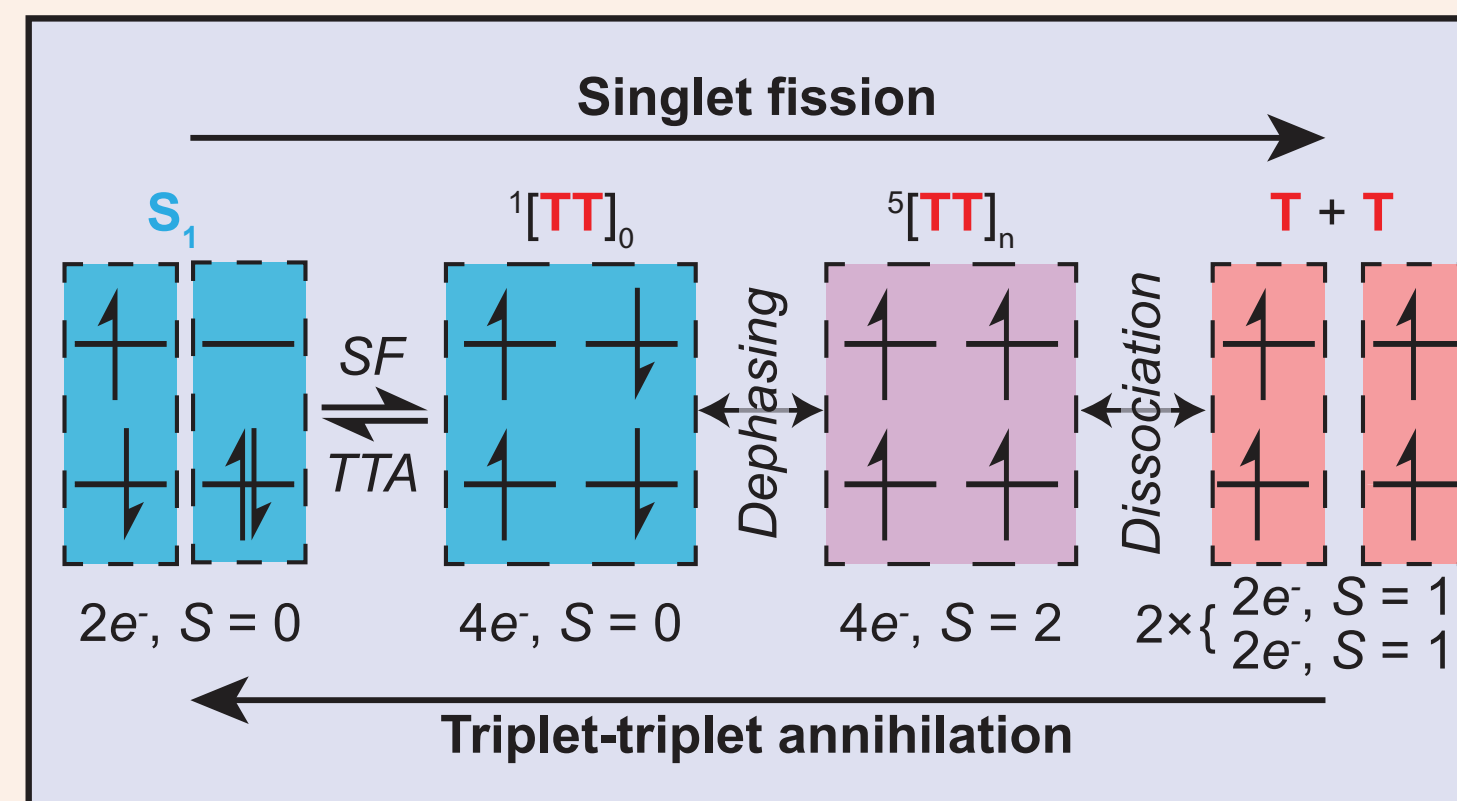
Excitons as a natural platform for logic



Logical processes with excitons

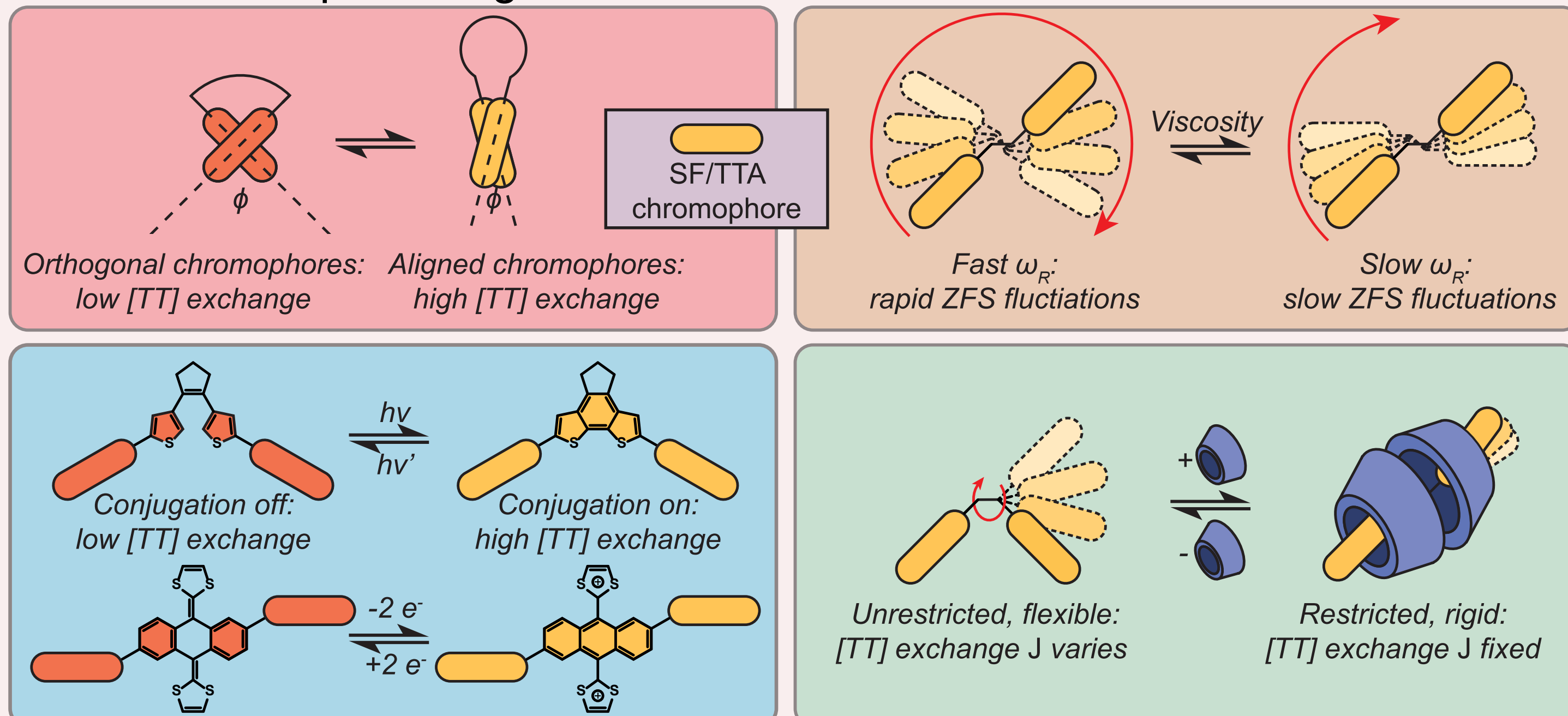
Classical logic uses **multi-bit interactions**.
Excitonic logic needs **multiexcitonic processes**:

- $1S \rightarrow 3T + 3T$ (singlet fission, SF)
- $3T + 3T \rightarrow 1S$ (triplet-triplet annihilation, TTA)



Multiexcitonic molecular devices

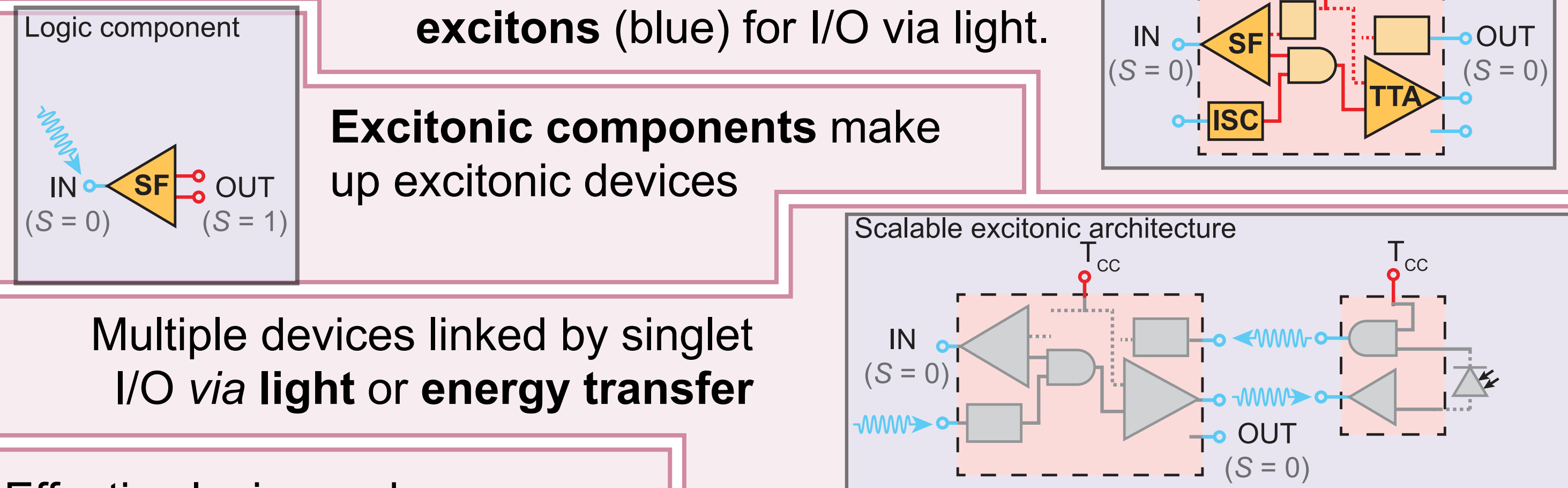
Molecular devices could act as chemical sensors reporting through excitonic pathways, as transducers to link excitonic inputs to (photo)chemical outcomes, or as more complex integrated devices.



Stimulus-responsive SF/TTA dimers. Coupling could be controlled through a) conformational switching or b) switchable conjugation, or spin-spin interactions within the (TT) influenced with changes in dynamics (c,d).

Scalable excitonic logic: the need for spin

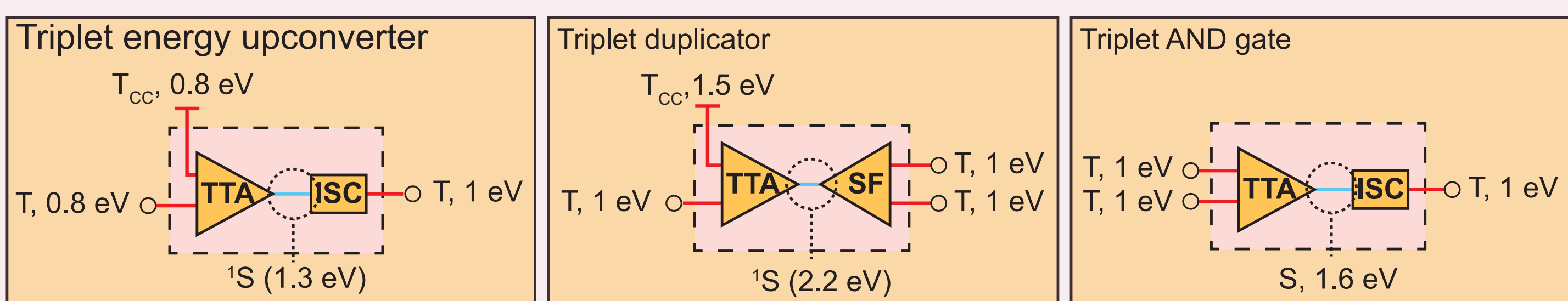
We propose excitonic devices that use a long-lived **triplet excitons** (red) internally and **singlet excitons** (blue) for I/O via light.



