



Universiteit
Leiden
The Netherlands

Insights into microtubule catastrophes: the effect of end-binding proteins and force

Kalisch, S.M.J.

Citation

Kalisch, S. M. J. (2023, December 13). *Insights into microtubule catastrophes: the effect of end-binding proteins and force*. Retrieved from <https://hdl.handle.net/1887/3673428>

Version: Publisher's Version

[Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

License: <https://hdl.handle.net/1887/3673428>

Note: To cite this publication please use the final published version (if applicable).

References

- [web, a] <http://celldynamics.org/celldynamics/research/cytokinesis/>.
- [web, b] <http://www.london-research-institute.org.uk/research/takashi-toda/projects>.
- [web, c] <http://www.proteinatlas.org/dictionary/cell/cytoskeleton++microtubules>.
- [Adames and Cooper, 2000] Adames, N. R. and Cooper, J. A. (2000). Microtubule interactions with the cell cortex causing nuclear movements in *saccharomyces cerevisiae*. *J Cell Biol*, 149(4):863–874.
- [Aher et al., 2018] Aher, A., Kok, M., Sharma, A., Rai, A., Olieric, N., Rodriguez-Garcia, R., Katrukha, E., Weinert, T., Olieric, V., Kapitein, L., Steinmetz, M., Dogterom, M., and Akhmanova, A. (2018). CLASP suppresses microtubule catastrophes through a single TOG domain. *Dev Cell*, 46:40–58.
- [Akhmanova et al., 2001] Akhmanova, A., Hoogenraad, C. C., Drabek, K., Stepanova, T., Dortland, B., Verkerk, T., Vermeulen, W., Burgering, B. M., De Zeeuw, C. I., Grosveld, F., and Galjart, N. (2001). Clasps are clip-115 and-170 associating proteins involved in the regional regulation of microtubule dynamics in motile fibroblasts. *Cell*, 104(6):923–935–.
- [Akhmanova and Steinmetz, 2008] Akhmanova, A. and Steinmetz, M. O. (2008). Tracking the ends: a dynamic protein network controls the fate of microtubule tips. *Nature Reviews Molecular Cell Biology*, 9(4):309–322–.
- [Akhmanova and Steinmetz, 2015] Akhmanova, A. and Steinmetz, M. O. (2015). Control of microtubule organization and dynamics: two ends in the limelight. *Nature reviews. Molecular cell biology*, 16:711–726.
- [Alberts et al., 2002] Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2002). *Molecular Biology Of The Cell*, volume 4. Garland Publishing, New York.
- [Allen and Borisy, 1974] Allen, C. and Borisy, G. G. (1974). Structural polarity and directional growth of microtubules of chlamydomonas flagella. *Journal of Molecular Biology*, 90(2):381–402.
- [Alushin et al., 2014] Alushin, G., Lander, G., Kellogg, E., Zhang, R., Baker, D., and Nogales, E. (2014). High-resolution microtubule structures reveal the structural transitions in ab-tubulin upon gtp hydrolysis. *Cell*, 157:1117–1129.
- [Amos and Klug, 1974] Amos, L. A. and Klug, A. (1974). Arrangement of subunits in flagellar microtubules. *Journal of Cell Science*, 14(3):523–549.
- [Antal et al., 2007] Antal, T., Krapivsky, P., Redner, S., Mailman, M., and Chakraborty, B. (2007). Dynamics of an idealized model of microtubule growth and catastrophe. *Phys Rev E Stat Nonlin Soft Matter Phys*, 76:41907.
- [Arnal et al., 2004] Arnal, I., Heichette, C., Diamantopoulos, G. S., and Chretien, D. (2004). Clip-170/tubulin-curved oligomers coassemble at microtubule ends and promote rescues. *Current Biology*, 14(23):2086–2095–.
- [Ashkin, 1970] Ashkin, A. (1970). Acceleration and trapping of particles by radiation pressure. *Physical Review Letters*, 24(4):156–159–.
- [Atkins, 1979] Atkins, P. W. (1979). *Physical Chemistry*. Oxford University Press.
- [Aumeier et al., 2016] Aumeier, C., Schaedel, L., Gaillard, J., John, K., Blanchoin, L., and Théry, M. (2016). Self-repair promotes microtubule rescue. *Nature cell biology*, 18:1054–1064.
- [Barnes et al., 2001] Barnes, R. S. K., Calow, P., Olive, P., Golding, D., and Spicer, J. (2001). *Invertebrates with Legs: the Arthropods and Similar Groups. The Invertebrates: A Synthesis..* Blackwell Publishing.
- [Barton and Goldstein, 1996] Barton, N. R. and Goldstein, L. S. (1996). Going mobile: microtubule motors and chromosome segregation. *Proceedings of the National Academy of Sciences*, 93(5):1735–1742.
- [Bayley et al., 1989] Bayley, P., Schilstra, M., and Martin, S. (1989). A lateral cap model of microtubule dynamic instability. *FEBS Lett*, 259:181–184.

