Lattice dynamics in microtubules: active and passive mechanisms

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Microtubules are key structural elements of living cells that are crucial for cell division, intracellular transport and motility. They are dynamic polymers, which grow and shrink by addition and removal of tubulin dimers at their extremities. Within the microtubule shaft, dimers adopt a densely packed and highly ordered crystal-like lattice structure, which is generally not considered to be dynamic.

Recent experiments have shown that microtubules exhibit a lattice dynamics far away from the extremities. This dynamics manifests itself as localized incorporation of free tubulin into the microtubule shaft, either spontaneously or facilitated by microtubule associated proteins, e.g. molecular motors and severing enzymes. A major biological corollary of such fresh tubulin incorporation events is the increased stability of dynamic microtubules.

The origin and underlying mechanisms of tubulin incorporation are still an open question. Here I theoretically explore potential mechanisms of lattice turnover. Thereby I concentrate on two cases: the spontaneous lattice turnover at structural defects [1] and the lattice dynamics stimulated by molecular motors, where lattice vacancies may play a major role [2,3].

[1] Schaedel *et al.* Nat. Phys. 15, 830 (2019)

[2] Triclin *et al.* Nat. Mater. 20, 883 (2021)

[3] Lecompte & John PRX LIFE 1, 013012 (2023)