Damping Mechanisms of Filament Longitudinal Oscillations

P. F. Chen

chenpf@nju.edu.cn

Nanjing University, China

Significance

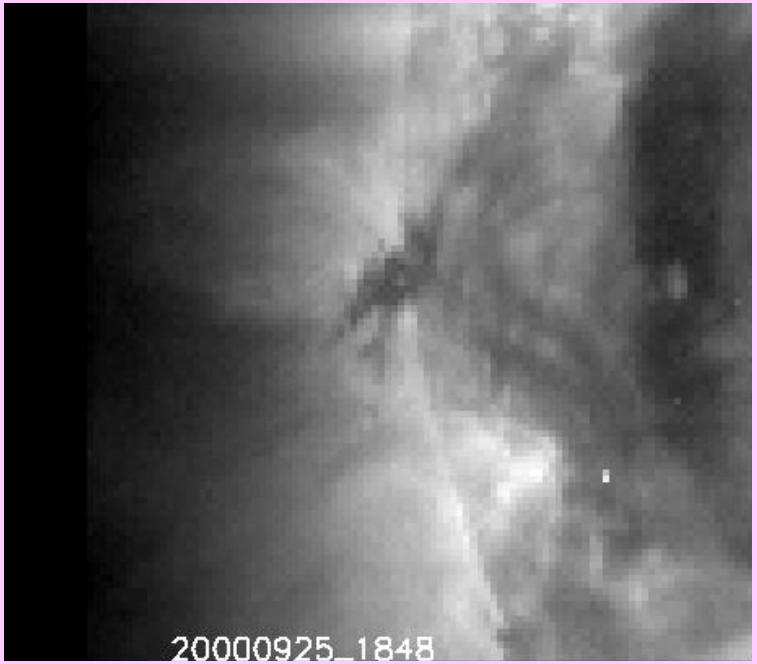
Period

Decay timescale

Prominence seismology (Arregui, Oliver, Ballester 2018)

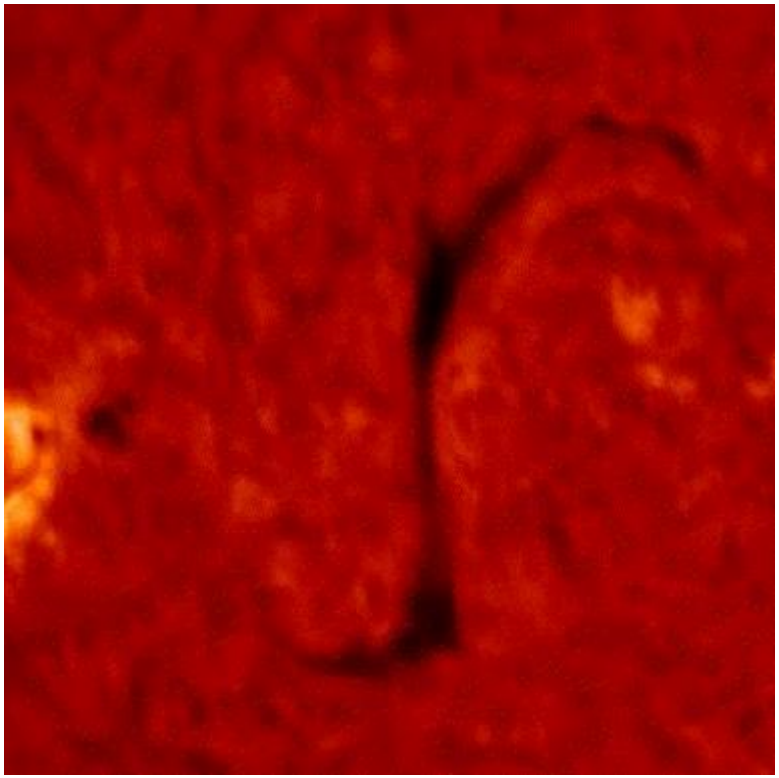
Prominence oscillation:

One of the CME precursors



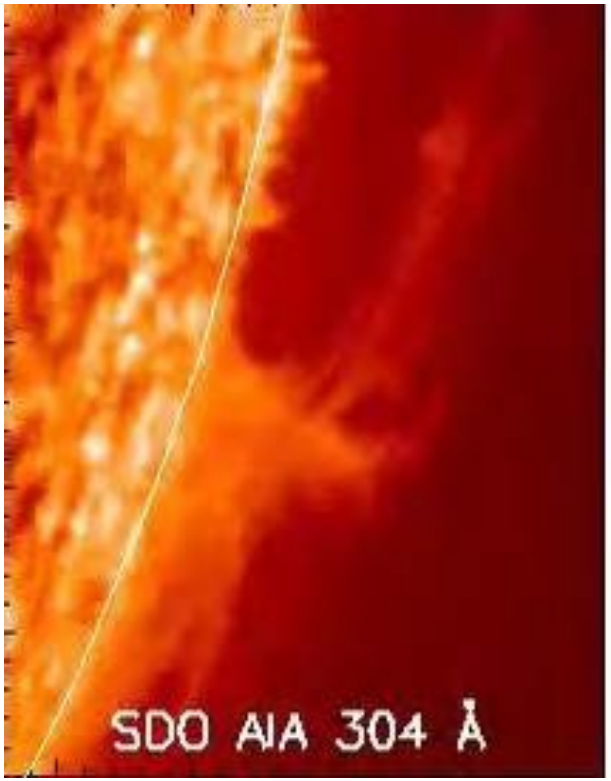
Chen, Innes, & Solanki (2008)

Longitudinal



Jing et al. (2003)
Vrsnak et al. (2006)

Transverse

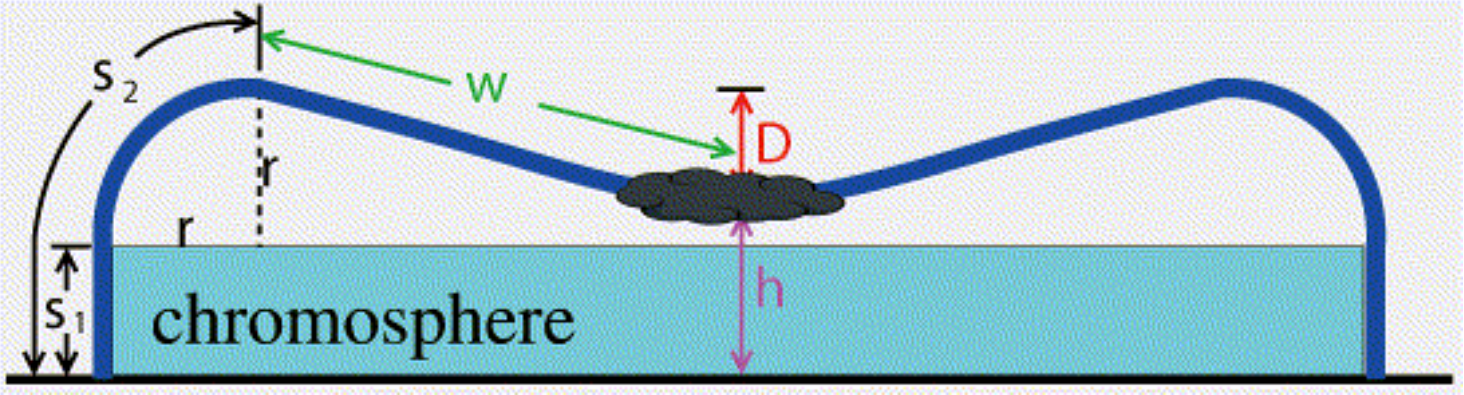


Ramsey and Smith (1965)
Pouget + (06)
Shen et al. (2014)

What determines *P*?

What is the restoring force?

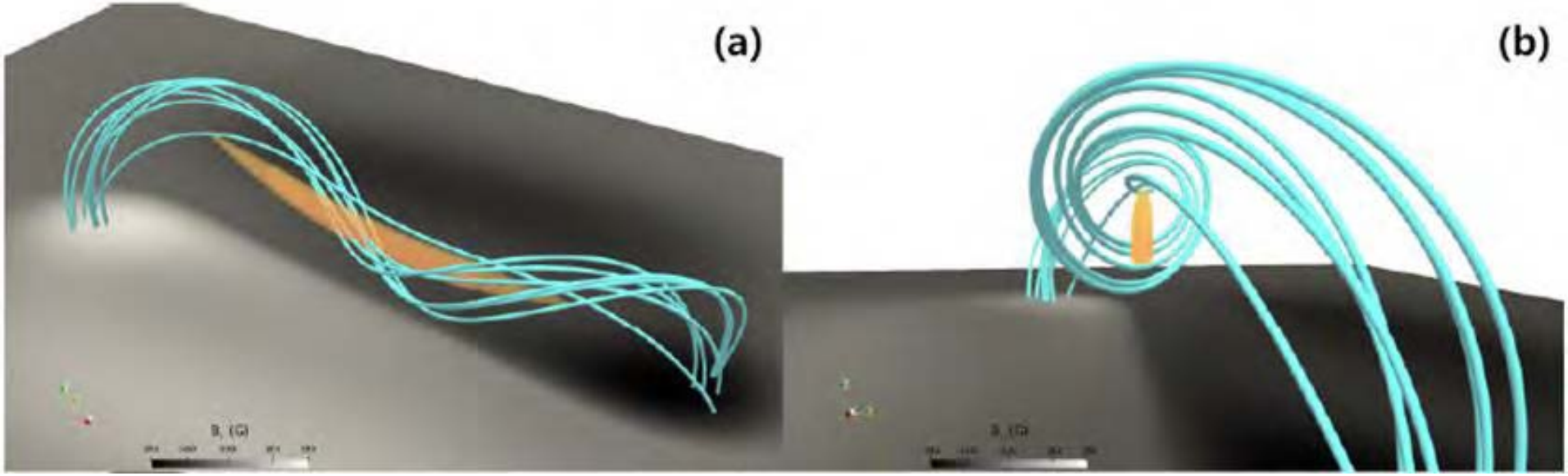
For longitudinal oscillations:



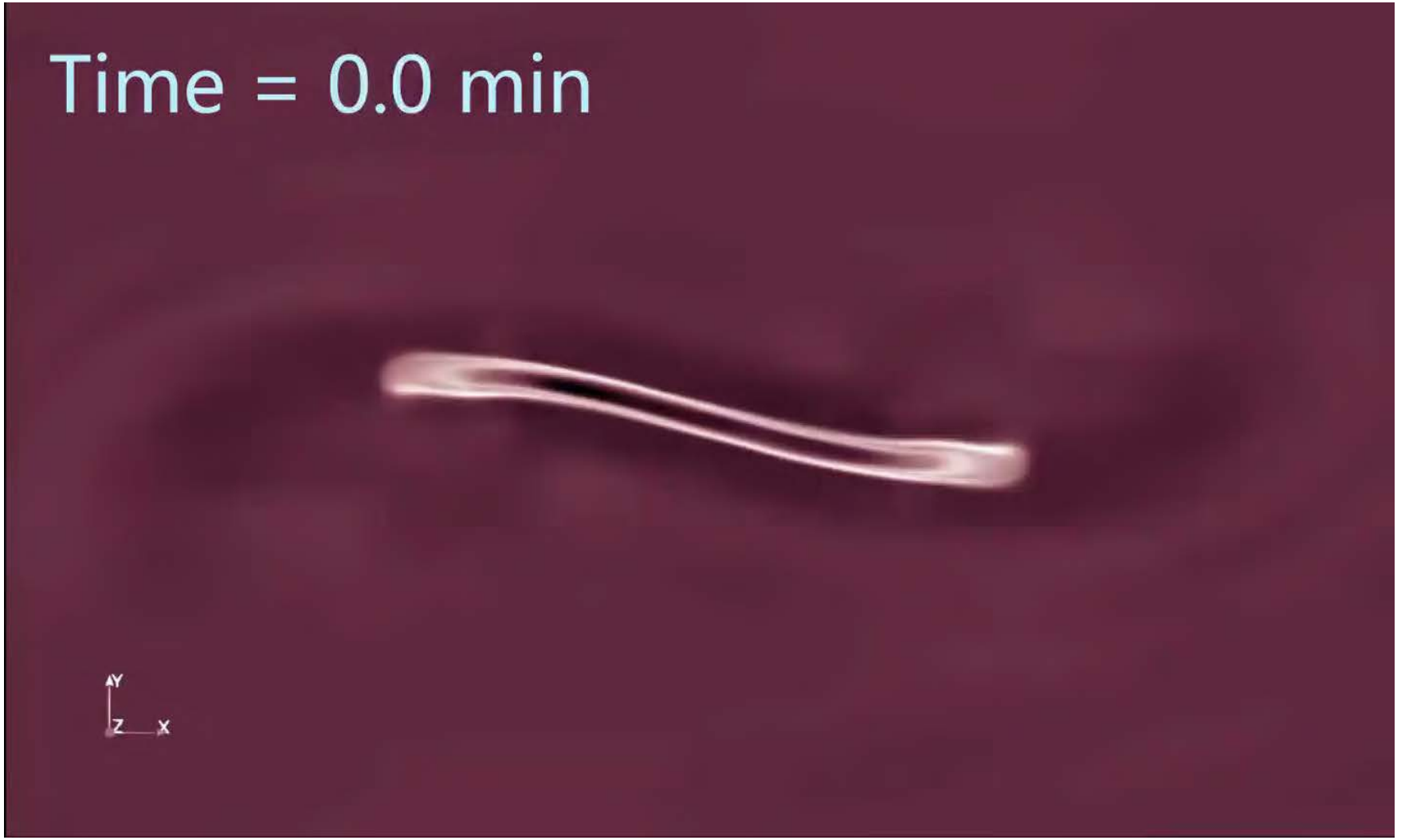
$$P = 2\pi\sqrt{\frac{R}{g}}$$

Luna + (2012), Zhang + (2012)

Zhou et al. (2018, ApJ, 856, 179)

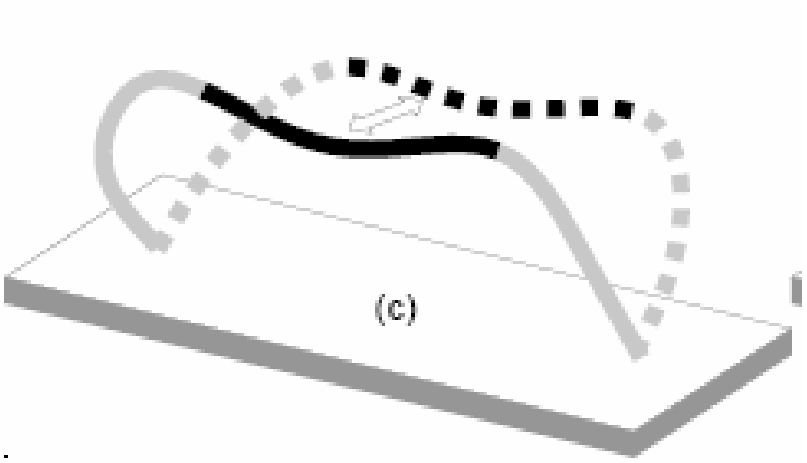


Zhou et al. (2018, ApJ, 856, 179)