-
- [Beinhauer et al., 1997] Beinhauer, J. D., Hagan, I. M., Hegemann, J. H., and Fleig, U. (1997). Mal3, the fission yeast homologue of the human apc-interacting protein eb-1 is required for microtubule integrity and the maintenance of cell form. *J Cell Biol*, 139(3):717–728.
- [Bieling et al., 2008] Bieling, P., Kandels-Lewis, S., Telley, I. A., van Dijk, J., Janke, C., and Surrey, T. (2008). Clip-170 tracks growing microtubule ends by dynamically recognizing composite eb1/tubulin-binding sites. *Journal of Cell Biology*, 183(7):1223–1233–.
- [Bieling et al., 2007] Bieling, P., Laan, L., Schek, H., Munteanu, E. L., Sandblad, L., Dogterom, M., Brunner, D., and Surrey, T. (2007). Reconstitution of a microtubule plus-end tracking system in vitro. *Nature*, 450(7172):1100–1105.
- [Bollinger and Stevens, 2019] Bollinger, J. and Stevens, M. (2019). Diverse balances of tubulin interactions and shape change drive and interrupt microtubule depolymerization. *Soft Matter*, 15:8137–8146.
- [Bouchet et al., 2016] Bouchet, B., Noordstra, I., Van Amersfoort, M., Katrukha, E., Ammon, Y., Ter Horst, N., Hodgson, L., Dogterom, M., DerkSEN, P., and Akhmanova, A. (2016). Mesenchymal cell invasion requires cooperative regulation of persistent microtubule growth by SLAIN2 and CLASP1. *Dev Cell*, 39:708–723.
- [Bowne-Anderson et al., 2015] Bowne-Anderson, H., Hibbel, A., and Howard, J. (2015). Regulation of microtubule growth and catastrophe: Unifying theory and experiment. *Trends in cell biology*, 25:769–779.
- [Bowne-Anderson et al., 2013] Bowne-Anderson, H., Zanic, M., Kauer, M., and Howard, J. (2013). Microtubule dynamic instability: a new model with coupled gtp hydrolysis and multistep catastrophe. *BioEssays : news and reviews in molecular, cellular and developmental biology*, 35:452–461.
- [Brangwynne et al., 2006] Brangwynne, C., Mackintosh, F., Kumar, S., Geisse, N., Talbot, J., Mahadevan, L., Parker, K., Ingber, D., and Weitz, D. (2006). Microtubules can bear enhanced compressive loads in living cells because of lateral reinforcement. *J Cell Biol*, 173:733–741.
- [Brangwynne et al., 2007] Brangwynne, C., Mackintosh, F., Weitz ; G, D., and Rice, L. (2007). Force fluctuations and polymerization dynamics of intracellular microtubules. *Proc Natl Acad Sci U S A*, 104:451–463.
- [Brouhard and Rice, 2018] Brouhard, G. and Rice, L. (2018). Microtubule dynamics: an interplay of biochemistry and mechanics. *Nat Rev Mol Cell Biol*, 19:451–463.
- [Brouhard et al., 2008] Brouhard, G. J., Stear, J. H., Noetzel, T. L., Al-Bassam, J., Kinoshita, K., Harrison, S. C., Howard, J., and Hyman, A. A. (2008). Xmap215 is a processive microtubule polymerase. *Cell*, 132(1):79–88–.
- [Browning et al., 2003] Browning, H., Hackney, D. D., and Nurse, P. (2003). Targeted movement of cell end factors in fission yeast. *Nature Cell Biology*, 5(9):812–818–.
- [Browning et al., 2000] Browning, H., Hayles, J., Mata, J., Aveline, L., Nurse, P., and McIntosh, J. R. (2000). Tea2p is a kinesin-like protein required to generate polarized growth in fission yeast. *Journal of Cell Biology*, 151(1):15–27–.
- [Brun et al., 2009] Brun, L., Rupp, B., Ward, J. J., and N??d??lec, F. (2009). A theory of microtubule catastrophes and their regulation. *Proceedings of the National Academy of Sciences*, 106(50):21173–21178.
- [Brunner and Nurse, 2000a] Brunner, D. and Nurse, P. (2000a). Clip170-like tip1p spatially organizes microtubular dynamics in fission yeast. *Cell*, 102(5):695–704–.
- [Brunner and Nurse, 2000b] Brunner, D. and Nurse, P. (2000b). New concepts in fission yeast morphogenesis. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences*, 355(1399):873–877–.
- [Burakov et al., 2002] Burakov, A. V., Nadezhina, E. S., and Rodionov, V. I. (2002). The nature of the centering force. *Molecular Biology of the Cell*, 13:199A–199A–.
- [Busch and Brunner, 2004] Busch, K. E. and Brunner, D. (2004). The microtubule plus end-tracking proteins mal3p and tip1p cooperate for cell-end targeting of interphase microtubules. *Current Biology*, 14(7):548–559–.

- [Busch et al., 2004] Busch, K. E., Hayles, J., Nurse, P., and Brunner, D. (2004). Tea2p kinesin is involved in spatial microtubule organization by transporting tip1p on microtubules. *Developmental Cell*, 6(6):831–843–.
- [Caplow et al., 1994] Caplow, M., Ruhlen, R. L., and Shanks, J. (1994). The free energy for hydrolysis of a microtubule-bound nucleotide triphosphate is near zero: all of the free energy for hydrolysis is stored in the microtubule lattice. *J. Cell Biol.*, 127(3):779–788.
- [Caplow and Shanks, 1996] Caplow, M. and Shanks, J. (1996). Evidence that a single monolayer tubulin-gtp cap is both necessary and sufficient to stabilize microtubules. *Mol Biol Cell*, 7(4):663–675.
- [Carlier and Pantaloni, 1982] Carlier, M. and Pantaloni, D. (1982). Assembly of microtubule protein: role of guanosine di- and triphosphate nucleotides. *Biochemistry*, 21:1215–1224.
- [Carlier et al., 1989] Carlier, M. F., Didry, D., Simon, C., and Pantaloni, D. (1989). Mechanism of gtp hydrolysis in tubulin polymerization: characterization of the kinetic intermediate microtubule-gdp-pi using phosphate analogs. *Biochemistry*, 28(4):1783–1791.
- [Carlier et al., 1984] Carlier, M.-F., Hill, T. L., and Chen, Y.-D. (1984). Interference of GTP hydrolysis in the mechanism of microtubule assembly: an experimental study. *Proc. Natl. Acad. Sci.*, 81(3):771–775.
- [Carlier and Pantaloni, 1981] Carlier, M. F. and Pantaloni, D. (1981). Kinetic analysis of guanosine 5'-triphosphate hydrolysis associated with tubulin polymerization. *Biochemistry*, 20:1918–1924.
- [Charlebois et al., 2010] Charlebois, B. D., Schek III, H. T., and Hunt, A. J. (2010). Chapter 12 - nanometer-resolution microtubule polymerization assays using optical tweezers and microfabricated barriers. In Wilson, L. and Correia, J. J., editors, *Microtubules, in vitro*, volume Volume 95, pages 207–219. Academic Press.
- [Chen and Hill, 1985] Chen, Y. and Hill, T. (1985). Monte Carlo study of the GTP cap in a five-start helix model of a microtubule. *Proc Natl Acad Sci U S A*, 82:1131–1135.
- [Chretien et al., 1995] Chretien, D., Fuller, S. D., and Karsenti, E. (1995). Structure of growing microtubule ends - 2-dimensional sheets close into tubes at variable rates. *Journal of Cell Biology*, 129(5):1311–1328–.
- [Chretien et al., 1992] Chretien, D., Metoz, F., Verde, F., Karsenti, E., and Wade, R. H. (1992). Lattice-defects in microtubules - protofilament numbers vary within individual microtubules. *Journal of Cell Biology*, 117(5):1031–1040–.
- [Chretien and Wade, 1991] Chretien, D. and Wade, R. H. (1991). New data on the microtubule surface lattice. *Biology of the Cell*, 71(1-2):161–174–.
- [Cleary and Hancock, 2021] Cleary, J. M. and Hancock, W. O. (2021). Molecular mechanisms underlying microtubule growth dynamics. *Current Biology*, 31(10):R560–R573.
- [Coletti et al., 2007] Coletti, C., Jaroszeski, M., Pallaoro, A., Hoff, A., Iannotta, S., and Saddow, S. (2007). Biocompatibility and wettability of crystalline SiC and Si surfaces. *Conf Proc IEEE Eng Med Biol Soc*, pages 5850–5853.
- [Colin et al., 2018] Colin, A., Singaravelu, P., Thery, M., Blanchoin, L., and Gueroui, Z. (2018). Actin-network architecture regulates microtubule dynamics. *Curr Biol*.
- [Coombes et al., 2013] Coombes, C., Yamamoto, A., Kenzie, M., Odde, D., and Gardner, M. (2013). Evolving tip structures can explain age-dependent microtubule catastrophe. *Curr Biol*, 23:1342–1348.
- [Das et al., 2014] Das, D., Das, D., and Padinhateeri, R. (2014). Force-induced dynamical properties of multiple cytoskeletal filaments are distinct from that of single filaments. *PLoS One*, 9:e114014.
- [Debs et al., 2020] Debs, G. E., Cha, M., Liu, X., Huehn, A. R., and Sindelar, C. V. (2020). Dynamic and asymmetric fluctuations in the microtubule wall captured by high-resolution cryoelectron microscopy. *Proceedings of the National Academy of Sciences of the United States of America*, 117:16976–16984.
- [Desai and Mitchison, 1997] Desai, A. and Mitchison, T. J. (1997). Microtubule polymerization dynamics. *Annu Rev Cell Dev Biol*, 13:83–117–.

