# Link Statistics of Dislocation Network during Strain Hardening

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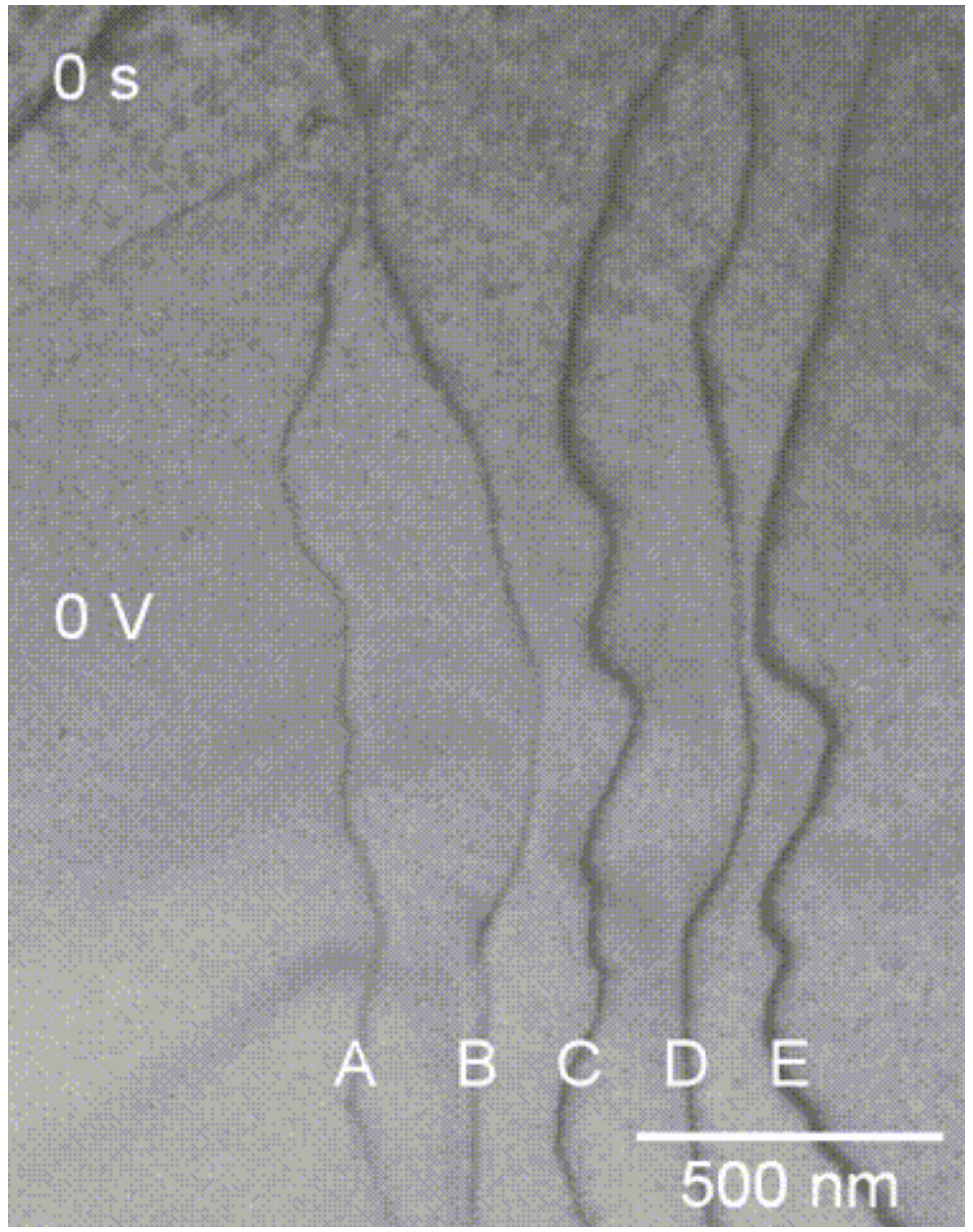
# Discrete Dislocation Dynamics (DDD)

Dislocations are line defects in crystals
(figure from experiment)