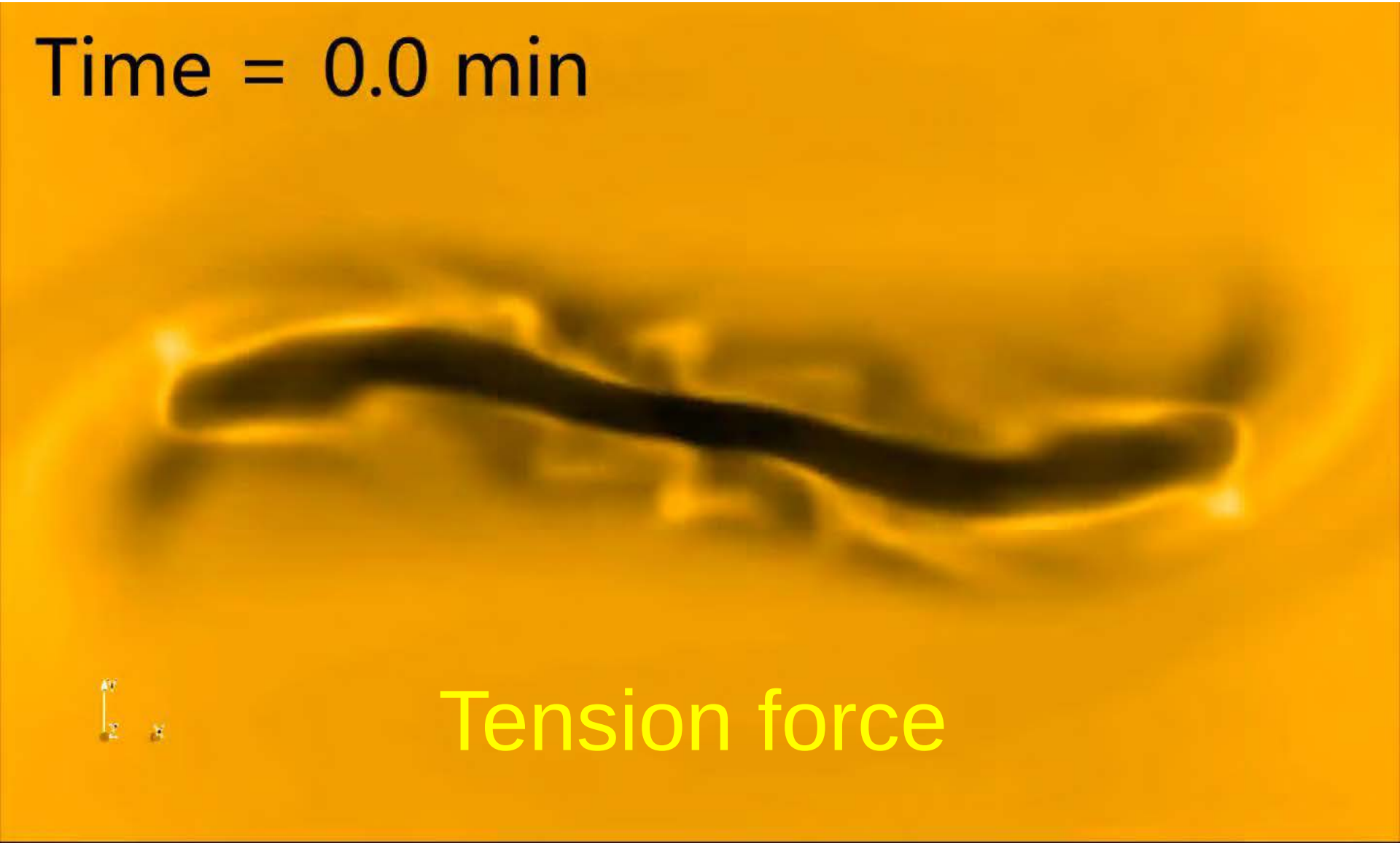


For transverse oscillations:

Lorentz force

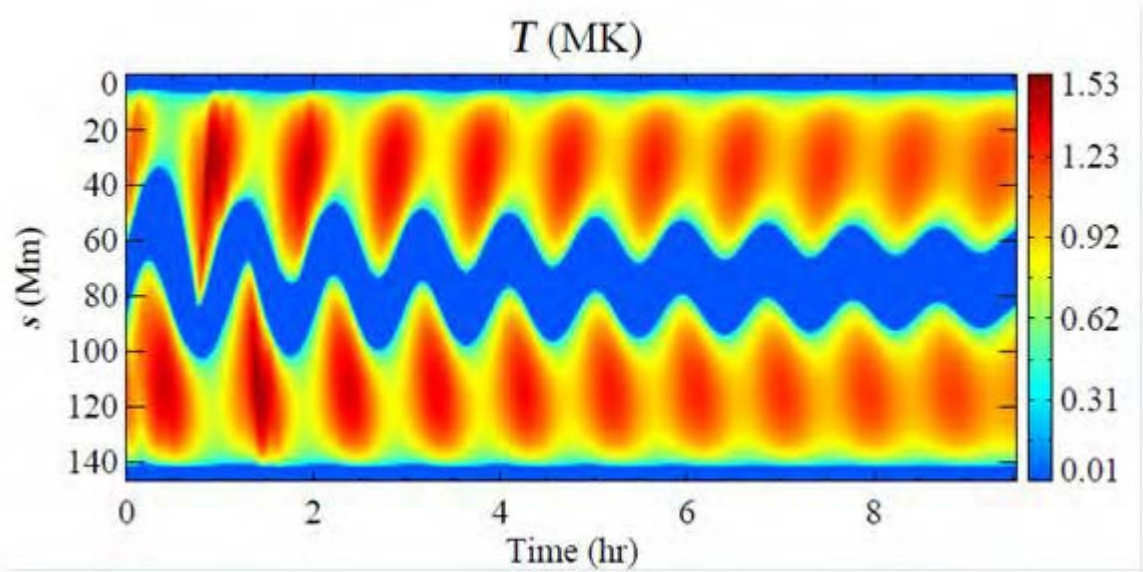


Zhou et al. (2018, ApJ, 856, 179)



What determines τ?

(1) Thermal process (radiation, conduction)



Zhang et al. (2013, A&A, 554, A124)

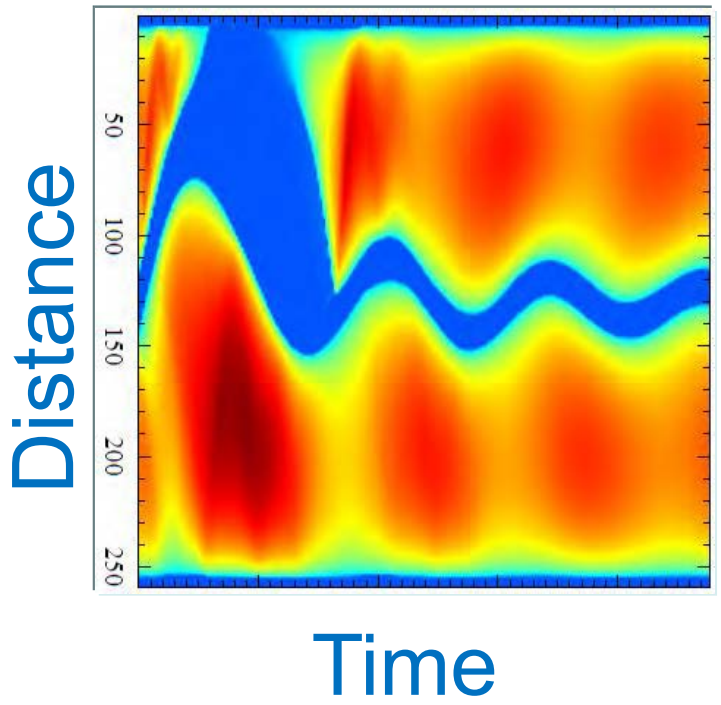
$$\tau \sim l^{1.63} D^{0.66} w^{-1.21} v_0^{-0.30}$$

