Supplementary Information for

Depletion Force Induced Collective Motion of Microtubules Driven by Kinesin

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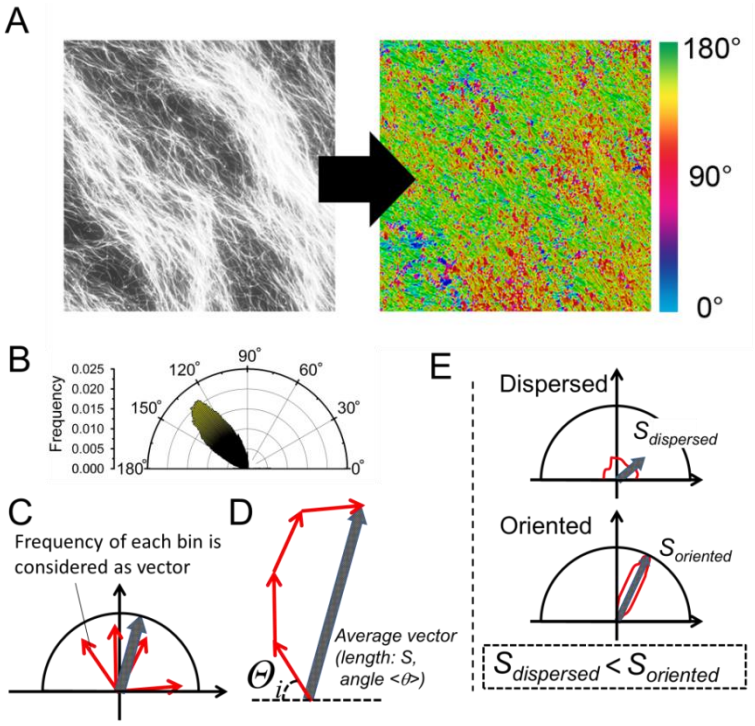


Fig. S1 Analysis method of the angles and degree of orientation of microtubules. (**A**) Fluorescent microscopic image of microtubules (left), and color map representing the distribution of microtubule orientation angles (right). (**B**) Circular histogram of orientation angles of microtubules obtained from the fluorescent microscopic image of microtubules in (A). (**C**) (**D**) (**E**) Directional analysis method. Here each bin in the circular histogram is considered as a vector (length: R_i, angle: Θ_i). (**D**) Nematic order parameter, S is calculated as the size of average vector (length: S, mean orientation angle $<\theta>$) was used for evaluation of orientation direction and degree of orientation. (**E**) Relationship between the S and degree of orientation. If distribution of microtubules angles is dispersed, S becomes smaller ($S_{\text{dispersed}}$) than that of highly oriented microtubules (S_{oriented}).

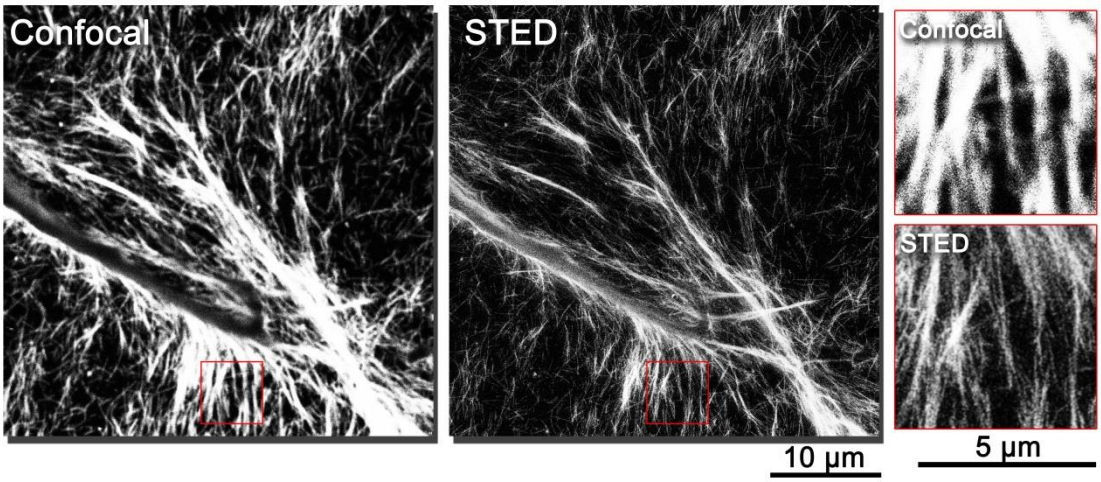


Fig. S2 Comparison of fluorescence images of microtubule streams observed under (left) confocal and (right) stimulated emission depletion (STED) microscope.

