Single Molecule Nano-Bioscience

Toshio Yanagida

Formation of soft nano-machines CREST, JST, and
Graduate School of Frontier Bioscience, Osaka University Medical School
http://www.phys1.med.osaka-u.ac.jp/

Biomolecules assemble to form molecular machines such as molecular motors, cell signal processors, DNA transcription processors and protein synthesizers to fulfill their functions. Their collaboration allows the activity of biological systems. The reactions and behaviors of molecular machines vary flexibly while responding to their surroundings. This flexibility is essential for biological organisms. The underlying mechanism of molecular machines is not as simple as that expected from analogy with man-made machines. Since molecular machines are only nanometers in size and has a flexible structure, it is very prone to thermal agitation. Furthermore, the input energy level is not much difference from average thermal energy, kBT. Molecular machines can thus operate under the strong influence of this thermal noise, with a high efficiency of energy conversion. They would not overcome thermal noise but effectively use it for their functions. This is in sharp contrast to man-made machines that operate at energies much higher than the thermal noise. In recent years, the single molecule detection (SMD) and nano-technologies have rapidly been expanding to include a wide range of life science. The dynamic properties of biomolecules and the unique operations of molecular machines, which were previously hidden in averaged ensemble measurements, have now been unveiled. The aim of our research is to approach the engineering principle of adaptive biological system by uncovering the unique operation of biological molecular machines. I survey our SMD experiments designed to investigate molecular motors, enzyme reactions, protein dynamics, DNA transcription and cell signaling.

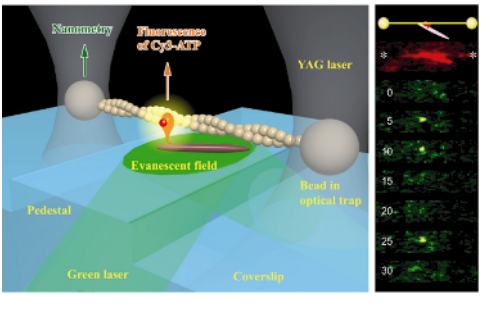

Fig. 1. Single molecule imaging and nano-manipulation of an actomyosin molecular motor. The position and chemical (ATPase) reaction of a myosin molecule are observed by evanescence-based fluorescence microscopy and individual mechanical events due to actin and myosin interaction are detected by optical trapping nanometry.

A.J. Ijspeert et al. (Eds.): BioADIT 2006, LNCS 3853, p. 4, 2006.