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## 1.- What is microrheology?

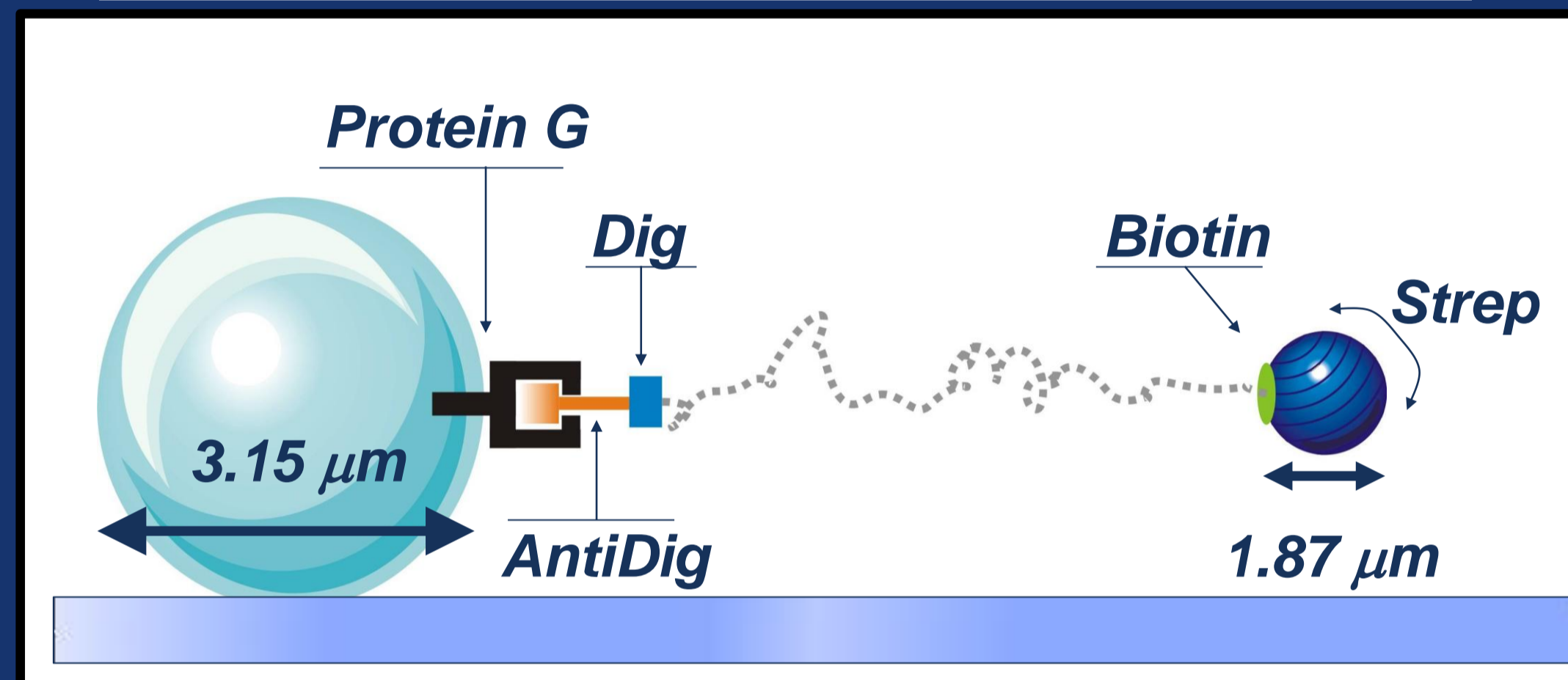
Microrheology is a technique to measure local viscous and elastic properties in small samples of a material, by observing the motion of micrometer-sized probe particles.

Advantages over conventional macrorheology:

- i) Viscoelasticity can be measured over a wide frequency range.
- ii) Sample amounts can be as small as a femtoliter
- iii) The influence of the size and surface properties of the probe particle on the viscoelasticity can be studied.