What determines τ ?

(2) Mass change (increase, drainage)

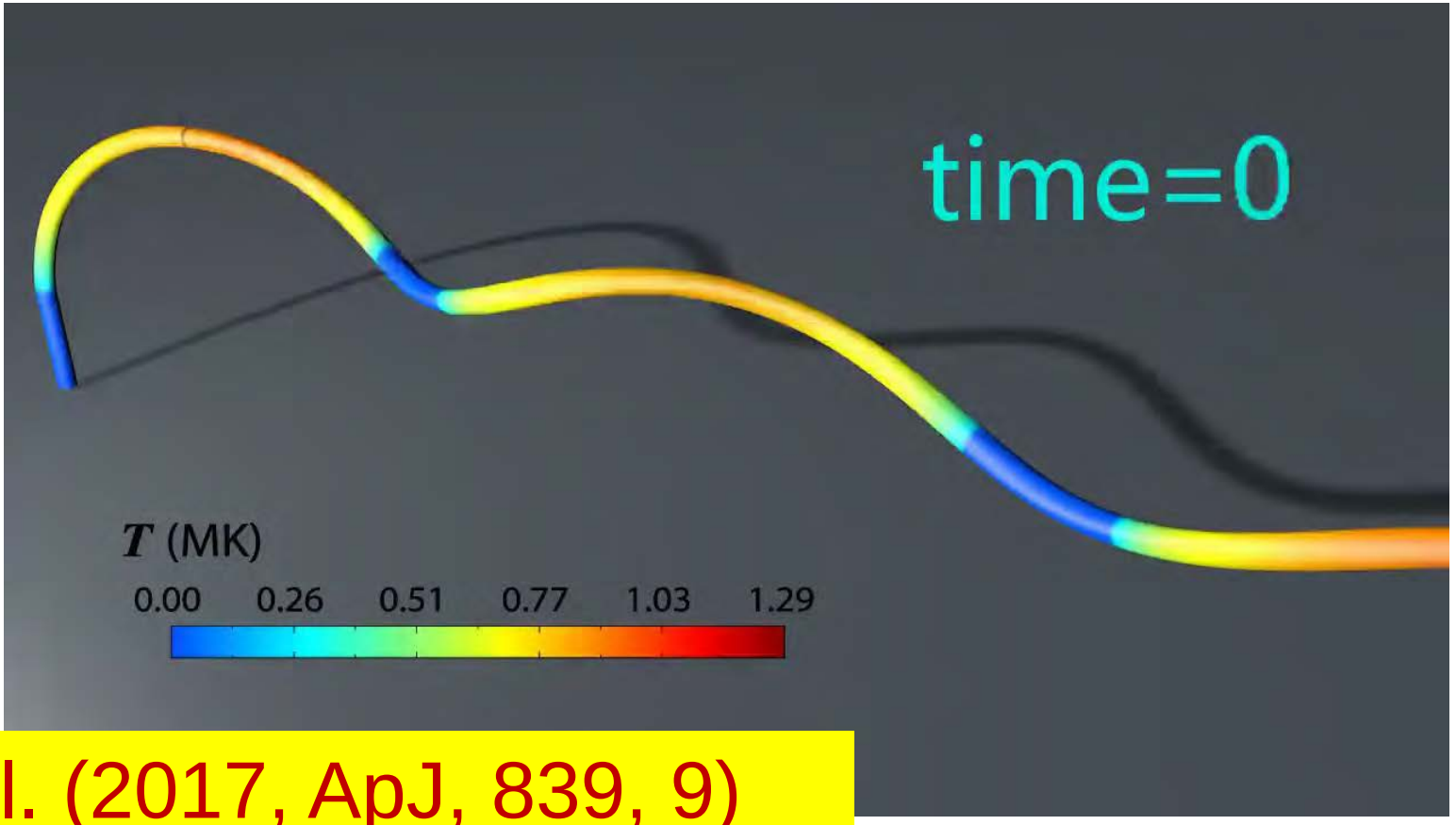
Luna & Karpen (2012, ApJ, 750, L1)

Zhang et al. (2013, A&A, 554, A124)



