



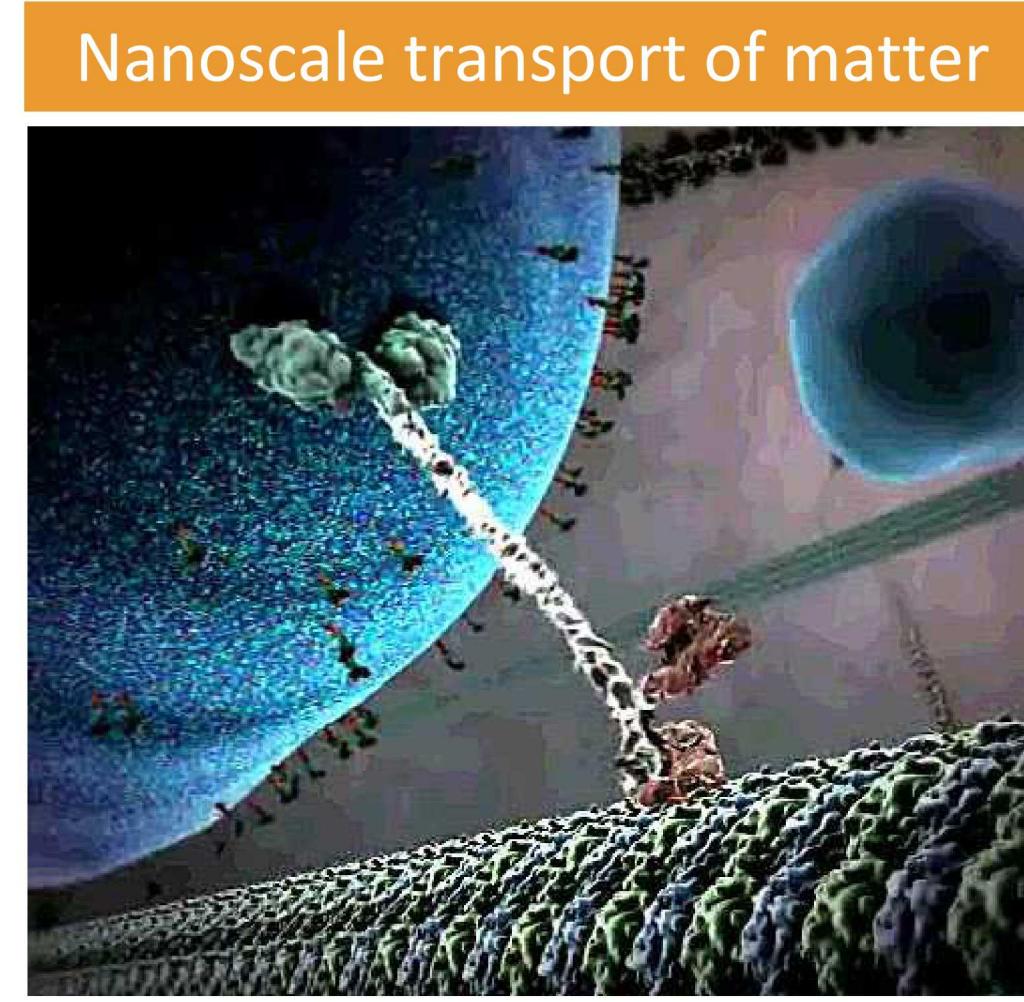
# The Biological Nanomotors Lab

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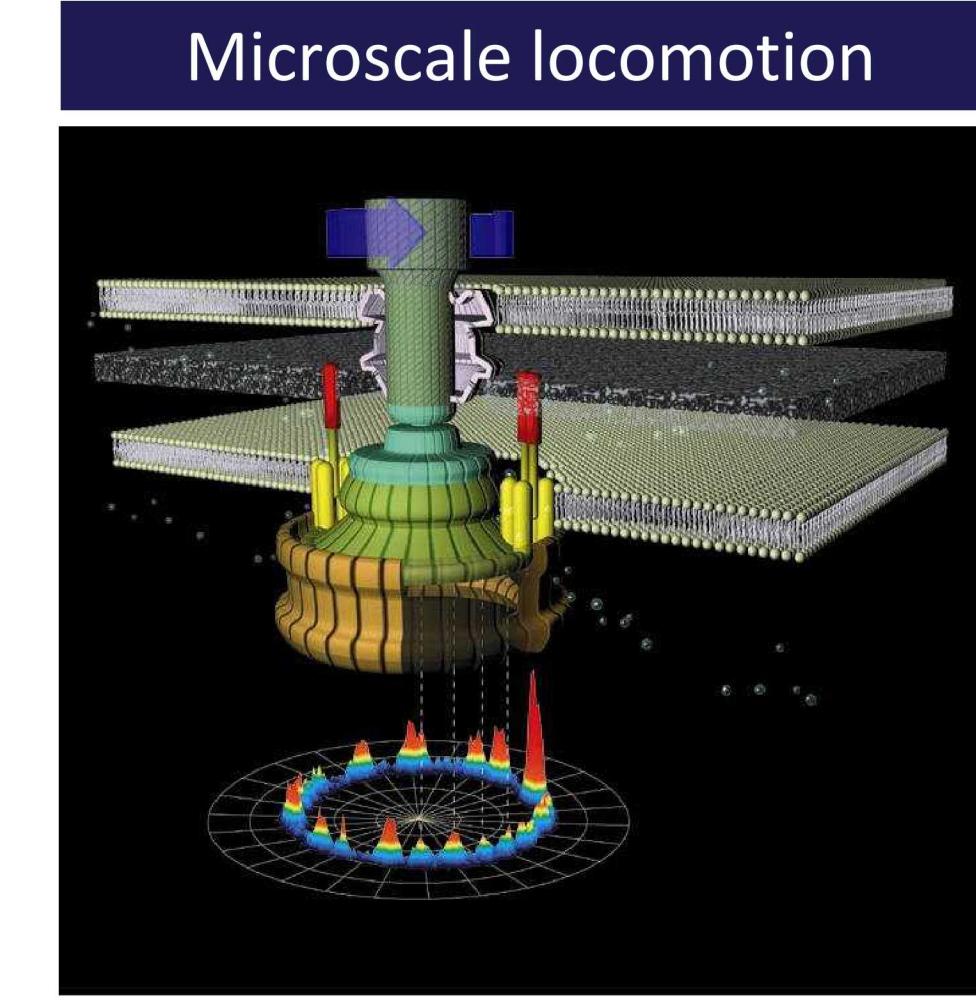