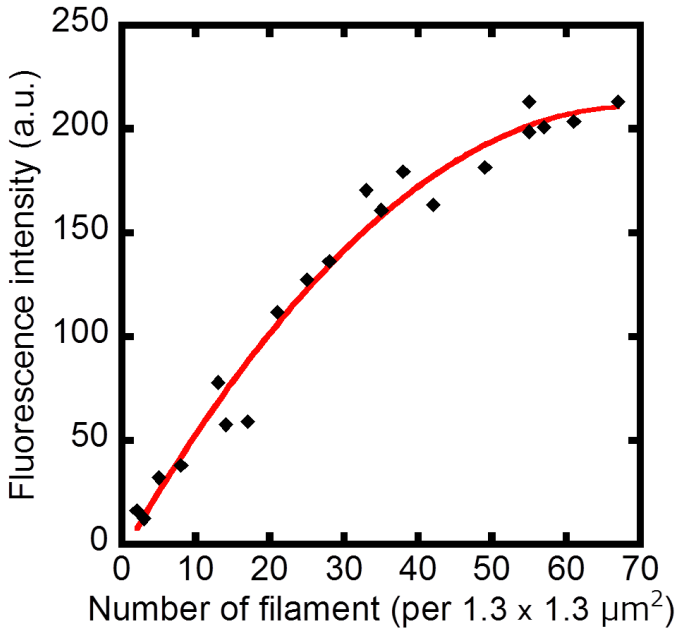


Fig. S3 Correlation between the number of microtubules in streams determined by a STED image and average fluorescence intensity obtained from a confocal image. The correlation curve is estimated by: $f(x) = ax^2 + bx + c$, with $a = -0.045, b = 6.2, c = -4.5$

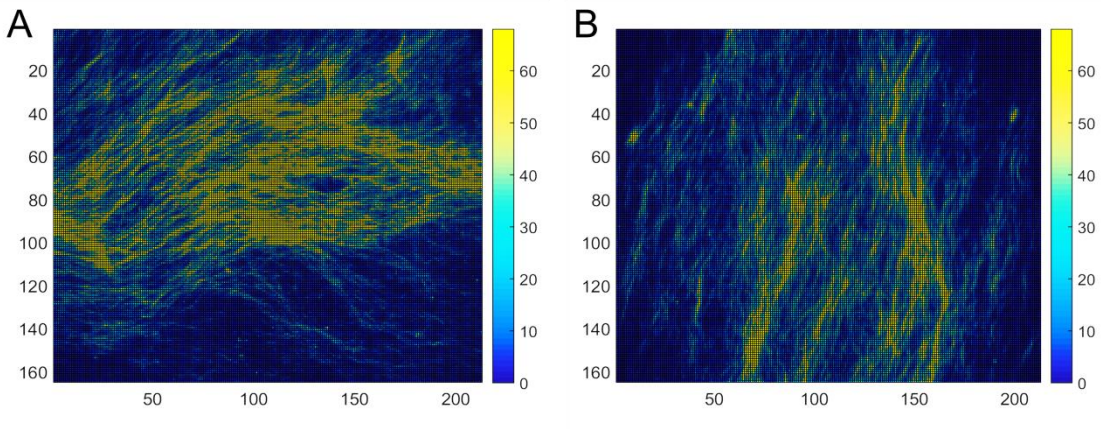


Fig. S4 Distribution of estimated microtubule numbers at the time 90 min in microtubule gliding assay with MAP4 fragment (**A**) and without MAP4 fragment (**B**). Yellow: higher density, Blue: lower density. Density fluctuation, D_f is calculated by the distribution of microtubule density or the numbers of microtubules per tiles covering a movie frame.

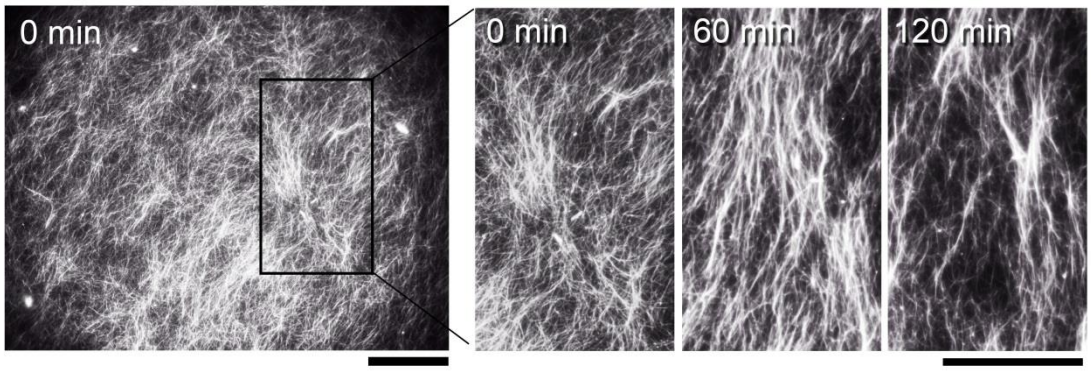


Fig. S5 Disappearance of the stream of collectively moving microtubules in the presence of 0.3 wt% MC without MAP4 fragment. Scale bar: 50 μm