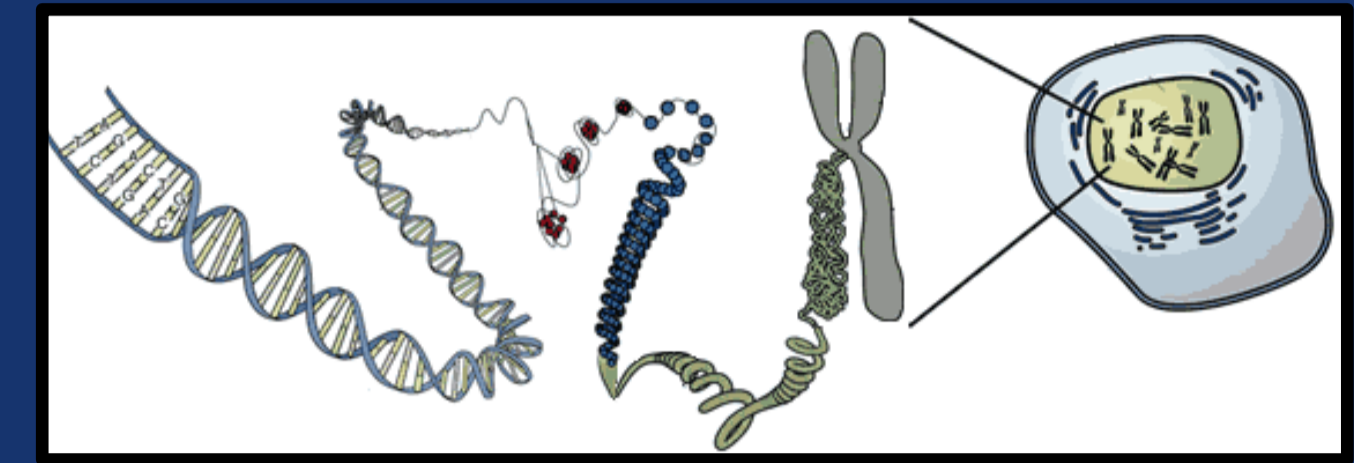
Previous studies have been conducted by other groups to know friction, spring constant and relaxation time of DNA.<sup>1,2</sup>

## 3.- How is the DNA molecule attached?



## 2.- Why DNA?

The difference between the length scales of DNA and cell nuclei is around four orders of magnitude.



Transcription, translation and replication requires DNA to loosen its quaternary structure. After this the molecule returns to its previous stage.