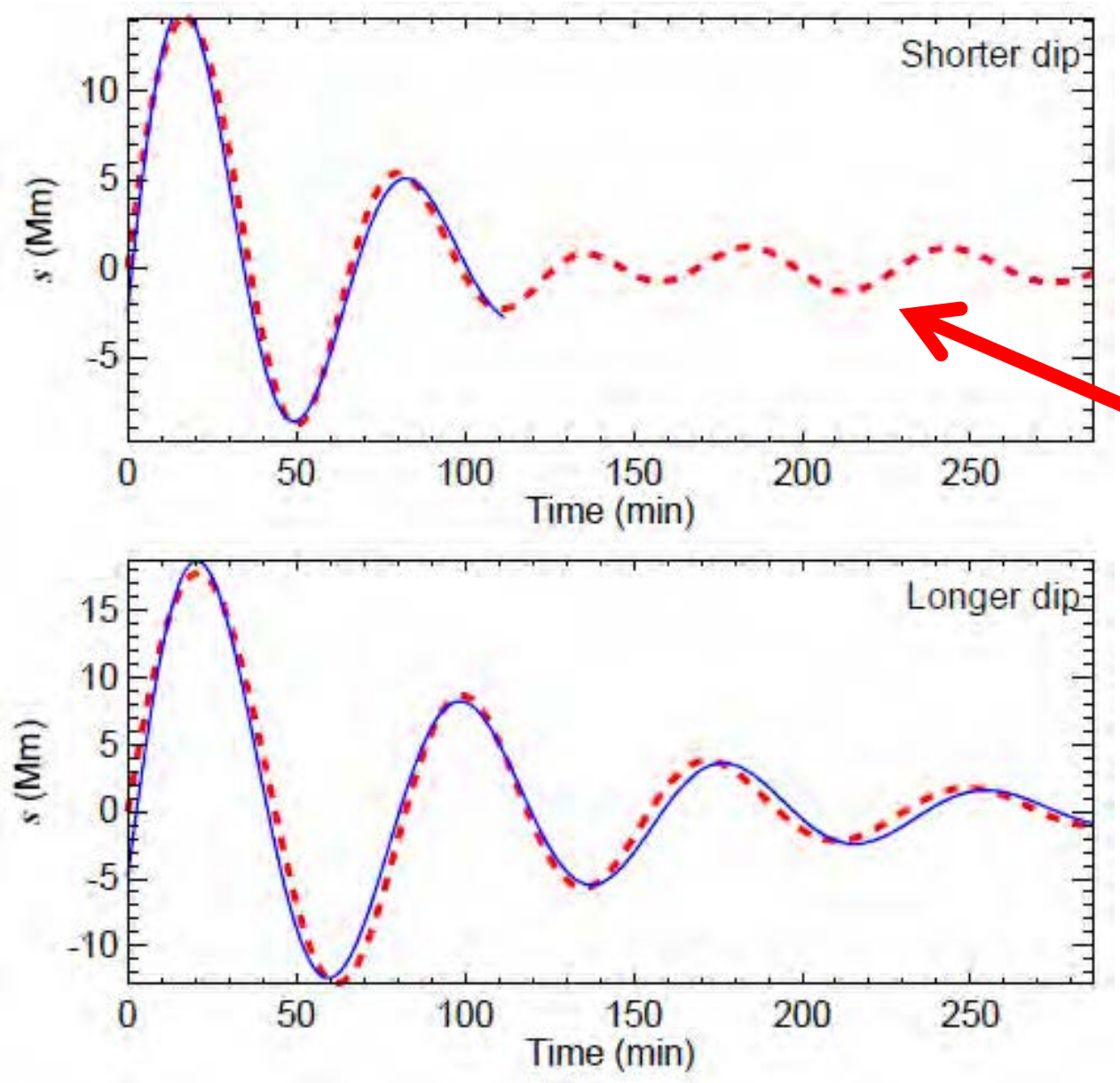
What determines τ ?

(3) Thread-thread Interaction



Zhou et al. (2017, ApJ, 839, 9)

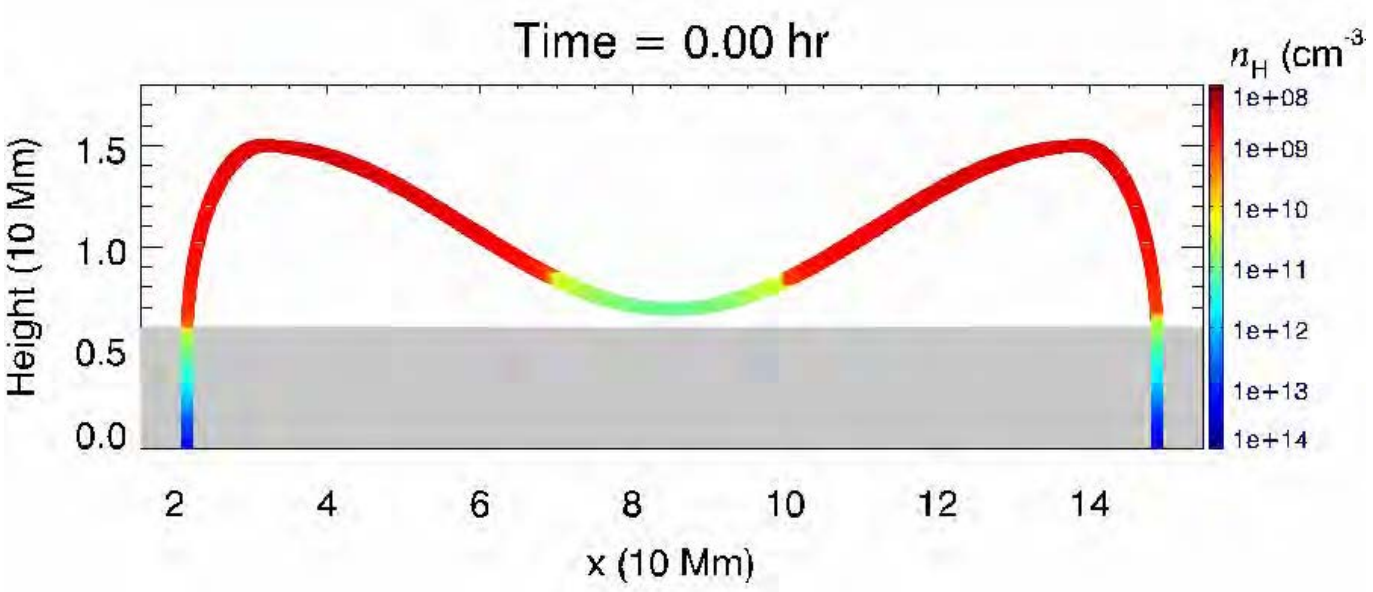
Zhou et al. (2017, ApJ, 839, 9)



Decayless oscillation

What determines τ ?

