Systems Biology 204

"Biomolecular Engineering and Synthetic Biology"

2011 Spring Term

Session #1a

William Shih

http://sb204.net/

Natural Inspiration: What technical capabilities are possible with biomolecular engineering?

Motivation: What demand-meeting applications can be met by an advanced synthetic biology?

Midterm projects: What skills will students gain from taking this course?

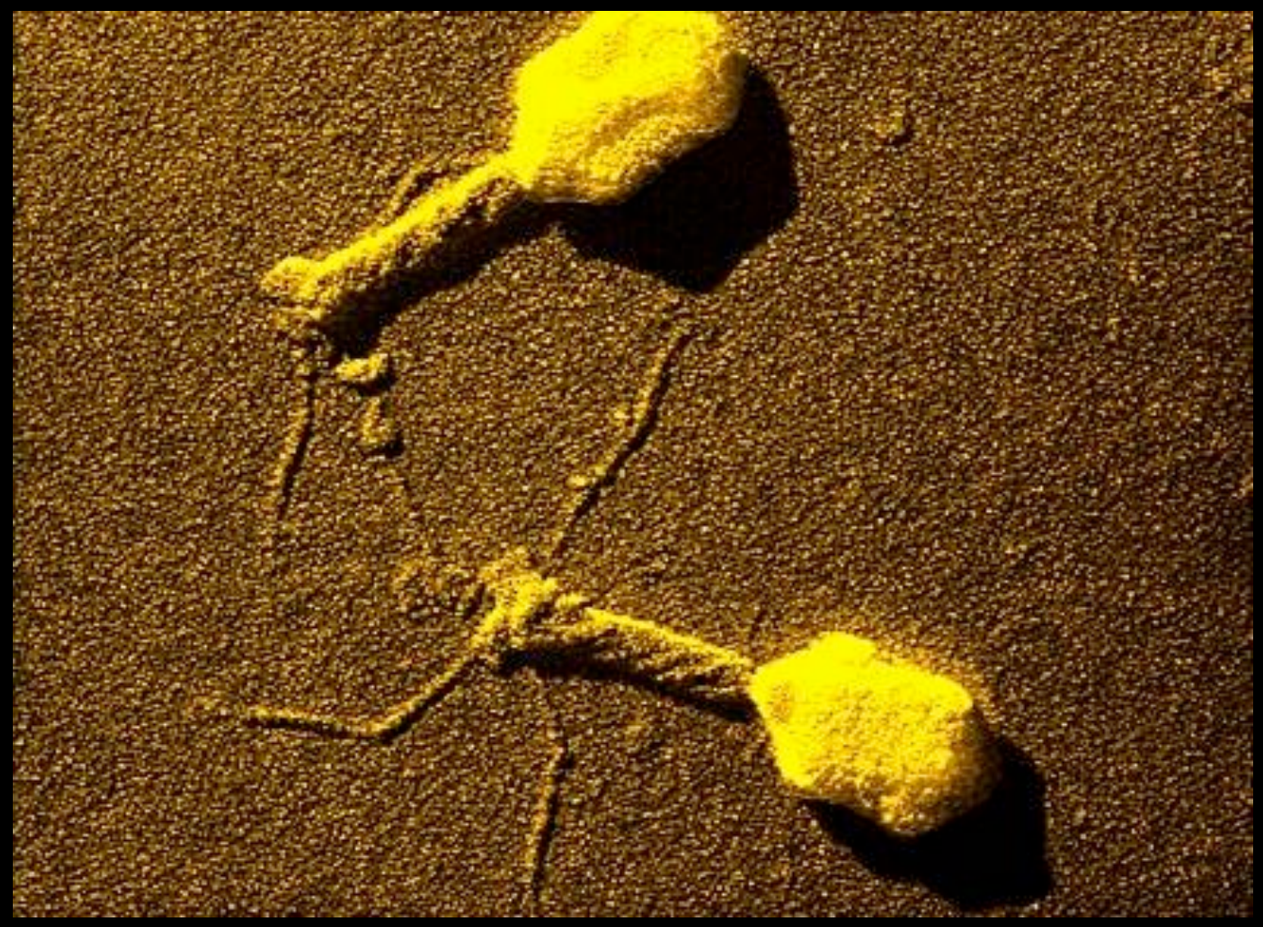
Living Systems exhibit extraordinary capabilities . . .

