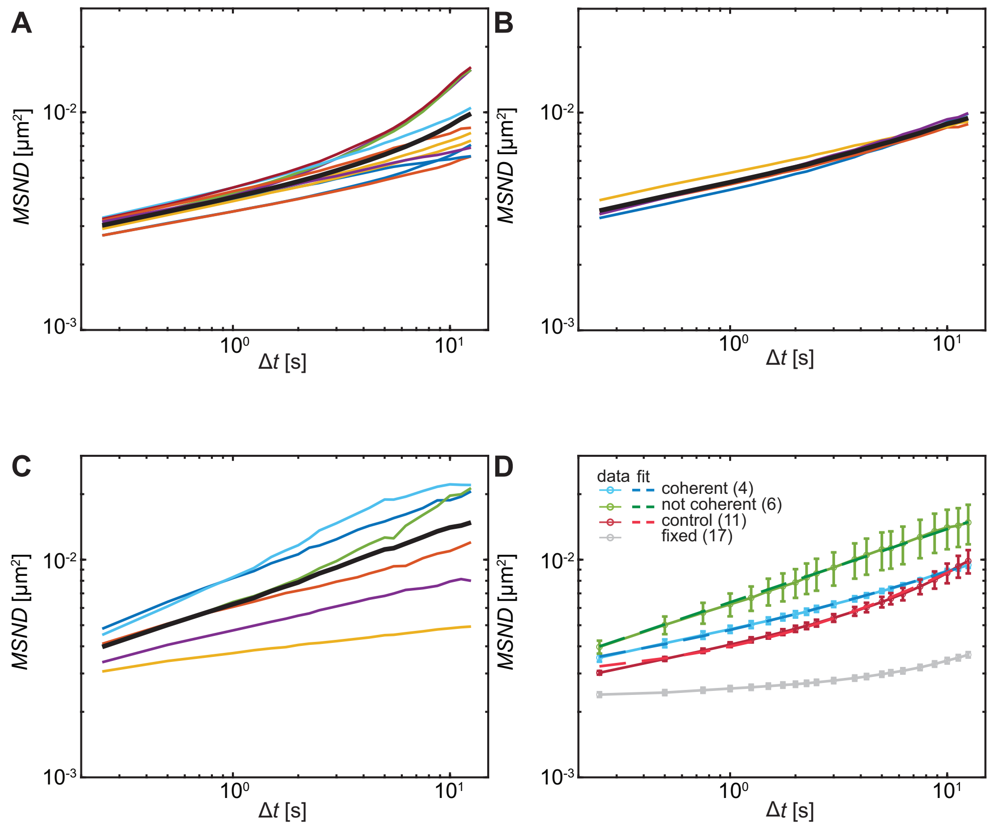
Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information

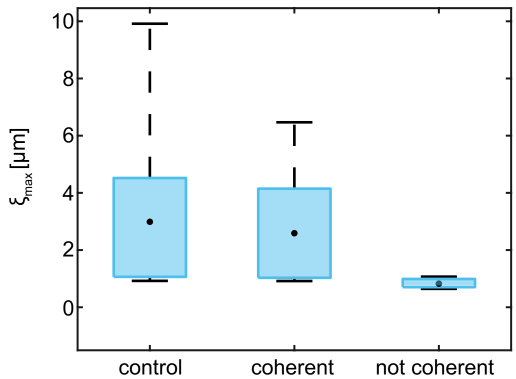
Mechanical stress affects dynamics and rheology of the human genome

Christina M. Caragine[1], Nikitas Kanellakopoulos[1] and Alexandra Zidovska[1,*]

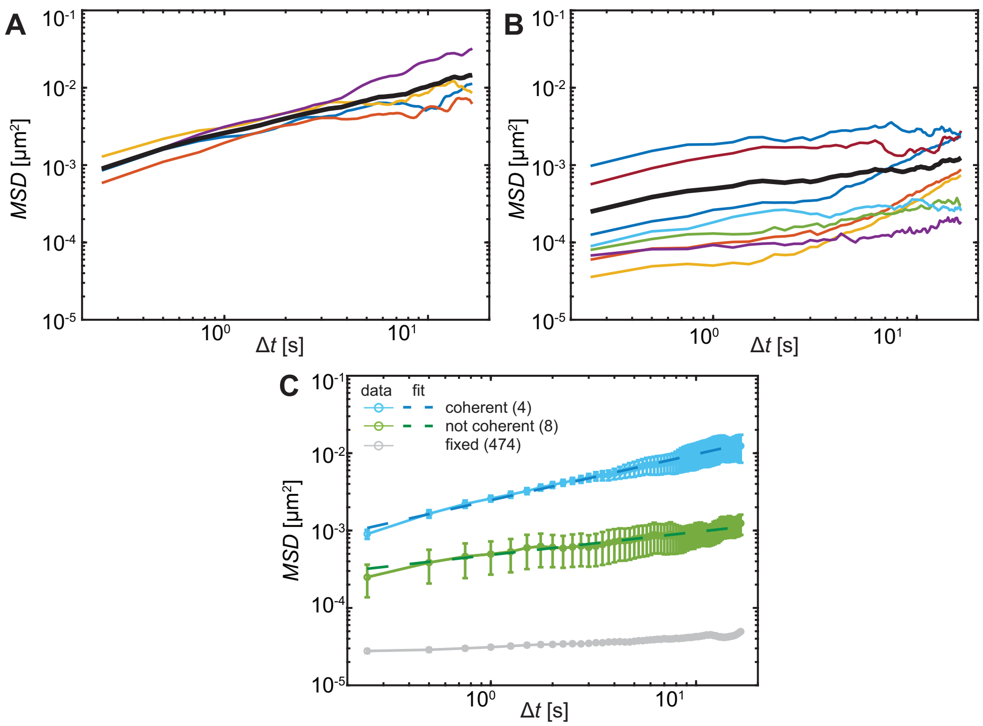


Supplementary Fig. 1 Analysis of chromatin motions inside the nucleus. (**A**) *MSND*(Δt) computed from chromatin displacements in nuclei under physiological conditions (*colored lines*) and average *MSND*(Δt) (*thick black line*). (**B**) *MSND*(Δt) computed from chromatin displacements in injected nuclei exhibiting coherent chromatin motions (*colored lines*) and average *MSND*(Δt) (*thick black line*). (**C**) *MSND*(Δt) computed from chromatin displacements in injected nuclei whose chromatin did not move coherently (*colored lines*) and average *MSND*(Δt) (*thick black line*). (**D**) Average *MSND*(Δt) computed from chromatin displacements in nuclei under physiological conditions (control, *red*), injected nuclei exhibiting coherent chromatin motions (coherent, *blue*) and injected nuclei, whose chromatin did not move coherently (not coherent, *green*). Dashed lines indicate fits to $f(\Delta t) = A + B\Delta t^{\alpha}$. All measurements are well above the noise floor, which was obtained by measuring *MSND*(Δt) for chromatin in formaldehyde-fixed nuclei (fixed, *gray*). Error bars show standard error.

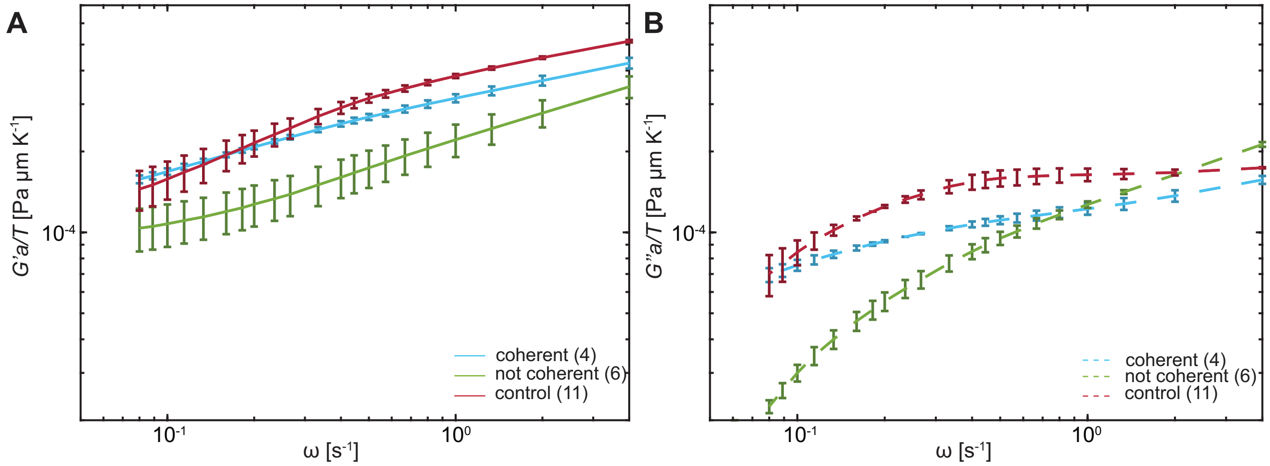
[1] *Center for Soft Matter Research, Department of Physics, New York University, New York, NY 10003, United States of America.*
[*] *To whom correspondence should be addressed. E-mail: alexandra.zidovska@nyu.edu*



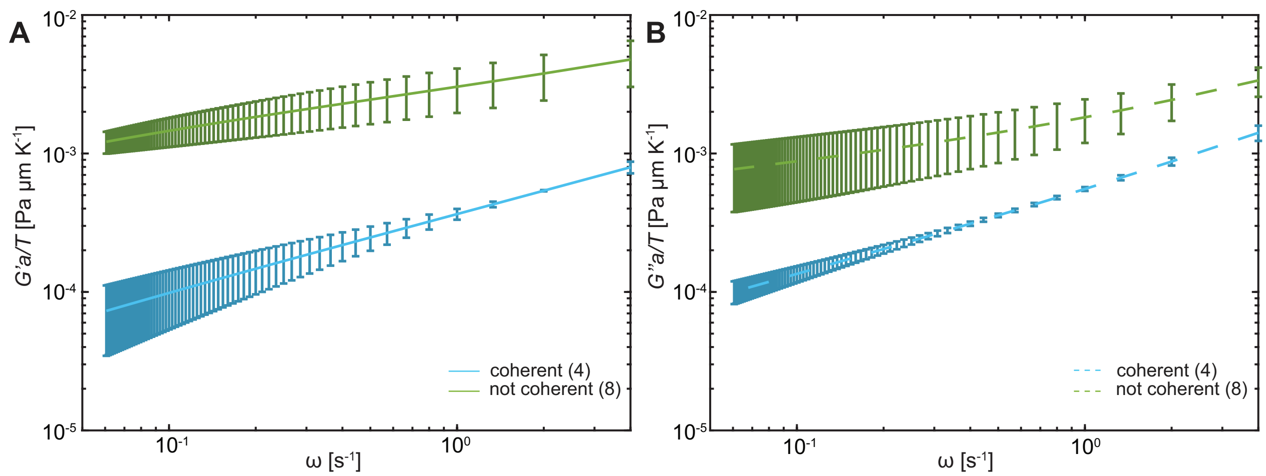
Supplementary Fig. 2 Maximum correlation length, ξ_{max}, measured for control nuclei and injected nuclei with and without coherent chromatin motions. The black dot indicates the mean, black lines the minimum and maximum values, and the edges of the blue box indicate the 25th and 75th percentiles. We find the following mean $\pm$ standard deviation for ξ_{max}: $(2.98 \pm 3.08)\mu$m for control nuclei, $(2.59 \pm 2.61)\mu$m for injected nuclei with coherent chromatin motions and $(0.82 \pm 0.17)\mu$m for injected nuclei lacking the chromatin coherency.



