

MCEN GRADUATE SEMINAR

Thomas Perkins

JILA and Dept of Molecular, Cellular, and Developmental Biology
CU, Boulder

Advanced Force Spectroscopy Techniques for Optical Traps and AFMs

Sep 10th 2009 3:00PM-4:00PM DLC

Abstract:

Force spectroscopy is an important single-molecule technique to study the energetics and dynamics of biological systems. Both optical traps and atomic force microscopes (AFMs) can measure the dynamics of individual molecules. My talk will focus on two intellectually distinct ways to improve these experiments: passive force clamps and an optically stabilized AFM.

To increase measurement precision, feedback is used to maintain a constant force on a molecule – often called a force clamp. Yet, active feedback is inherently bandwidth limited. Here, we show that a passive force clamp – where the bead is held at the position of maximum force in a trap, not the linear region ($F = -k_{\text{trap}} \cdot x_{\text{bd}}$) – eliminated the short-lived spurious transitions present in active force clamps. Overall, the dynamics determined in force clamps can be significantly altered by the mechanism of force feedback.

In a typical AFM-based force spectroscopy experiment, this sensitivity to drift – in all three dimensions – is exacerbated by the short contour lengths of proteins. We developed an ultrastable AFM by scattering a laser off the apex of a commercial AFM tip, not its back side. A second laser was used to detect and thereby stabilize the sample. These two lasers established an optically based, differential reference frame. This reference frame was stable to 0.02 nm in 3D. This new tip measurement capability will enable operation in force- or position-clamp modes that are essentially insensitive to long-term drift of the AFM assembly.

Biography:

Thomas Perkins studied physics at Harvard University. He received his Ph. D. in single-molecule polymer physics at Stanford University in the group of Steve Chu. For this work, he received the APS Padden Award. His post-doctoral research focused on DNA-based molecular motors at both Princeton and Stanford Universities in the group of Steve Block. He won a Burroughs Wellcome Fund Career Award in the Biomedical Sciences. He is currently a Fellow at JILA, a staff member of NIST's Quantum Physics Division, and an assistant professor (adjoint) in the Molecular, Cellular, and Developmental Biology Department at CU-Boulder.