BUILD HEAL

ADAPT REPRODUCE

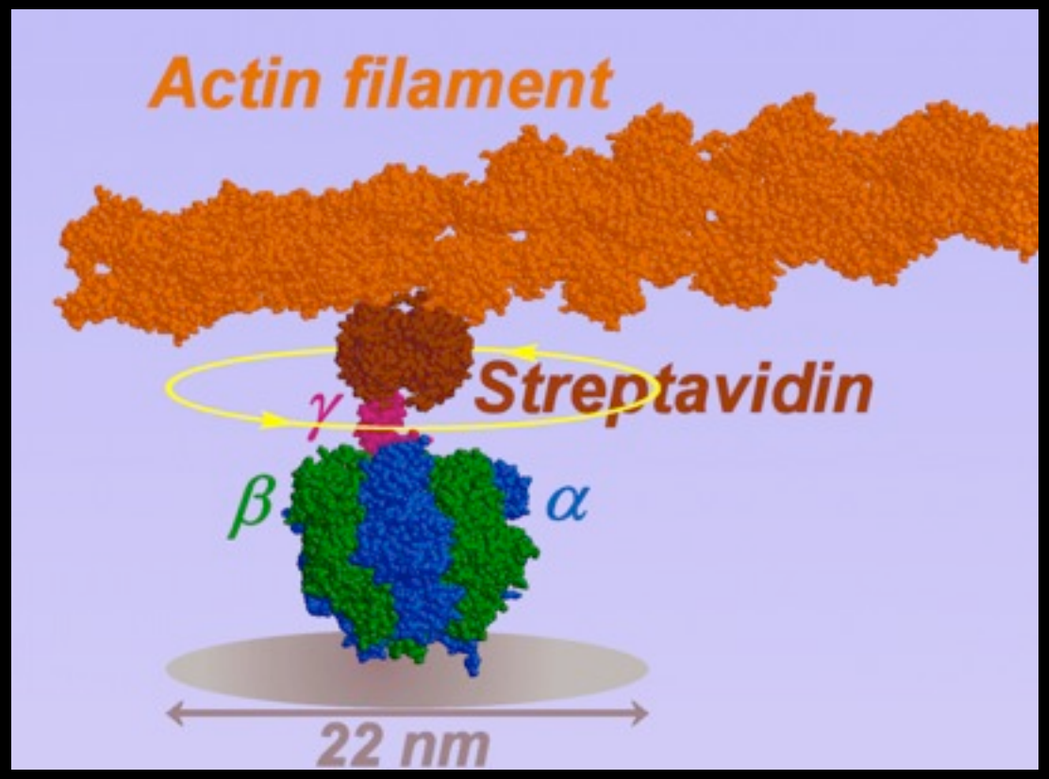
10 nanometers

100 nanometers



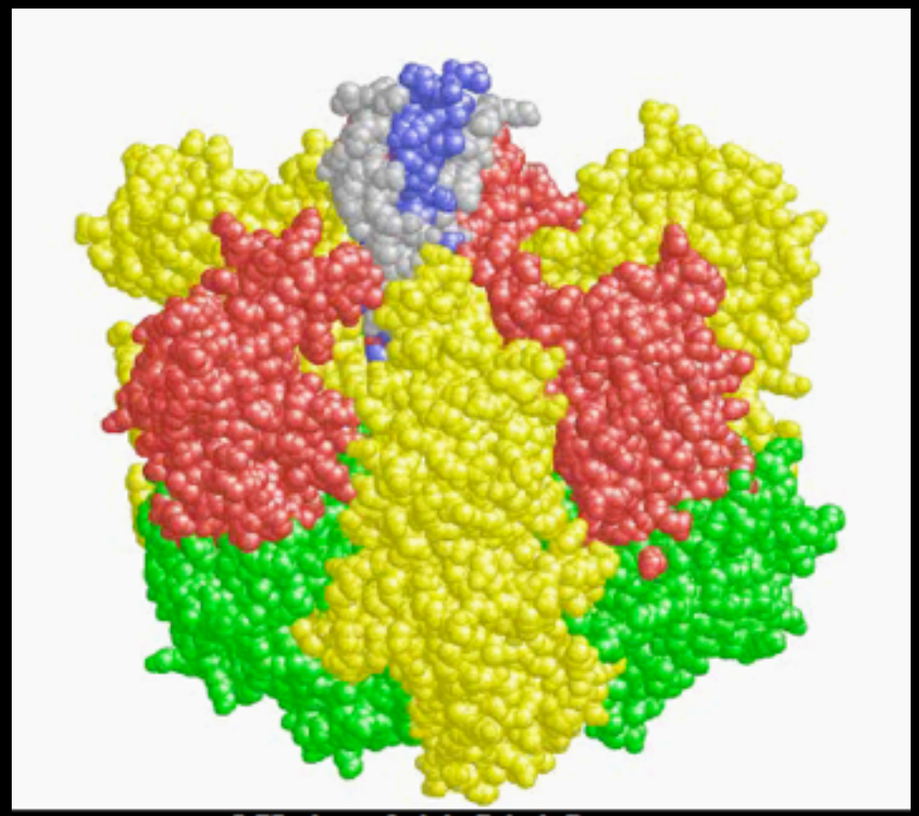
made possible by Molecular Manufacturing

Biopolymer Machines



Noji, H. et al., *Nature* **386,** 299-302 (1997).

F1 ATPase



http://www.biochemweb.org/neutrophil.shtml

Synthetic Biology of Parts: Goals

Understand how to build with atomic precision on increasing length scales (to 100 nm and beyond)

Understand how to build sophisticated molecular devices that rival those from Nature

Construct and deploy useful said devices
e.g. tools for biophysics, diagnostics, therapeutics
communication, computing, energy, etc.