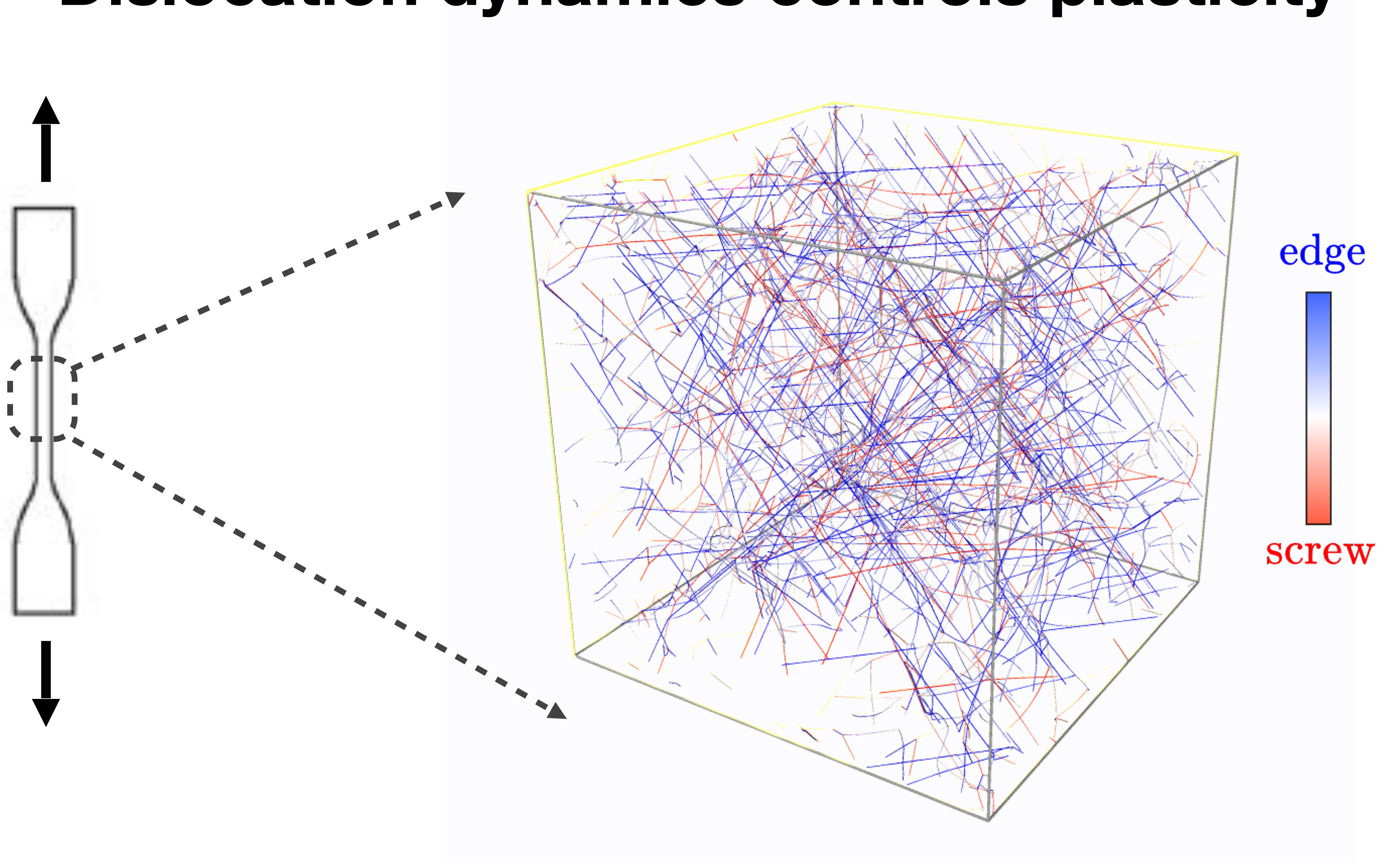


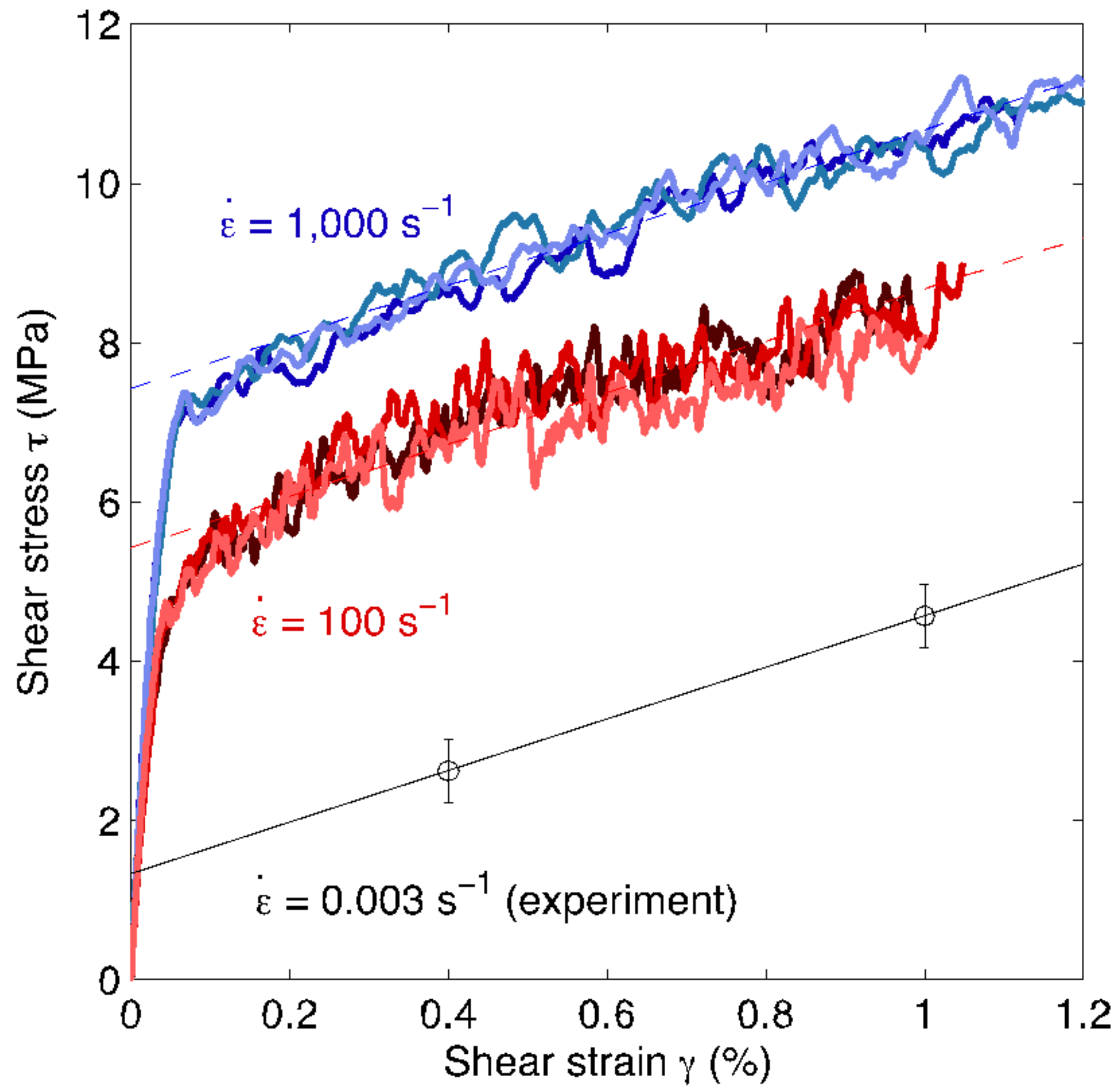

Li et al., *Nature Materials*, 2023

**Lack of connection between**

**microstructure & strain-hardening!**

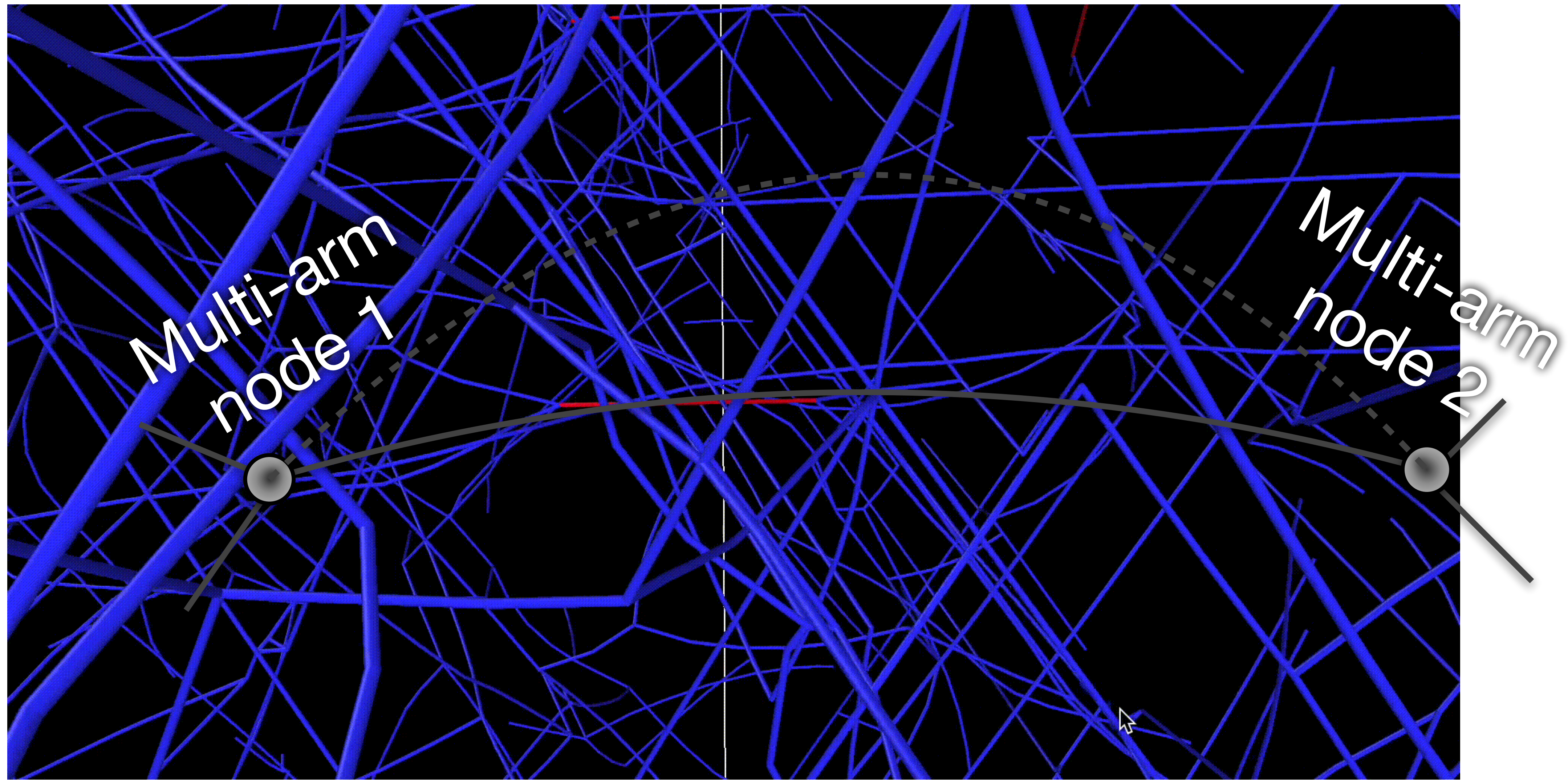
## Dislocation dynamics controls plasticity