-
- [Dhar et al., 2009] Dhar, S., Seitz, O., Halls, M., Choi, S., Chabal, Y., and Feldman, L. (2009). Chemical properties of oxidized silicon carbide surfaces upon etching in hydrofluoric acid. *J Am Chem Soc*, 131:16808–16813.
- [Dimitrov et al., 2008] Dimitrov, A., Quesnoit, M., Moutel, S., Cantaloube, I., Pous, C., and Perez, F. (2008). Detection of gtp-tubulin conformation in vivo reveals a role for gtp remnants in microtubule rescues. *Science*, 322(5906):1353–1356–.
- [Dixit et al., 2009] Dixit, R., Barnett, B., Lazarus, J. E., Tokito, M., Goldman, Y. E., and Holzbaur, E. L. F. (2009). Microtubule plus-end tracking by clip-170 requires eb1. *Proceedings of the National Academy of Sciences of the United States of America*, 106(2):492–497–.
- [Dogterom and Leibler, 1993] Dogterom and Leibler (1993). Physical aspects of the growth and regulation of microtubule structures. *Phys Rev Lett*, 70(9):1347–1350.
- [Dogterom et al., 1996] Dogterom, M., Felix, M. A., Guet, C. C., and Leibler, S. (1996). Influence of m-phase chromatin on the anisotropy of microtubule asters. *J Cell Biol*, 133(1):125–40–.
- [Dogterom et al., 2002] Dogterom, M., Janson, M., Faivre-Moskalenko, C., van der Horst, A., Kerssemakers, J., Tanase, C., and Mulder, B. (2002). Force generation by polymerizing microtubules. *Applied Physics A: Materials Science & Processing*, 75:331–336. 10.1007/s003390201342.
- [Dogterom et al., 2005] Dogterom, M., Kerssemakers, J. W., Romet-Lemonne, G., and Janson, M. E. (2005). Force generation by dynamic microtubules. *Curr Opin Cell Biol*, 17(1):67–74–.
- [Dogterom and Koenderink, 2019] Dogterom, M. and Koenderink, G. H. (2019). Actin-microtubule crosstalk in cell biology. *Nature reviews. Molecular cell biology*, 20:38–54.
- [Dogterom and Yurke, 1997] Dogterom, M. and Yurke, B. (1997). Measurement of the force-velocity relation for growing microtubules. *Science*, 278(5339):856–860–.
- [Drechsel and Kirschner, 1994] Drechsel, D. N. and Kirschner, M. W. (1994). The minimum gtp cap required to stabilize microtubules. *Current Biology*, 4(12):1053–1061–.
- [Drummond and Cross, 2000] Drummond, D. R. and Cross, R. A. (2000). Dynamics of interphase microtubules in schizosaccharomyces pombe. *Curr Biol*, 10(13):766–775.
- [Duellberg et al., 2016a] Duellberg, C., Cade, N., Holmes, D., and Surrey, T. (2016a). The size of the EB cap determines instantaneous microtubule stability. *Elife*, 5.
- [Duellberg et al., 2016b] Duellberg, C., Cade, N., and Surrey, T. (2016b). Microtubule aging probed by microfluidics-assisted tubulin washout. *Mol Biol Cell*, 27:3563–3573.
- [Felgner et al., 1997] Felgner, H., Frank, R., Biernat, J., Mandelkow, E.-M., Mandelkow, E., Ludin, B., Matus, A., and Schliwa, M. (1997). Domains of neuronal microtubule-associated proteins and flexural rigidity of microtubules. *J. Cell Biol*, 138(5):1067–1075.
- [Felgner et al., 1996] Felgner, H., Frank, R., and Schliwa, M. (1996). Flexural rigidity of microtubules measured with the use of optical tweezers. *J Cell Sci*, 109(2):509–516.
- [Finer et al., 1994] Finer, J. T., Simmons, R. M., and Spudich, J. A. (1994). Single myosin molecule mechanics: piconewton forces and nanometre steps. *Nature*, 368(6467):113–119.
- [Floyd et al., 2010] Floyd, D. L., Harrison, S. C., and van Oijen, A. M. (2010). Analysis of kinetic intermediates in single-particle dwell-time distributions. *Biophysical Journal*, 99(2):360–366.
- [Flyvbjerg et al., 1994] Flyvbjerg, H., Holy, T., and Leibler (1994). Stochastic dynamics of microtubules: A model for caps and catastrophes. *Phys Rev Lett*, 73(17):2372–2375.
- [Flyvbjerg et al., 1996] Flyvbjerg, H., Holy, T., and Leibler, S. (1996). Microtubule dynamics: Caps, catastrophes, and coupled hydrolysis. *Phys Rev E Stat Phys Plasmas Fluids Relat Interdiscip Topics*, 54:5538–5560.
- [Foethke et al., 2009] Foethke, D., Makushok, T., Brunner, D., and Nedelec, F. (2009). Force and length-dependent catastrophe activities explain interphase microtubule organization in fission yeast. *Molecular systems biology*, pages —.
- [Freedman and Diaconis, 1981] Freedman, D. and Diaconis, P. (1981). On the histogram as a density estimator: L2 theory. *Probability Theory and Related Fields*, 57:453–476. 10.1007/BF01025868.