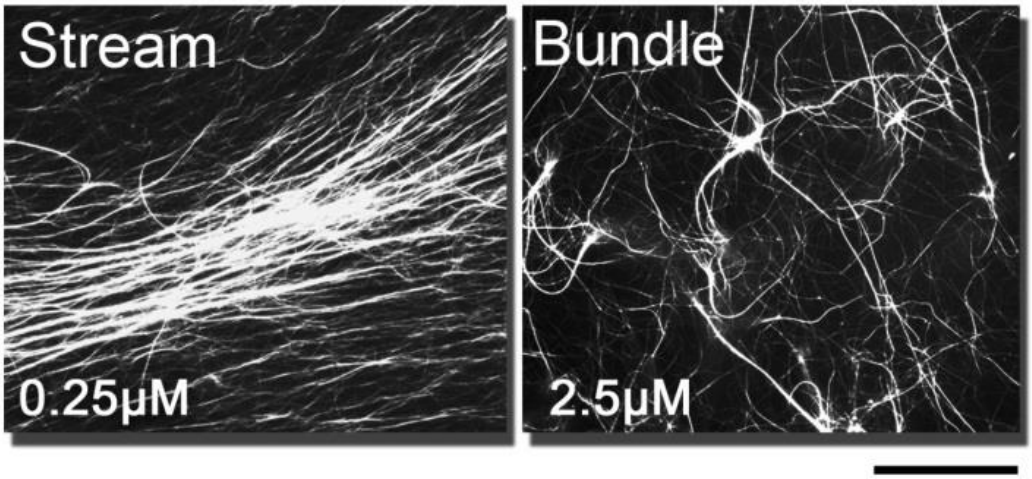


Fig. S6 Effect of concentration of MAP4 fragment in the presence of 0.3 wt% MC on morphology of collectively moving microtubules. Scale bar: 50 μm

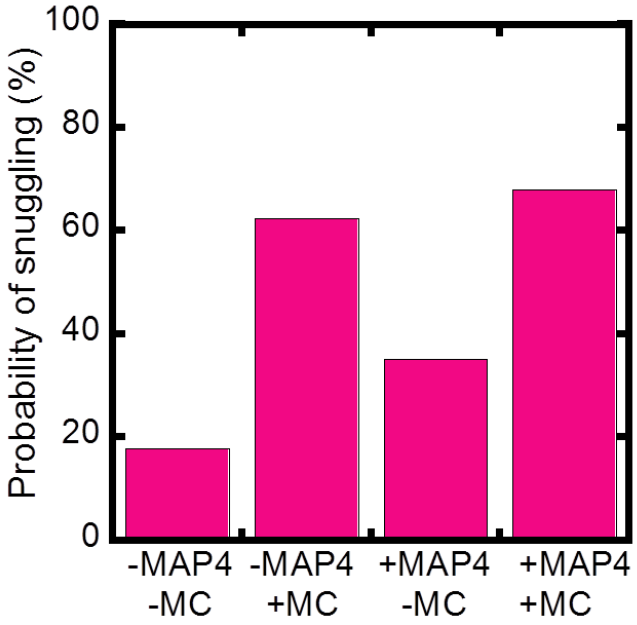
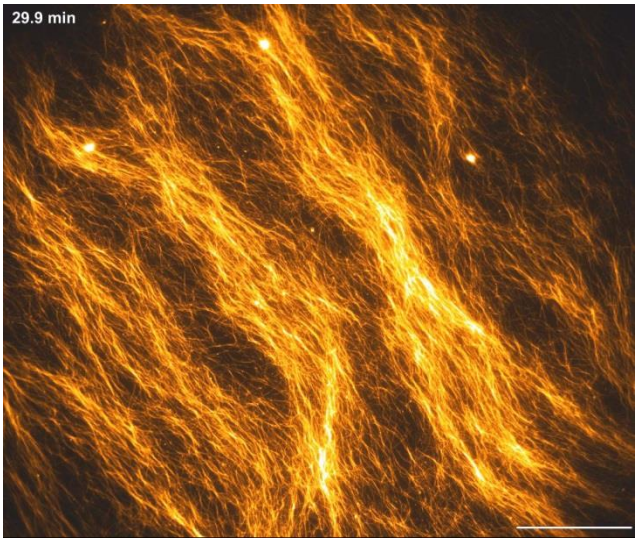


Fig. S7 Effect of MAP4 fragment and MC on the behaviour of gliding microtubules. Probability of snuggling was evaluated in the presence or absence of MAP4 fragment without and with 0.3 wt% MC. Kinesin concentration was fixed at 1000 nM. '+' and '-' indicate 'presence' and 'absence', respectively.



Movie. 1 Emergence of collective motion of microtubules in the presence of 0.3 wt% MC without MAP4 fragment. Density of microtubules is 65 $\times 10^4$ filaments mm^{-2}. Scale bar: 50 μm