Sills *et al.*, *PRL*, 2018

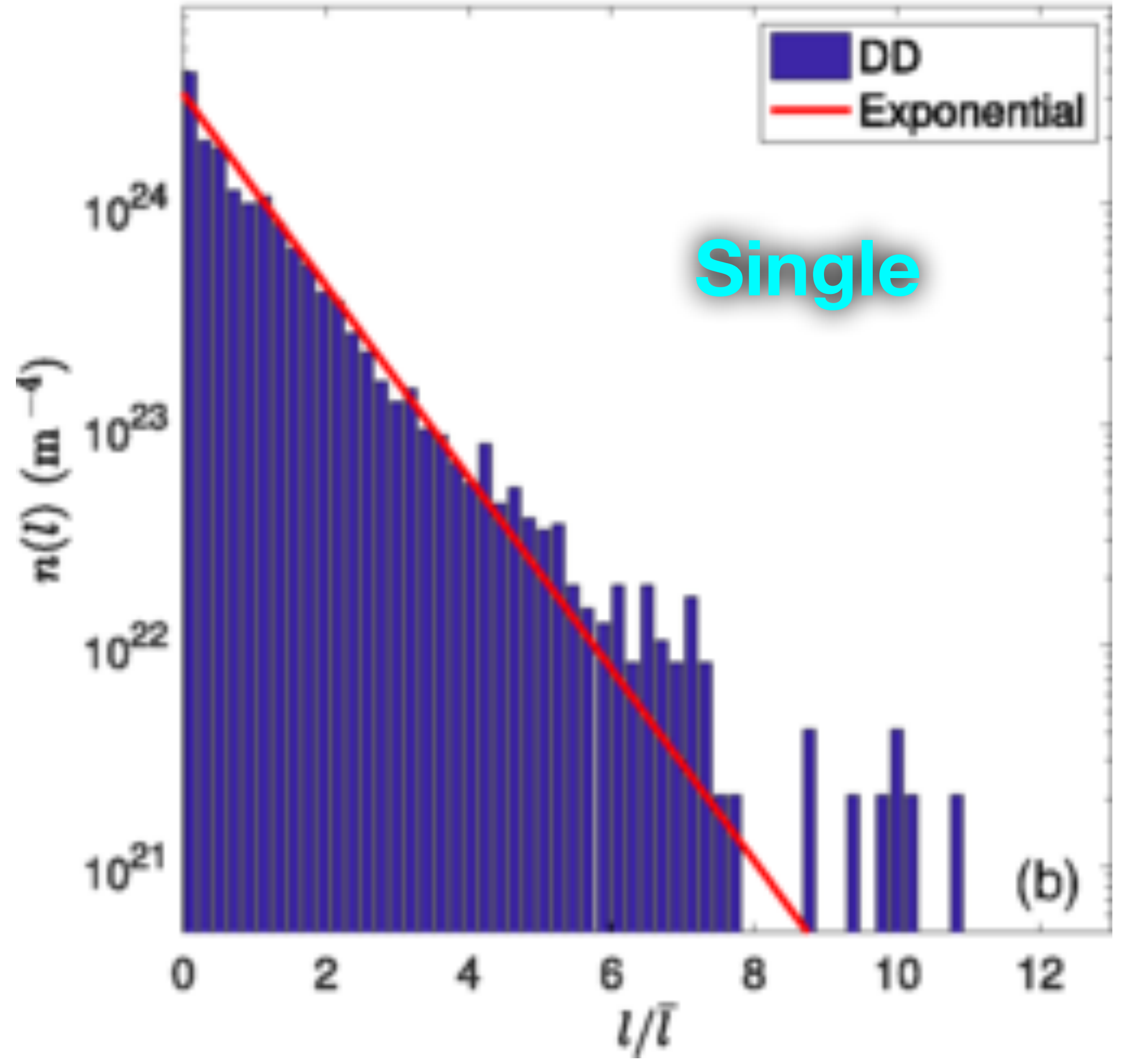
# Dislocation link lengths are exponentially distributed



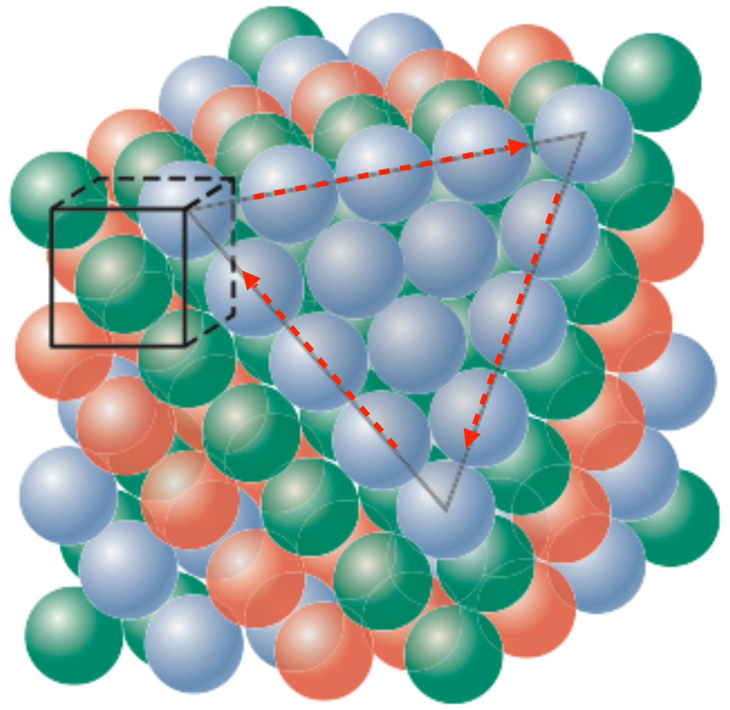

What is a link?

Dislocation link length are exponentially distributed

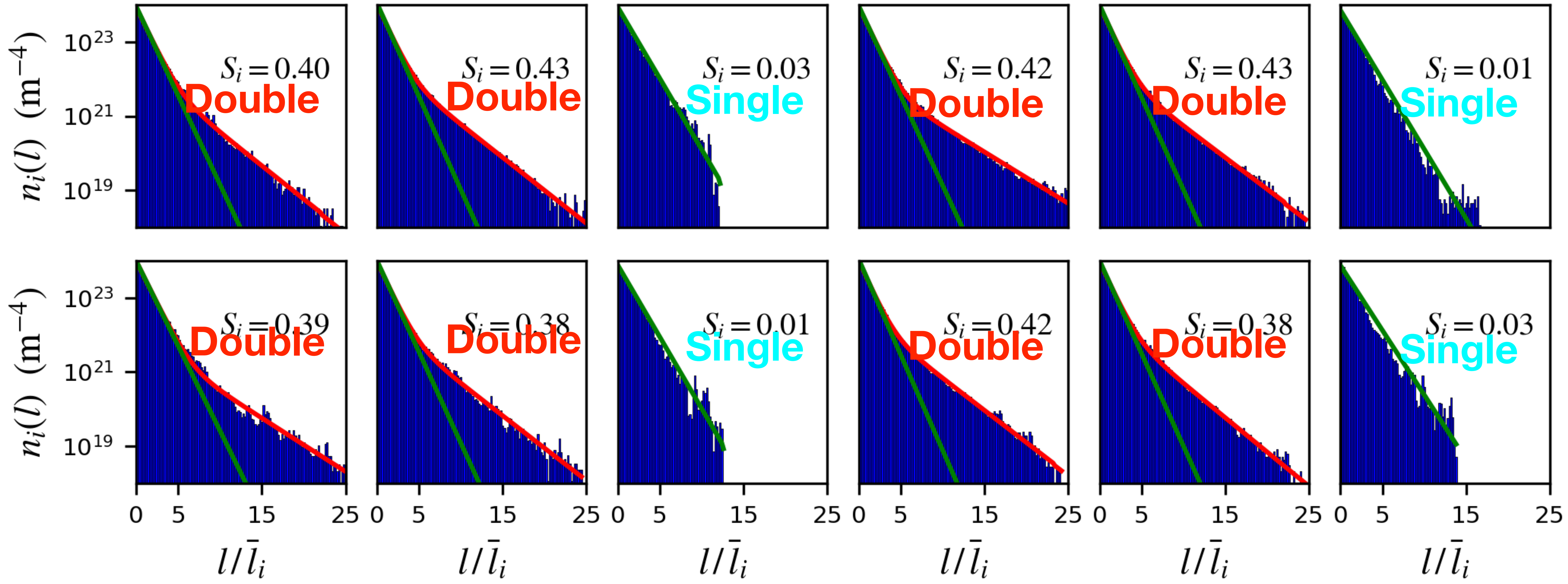
Studies were done on Cu (FCC), which contains 12 slip systems.