- [Fygenson et al., 1994] Fygenson, D. K., Braun, E., and Libchaber, A. (1994). Phase-diagram of microtubules. *Physical Review E*, 50(2):1579–1588–.
- [Fygenson et al., 1997] Fygenson, D. K., Marko, J. F., and Libchaber, A. (1997). Mechanics of microtubule-based membrane extension. *Phys. Rev. Lett.*, 79(22):4497–4500–.
- [Gadde and Heald, 2004] Gadde, S. and Heald, R. (2004). Mechanisms and molecules of the mitotic spindle. *Current Biology*, 14(18):R797–R805–.
- [Gardner et al., 2011a] Gardner, M. K., Charlebois, B. D., Jánosi, I. M., Howard, J., Hunt, A. J., and Odde, D. J. (2011a). Rapid microtubule self-assembly kinetics. *Cell*, 146(4):582–592.
- [Gardner et al., 2011b] Gardner, M. K., Zanic, M., Gell, C., Bormuth, V., and Howard, J. (2011b). Depolymerizing kinesins kip3 and mcak shape cellular microtubule architecture by differential control of catastrophe. *Cell*, 147(5):1092–1103.
- [Gardner et al., 2013] Gardner, M. K., Zanic, M., and Howard, J. (2013). Microtubule catastrophe and rescue. *Current opinion in cell biology*, 25:14–22.
- [Gildersleeve et al., 1992] Gildersleeve, R. F., Cross, A. R., Cullen, K. E., Fagen, A. P., and Williams, R. C. (1992). Microtubules grow and shorten at intrinsically variable rates. *Journal of Biological Chemistry*, 267(12):7995–8006.
- [Gittes et al., 1996] Gittes, F., Meyh?fer, E., Baek, S., and Howard, J. (1996). Directional loading of the kinesin motor molecule as it buckles a microtubule. *Biophys J*, 70(1):418–429.
- [Gittes and Schmidt, 1998] Gittes, F. and Schmidt, C. F. (1998). Signals and noise in micromechanical measurements. *Methods in Cell Biology*, Vol 55, 55:129–156–.
- [Gouveia et al., 2010] Gouveia, S. M., Leslie, K., Kapitein, L. C., Buey, R. M., Grigoriev, I., Wagenbach, M., Smal, I., Meijering, E., Hoogenraad, C. C., Wordeman, L., Steinmetz, M. O., and Akhmanova, A. (2010). In vitro reconstitution of the functional interplay between mcak and eb3 at microtubule plus ends. *Curr Biol*.
- [Gregoretti et al., 2006] Gregoretti, I. V., Margolin, G., Alber, M. S., and Goodson, H. V. (2006). Insights into cytoskeletal behavior from computational modeling of dynamic microtubules in a cell-like environment. *J Cell Sci*, 119(Pt 22):4781–4788.
- [Grishchuk et al., 2005] Grishchuk, E. L., Molodtsov, M. I., Ataullakhhanov, E. I., and McIntosh, J. R. (2005). Force production by disassembling microtubules. *Nature*, 438(7066):384–388–.
- [Guizar-Sicairos et al., 2008] Guizar-Sicairos, M., Thurman, S., and Fienup, J. (2008). Efficient subpixel image registration algorithms. *Opt Lett*, 33:156–158.
- [Gurel et al., 2014] Gurel, P., Hatch, A., and Higgs, H. (2014). Connecting the cytoskeleton to the endoplasmic reticulum and Golgi. *Curr Biol*, 24:R660–R672.
- [Hill, 1987] Hill, T. (1987). *Linear aggregation theory in cell biology*. Springer-Verlag, New York, Berlin, Heidelberg.
- [Hill and Kirschner, 1982] Hill, T. and Kirschner, M. (1982). Bioenergetics and kinetics of microtubule and actin filament assembly and disassembly. *Int. Rev. Cytol.*, 78:1–125–.
- [Hill, 1984] Hill, T. L. (1984). Introductory analysis of the gtp-cap phase-change kinetics at the end of a microtubule. *Proceedings of the National Academy of Sciences*, 81(21):6728–6732.
- [Holy et al., 1997] Holy, T. E., Dogterom, M., Yurke, B., and Leibler, S. (1997). Assembly and positioning of microtubule asters in microfabricated chambers. *Proceedings of the National Academy of Sciences of the United States of America*, 94(12):6228–6231–.
- [Holy and Leibler, 1994] Holy, T. E. and Leibler, S. (1994). Dynamic instability of microtubules as an efficient way to search in space. *Proceedings of the National Academy of Sciences*, 91(12):5682–5685.
- [Honnappa et al., 2009] Honnappa, S., Gouveia, S. M., Weisbrich, A., Damberger, F. F., Bhavesh, N. S., Jawhari, H., Grigoriev, I., van Rijssel, F. J., Buey, R. M., Lawera, A., Jelesarov, I., Winkler, F. K., Wuthrich, K., Akhmanova, A., and Steinmetz, M. O. (2009). An eb1-binding motif acts as a microtubule tip localization signal. *Cell*, 138(2):366–76–.
- [Hotani and Miyamoto, 1990] Hotani, H. and Miyamoto, H. (1990). Dynamic features of microtubules as visualized by dark-field microscopy. *Advances in Biophysics*, 26(0):135–156.