## Biomolecular Motors & Nanotechnology

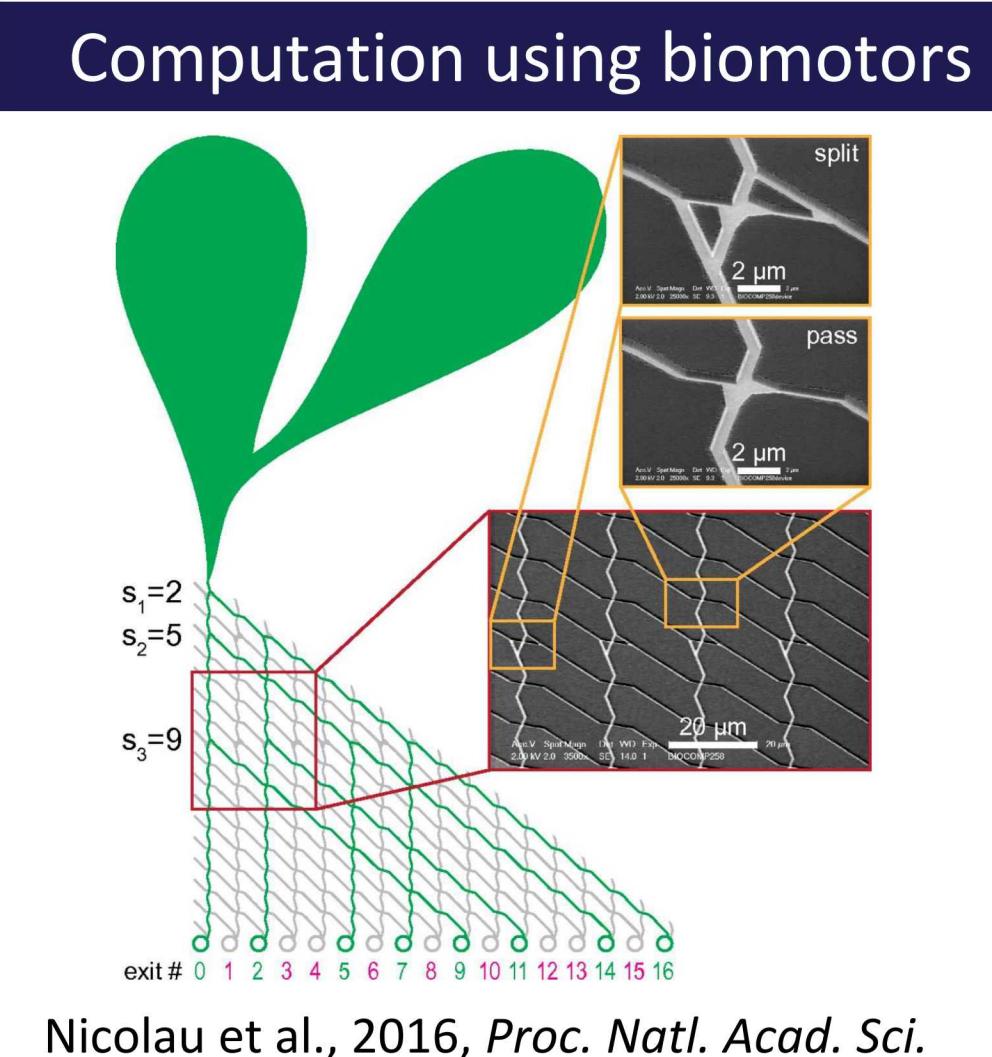
Nature provides brilliant examples of nanoscale engines and actuators that perform a variety of macroscale functions including cellular locomotion, nanofluidic transport, energy production, and muscle actuation.



