ZERNIKE INSTITUTE COLLOQUIUM

Thursday, March 2nd, 2017

16:00h, Lecture Hall: 5111.0080 Coffee and cakes from 15:30h

Engineering with molecular motors

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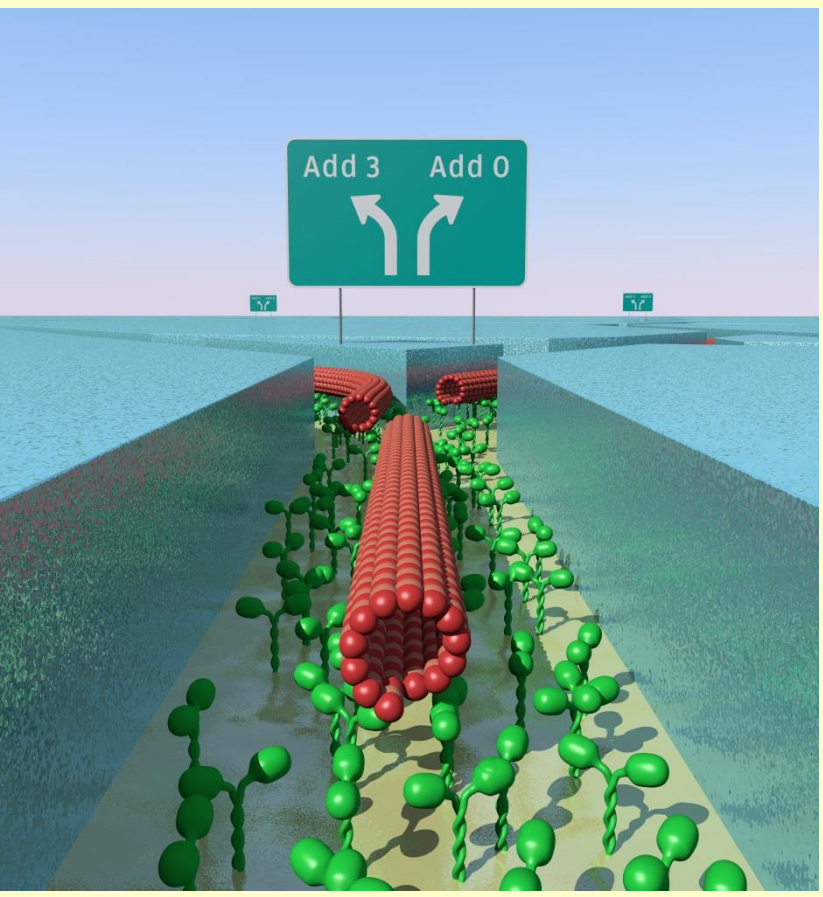
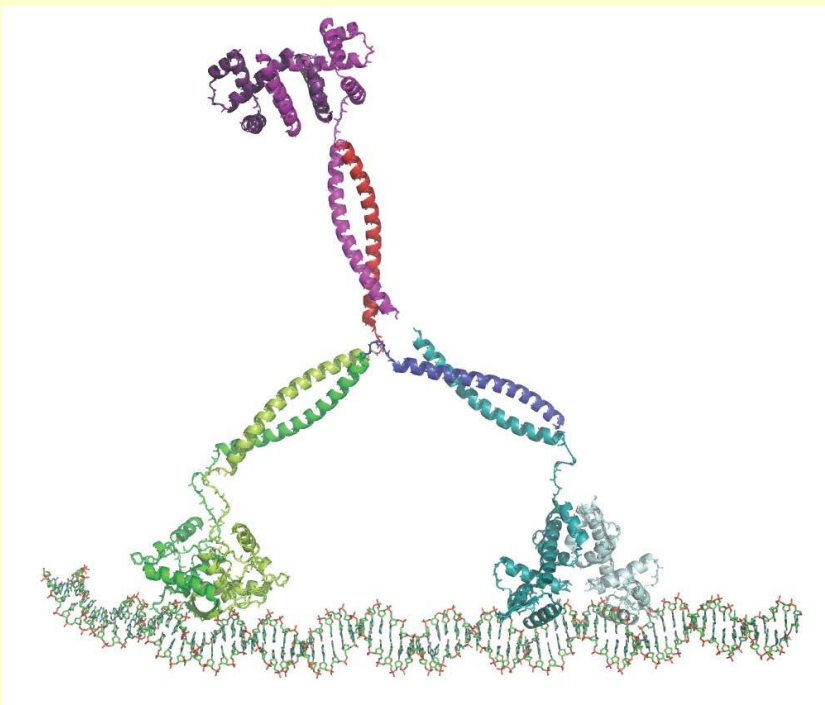


Protein-based molecular motors are ubiquitous in biology where they play central roles in essentially all cellular processes. In this colloquium, I will present two major projects concerning the engineering of, and with, protein based molecular motors.

First, I will report the status of an international effort to create an artificial, protein-based motor. Using the same material system (proteins) as biology is a high-risk, high gain effort. On the one hand, due to its complexity, it is still very difficult to design a protein with specific functions from the bottom up. On the other hand, the exquisite variety and performance (e.g. an almost ideal energy efficiency) of biological motors shows that a high degree of engineering excellence can be achieved in principle. I will report on the design and construction of "Tumbleweed", a protein assembly designed to move along a DNA track, powered by externally controlled changes in ligand concentrations that control binding and unbinding between Tumbleweed and track.

Second, I will discuss efforts to use biological molecular motors for engineering applications, specifically to build an highly energy efficient, parallel computer. Electronic computers are extremely powerful at performing a high number of operations at very high speeds, sequentially. However, they struggle with combinatorial tasks that can be solved faster if many operations are performed in parallel. We recently presented proof-of-concept of a molecular-motor based parallel computer by solving the specific instance {2, 5, 9} of a classical nondeterministic-polynomial-time complete ("NP-complete") problem, the subset sum problem. The computer consists of a specifically designed, nanostructured network explored by a large number of molecular-motor-driven, protein filaments. This system is highly energy efficient, thus avoiding the heating issues limiting electronic computers. I will discuss the technical advances necessary to solve larger combinatorial problems than existing computation devices.



Nicolau, D. V et al. (2016). Parallel computation with molecular-motor-propelled agents in nanofabricated networks. *PNAS*, **113** 2591–2596 (2016).

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