Probing Stress-Regulated Ordering of Plant Cortical Microtubule Arrays via a Computational Approach.

Q: How does Mechanical Stress → CMT development?

Results:

Paper hypothesises "stress-sensing components" that change MT dynamics (based on stress)

Model relates stress → MT dynamics "linearly".

Anisotropic Stress Patterns:

Experiments show:

- Stress ↑ polymerisation rate, rescue freq.
- Stress ↓ de-poly rate, disaster freq.

Measure alignment (w.r.t. some reference direction) as $S_p \in [-1, 1]$.

In isotropic stress ($\sigma_x = \sigma_y$)

- MTs align in random direction. ← w.r.t. average orientation.
- At study state, $S_p \approx 0.4$ to 0.5.

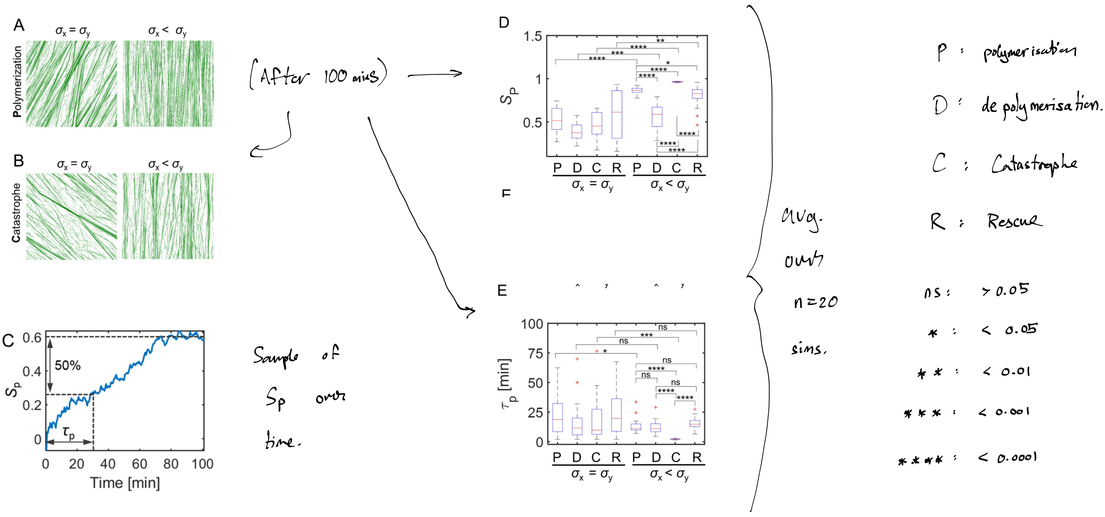
In anisotropic stress ($\sigma_x < \sigma_y$) ← specifically $\sigma_x : \sigma_y = 1:10$

- MTs align y-axis (principal direction of stress).
- At steady state $S_p \approx 0.8$ to 0.9.

Order parameter:

$$S_p = \frac{\sum_{i=1}^{N_{MT}} \cos\{2(\theta_i - \theta_p)\}\, l_i}{\sum_{i=1}^{N_{MT}} l_i}$$

where l_i, θ_i = length, angle of MT i.
θ_p = reference direction.

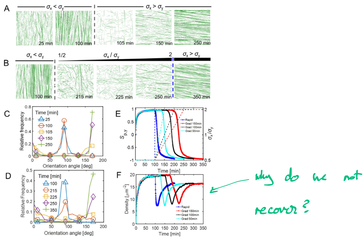


Threshold stress anisotropy to change MT ordering:

1.5 : 1

Can Reorganise MT structure by Re-Orienting Stress:

Assumption: Catastrophe freq. affected by σ.



Stress Grad ⇒ fine-scale patterning of MTs: