Single Molecule Methods
and their applications in protein/nucleic acid interactions
MAGNETIC TRAPPING

\[ F_r \approx F_m \theta = \left( F_m \Delta x \right) / L \]

Hookean spring equation
\[ F_r = \left( F_m / L \right) \Delta x = \kappa \Delta x \]

Mean energy in a spring
\[ E = \kappa \langle \Delta x^2 \rangle / 2 \]
\[ E = \left( F_m / L \right) \langle \Delta x^2 \rangle / 2 \]

Equipartition theorem
\[ E = k_B T / 2 \]
\[ F_m = \left( k_B T \right) L / \langle \Delta x^2 \rangle \]
MAGNETIC TRAPPING

by raising or lowering the magnets, one can stretch the DNA as in the optical tweezer.

this allows the calculation of material properties like the persistence length \( (p) \) and the stretch modulus \( (s) \).

practical course, TU Dresden, Ralf Seidel
MAGNETIC TRAPPING

NdFeB magnets

magnetic bead

DNA

objective

n turns

dx
MAGNETIC TRAPPING

the real strength of the magnetic tweezer is the ability to twist the bead by turning the magnets.

measure how the polymer responds to torque.

DNA with a known amount of supercoils can be generated and used as a template for experiments with several classes of enzymes.
MAGNETIC TRAPPING

topoisormerase II

MAGNETIC TRAPPING
RNA polymerase promoter opening

Lk = Wr + Tw

Lk: linking number
Wr: writhe
Tw: twist

MAGNETIC TRAPPING

RNA polymerase promoter opening