Goals for course

Learn how to use molecular-design software tools

Use these tools for midterm and final design projects

Survey developments in
nucleic-acid and protein nanotechnologies

http://sb204.net/

Demand-meeting applications for an advanced Synthetic Biology

Smart drug-delivery vehicles with efficient targeting and barrier avoidance

Injectable self-assembling cm-scale stents from molecular components

Amyloid plaque busters

Renewable anti-fouling surfaces

Nanocalipers for protein structure determination

http://sb204.net/

Midterm projects

Project descriptions at http://sb204.net/

Midterm #1: Molecular-machine design using structural DNA nanotechnology

Due date: Mon 2011 October 17 by noon

PICK ONE

- Flashing ratchet
- Bipedal ratchet
- Electrophoretic ratchet

Midterm projects

Project descriptions at http://sb204.net/

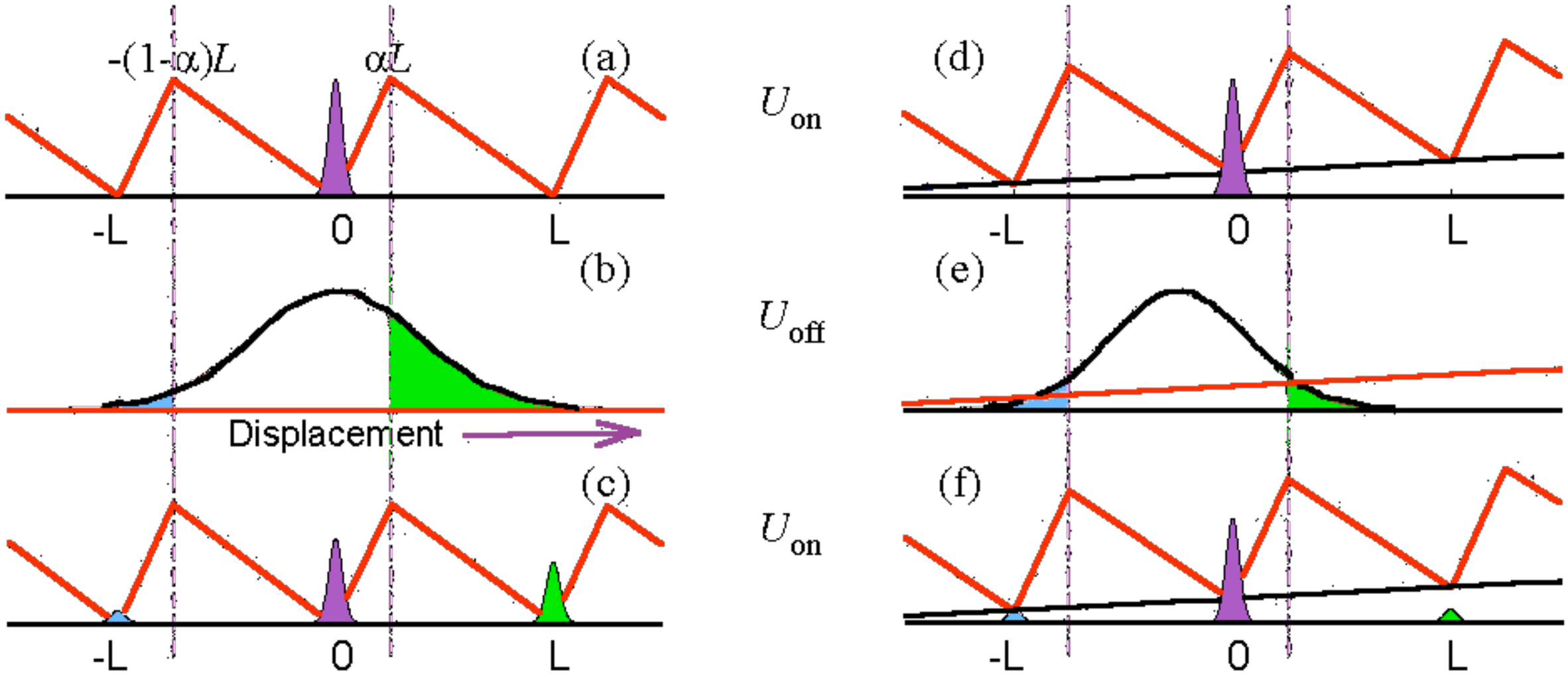
Midterm #2: Dynamic self-assembly using meta-stable hairpins