Supplementary Fig. 3 Analysis of particle motions inside the nucleus. (**A**) $MSD(\Delta t)$ computed from motions of fluorescent particles inside nuclei that display coherent chromatin motions (*colored lines*) and average $MSD(\Delta t)$ (*thick black line*). (**B**) $MSD(\Delta t)$ computed from motions of fluorescent particles inside nuclei that lack chromatin coherency (*colored lines*) and average $MSD(\Delta t)$ (*thick black line*). (**C**) Average $MSD(\Delta t)$ computed from motions of fluorescent particles inside nuclei that display coherent chromatin motions (coherent, *blue*) and such that lack chromatin coherency (not coherent, *green*). Dashed lines indicate fits to $f(\Delta t) = B\Delta t^{\alpha}$. The noise floor was measured by tracking motion of fluorescent particles bound to a cover slip (fixed, *gray*). Error bars show standard error.



Supplementary Fig. 4 Storage and loss moduli from Fig. 5A plotted with error bars. (**A**) Storage moduli, $G'(\omega)a/T$ (*solid lines*) calculated from *MSND*, for control nuclei (control, *red lines*), injected nuclei with coherent chromatin motions (coherent, *blue lines*) and without coherent motions (not coherent, *green lines*). (**B**) Loss moduli, $G"(\omega)a/T$ (*dashed lines*) calculated from *MSND*, for control nuclei (control, *red lines*), injected nuclei with coherent chromatin motions (coherent, *blue lines*) and without coherent motions (not coherent, *green lines*). Error bars represent the moduli for the average *MSND* $\pm$ the standard error.



Supplementary Fig. 5 Storage and loss moduli from Fig. 5B plotted with error bars. (**A**) Storage moduli, $G'(\omega)a/T$ (*solid lines*) calculated from particle *MSD*(Δt), for particles in injected nuclei with coherent chromatin motions (coherent, *blue lines*) and for particles in injected nuclei without coherent motions (not coherent, *green lines*). (**B**) Loss moduli, $G''(\omega)a/T$ (*dashed lines*) calculated from particle *MSD*(Δt), for particles in injected nuclei with coherent chromatin motions (coherent, *blue lines*) and for particles in injected nuclei without coherent motions (not coherent, *green lines*). Error bars represent the moduli for the average *MSD*(Δt) $\pm$ the standard error.

	$MSND(\Delta t) = A + B\Delta t^{\alpha}$			$MSD(\Delta t) = B\Delta t^{\alpha}$	
	α	A [μm^2]	B [μm^{2}s$^{-\alpha}$]	α	B [μm^{2}s$^{-\alpha}$]
Control	0.68 ± 0.02	0.0028 ± 0.0001	0.0012 ± 0.0001	–	–
Coherent	0.39 ± 0.02	0.0019 ± 0.0001	0.0028 ± 0.0001	0.59 ± 0.01	0.0025 ± 0.0001
Not Coherent	0.33 ± 0.02	$10^{-7} \pm 0.0001$	0.006 ± 0.001	0.30 ± 0.02	0.00048 ± 0.00002

Supplementary Table 1 Summary of fitting parameters for fits to data in Fig. 4. $MSND(\Delta t)$ data shown in Fig. 4A were fitted to $MSND(\Delta t) = A + B\Delta t^{\alpha}$ and $MSD(\Delta t)$ data in Fig. 4B were fitted to $MSD(\Delta t) = B\Delta t^{\alpha}$.

	Bulk Moduli		*Local Moduli*	
	G′ [Pa]	G″ [Pa]	G′ [Pa]	G″ [Pa]
Control	0.1 – 30	0.04 – 10	–	–
Coherent	0.1 – 24	0.03 – 9	0.4 – 4.6	0.6 – 8.0
Not Coherent	0.1 – 19.8	0.01 – 12.3	6.9 – 28	4.4 – 19.4

Supplementary Table 2 Summary of values for storage (G') and loss (G'') moduli estimated from data in Fig. 5. Bulk moduli were estimated from data in Fig. 5A using a particle size of 10 nm – 1000 nm and local moduli were estimated from data in Fig. 5B using a particle size of 100 nm, with values obtained over all measured frequencies. In both cases an effective temperature of 300°C was used.