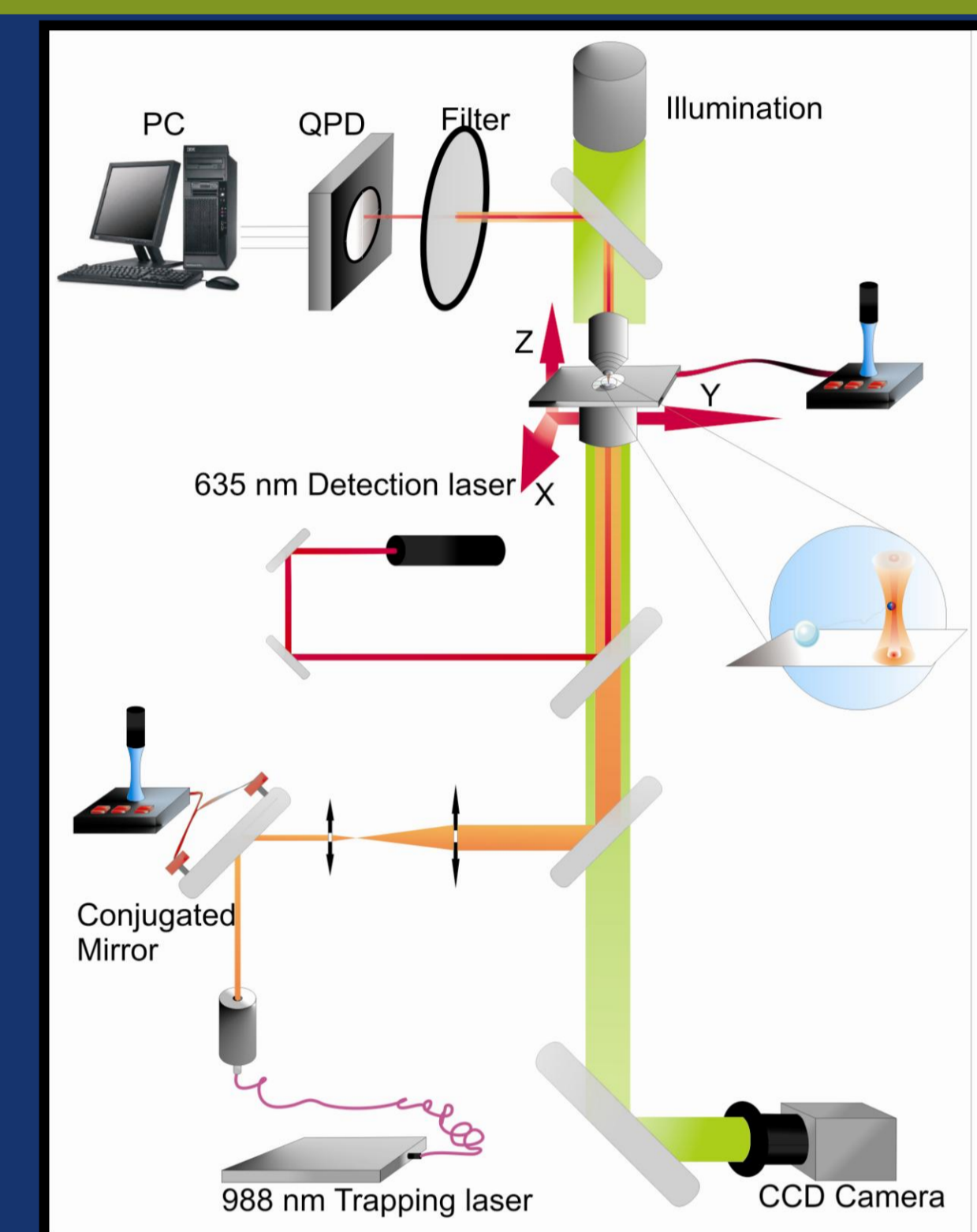


## 4.- Optical setup

An inverted microscope with a 100X, high NA immersion oil objective is used to focus the 985 nm trapping laser and the 635 nm detection laser.

The position of the small bead is sampled at 50 kHz.

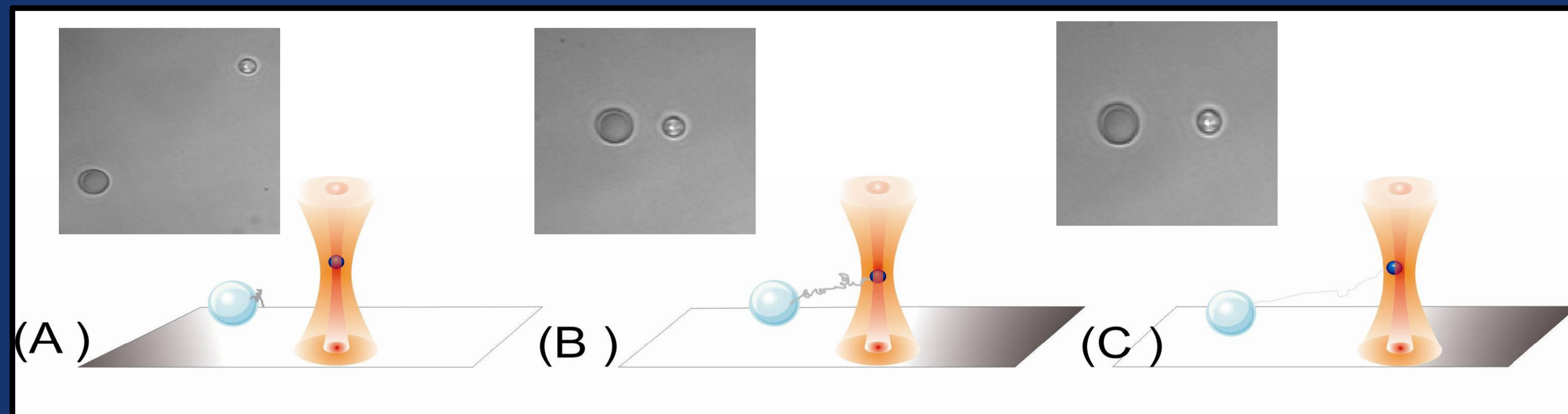
The sample and trapping laser are electronically controlled by joysticks.