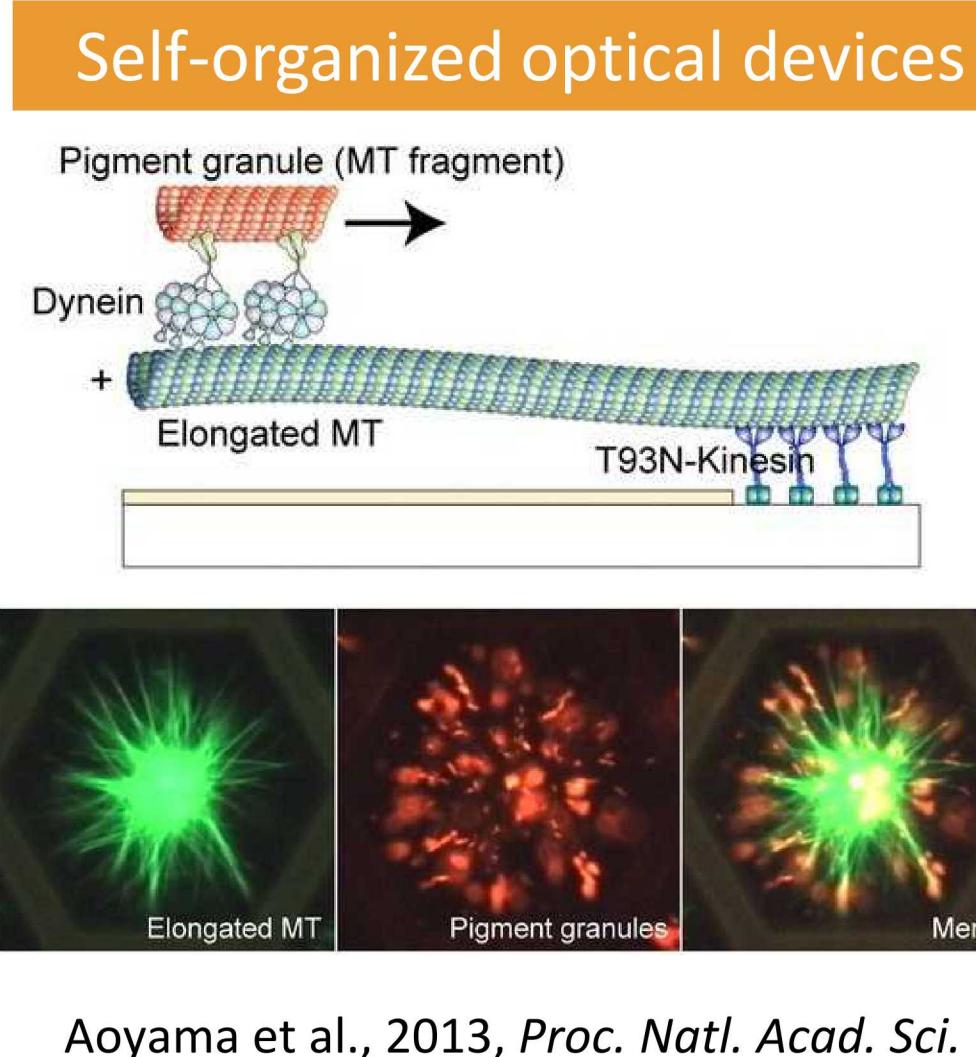
R. Lue & A. Viel/Harvard University and J. Liebler/XVIVO, LLC



Akihiko Ishii, <http://www.fbs.osaka-u.ac.jp/labs/ishii/index-E.html>



Nicolau et al., 2016, *Proc. Natl. Acad. Sci.*

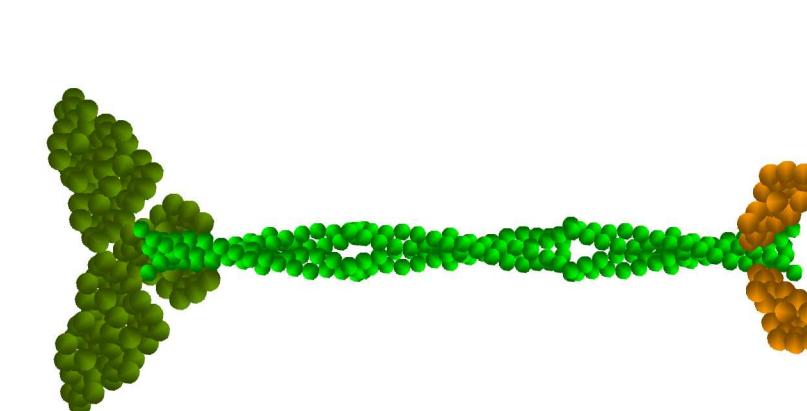


Aoyama et al., 2013, *Proc. Natl. Acad. Sci.*

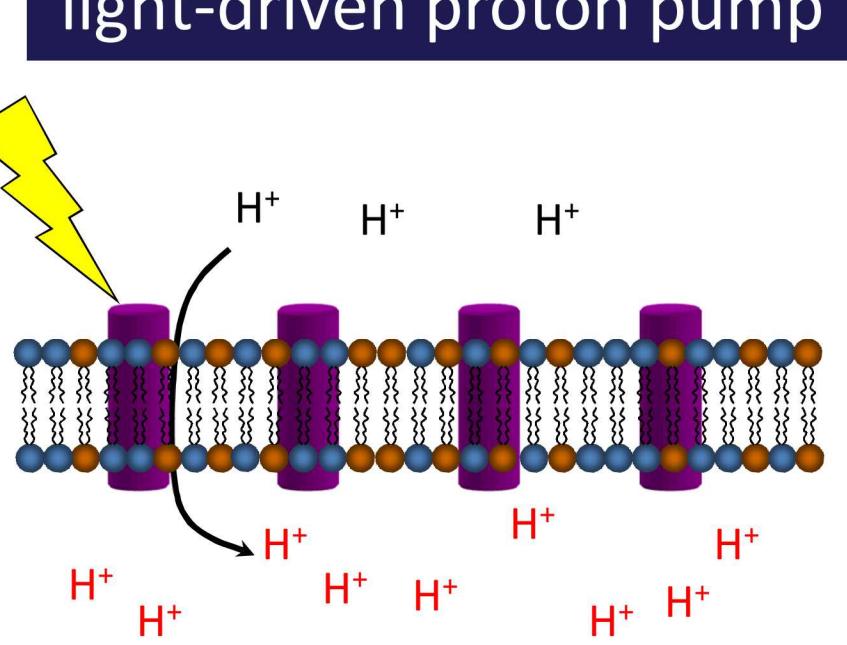
## Toolbox of Biological Nanomotors

A variety of biological nanomotors have been isolated and reconstituted *ex vivo*. CINT's library of biomotors includes:

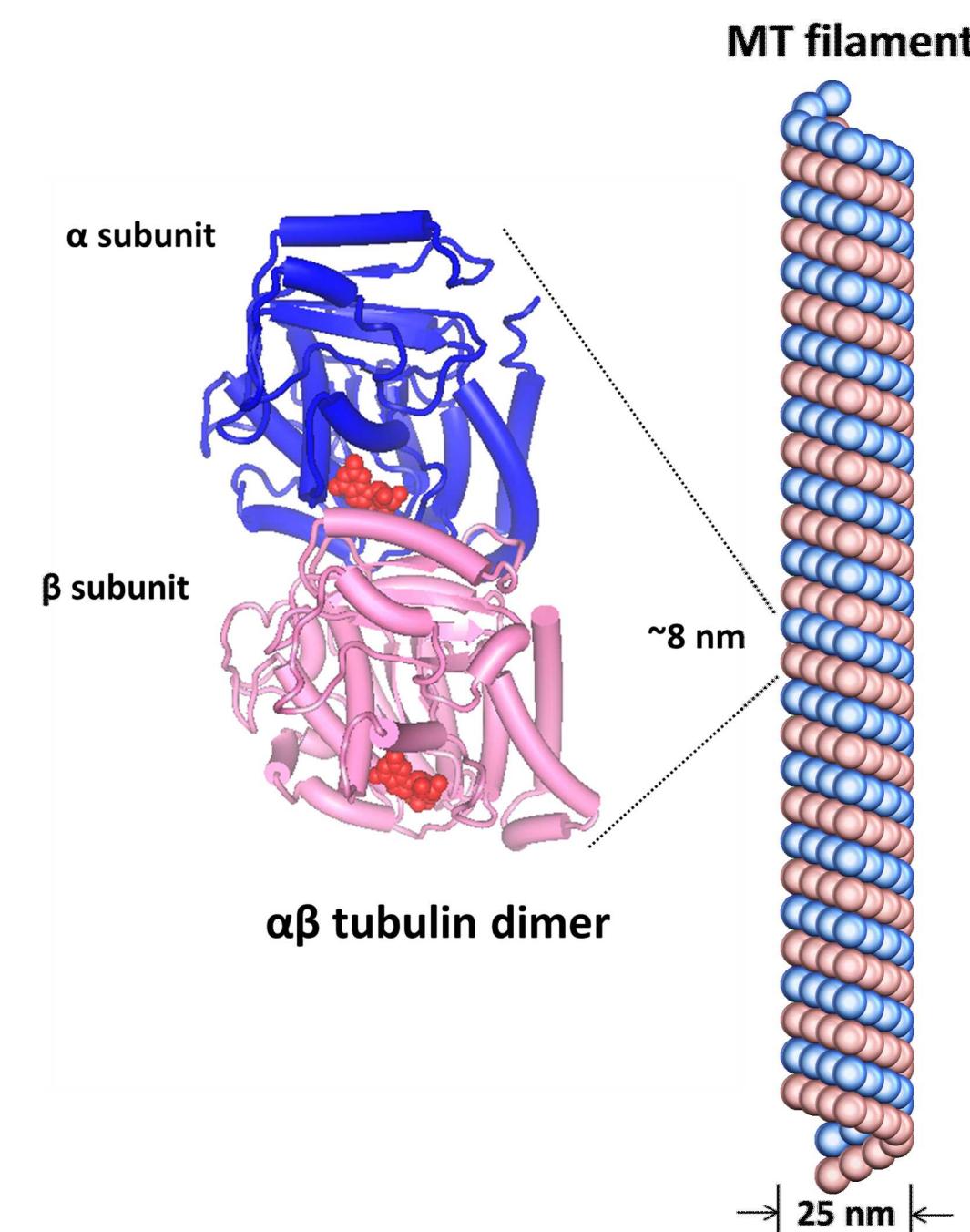
### Kinesin transport motor



### Bacteriorhodopsin light-driven proton pump

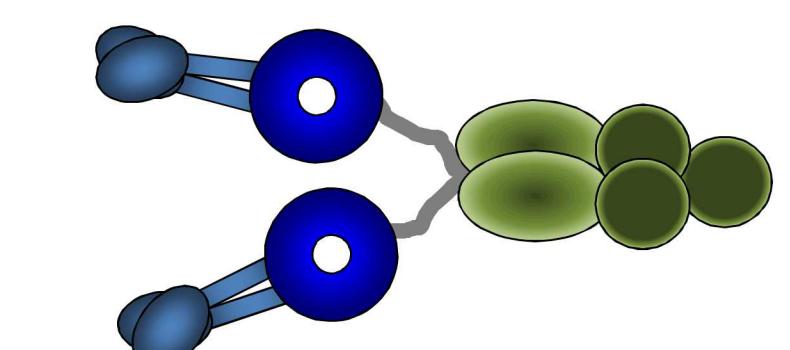


### Microtubule (MT) active biopolymer

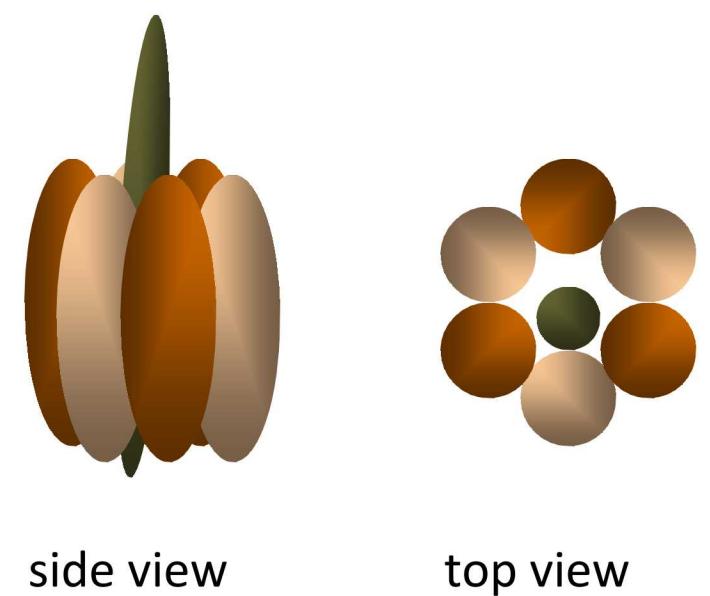


MT filament

### Dynein linear motor



### F<sub>1</sub>-ATP synthase rotary motor

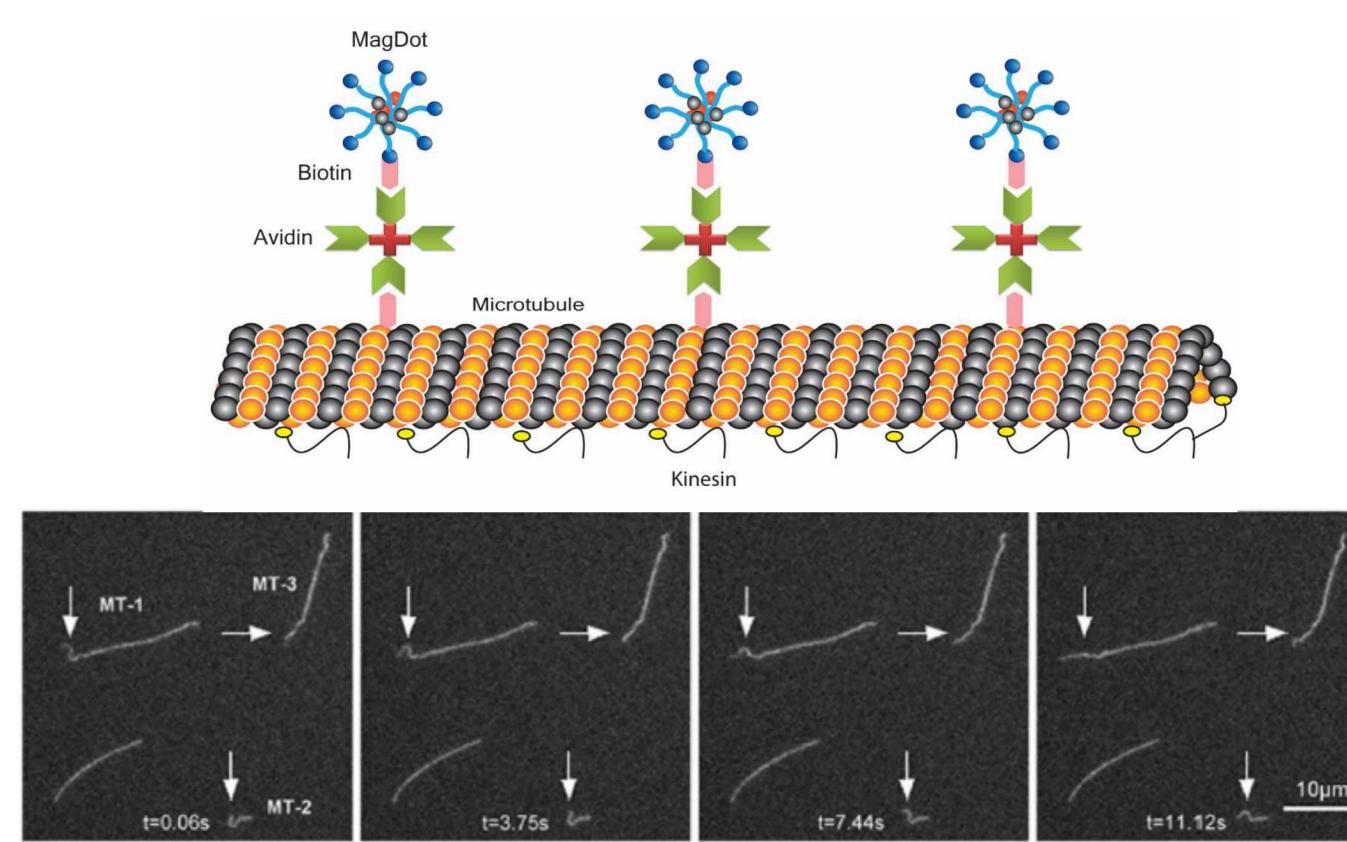


## Examples of CINT User Projects

### Magnetic Steering of Biomotor Transport

User: Jessica Winter (Ohio State University)