Due date: Wed 2011 October 26 by noon

PICK ONE

- Hairpin walker
- Hairpin dendrimer
- Catalytic self-assembly

Flashing ratchet



http://www.eleceng.adelaide.edu.au/Groups/parrondo/brd.gif

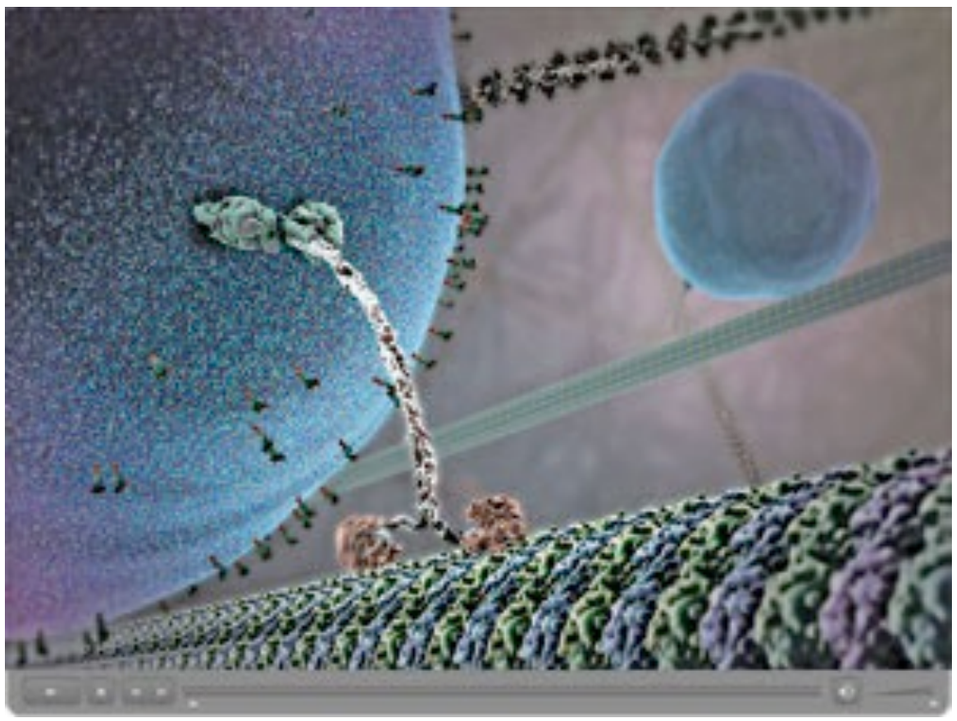
http://www.elmer.unibas.ch/bm/index.html

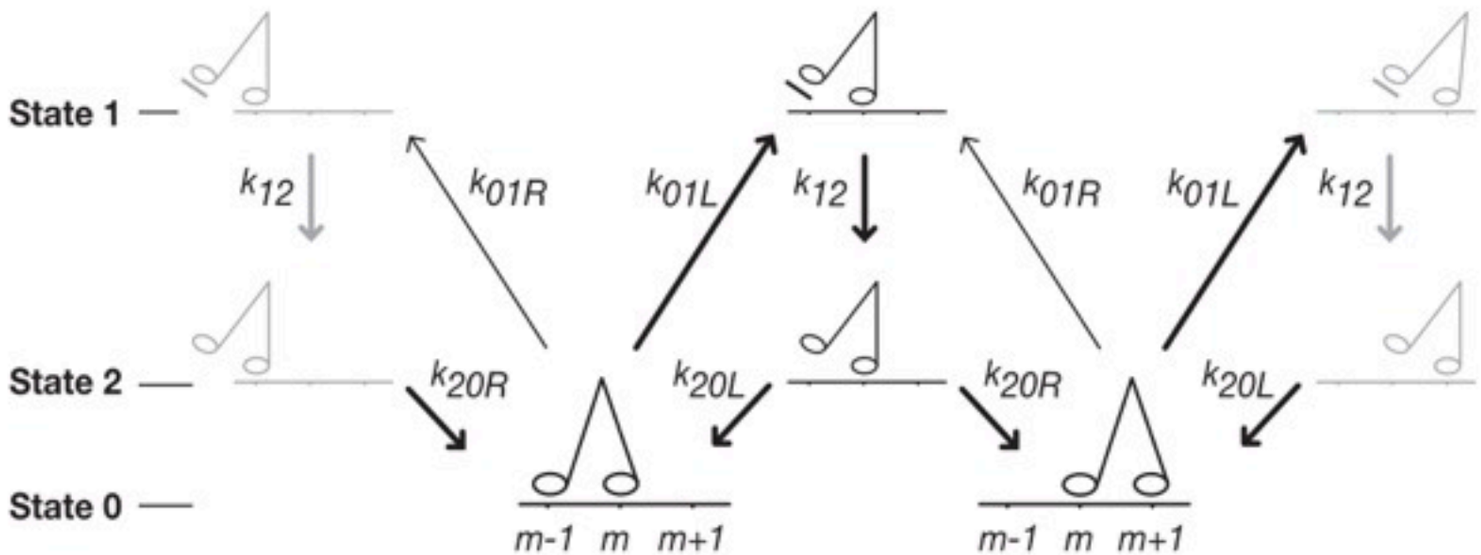
Bipedal-walker ratchet

PRL **101,** 238101 (2008) PHYSICAL REVIEW LETTERS week ending 5 DECEMBER 2008

Coordinated Chemomechanical Cycles: A Mechanism for Autonomous Molecular Motion

S. J. Green, J. Bath, and A. J. Turberfield*
University of Oxford, Department of Physics, Parks Road, Oxford OX1 3PU, United Kingdom
(Received 15 February 2008; revised manuscript received 10 September 2008; published 3 December 2008)