Sills *et al.*, *PRL*, 2018

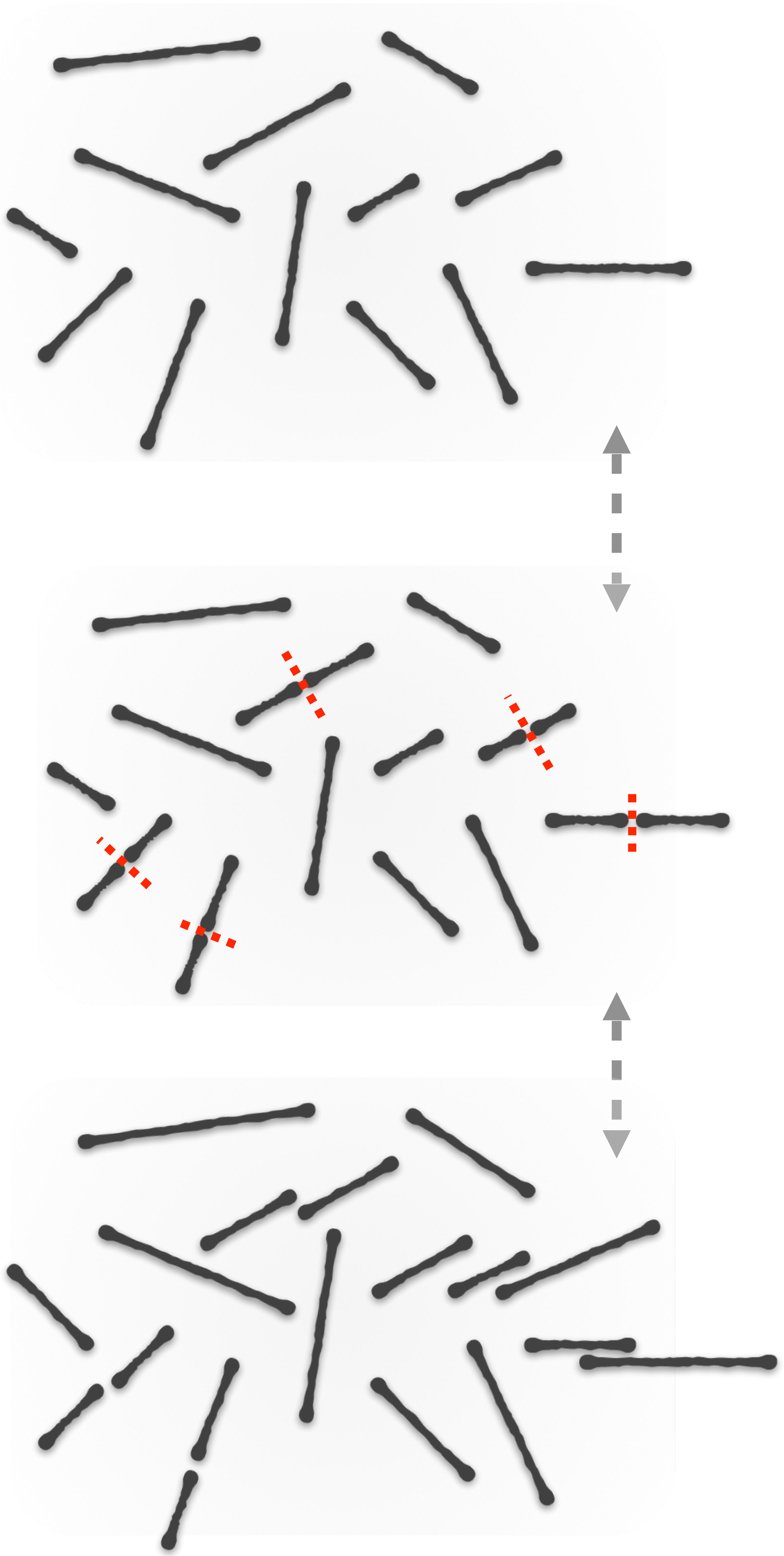


What about link length distribution on slip systems?



# Why double exponential?

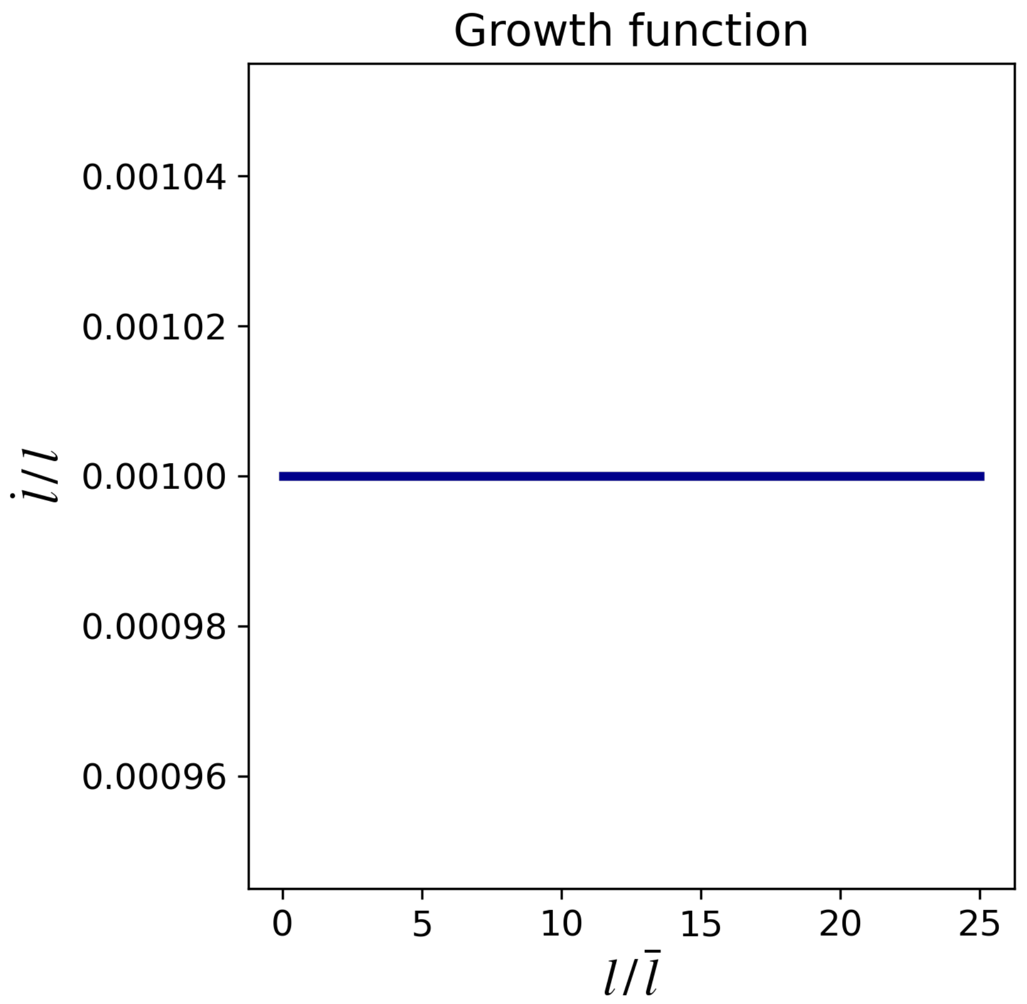
# Poisson process with growth reproduces distributions

