文献汇报

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Physical manipulation of theEscherichia coli chromosome reveals its soft nature

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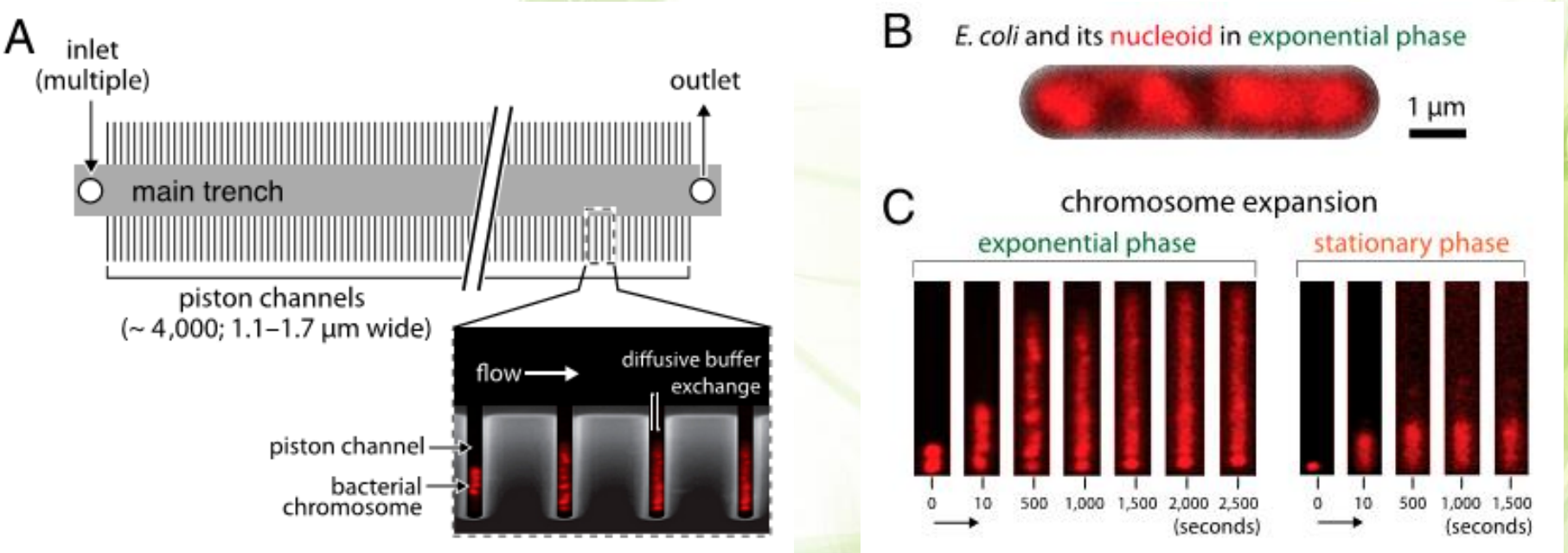
Introduction

- Escherichia coli has a single circular chromosome.In vivo, the chromosome exists in a highly compacted state, occupying only a subvolume of the micron-sized rod-shaped cell.
- how much force is required to maintain the in vivo chromosomes in their compacted state or to segregate them during DNA replication

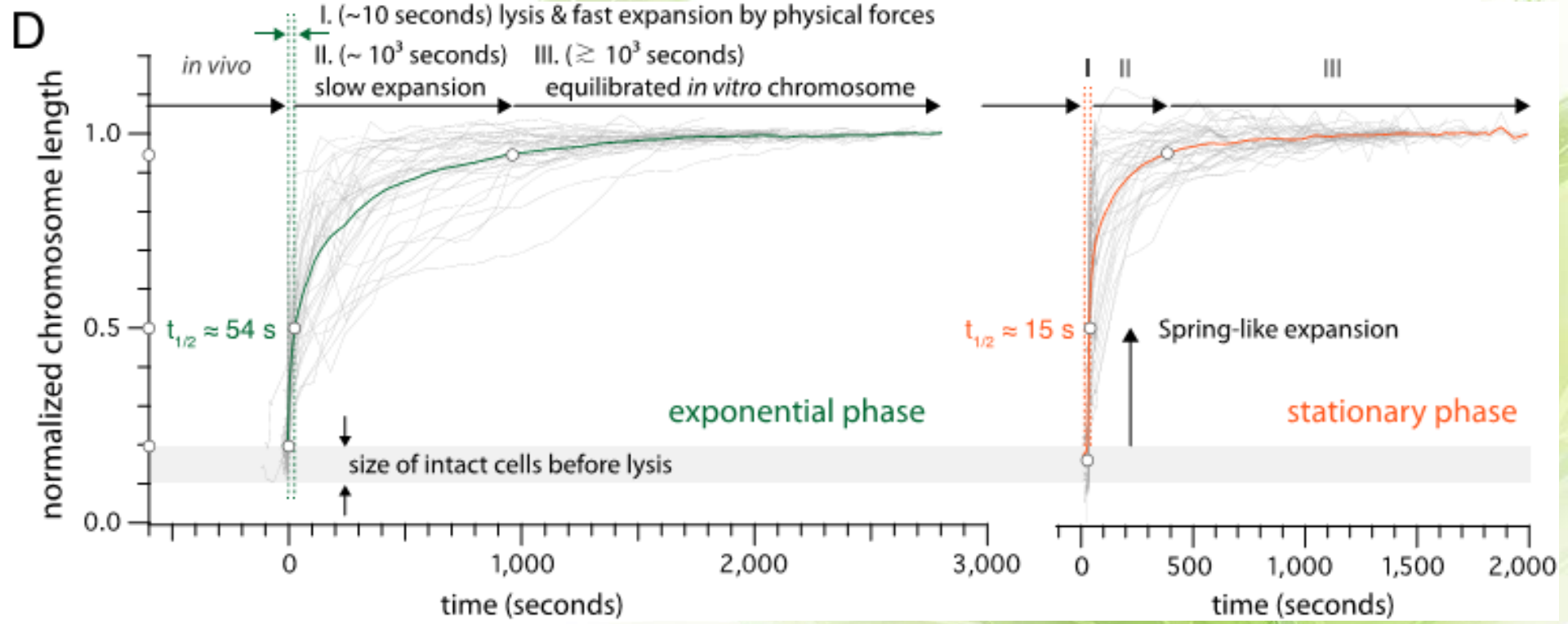
- we developed a new experimental system that brings together imaging, microfluidics, and single-molecule manipulation techniques. Importantly, by combining the microfluidic “mother machine” and an optical trap, we developed the micropiston to compress isolated single chromosomes confined in long narrow microchannels.

result

Illustration of the device

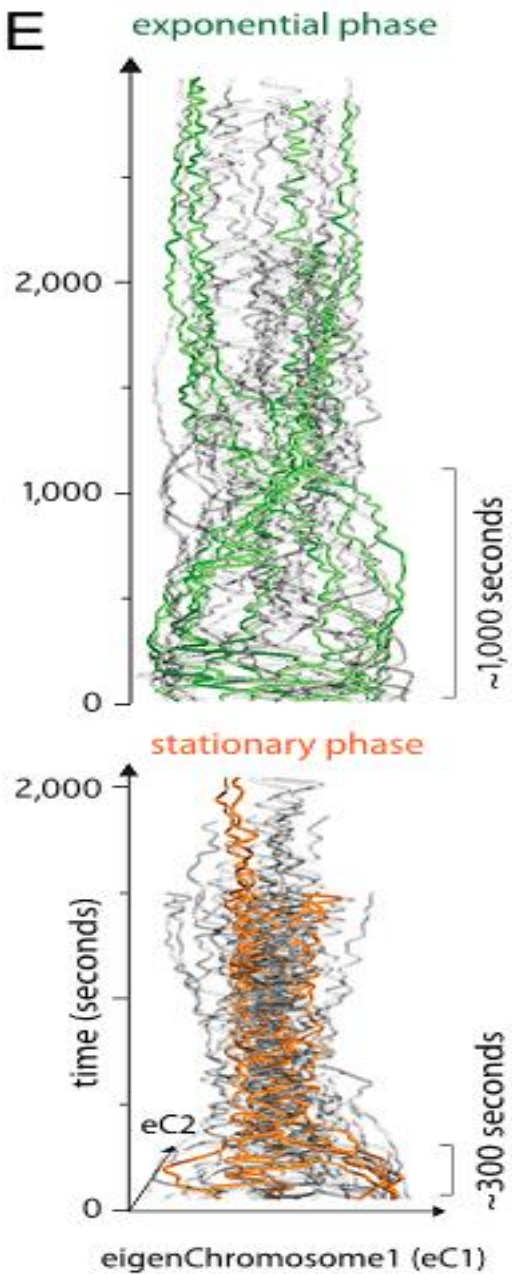


(D) Normalized chromosome length vs. time shows rapid expansion of chromosomes to half their equilibrium length in tens of seconds.

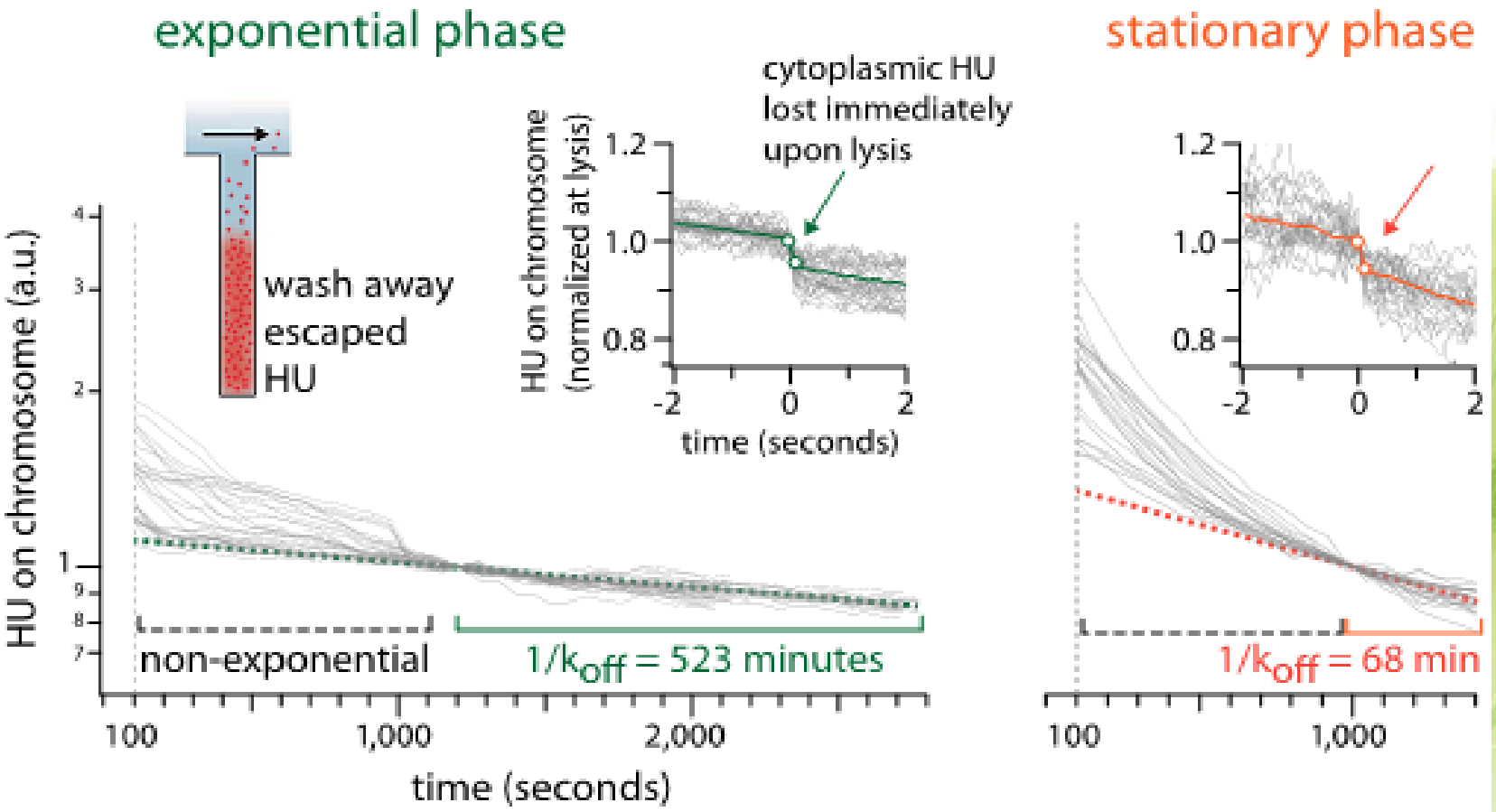


(E) Morphological relaxation analyzed by principal component analy sis.