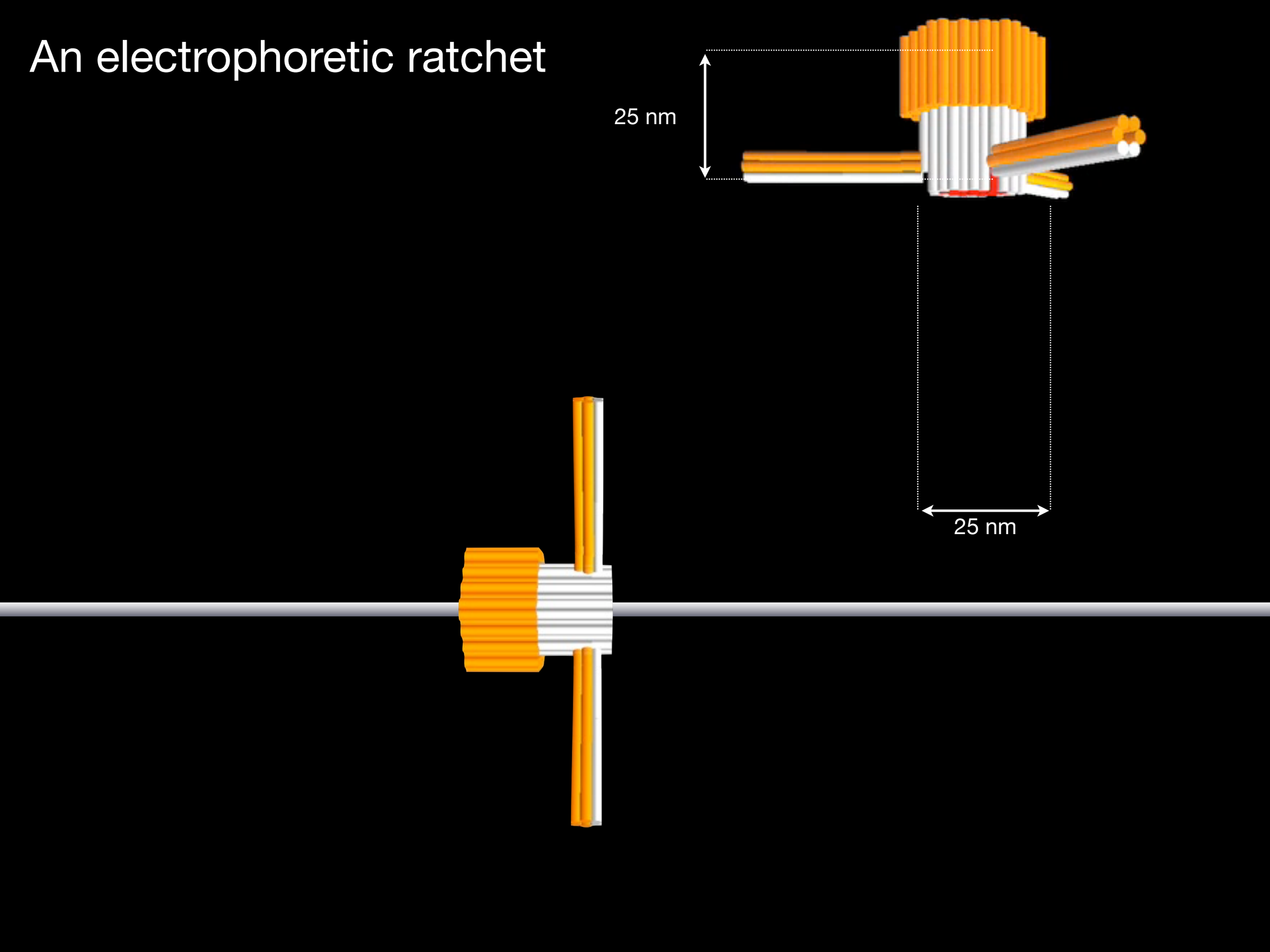




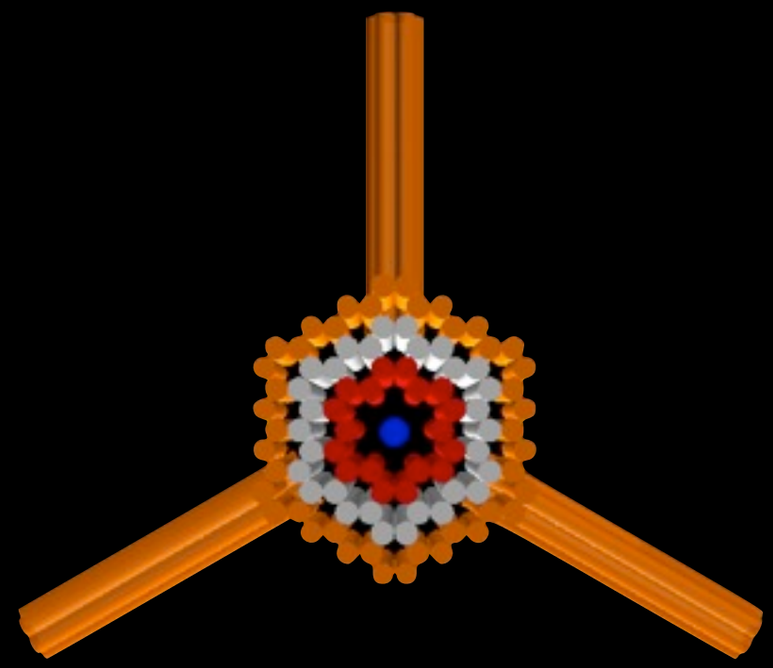
How to bias k01L >> k01R ?