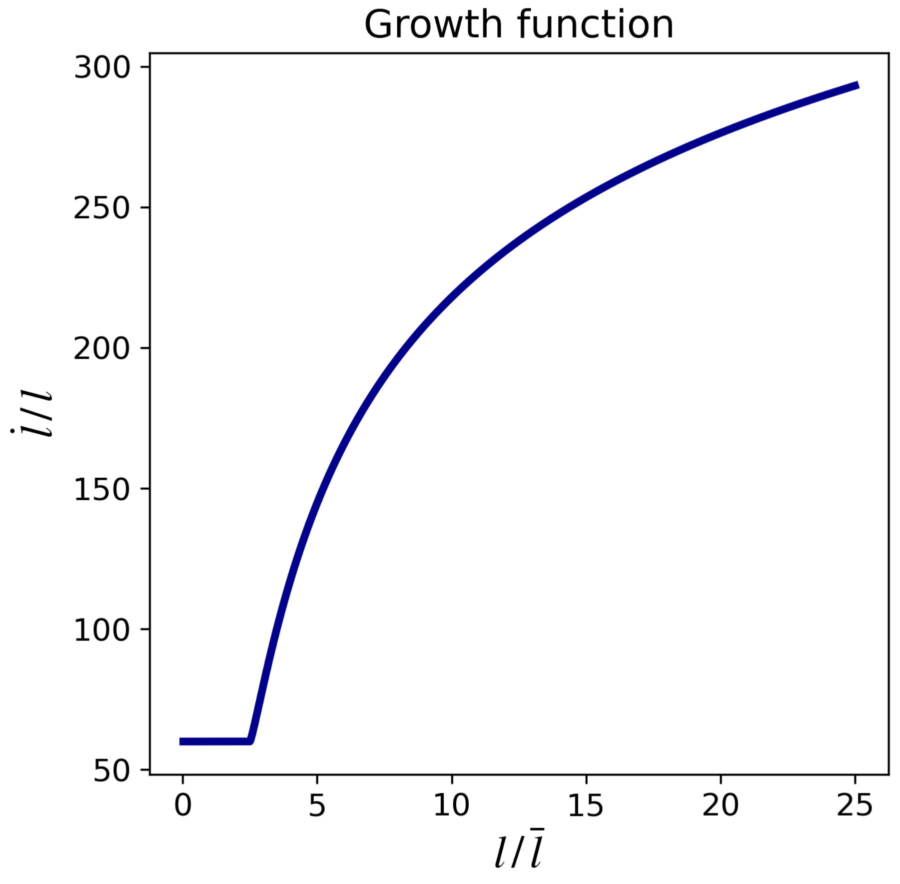


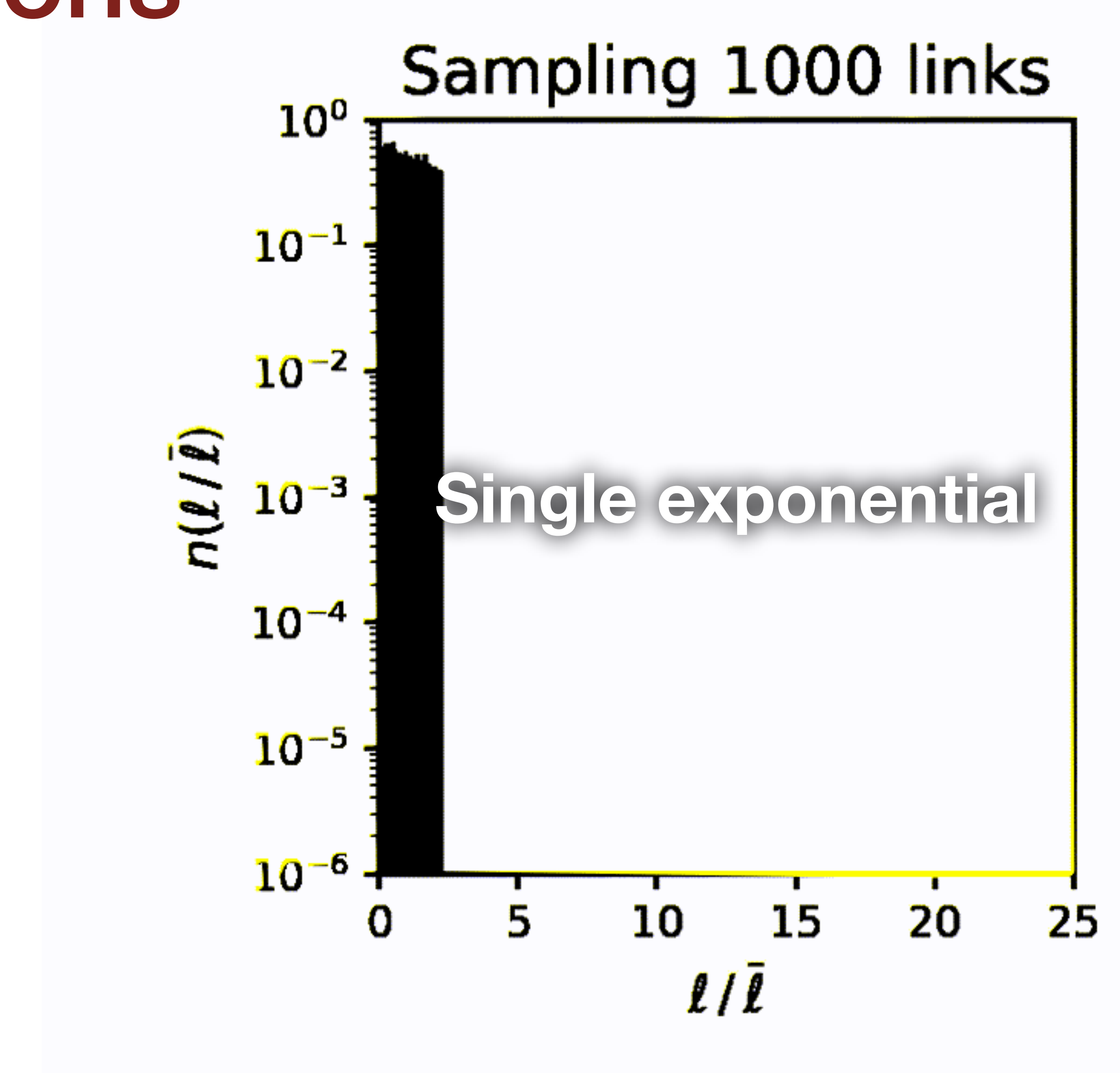
Probability rate of cut $r_i = A \cdot \left(l_i/\bar{l}\right)$