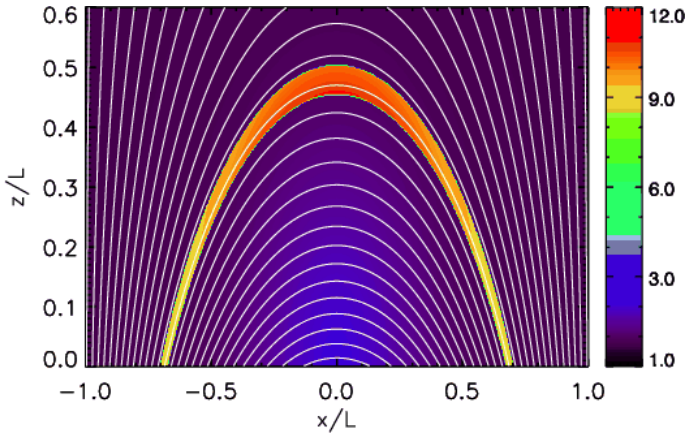
(4) Wave leakage



Zhang et al. (2013, A&A, 554, A124)

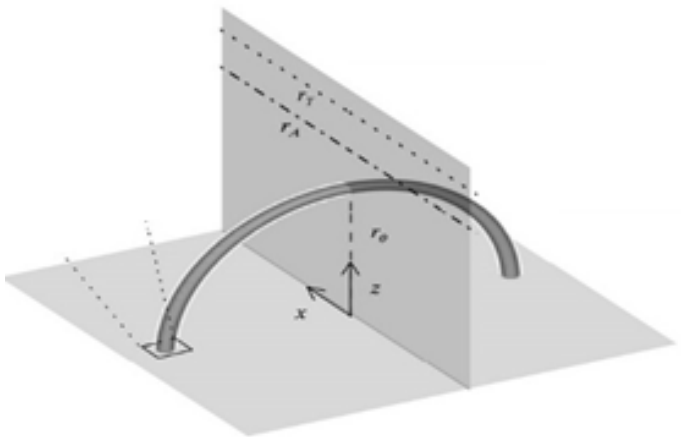
Wave leakage ignored for 2 reasons

1. Might not be effective?



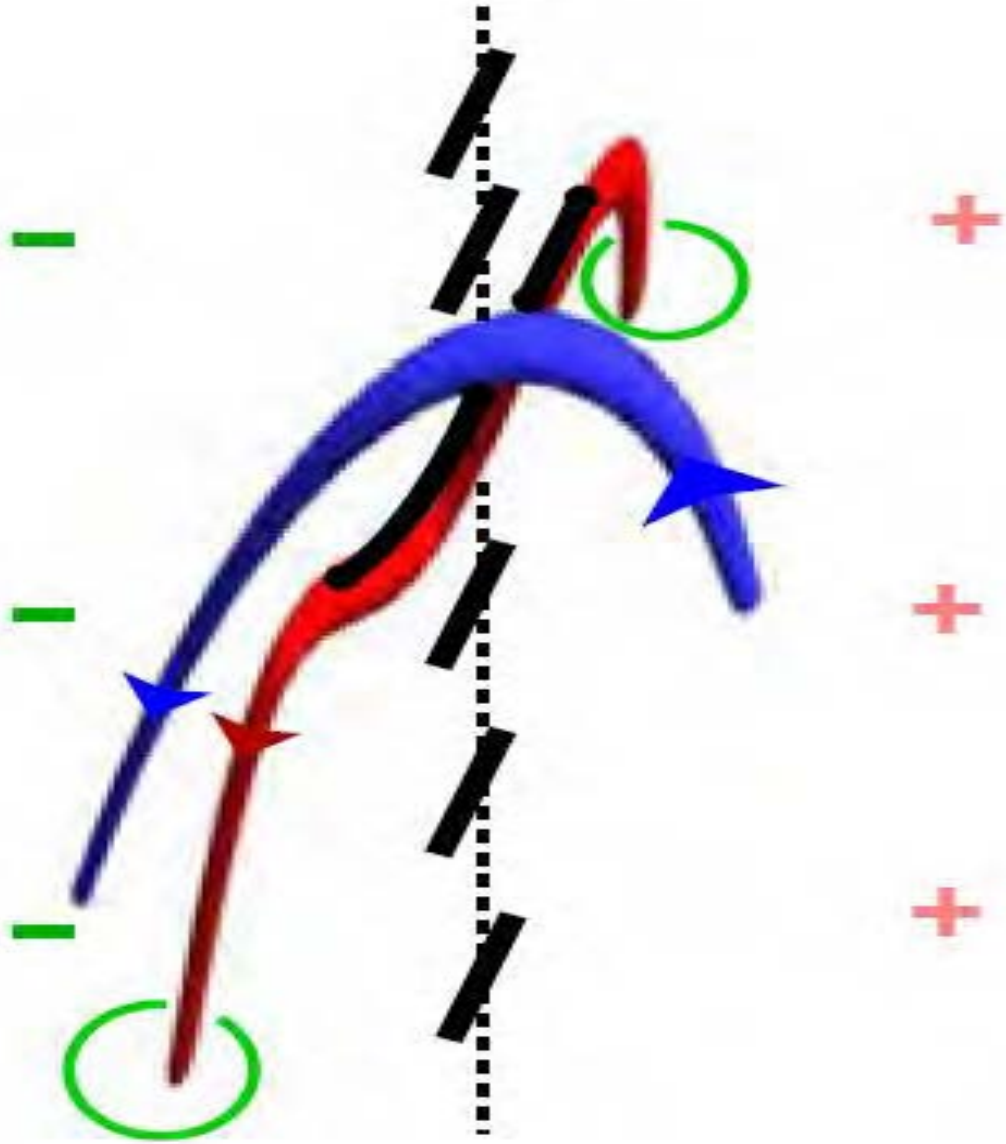
Effective in 2D