## 5.- Experimental procedure

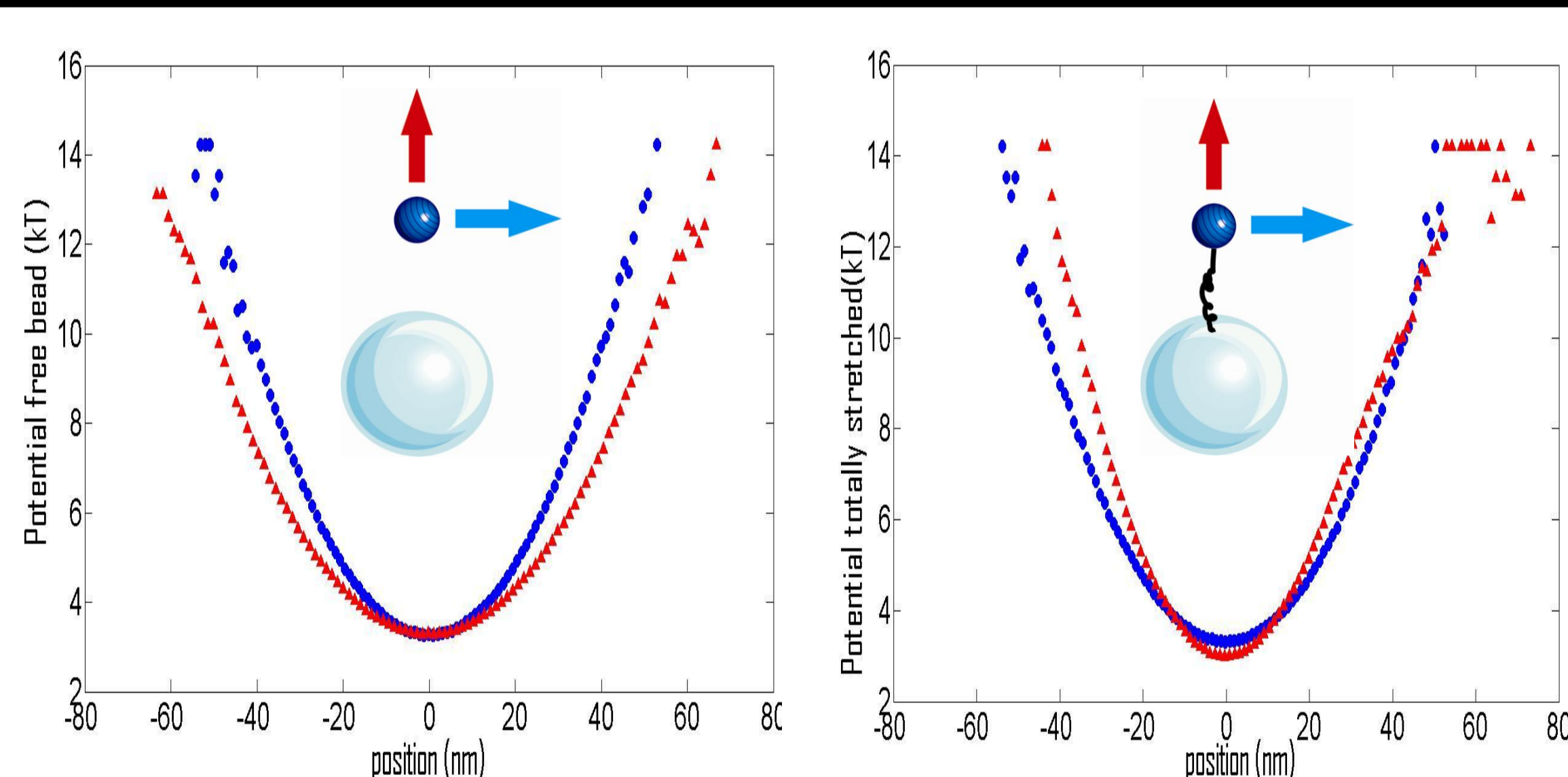
We have studied the behavior of the DNA molecule in three different situations:

- A. Free bead
- B. Intermediately stretched (~2nm)
- C. Totally stretched (~4nm)