-
- [Howard, 2001] Howard, J. (2001). *Mechanics of Motor Proteins and the Cytoskeleton*, volume 1. Sinauer Associates, Sunderland, USA.
- [Howard and Hyman, 2007] Howard, J. and Hyman, A. A. (2007). Microtubule polymerases and depolymerases. *Curr Opin Cell Biol*, 19(1):31–35–.
- [Hyman et al., 1992] Hyman, A. A., Salser, S., Drechsel, D. N., Unwin, N., and Mitchison, T. J. (1992). Role of gtp hydrolysis in microtubule dynamics - information from a slowly hydrolyzable analog, gmpcpp. *Mol Biol Cell*, 3(10):1155–1167–.
- [Inoue and Salmon, 1995] Inoue, S. and Salmon, E. D. (1995). Force generation by microtubule assembly disassembly in mitosis and related movements. *Mol Biol Cell*, 6(12):1619–1640–.
- [Janosi et al., 2002] Janosi, I. M., Chretien, D., and Flyvbjerg, H. (2002). Structural microtubule cap: Stability, catastrophe, rescue, and third state. *Biophysical Journal*, 83(3):1317–1330–.
- [Janson, 2002] Janson, M. E. (2002). *Force Generation by Growing Microtubules*. PhD thesis, Leiden University.
- [Janson and Dogterom, 2004] Janson, M. E. and Dogterom, M. (2004). A bending mode analysis for growing microtubules: Evidence for a velocity-dependent rigidity. *Biophysical Journal*, 87(4):2723–2736–.
- [Janson et al., 2003] Janson, M. E., Dood, M. E. d., and Dogterom, M. (2003). Dynamic instability of microtubules is regulated by force. *The Journal of Cell Biology*, 161(6):1029–1034–.
- [Johnson et al., 1994] Johnson, N., Kotz, S., and Balakrishnan, N. (1994). *Continuous Univariate Distributions*, volume 1. Wiley.
- [Kalisch et al., 2011] Kalisch, S.-M., Laan, L., and Dogterom, M. (2011). Microtubule dynamics : methods and protocols. In *Springer Protocols. Methods in Molecular Biology*, volume 777, pages Chap. 11: 147–165. Humana; Springer, New York.
- [Karr and Purich, 1978] Karr, T. and Purich, D. (1978). Examination of tubulin-nucleotide interactions by protein fluorescence quenching measurements. *Biochem Biophys Res Commun*, 84:957–961.
- [Katsuki et al., 2009] Katsuki, M., Drummond, D. R., Osei, M., and Cross, R. A. (2009). Mal3 masks catastrophe events in schizosaccharomyces pombe microtubules by inhibiting shrinkage and promoting rescue. *J Biol Chem*, 284(43):29246–29250.
- [Kellogg et al., 1994] Kellogg, D. R., Moritz, M., and Alberts, B. M. (1994). The centrosome and cellular organization. *Annu. Rev. Biochem.*, 63(1):639–674.
- [Kerssemakers et al., 2003] Kerssemakers, J. W. J., Janson, M. E., Van der Horst, A., and Dogterom, M. (2003). Optical trap setup for measuring microtubule pushing forces. *Applied Physics Letters*, 83:4441–.
- [Kerssemakers et al., 2006] Kerssemakers, J. W. J., Munteanu, E. L., Laan, L., Noetzel, T. L., Janson, M. E., and Dogterom, M. (2006). Assembly dynamics of microtubules at molecular resolution. *Nature*, 442(7103):709–712–.
- [Kim and Rice, 2019] Kim, T. and Rice, L. (2019). Long-range, through-lattice coupling improves predictions of microtubule catastrophe. *Mol Biol Cell*, 30:1451–1462.
- [Kinoshita et al., 2001] Kinoshita, K., Arnal, I., Desai, A., Drechsel, D. N., and Hyman, A. A. (2001). Reconstitution of physiological microtubule dynamics using purified components. *Science*, 294(5545):1340–1343–.
- [Kinoshita et al., 2002] Kinoshita, K., Habermann, B., and Hyman, A. A. (2002). Xmap215: a key component of the dynamic microtubule cytoskeleton. *Trends in Cell Biology*, 12(6):267–273–.
- [Kok et al., 2021] Kok, M., Huber, F., Kalisch, S.-M., and Dogterom, M. (2021). Eb3-informed dynamics of the microtubule stabilizing cap during stalled growth. *bioRxiv*.
- [Komarova et al., 2009] Komarova, Y., Groot, C. O. D., Grigoriev, I., Gouveia, S. M., Munteanu, E. L., Schober, J. M., Honnappa, S., Buey, R. M., Hoogenraad, C. C., Dogterom, M., Borisy, G. G., Steinmetz, M. O., and Akhmanovabru, A. (2009). Mammalian end binding proteins control persistent microtubule growth. *J Cell Biol*, 184(5):691–706.

- [Komarova et al., 2002] Komarova, Y. A., Akhmanova, A. S., Kojima, S.-I., Galjart, N., and Borisy, G. G. (2002). Cytoplasmic linker proteins promote microtubule rescue in vivo. *J Cell Biol*, 159(4):589–599.
- [Laan et al., 2008] Laan, L., Husson, J., Munteanu, E. L., Kerssemakers, J. W. J., and Dogterom, M. (2008). Force-generation and dynamic instability of microtubule bundles. *Proc Natl Acad Sci U S A*, 105(26):8920–8925.
- [Laan et al., 2012] Laan, L., Pavin, N., Husson, J., Romet-Lemonne, G., van Duijn, M., L?pez, M. P., Vale, R. D., J?licher, F., Reck-Peterson, S. L., and Dogterom, M. (2012). Cortical dynein controls microtubule dynamics to generate pulling forces that position microtubule asters. *Cell*, 148(3):502–514.
- [Lansbergen et al., 2006] Lansbergen, G., Grigoriev, I., Mimori-Kiyosue, Y., Ohtsuka, T., Higa, S., Kitajima, I., Demmers, J., Galjart, N., Houtsmailler, A. B., Grosfeld, F., and Akhmanova, A. (2006). Clasps attach microtubule plus ends to the cell cortex through a complex with II5 beta. *Developmental Cell*, 11(1):21–32–.
- [Lee and Terentjev, 2019] Lee, C. and Terentjev, E. (2019). Structural effects of cap, crack, and intrinsic curvature on the microtubule catastrophe kinetics. *J Chem Phys*, 151:135101.
- [Letort et al., 2016] Letort, G., Nedelec, F., Blanchoin, L., and Thery, M. (2016). Centrosome centering and decentering by 988 microtubule network rearrangement. *Mol Biol Cell*, 27:2833–2843.
- [Li and Kolomeisky, 2014] Li, X. and Kolomeisky, A. B. (2014). Theoretical analysis of microtubule dynamics at all times. *The journal of physical chemistry. B*, 118:13777–84.
- [Lombillo et al., 1995] Lombillo, V. A., Stewart, R. J., and McIntosh, J. R. (1995). Minus-end-directed motion of kinesin-coated microspheres driven by microtubule depolymerization. *Nature*, 373(6510):161–164–.
- [Lopez et al., 2014] Lopez, P. M., Huber, F., Grigoriev, I., Steinmetz, M., Akhmanova, A., Koenderink, G., and Dogterom, M. (2014). Actin-microtubule coordination at growing microtubule ends. *Nat Commun*, 5:4778.
- [Lye and McIntosh, 1987] Lye, R.J., P. M. S. J. and McIntosh, J. (1987). Identification of a microtubule-based cytoplasmic motor in the nematode *C. elegans*. *Cell*, 51:309–318–.
- [Mahserejian et al., 2022] Mahserejian, S. M., Scripture, J. P., Mauro, A. J., Lawrence, E. J., Jonasson, E. M., Murray, K. S., Li, J., Gardner, M., Alber, M., Zanic, M., and Goodson, H. V. (2022). Quantification of microtubule stutters: dynamic instability behaviors that are strongly associated with catastrophe. *Molecular biology of the cell*, 33:ar22.
- [Maiato et al., 2004] Maiato, H., DeLuca, J., Salmon, E. D., and Earnshaw, W. C. (2004). The dynamic kinetochore-microtubule interface. *Journal of Cell Science*, 117(23):5461–5477–.
- [Maiato et al., 2003] Maiato, H., Fairley, E. A., Rieder, C. L., Swedlow, J. R., Sunkel, C. E., and Earnshaw, W. C. (2003). Human clasp1 is an outer kinetochore component that regulates spindle microtubule dynamics. *Cell*, 113(7):891 – 904.
- [Mandelkow et al., 1991] Mandelkow, E., Mandelkow, E., and Milligan, R. (1991). Microtubule dynamics and microtubule caps: a time-resolved cryo-electron microscopy study. *J. Cell Biol*, 114(5):977–991.
- [Mandelkow et al., 1986] Mandelkow, E. M., Schultheiss, R., Rapp, R., MÄ4ller, M., and Mandelkow, E. (1986). On the surface lattice of microtubules: helix starts, protofilament number, seam, and handedness. *The Journal of Cell Biology*, 102(3):1067–1073.
- [Margolin et al., 2006] Margolin, G., Gregoret, I., Goodson, H., and Alber, M. (2006). Analysis of a mesoscopic stochastic model of microtubule dynamic instability. *Phys Rev E Stat Nonlin Soft Matter Phys*, 74:41920.
- [Margolin et al., 2012] Margolin, G., Gregoret, I. V., Cickovski, T. M., Li, C., Shi, W., Alber, M. S., and Goodson, H. V. (2012). The mechanisms of microtubule catastrophe and rescue: implications from analysis of a dimer-scale computational model. *Molecular Biology of the Cell*, 23(4):642–656.
- [Maurer et al., 2014] Maurer, S., Cade, N., Bohner, G., Gustafsson, N., Boutant, E., and Surrey, T. (2014). EB1 accelerates two conformational transitions important for microtubule maturation and dynamics. *Curr Biol*, 24:372–384.
- [Maurer et al., 2011] Maurer, S. P., Bieling, P., Cope, J., Hoenger, A., and Surrey, T. (2011). Gtpgamma mas microtubules mimic the growing microtubule end structure recognized by end-binding proteins (ebs). *Proc Natl Acad Sci U S A*, 108(10):3988–3993.