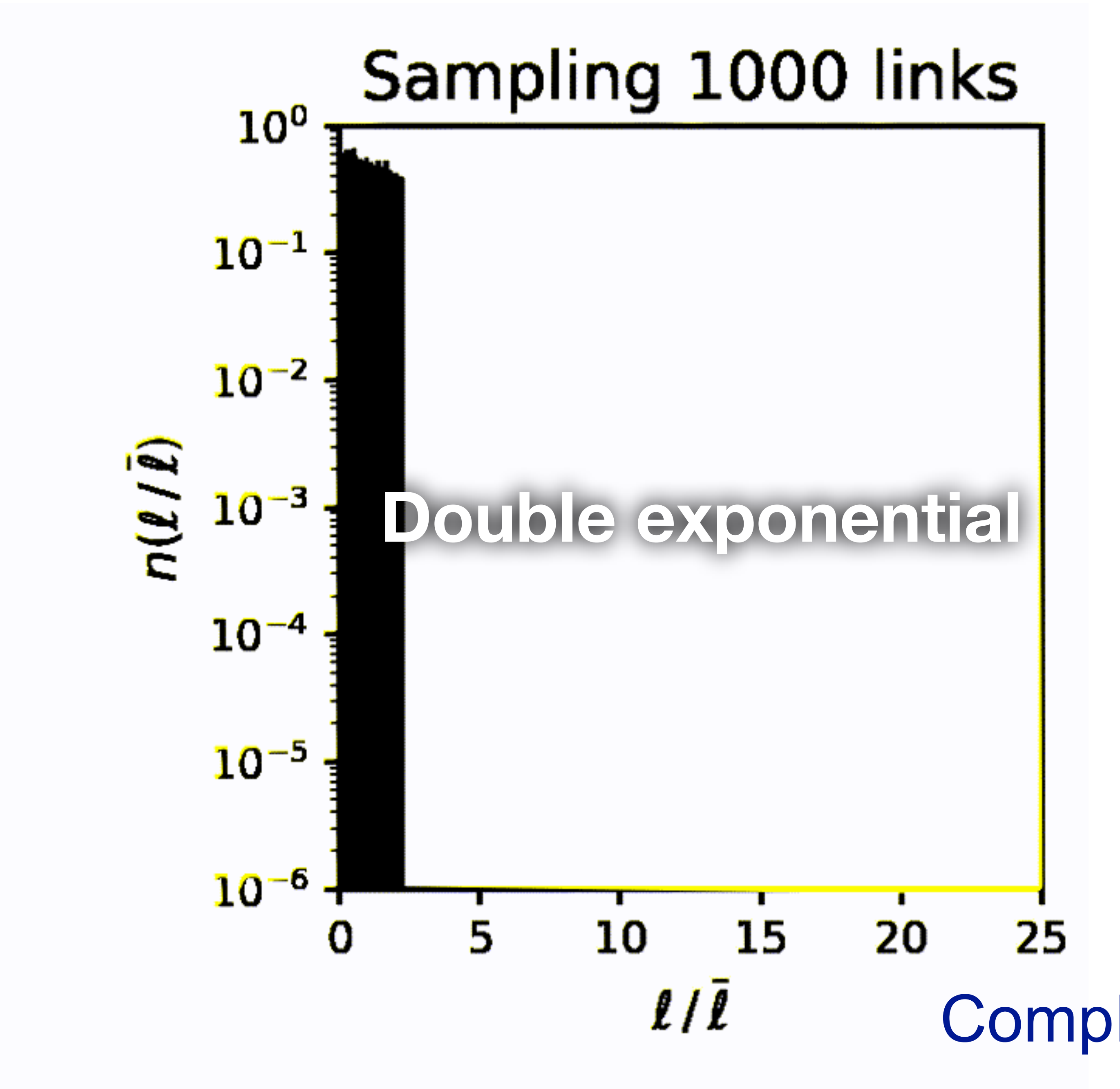
Probability of split $p_{\text{split}} = r\text{d}t$

Links will grow $\dot{l}/l = G(l/\bar{l})$



# Summary

- Discovered a new link length distribution from DDD simulations.

    Single exponential for inactive slip systems.

    Double exponential for active slip systems.

- Proposed a new theory explaining the link length distribution.

    Generalized Poisson process with growth functions.

**Open source DDD code**

https://opendis.github.io/OpenDiS/