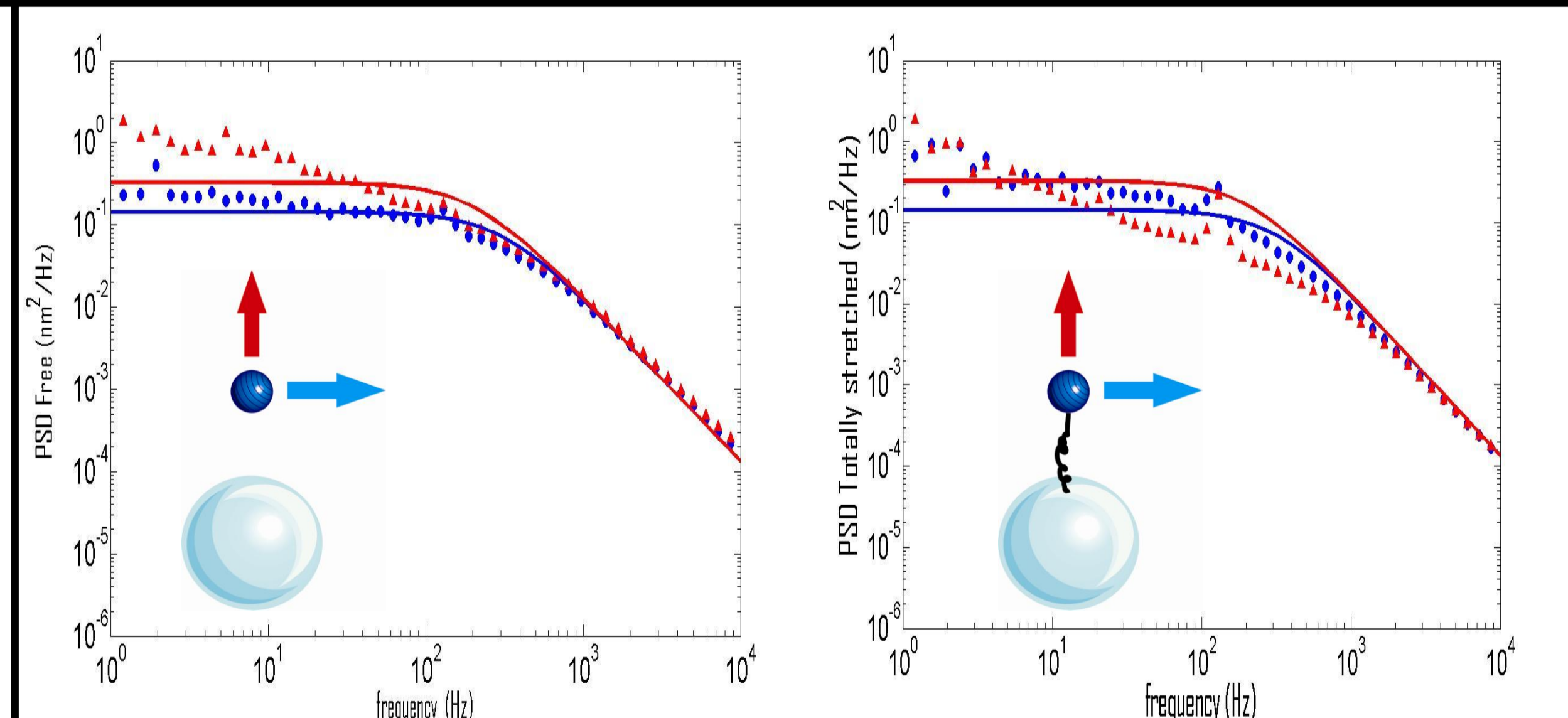
## 6.- Results

Potential energy of the bead



$$prob(x) \propto e^{-\frac{Potential(x)}{kT}} \Rightarrow Potential(x) = -kT \log(p(x))$$

Power spectral density of the bead position



$$|X_{Free}(f)|^2 = \frac{kT}{2\pi^2(f^2 + f_c^2)} \Rightarrow |X_{attached}(f)|^2 = ?$$

## 7.- Conclusions

Optical trapping microrheology allows investigating the visco-elastic properties of a single DNA molecule. Analyzing the displacement histogram provides information on the variation of the potential energy along the DNA axis and perpendicular to it. Future work will concentrate on understanding the differences between the PSD's of stretched and unstretched DNA molecules.

## 8.- References

- 1) J. Meiners et al, "Femtonewton Force Spectroscopy of single extended DNA molecules", *PRL* 84, 2000, 5014
- 2) D. Mizuno et al, "Active and Passive Microrheology in Equilibrium and Nonequilibrium Systems", *Macromolecules*, 41, 7194-7202

## 9.- Acknowledgements:

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