-
- [Maurer et al., 2012] Maurer, S. P., Fourniol, F. J., Bohner, G., Moores, C. A., and Surrey, T. (2012). Ebs recognize a nucleotide-dependent structural cap at growing microtubule ends. *Cell*, 149(2):371–382.
- [Mcintosh et al., 2018] Mcintosh, J., O’toole, E., Morgan, G., Austin, J., Ulyanov, E., Ataullakhanov, F., and Gudimchuk, N. (2018). Microtubules grow by the addition of bent guanosine triphosphate tubulin to the tips of curved protofilaments. *J Cell Biol*.
- [Mcintosh and Mcdonald, 1989] Mcintosh, J. R. and Mcdonald, K. L. (1989). The mitotic spindle. *Scientific American*, 261(4):48–56–.
- [McIntosh and Pfarr, 1991] McIntosh, J. R. and Pfarr, C. M. (1991). Mitotic motors. *The Journal of Cell Biology*, 115(3):577–585.
- [Meadows et al., 2018] Meadows, J., Messin, L., Kamnev, A., Lancaster, T., Balasubramanian, M., Cross, R., and Millar, J. (2018). Opposing kinesin complexes queue at plus tips to ensure microtubule catastrophe at cell ends. *EMBO Rep*, 19.
- [Michaels et al., 2020] Michaels, T., Feng, S., Liang, H., and Mahadevan, L. (2020). Mechanics and kinetics of dynamic instability.
- [Mickey and Howard, 1995] Mickey, B. and Howard, J. (1995). Rigidity of microtubules is increased by stabilizing agents. *Journal of Cell Biology*, 130(4):909–917–.
- [Mickolajczyk et al., 2019] Mickolajczyk, K. J., Geyer, E. A., Kim, T., Rice, L. M., and Hancock, W. O. (2019). Direct observation of individual tubulin dimers binding to growing microtubules. *Proceedings of the National Academy of Sciences*, 116(15):7314–7322.
- [Mimori-Kiyosue et al., 2005] Mimori-Kiyosue, Y., Grigoriev, I., Lansbergen, G., Sasaki, H., Matsui, C., Severin, F., Galjart, N., Grosfeld, F., Vorobjev, I., Tsukita, S., and Akhmanova, A. (2005). Clasp1 and clasp2 bind to eb1 and regulate microtubule plus-end dynamics at the cell cortex. *The Journal of Cell Biology*, 168(1):141–153.
- [Mimori-Kiyosue et al., 2000] Mimori-Kiyosue, Y., Shiina, N., and Tsukita, S. (2000). The dynamic behavior of the apc-binding protein eb1 on the distal ends of microtubules. *Current Biology*, 10(14):865–868–.
- [Mitchison and Kirschner, 1984a] Mitchison, J. and Kirschner, M. (1984a). Dynamic instability of microtubule growth. *nature*, 312:237–242–.
- [Mitchison and Kirschner, 1984b] Mitchison, J. and Kirschner, M. (1984b). Microtubule assembly nucleated by isolated centrosomes. *nature*, 312:232–237–.
- [Mitchison, 1988] Mitchison, T. (1988). Microtubule dynamics and kinetochore function in mitosis. *Annu Rev Cell Biol*, 4:527–49.
- [Mitchison and Kirschner, 1987] Mitchison, T. J. and Kirschner, M. W. (1987). Some thoughts on the partitioning of tubulin between monomer and polymer under conditions of dynamic instability. *Cell Biophys*, 11:35–55.
- [Mogilner and Oster, 1999] Mogilner, A. and Oster, G. (1999). The polymerization ratchet model explains the force-velocity relation for growing microtubules. *Eur Biophys J. Biophys Lett*, 28(3):235–242–.
- [Mohan et al., 2013] Mohan, R., Katrukha, E., Doodhi, H., Smal, I., Meijering, E., Kapitein, L., Steinmetz, M., and Akhmanova, A. (2013). End-binding proteins sensitize microtubules to the action of microtubule-targeting agents. *Proc Natl Acad Sci U S A*, 110:8900–8905.
- [Molodtsov et al., 2005a] Molodtsov, M. I., Ermakova, E. A., Shnol, E. E., Grishchuk, E. L., McIntosh, J. R., and Ataullakhanov, F. I. (2005a). A molecular-mechanical model of the microtubule. *Biophysical Journal*, 88(5):3167–3179–.
- [Molodtsov et al., 2005b] Molodtsov, M. I., Grishchuk, E. L., Efremov, A. K., McIntosh, J. R., and Ataullakhanov, F. I. (2005b). Force production by depolymerizing microtubules: A theoretical study. *Proceedings of the National Academy of Sciences of the United States of America*, 102(12):4353–4358–.
- [Moudjou and Bornens, 1994] Moudjou, M. and Bornens, M. (1994). Isolation of centrosomes from cultured animal cells. *Cell Biology: A Laboratory Handbook*, ed. J.E.Celis Academic Press, New York, pages 595–604.–.