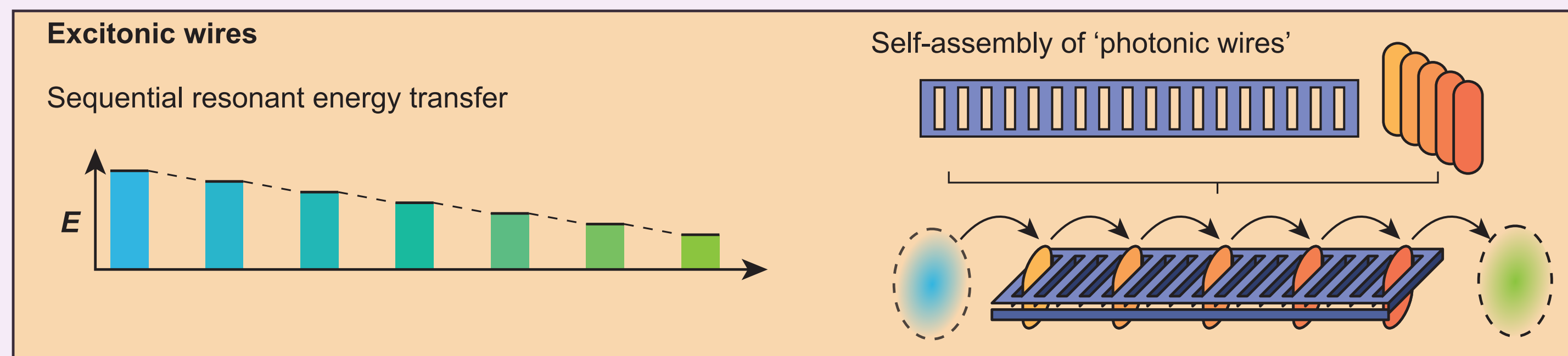
Effective logic needs:

- Input-output homogeneity: outputs and inputs with same basis, same energy.
- Fan-out: one output can drive multiple inputs.

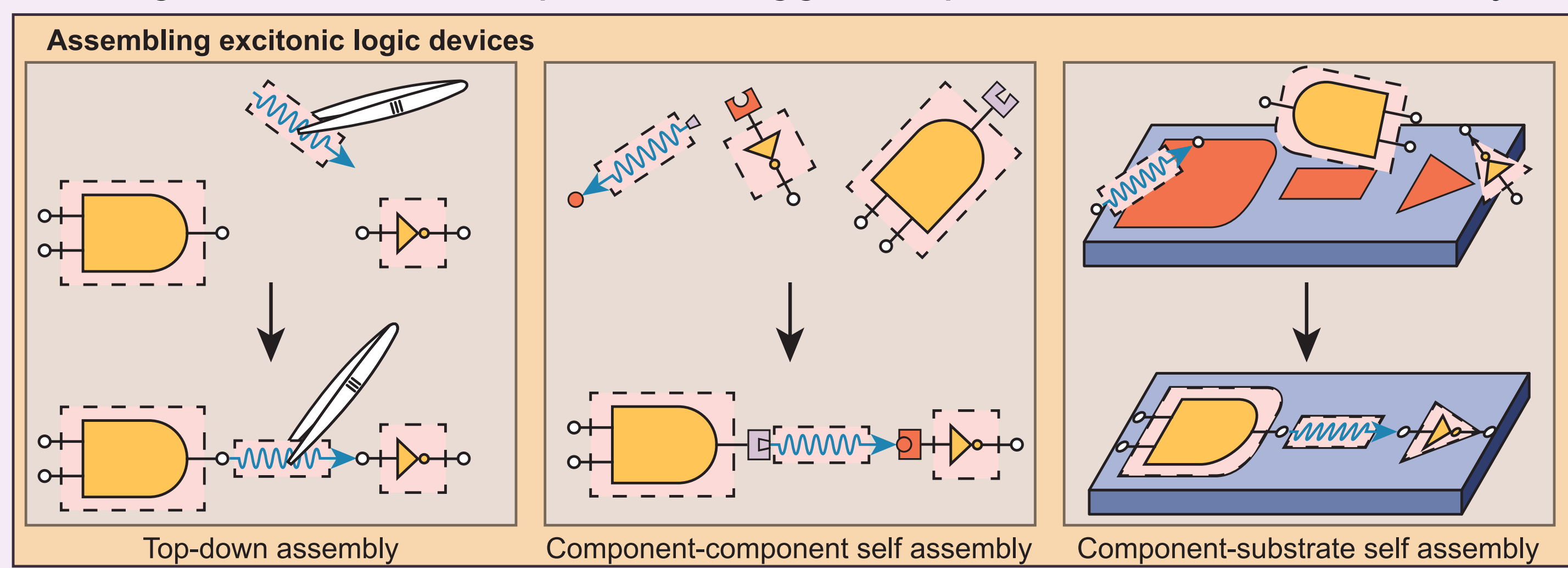
Need **amplification**, which draws energy. Drive amplifiers with a **triplet rail**:



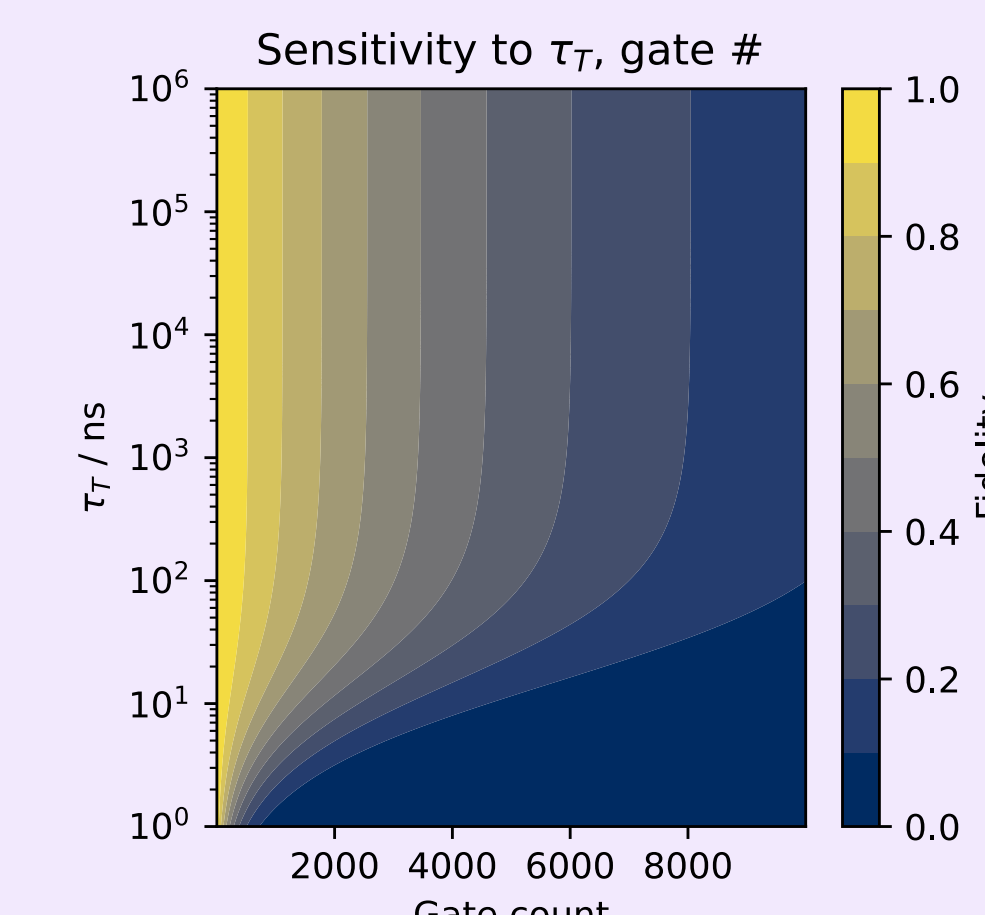
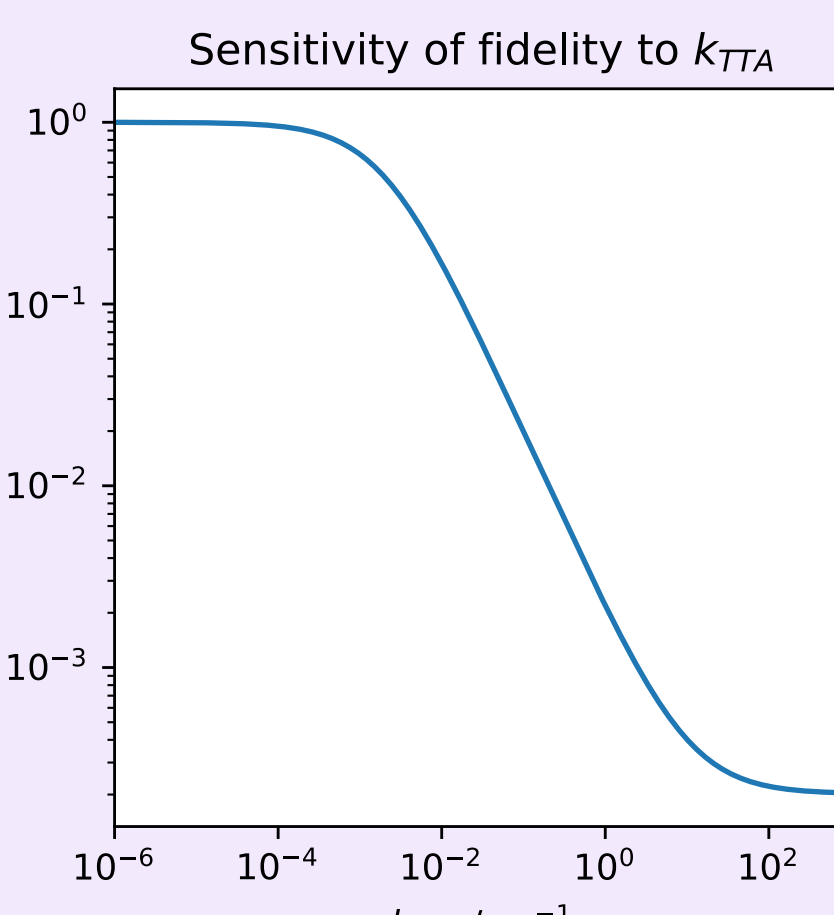
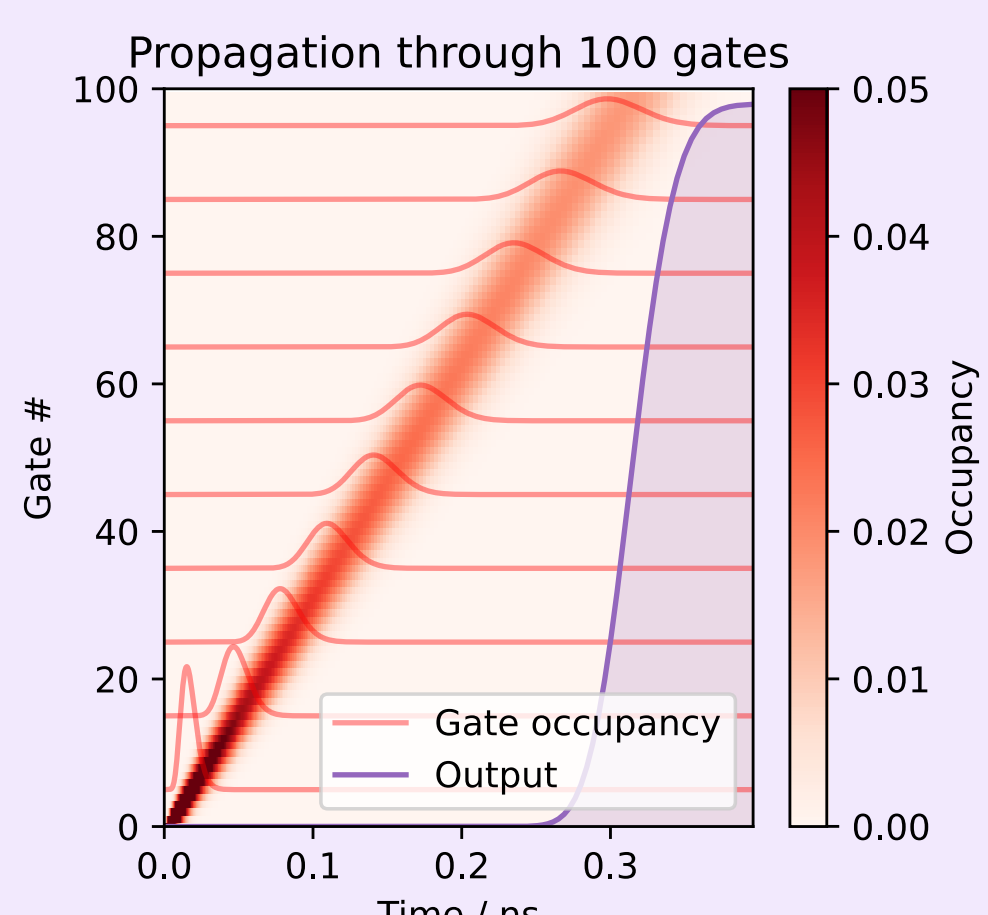
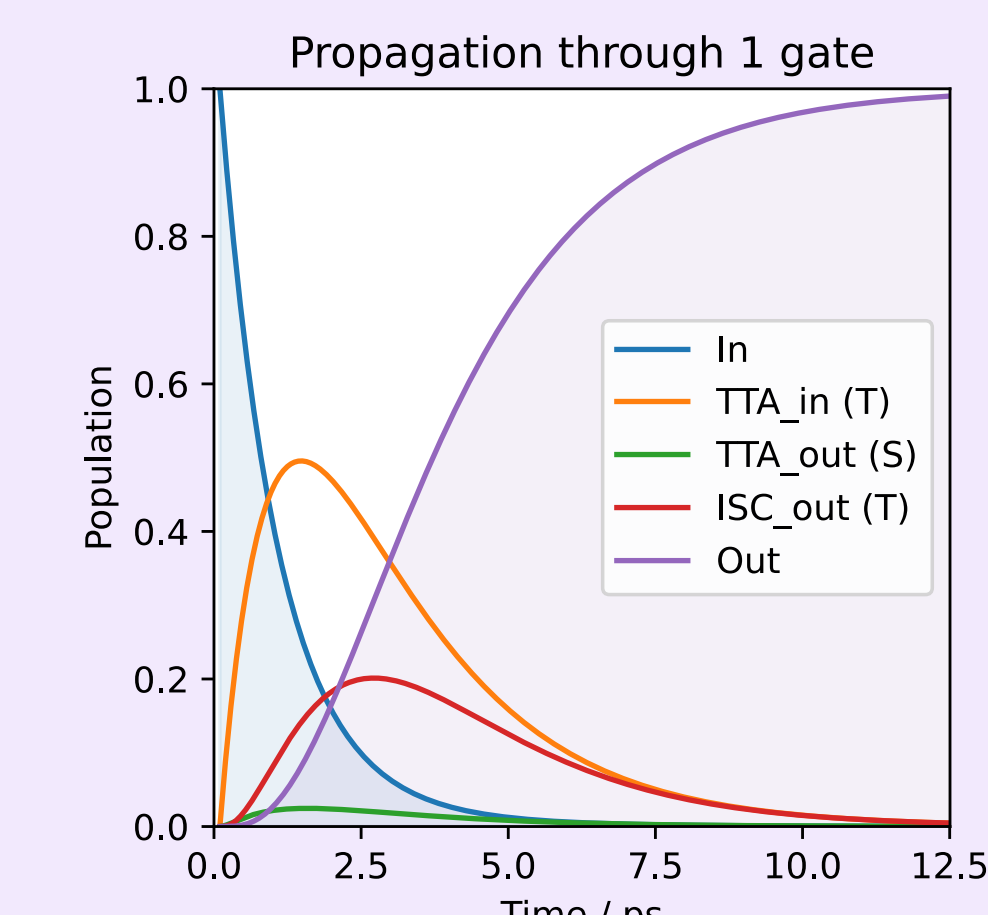
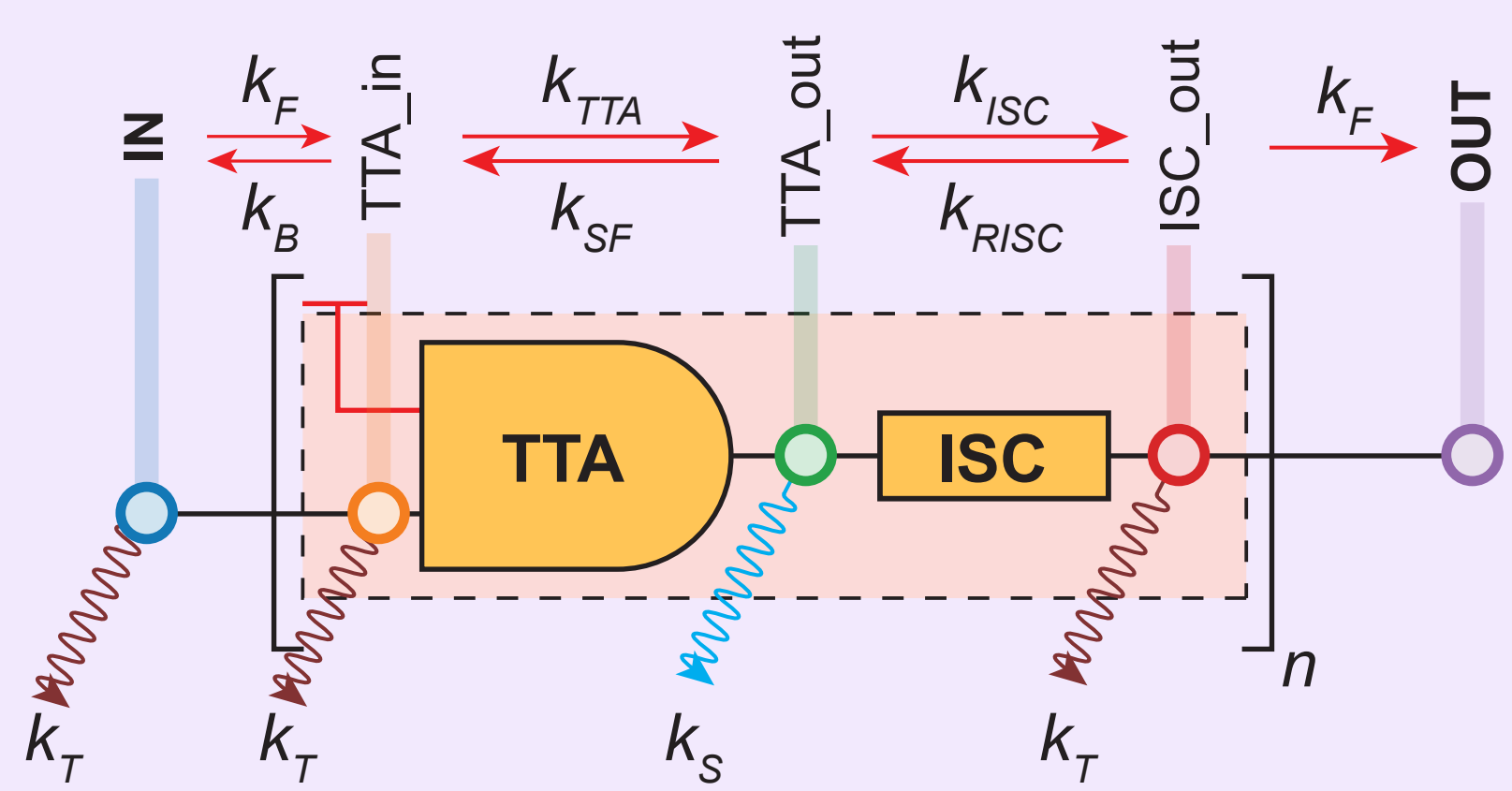
Building bigger



Excitonic devices need assembly of multiple components: wires, memory, and logic. Molecular components suggest supramolecular self-assembly.



Fidelity of excitonic devices



Propagation and dispersion of signals. Multiexcitonic processes must be fast relative to the triplet loss rate ($k_T = 0.5 \text{ ns}^{-1}$ here) for good fidelity over multiple gate operations.

Acknowledgements

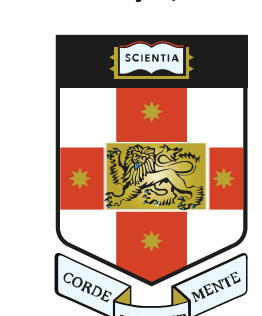
This work was funded through the ARC Centre of Excellence in Exciton Science



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