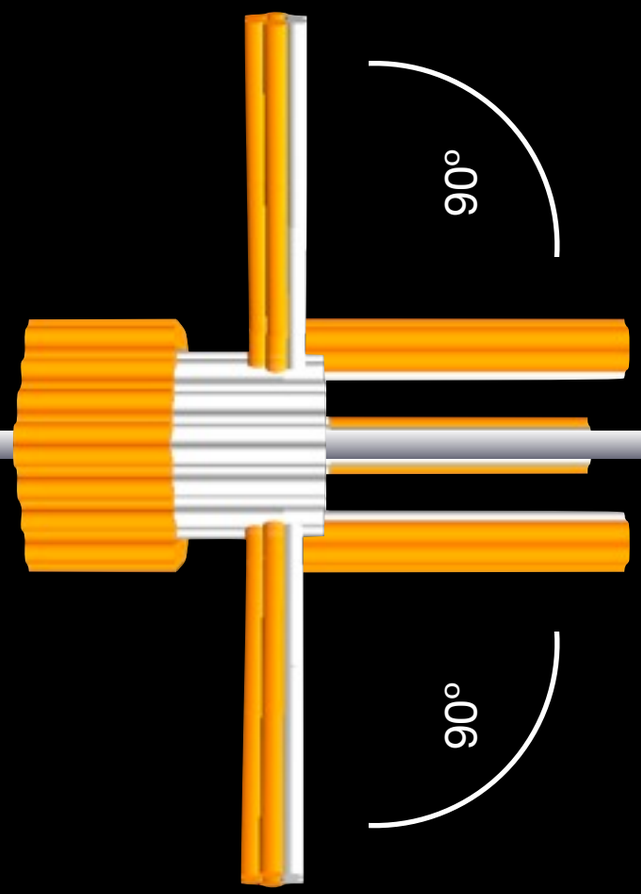
Goal: Communication between domains via tension

