The Third Dimension Casts New Light on Soft-Matter Science and Cell Biology

Francesco Pampaloni

European Molecular Biology Laboratory (EMBL), Heidelberg

and

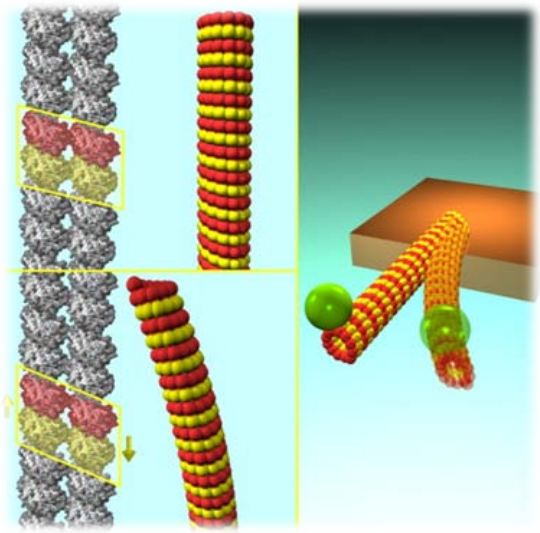
Frankfurt Institute for Molecular Life Sciences (FMLS), Frankfurt

Most of the assays in soft matter science and cell biology are performed on two-dimensional plastic or glass substrates. Although “coverslip”- and “Petri dish”-based experiments are invaluable in science, two-dimensional flat and hard substrates may introduce significant experimental biases.

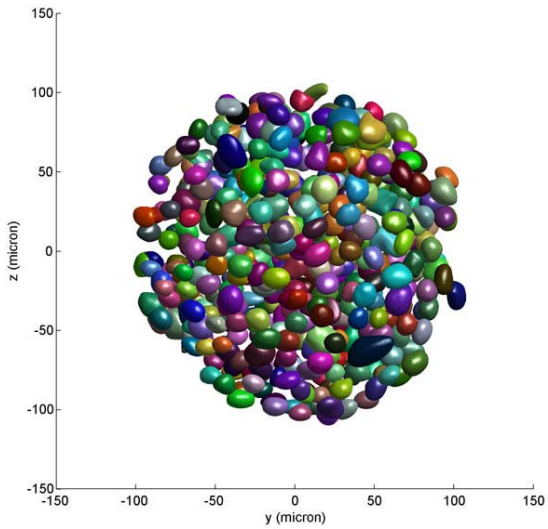
I will present three seemingly different sets of experiments illustrating the power of “moving to the third dimension” in soft matter science and cell biology.

1) Unexpected nanomechanical properties of microtubules, which are self-organizing cellular biopolymers, appear by analyzing the thermal motion of the microtubule’s tip fluctuating in three dimensions.
2) New aspects of microtubule shrinking and growing dynamics (the so-called “dynamic instability”) emerge in a three-dimensional environment.
3) Culturing cells in three-dimensional gels instead of on two-dimensional surfaces provides a powerful new approach to cell biology, by promoting tissue-like cell-cell and cell-matrix interactions.

A common aspect of all these experiments is the combination of three-dimensional sample preparation and three-dimensional imaging with light sheet-based fluorescence microscopy.



3D thermal fluctuations of microtubules



3D tumor cellular spheroid