- [Munteanu, 2008] Munteanu, E. M. (2008). *Dynamics and regulation at the tip*. PhD thesis, Leiden University.
- [Neuman and Block, 2004] Neuman, K. C. and Block, S. M. (2004). Optical trapping. *Rev. Sci. Instrum.*, 75(9):2787–2809.
- [Nguyen-Ngoc et al., 2007] Nguyen-Ngoc, T., Afshar, K., and Gonczy, P. (2007). Coupling of cortical dynein and Ga proteins mediates spindle positioning in *Caenorhabditis elegans*. *Nat Cell Biol*, 9:1294–1302.
- [Nogales, 1999] Nogales, E. (1999). A structural view of microtubule dynamics. *Cell Mol Life Sci*, 56:133–142.
- [Nogales, 2000] Nogales, E. (2000). Structural insights into microtubule function. *Annu Rev Biochem*, 69:277–302.
- [Odde et al., 1995] Odde, D., Cassimeris, L., and Buettner, H. (1995). Kinetics of microtubule catastrophe assessed by probabilistic analysis. *Biophysical Journal*, 69(3):796 – 802.
- [Odde et al., 1999] Odde, D., Ma, L., Briggs, A., Demarco, A., and Kirschner, M. (1999). Microtubule bending and breaking in living fibroblast cells. *J Cell Sci*, 112:3283–3288.
- [Odde et al., 1996] Odde, D. J., Buettner, H. M., and Cassimeris, L. (1996). Spectral analysis of microtubule assembly dynamics. *AIChE J*, 42(5):1434–1442.
- [Ohi and Zanic, 2016] Ohi, R. and Zanic, M. (2016).
- [Padinhateeri et al., 2012] Padinhateeri, R., Kolomeisky, A., and Lacoste, D. (2012). Random hydrolysis controls the dynamic instability of microtubules. *Biophys J*, 102:1274–1283.
- [Pallavicini et al., 2017] Pallavicini, C., Monastra, A., Bardeci, N., Wetzler, D., Levi, V., and Bruno, L. (2017). Characterization of microtubule buckling in living cells. *Eur Biophys J*.
- [Pampaloni et al., 2006] Pampaloni, F., Lattanzi, G., JonÁÅ, A., Surrey, T., Frey, E., and Florin, E.-L. (2006). Thermal fluctuations of grafted microtubules provide evidence of a length-dependent persistence length. *Proceedings of the National Academy of Sciences*, 103(27):10248–10253.
- [Parry and Brown, 1959] Parry, D. A. and Brown, R. H. J. (1959). The hydraulic mechanism of the spider leg. *Journal of Experimental Biology* 36, 2:423–433.
- [Perez et al., 1999] Perez, F., Diamantopoulos, G. S., Stalder, R., and Kreis, T. E. (1999). Clip-170 highlights growing microtubule ends in vivo. *Cell*, 96(4):517–527–.
- [Peskin et al., 1993] Peskin, C. S., Odell, G. M., and Oster, G. F. (1993). Cellular motions and thermal fluctuations - the brownian ratchet. *Biophys. J.*, 65(1):316–324–.
- [Pham, 2004] Pham, H. (2004). PE-CVD Silicon Carbide - a structured material for surface micromachined devices. Technical report.
- [Phillips R., 2008] Phillips R., Kondev J., T. J. (2008). *Physical Biology of the Cell*. Garland Science.
- [Piedra et al., 2016] Piedra, F., Kim, T., Garza, E., Geyer, E., Burns, A., Ye, X., and Rice, L. (2016). GDP-to-GTP exchange on the microtubule end can contribute to the frequency of catastrophe. *Mol Biol Cell*, 27:3515–3525.
- [Rice, 1995] Rice, J. (1995). *Mathematical Statistics and Data Analysis*. Duxbury Press.
- [Rickman et al., 2017] Rickman, J., Duellberg, C., Cade, N., Griffin, L., and Surrey, T. (2017). Steady-state EB cap size fluctuations are determined by stochastic microtubule growth and maturation. *Proc Natl Acad Sci U S A*, 114:3427–3432.
- [Roth et al., 2018] Roth, D., Fitton, B., Chmel, N., Wasiluk, N., and Straube, A. (2018). Spatial positioning of EB family proteins at microtubule tips involves distinct nucleotide-dependent binding properties. *J Cell Sci*, 132.
- [Sandblad et al., 2006] Sandblad, L., Busch, K. E., Tittmann, P., Gross, H., Brunner, D., and Hoenger, A. (2006). The *schizosaccharomyces pombe* eb1 homolog mal3p binds and stabilizes the microtubule lattice seam. *Cell*, 127(7):1415–1424–.
- [Schaedel et al., 2019] Schaedel, L., Triclin, S., Chrétien, D., Abrieu, A., Aumeier, C., Gaillard, J., Blanchoin, L., Théry, M., and John, K. (2019). Lattice defects induce microtubule self-renewal. *Nature Physics*, 15(8):830–838.

-
- [Schek et al., 2007] Schek, H. T., Gardner, M. K., Cheng, J., Odde, D. J., and Hunt, A. J. (2007). Microtubule assembly dynamics at the nanoscale. *Current Biology*, 17(17):1445–1455–.
- [Schek and Hunt, 2005] Schek, H. T. and Hunt, A. J. (2005). Micropatterned structures for studying the mechanics of biological polymers. *Biomed. Microdevices*, 7(1):41–46–.
- [Schindelin et al., 2012] Schindelin, J., Arganda-Carreras, I., Frise, E., Kaynig, V., Longair, M., Pietzsch, T., Preibisch, S., Rueden, C., Saalfeld, S., Schmid, B., Tinevez, J., White, D., Hartenstein, V., Eliceiri, K., Tomancak, P., and Cardona, A. (2012). Fiji: an open-source platform for biological-image analysis. *Nat Methods*, 9:676–682.
- [Seetapun et al., 2012] Seetapun, D., Castle, B., McIntyre, A., Tran, P., and Odde, D. (2012). Estimating the microtubule gtp cap size in vivo. *Current Biology*, 0():–.
- [Sept et al., 2003] Sept, D., Baker, N. A., and McCammon, J. A. (2003). The physical basis of microtubule structure and stability. *Protein Sci*, 12(10):2257–2261.
- [Simmons et al., 1996] Simmons, R. M., Finer, J. T., Chu, S., and Spudich, J. A. (1996). Quantitative measurements of force and displacement using an optical trap. *Biophys J*, 70(4):1813–1822.
- [Sirajuddin et al., 2014] Sirajuddin, M., Rice, L., and Vale, R. (2014). Regulation of microtubule motors by tubulin isotypes and post-translational modifications. *Nat Cell Biol*, 16:335–344.
- [Stepanova et al., 2010] Stepanova, T., Smal, I., van Haren, J., Akinci, U., Liu, Z., Miedema, M., Limpens, R., van Ham, M., van der Reijden, M., Poot, R., Grosveld, F., Mommaas, M., Meijering, E., and Galjart, N. (2010). History-dependent catastrophes regulate axonal microtubule behavior. *Curr Biol*.
- [Stukalin and Kolomeisky, 2004] Stukalin, E. B. and Kolomeisky, A. B. (2004). Simple growth models of rigid multifilament biopolymers. *J. Chem. Phys.*, 121(2):1097–1104.
- [Svoboda and Block, 1994] Svoboda, K. and Block, S. M. (1994). Force and velocity measured for single kinesin molecules. *Cell*, 77(5):773–784–.
- [Taberner et al., 2014] Taberner, N., Weber, G., You, C., Dries, R., Piehler, J., and Dogterom, M. (2014). Reconstituting functional microtubule-barrier interactions. *Methods Cell Biol*, 120:69–90.
- [Tilney et al., 1973] Tilney, L. G., Bryan, J., Bush, D. J., Fujiwara, K., Mooseker, M. S., Murphy, D. B., and Snyder, D. H. (1973). Microtubules: evidence for 13 protofilaments. *The Journal of cell biology*, 59:267–275.
- [Tirnauer et al., 2002] Tirnauer, J. S., Grego, S., Salmon, E. D., and Mitchison, T. J. (2002). Eb1-microtubule interactions in xenopus egg extracts: Role of eb1 in microtubule stabilization and mechanisms of targeting to microtubules. *Molecular Biology of the Cell*, 13(10):3614–3626–.
- [Tischer et al., 2009] Tischer, C., Brunner, D., and Dogterom, M. (2009). Force-and kinesin-8-dependent effects in the spatial regulation of fission yeast microtubule dynamics. *molecular systems biology*, pages –.
- [Tolic-Norrelykke et al., 2005] Tolic-Norrelykke, I. M., Sacconi, L., Stringari, C., Raabe, I., and Pavone, F. S. (2005). Nuclear and division-plane positioning revealed by optical micromanipulation. *Current Biology*, 15(13):1212–1216–.
- [Tolic-Norrelykke et al., 2004] Tolic-Norrelykke, I. M., Sacconi, L., Thon, G., and Pavone, F. S. (2004). Positioning and elongation of the fission yeast spindle by microtubule-based pushing. *Current Biology*, 14(13):1181–1186–.
- [Tran et al., 2001] Tran, P., Marsh, L., Doye, V., Inoue, S., and Chang, F. (2001). A mechanism for nuclear positioning in fission yeast based on microtubule pushing. *J. Cell Biol.*, 153(2):397–411–.
- [Tran et al., 1997] Tran, P. T., Joshi, P., and Salmon, E. D. (1997). How tubulin subunits are lost from the shortening ends of microtubules. *Journal of Structural Biology*, 118(2):107–118–.
- [Vale, 1985] Vale, R. D. (1985). identification of a novel force generating protein, kinesin. *Cell*, 42:39–50–.
- [Valiyakath and Gopalakrishnan, 2018] Valiyakath, J. and Gopalakrishnan, M. (2018). Polymerisation force of a rigid filament bundle: diffusive interaction leads to sublinear force-number scaling. *Sci Rep*, 8:2526.