An electrophoretic ratchet

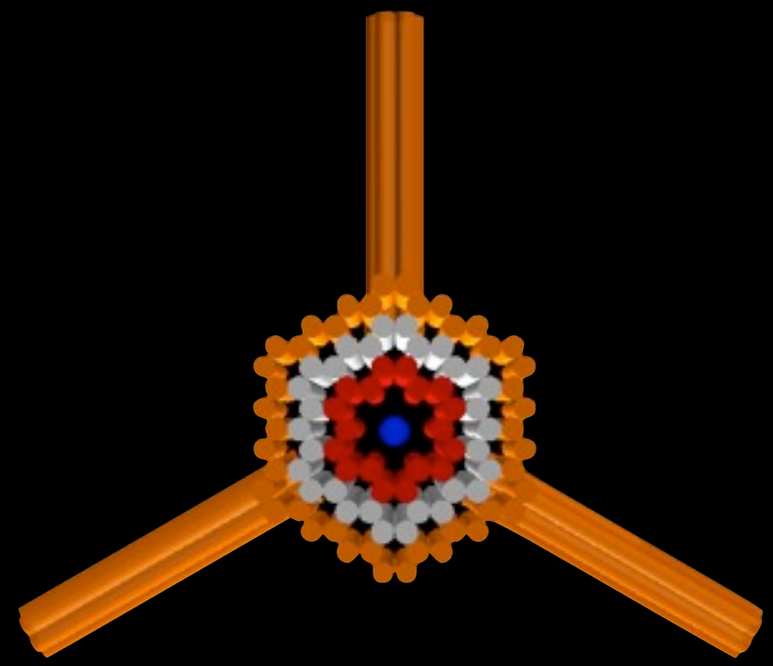


An electrophoretic ratchet



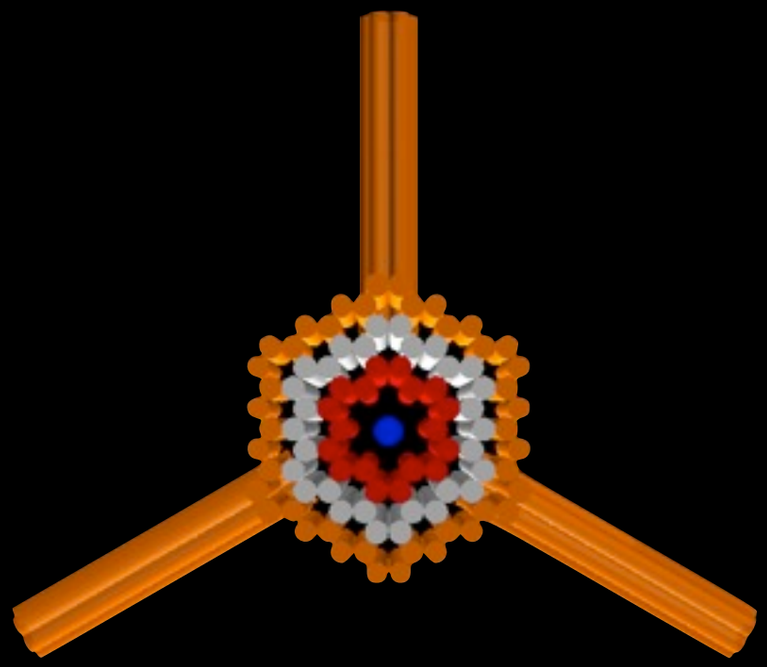


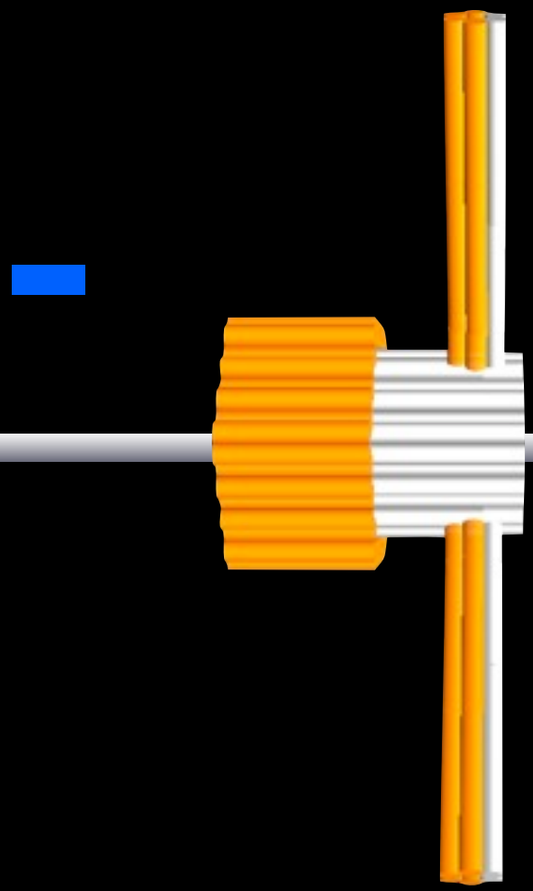
An electrophoretic ratchet



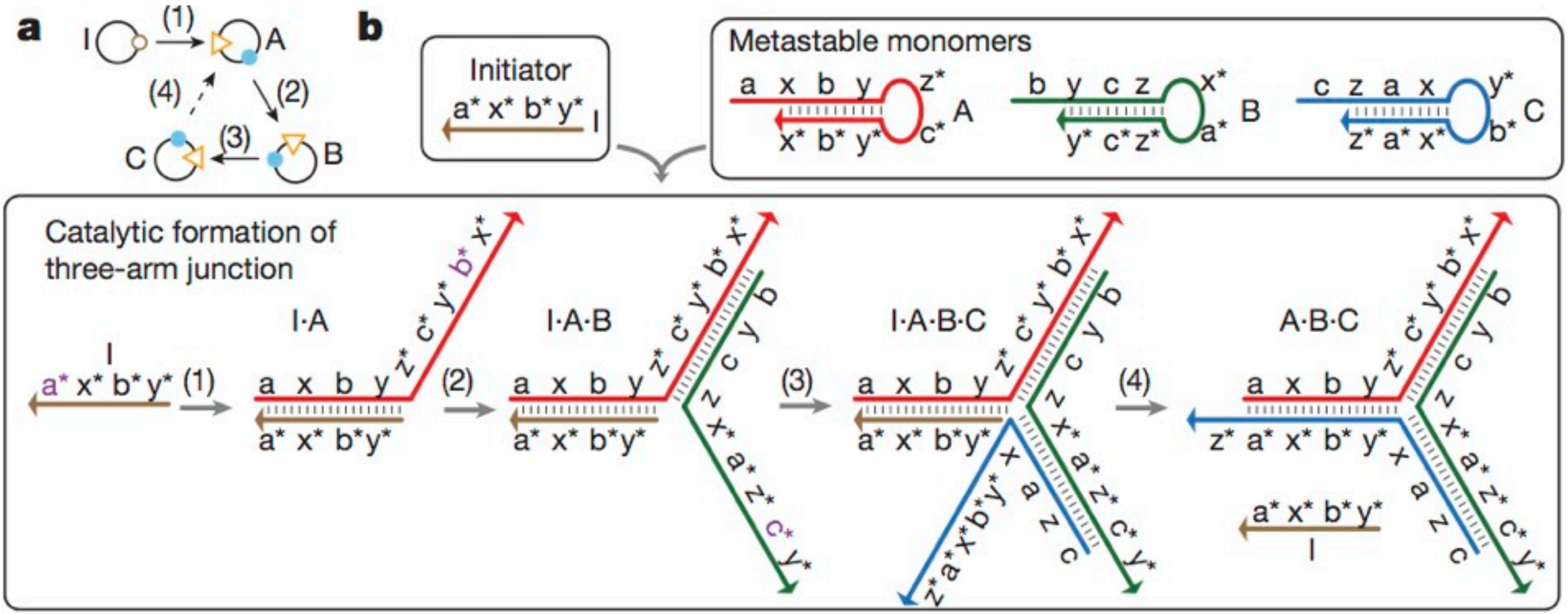
An electrophoretic ratchet

Expectation:
Net unidirectional propulsion through action of alternating electric field



