

The appeal of single-molecule and single-cell studies

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I will provide a number of highlights from our recent single-molecule and single-cell research:

1. *Dynamics of DNA supercoils* [1]

DNA in cells exhibits a supercoiled state where the double helix is additionally twisted to form extended intertwined loops known as plectonemes. Although supercoiling is vital to many cellular processes, its dynamics remain elusive. We have recently managed to directly visualize the dynamics of individual plectonemes. We observe that multiple plectonemes can be present and that their number depends on applied stretching force and ionic strength. Plectonemes are found to move along DNA by diffusion or, unexpectedly, by a fast hopping process which facilitates very rapid (< 20 ms) long-range plectoneme displacement by nucleating a new plectoneme at a distant position. The observations directly reveal the dynamics of plectonemes and identify a new mode of movement that allows long-distance reorganization of the conformation of the genome on a millisecond timescale. Follow up experiments now concentrate on the elucidating the effects of local pinning due to DNA sequence and bound proteins.

2. *DNA and protein translocation through solid-state nanopores* [2]

Solid-state nanopores have proven to be a surprisingly versatile probe for single-molecule analysis of DNA. I will describe some of our recent efforts to expand the capabilities of solid-state nanopores even further, in the direction of single-protein detection, graphene nanopores, plasmonic nanopores, DNA origami nanopores, and biomimetic nanopores.

3. *Min oscillations in arbitrarily shaped E. coli cells* [3]

I will show our ability to shape live *E. coli* bacteria into novel shapes such as rectangles, squares, triangles and circles. We study spatiotemporal oscillations of Min proteins – associated with cell division – in these geometries.

References

- [1] M.T.J. van Loenhout, M.V. de Grunt, C. Dekker: *Dynamics of DNA supercoils*. *Science* **338**, 94–97 (2012)
- [2] C. Dekker: *Solid-state nanopores*. *Nature Nanotechnol.* **2**, 209–215 (2007)
- [3] F. Wu et al, to be published