the exponential phase chromosomes always look more structured, and they equilibrate more slowly than the stationary phase chromosomes

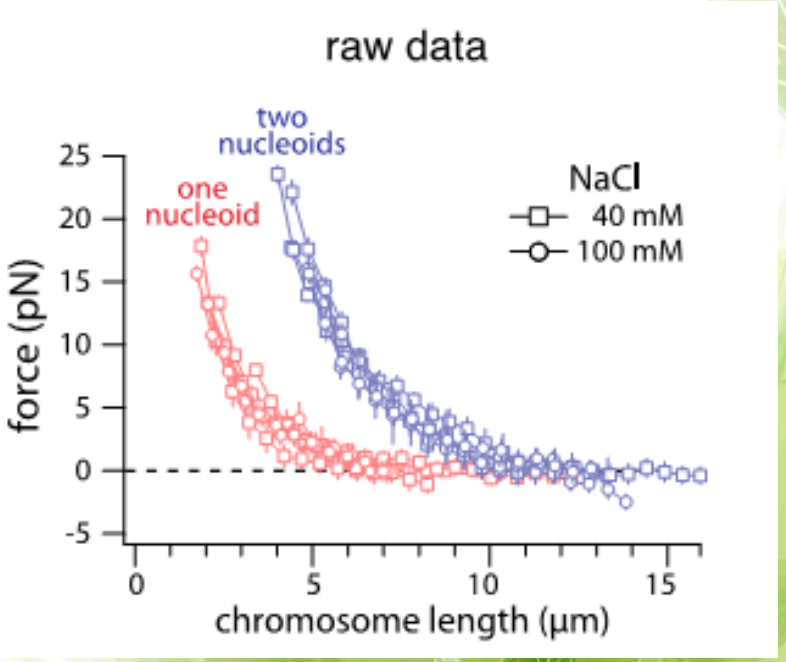


Dissociation of HU from whole chromosomes at 100 mM NaCl, after start of acquisition phase with negligible photobleaching.



a physical mechanism of chromosome segregation in bacteria:

$$\frac{f}{A} = \left(\frac{R}{R_0}\right) - \left(\frac{R}{R_0}\right)^{-2}$$



- f is the applied force
- A is the rescaled spring constant
- R the measured chromosome length during compression
- R_0 the chromosome length under no externally applied force.

Mechanical compressionof equilibrated chromosomes.