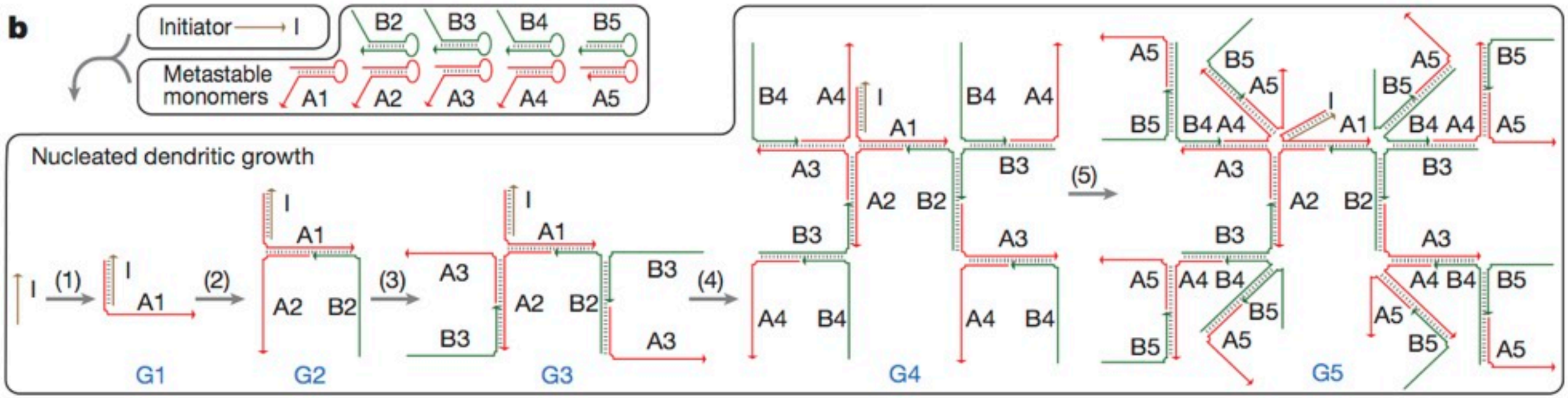


Catalytic self-assembly



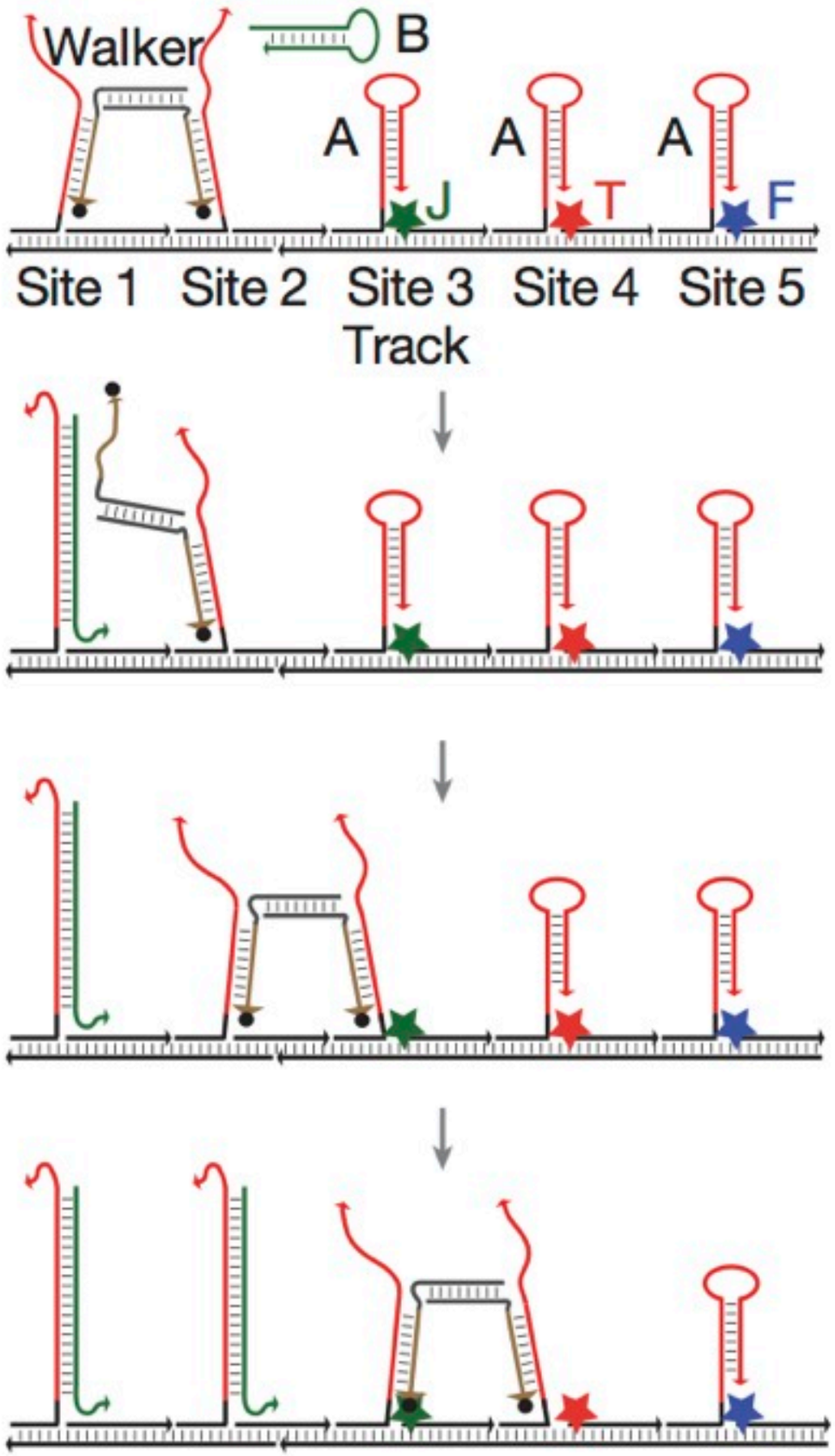
Yin P et al, Programming biomolecular self-assembly pathways, *Nature* 451, 318–322, 2008.

Hairpin dendrimer



Yin P et al, Programming biomolecular self-assembly pathways, *Nature* 451, 318–322, 2008.

Hairpin walker



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