Active fluctuations of Microtubules

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Microtubules are a key part of the cytoskeleton of eukaryotic cells. They are responsible for a wide range of mechanical properties and serve many different tasks within the cell e.g. they play an important role during mitosis. In order to be able to fulfill these tasks the microtubules have to be able to adapt their shape. However, Gittes et al have shown in vitro [1] that isolated microtubules have a very high thermal persistence length, which in fact means that they are very rigid and therefore do not show a high degree of bending. In this work the bending spectra of microtubules within a cell are investigated and their persistence length is analysed. It can be shown that the persistence lengths of the filaments in vivo are two orders of magnitudes smaller than in vitro and the bending spectrum of the filaments has a fundamentally different shape compared to purely thermally fluctuating ones. Besides the analysis of the experimental data a theoretical model is developed where active cross-linkers deform the microtubule and therefore lower their persistence length. This model for the dynamics of microtubules is able to reproduce experimental results and explain a possible origin of the high deformations of microtubules in living cells.

[1] Gittes F, Mickey B, Nettleton J and Howard J, The Journal of Cell Biology, 120:923-934 (1993).