Accomplishment: Demonstrated controlled steering and removal of microtubule transport using magnetic nanoparticles and external magnetic fields.

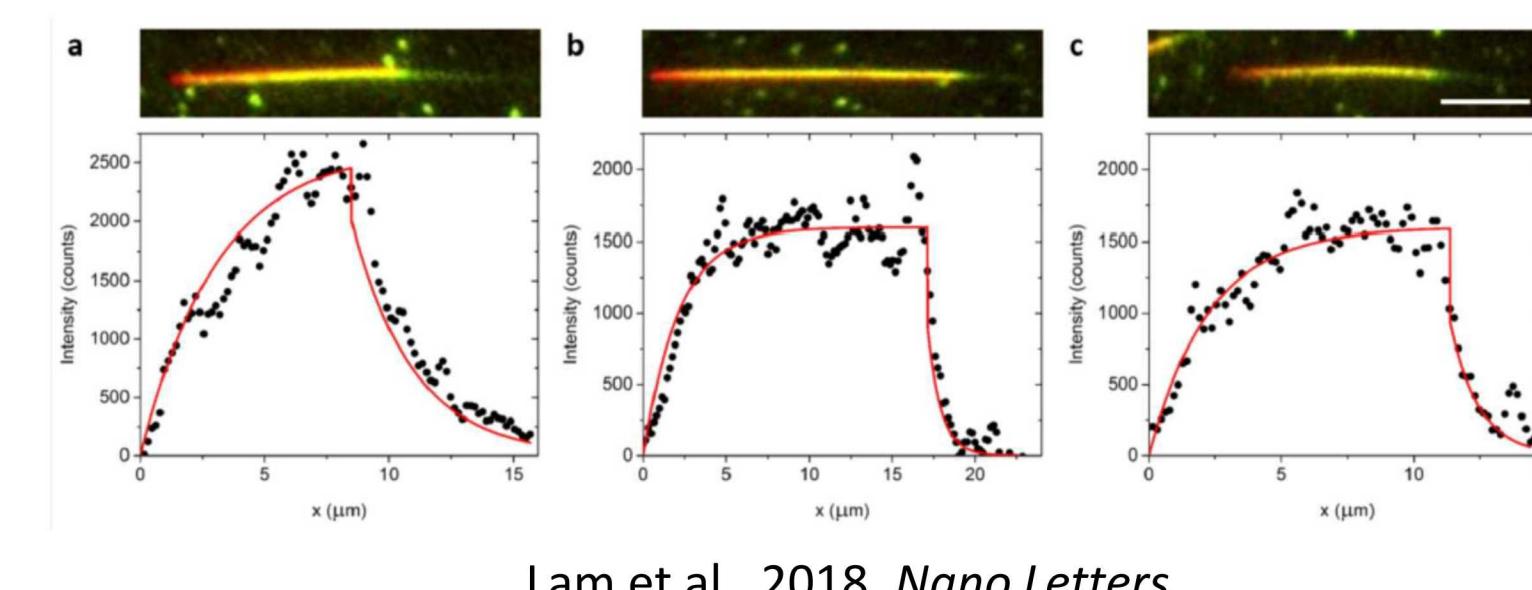
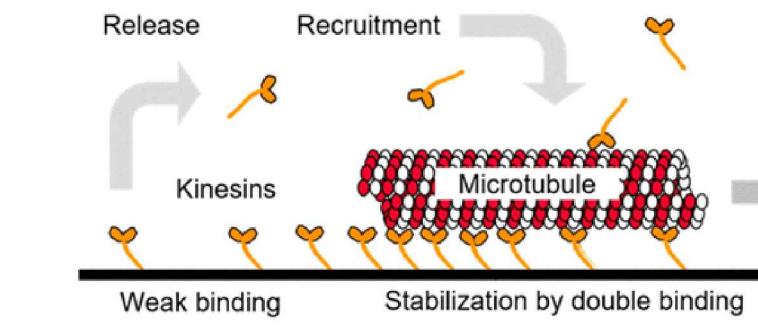


Mahajan et al., 2016, *Nanoscale*; Mahajan et al., 2018, *Biotechnol. J.*

### Dynamic Recruitment of Biomotors

User: Henry Hess (Columbia University)

Accomplishment: Realized a system in which active building blocks (i.e., motors) dynamically assemble and disassemble while retaining transport function.