- [Vallee and Stehman, 2005] Vallee, R. B. and Stehman, S. A. (2005). How dynein helps the cell find its center: a servomechanical model. *Trends in Cell Biology*, 15(6):288–294–.
- [van Doorn et al., 2000] van Doorn, G. S., Tanase, C., Mulder, B. M., and Dogterom, M. (2000). On the stall force for growing microtubules. *European Biophysics Journal with Biophysics Letters*, 29(1):2–6–.
- [VanBuren et al., 2005] VanBuren, V., Cassimeris, L., and Odde, D. J. (2005). Mechanochemical model of microtubule structure and self-assembly kinetics. *Biophysical Journal*, 89(5):2911–2926–.
- [VanBuren et al., 2002] VanBuren, V., Odde, D. J., and Cassimeris, L. (2002). Estimates of lateral and longitudinal bond energies within the microtubule lattice. *Proc Natl Acad Sci U S A*, 99(9):6035–6040.
- [Visscher et al., 1999] Visscher, K., Schnitzer, M. J., and Block, S. M. (1999). Single kinesin molecules studied with a molecular force clamp. *Nature*, 400(6740):184–189.
- [Vitre et al., 2008] Vitre, B., Coquelle, F. M., Heichette, C., Garnier, C., Chretien, D., and Arnal, I. (2008). Eb1 regulates microtubule dynamics and tubulin sheet closure in vitro. *Nature Cell Biology*, 10(4):U815–U81–.
- [Vleugel et al., 2016] Vleugel, M., Kok, M., and Dogterom, M. (2016). Understanding force-generating microtubule systems through in vitro reconstitution. *Cell Adh Migr*, pages 475–494.
- [Vogel et al., 2007] Vogel, S. K., Raabe, I., Dereli, A., Maghelli, N., and Tolic-Norrelykke, I. (2007). Interphase microtubules determine the initial alignment of the mitotic spindle. *Current Biology*, 17(5):438–444–.
- [Von Loeffelholz et al., 2017] Von Loeffelholz, O., Venables, N., Drummond, D., Katsuki, M., Cross, R., and Moores, C. (2017). Nucleotide- and Mal3-dependent changes in fission yeast microtubules suggest a structural plasticity view of dynamics. *Nat Commun*, 8:2110.
- [Walker et al., 1991] Walker, R., Pryer, N., and Salmon, E. (1991). Dilution of individual microtubules observed in real time in vitro: evidence that cap size is small and independent of elongation rate. *J Cell Biol*, 114:73–81.
- [Walker et al., 1988] Walker, R. A., Obrien, E. T., Pryer, N. K., Soboeiro, M. F., Voter, W. A., Erickson, H. P., and Salmon, E. D. (1988). Dynamic instability of individual microtubules analyzed by video light-microscopy - rate constants and transition frequencies. *J. Cell Biol.*, 107(4):1437–1448–.
- [Wang et al., 2005] Wang, H. W., Long, S., Finley, K. R., and Nogales, E. (2005). Assembly of gmpcpp-bound tubulin into helical ribbons and tubes and effect of colchicine. *Cell Cycle*, 4(9):1157–1160–.
- [Wang and Nogales, 2005] Wang, H. W. and Nogales, E. (2005). Nucleotide-dependent bending flexibility of tubulin regulates microtubule assembly. *Nature*, 435(7044):911–915–.
- [Waterman-Storer et al., 1995] Waterman-Storer, C., Gregory, J., Parsons, S., and Salmon, E. (1995). Membrane/microtubule tip attachment complexes (TACs) allow the assembly dynamics of plus ends to push and pull membranes into tubulovesicular networks in interphase Xenopus egg extracts. *J Cell Biol*, 130:1161–1169.
- [Yeaman et al., 1999] Yeaman, C., Grindstaff, K. K., and Nelson, W. J. (1999). New perspectives on mechanisms involved in generating epithelial cell polarity. *Physiological Reviews*, 79(1):73–98–.
- [Zakharov et al., 2015] Zakharov, P., Gudimchuk, N., Voevodin, V., Tikhonravov, A., Ataullakhhanov, F., and Grishchuk, E. (2015). Molecular and mechanical causes of microtubule catastrophe and aging. *Biophys J*, 109:2574–2591.
- [Zhang et al., 2015] Zhang, R., Alushin, G., Brown, A., and Nogales, E. (2015). Mechanistic origin of microtubule dynamic instability and its modulation by EB proteins. *Cell*, 162:849–859.
- [Zhou and Zhuang, 2007] Zhou, Y. and Zhuang, X. (2007). Kinetic analysis of sequential multistep reactions. *J. Phys. Chem. B*, 111(48):13600–13610.