Autocatalytic microtubule nucleation determines the size and mass of spindles.

Franziska Decker, David Oriola, Benjamin Dalton, Jan Brugués

Max Planck Institute of Molecular Cell Biology and Genetics.

Max Planck Institute for the Physics of Complex Systems.

Pfotenhauerstraße 108, 01307, Dresden, Germany

Regulation of size and growth is a fundamental problem in biology. A prominent example is the formation of the mitotic spindle, where protein concentration gradients around chromosomes are thought to regulate spindle growth by controlling microtubule nucleation [1][2]. Previous evidence suggests that microtubules nucleate throughout the spindle structure [3-5]. However, the physical mechanisms underlying microtubule nucleation and its spatial regulation are still unclear. Here, we developed an assay based on laser ablation to directly probe microtubule nucleation events in *Xenopus laevis* egg extracts. Combining this method with theory and quantitative microscopy, we show that the size of a spindle is controlled by autocatalytic growth of microtubules, driven by microtubule-stimulated microtubule nucleation. The autocatalytic activity of this nucleation system is spatially regulated by the availability of the active form of the small GTPase Ran, which decreases with distance from the chromosomes. Thus, the size of spindles is determined by the distance where one microtubule nucleates on average less than one new microtubule. This mechanism provides an upper limit to spindle size even when resources are not limiting and may have implications for spindle scaling during development.

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