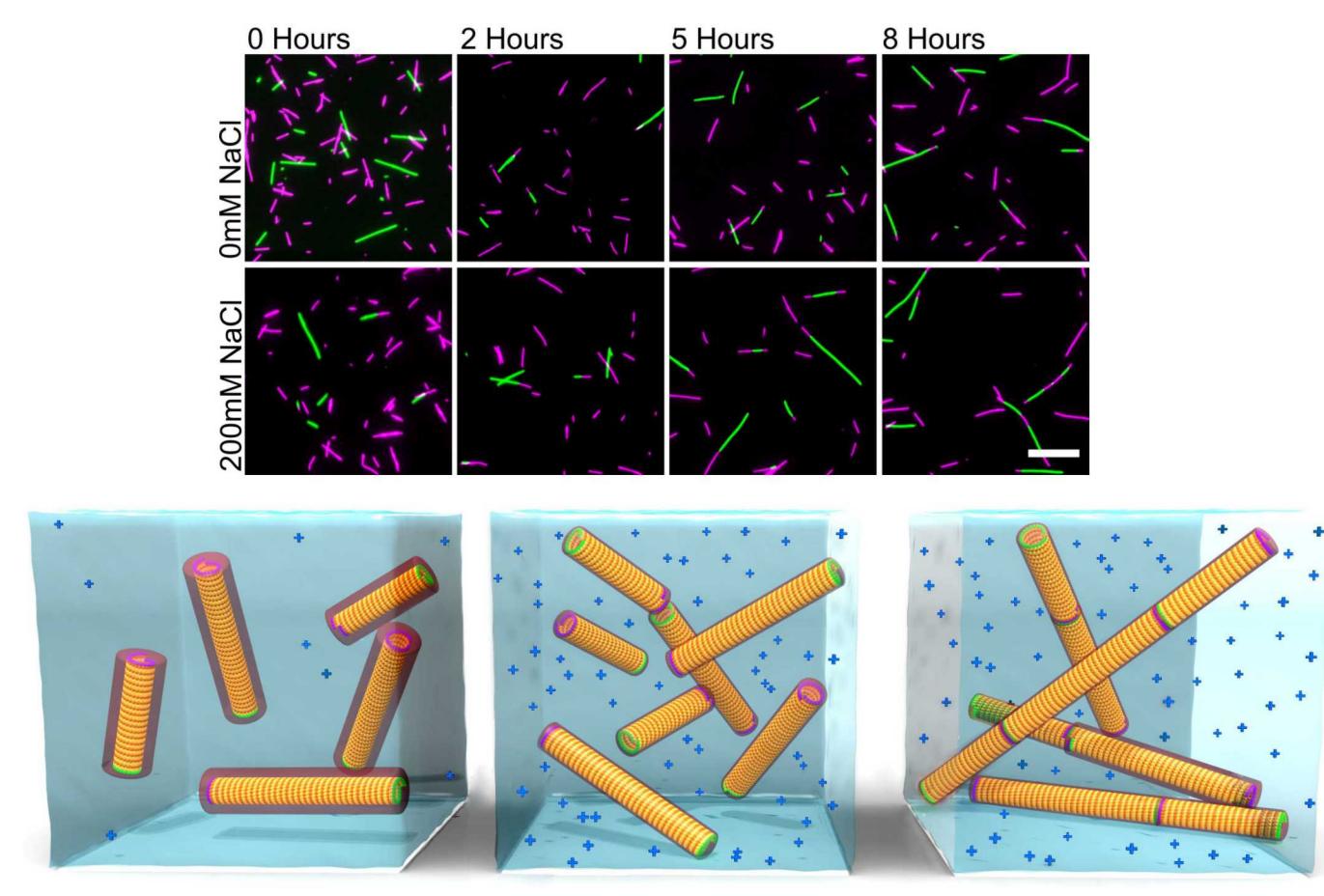


Lam et al., 2018, *Nano Letters*

### Directed Assembly of Janus Bio-Rods

User: Adrienne Greene (Sandia National Labs)