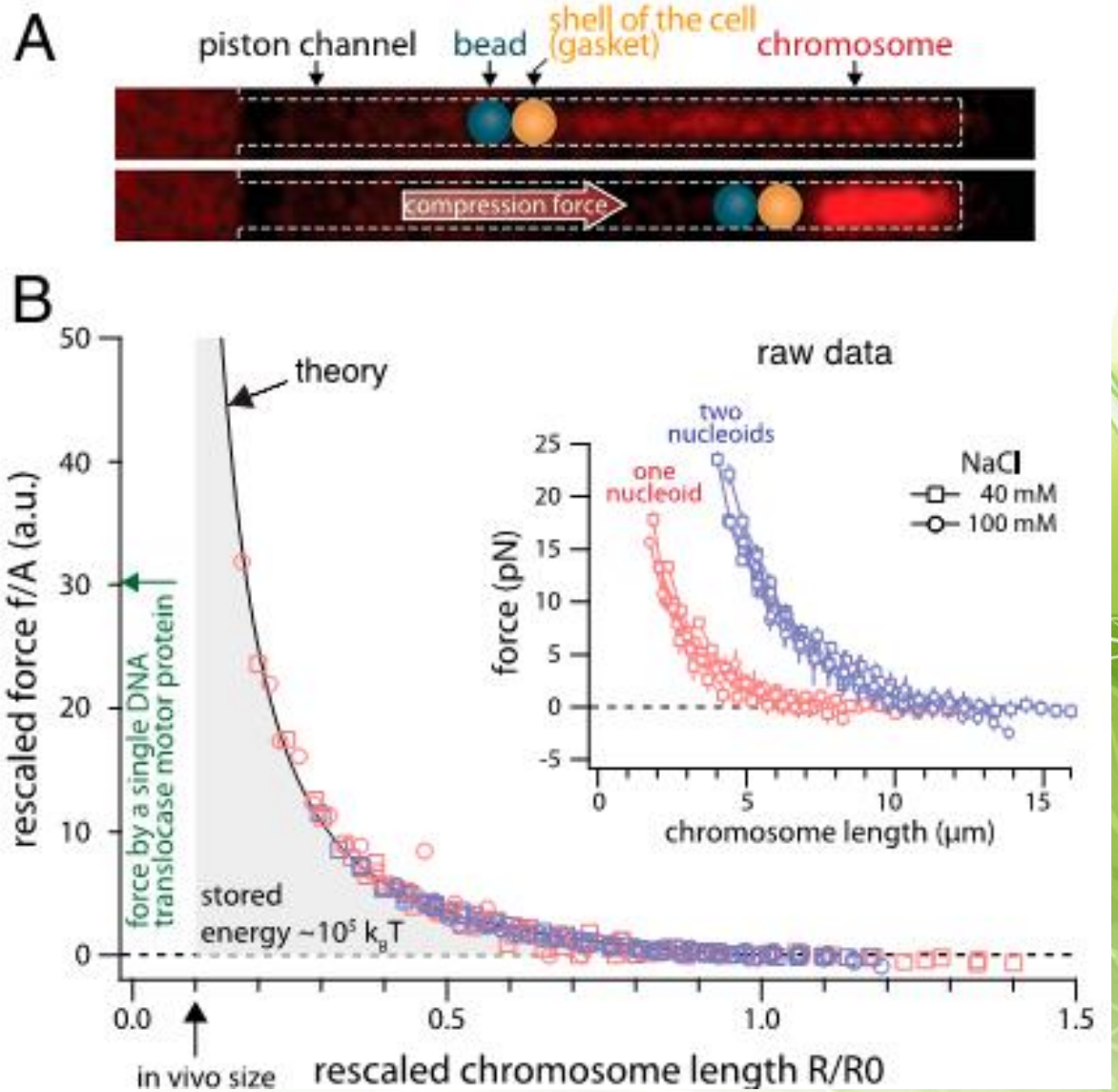
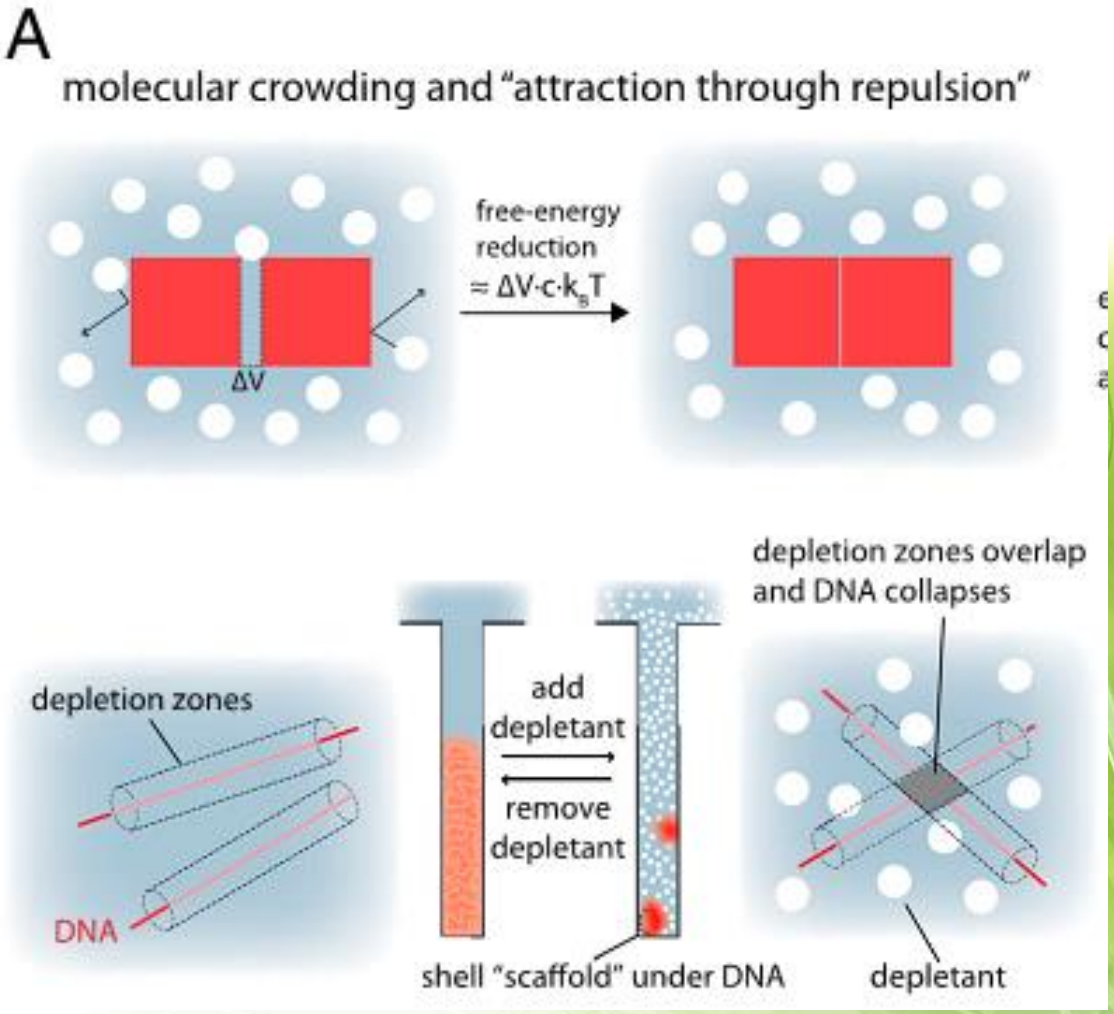
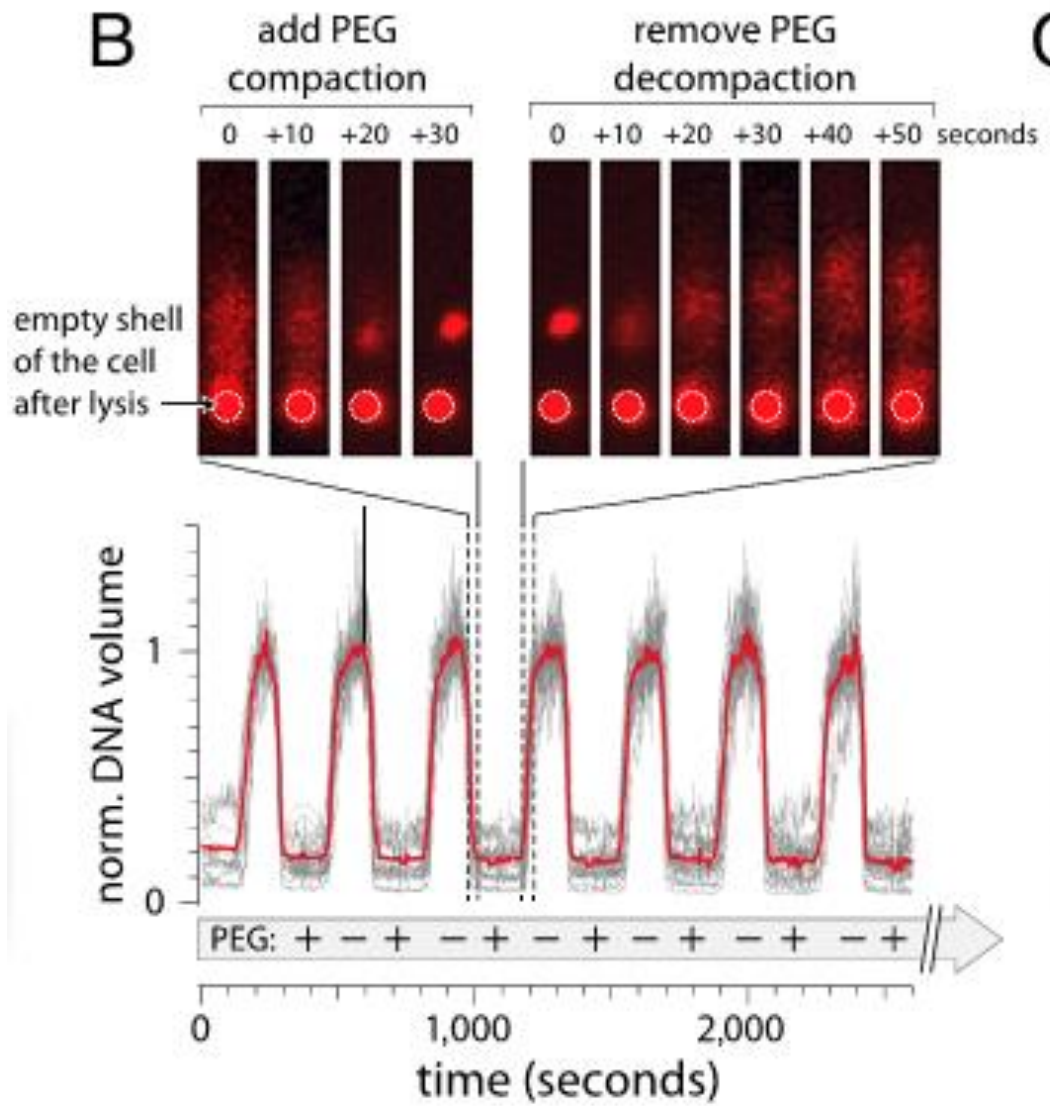
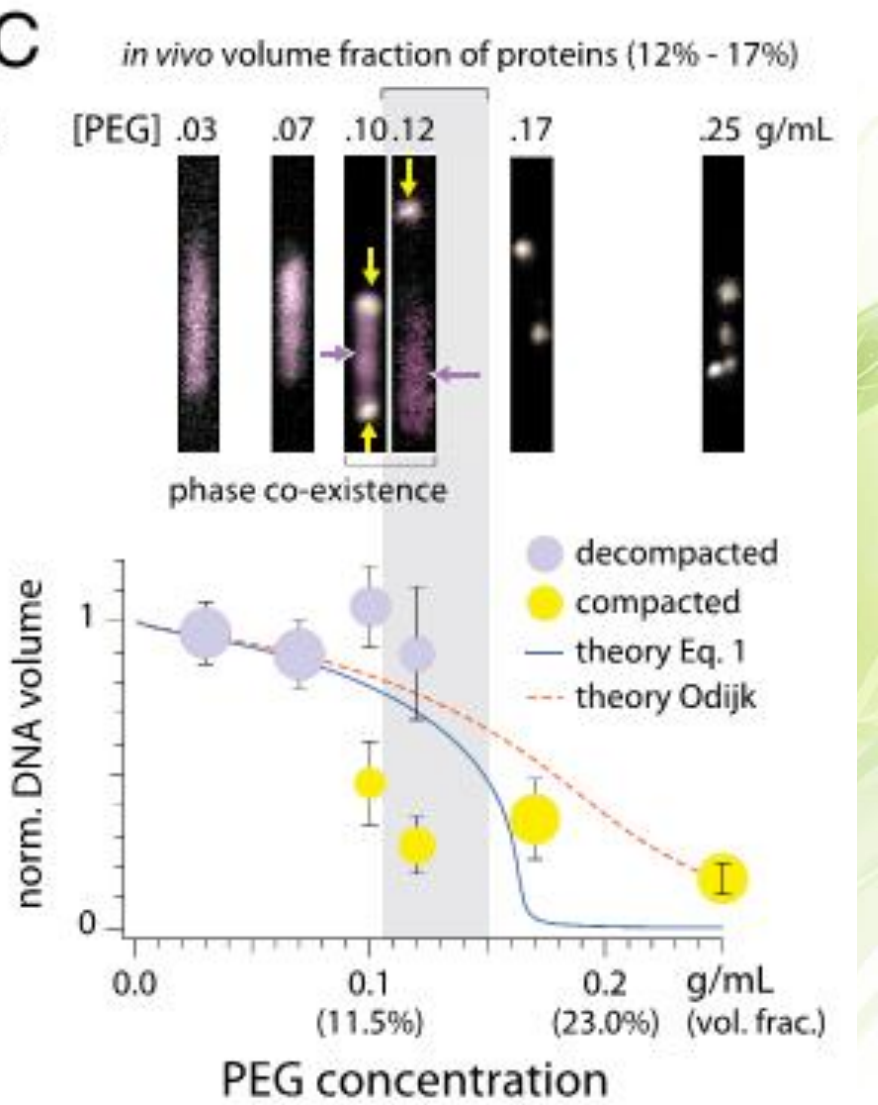


Illustration of depletion interactions .



Depletion (entropic) forces by molecular crowding induce chromosome compaction





Summarize

- We developed a unique “micropiston” and measured the force-compression behavior of single Escherichia coli chromosomes in confinement.

- we demonstrate the soft nature of the bacterial chromosome and the entropic forces that can compact it in a crowded intracellular environment.


Thank you!