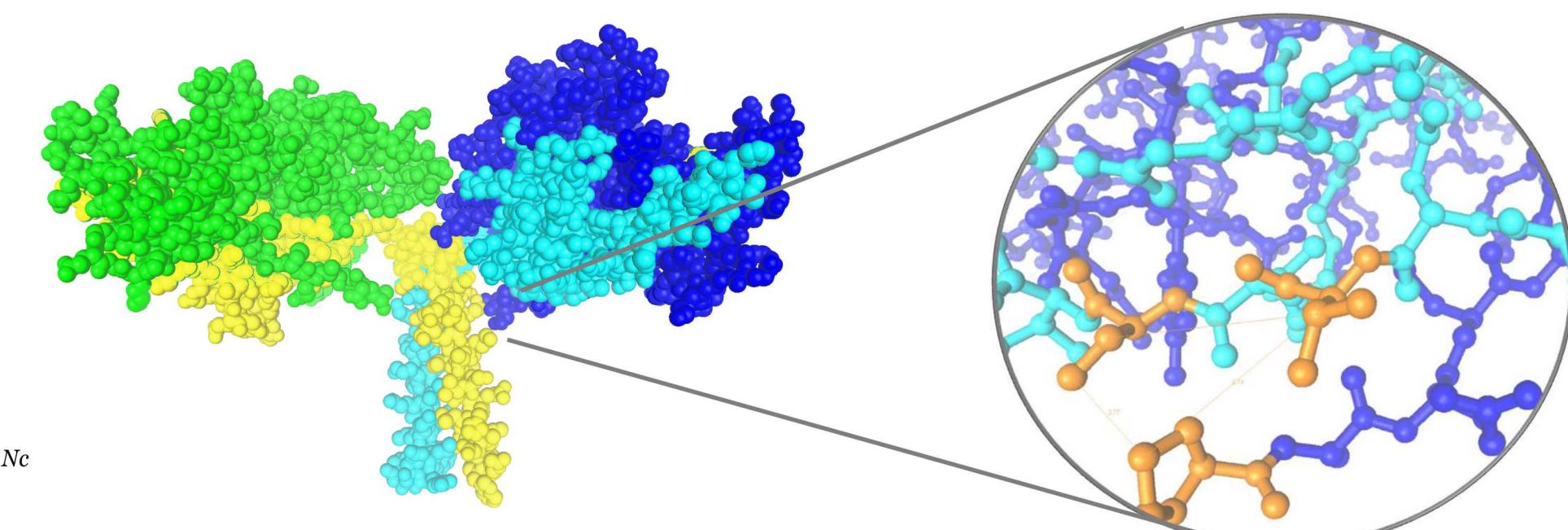
Accomplishment: Described the role of long- and short-range interactions in the head-to-tail assembly of microtubule filaments.



Greene et al., 2017, *Chem. Comm.*

## Design and Production of Biomotors

Genetic and protein engineering techniques are used to develop specialized biomotors for use in integrated nanosystems.



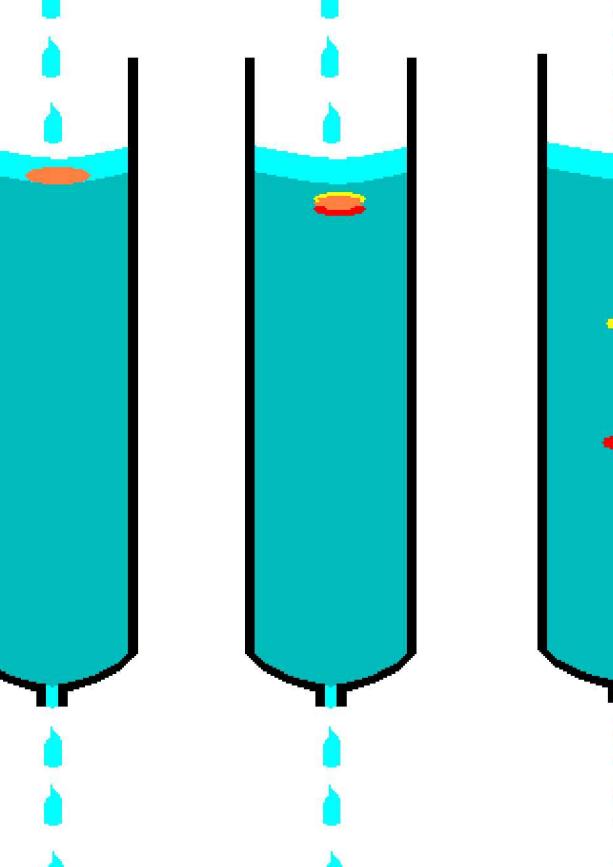
Asn Gln Lys **His** Leu Ser  
GAA CCA GAA **GCA** CCT ATC  
CTT GGT CTT **CGT** GGA TAG

Modify and enhance motors through changes in protein structure

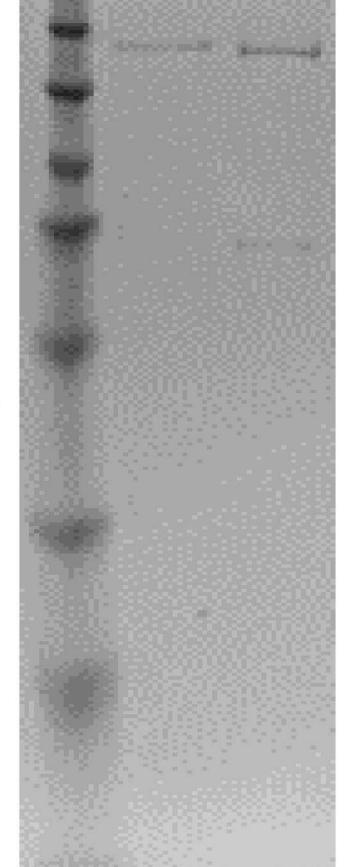
### Production in bacterial "factories"



### Separation and purification



### Purified protein



## Acknowledgments

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