(Cally 1986, Brady & Arber 2005; Selwa et al. 2006, D áz et al. 2006; Verwichte et al. 2006)



Not effective in 3D

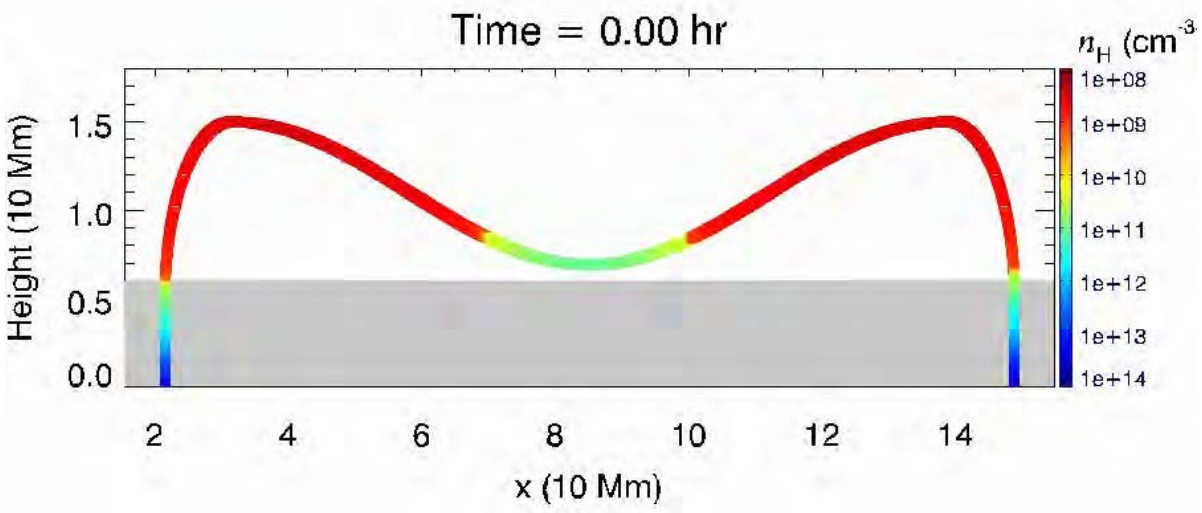
(Terradas et al. 2006)



Wave leakage ignored for 2 reasons

2. Low plasma beta

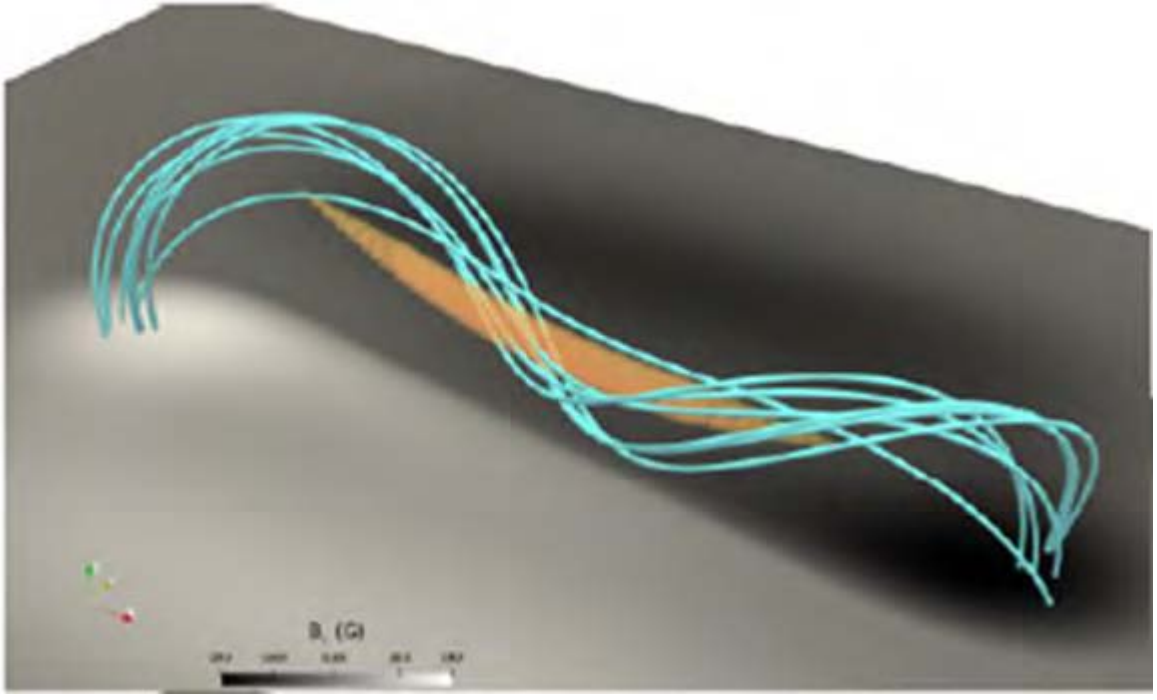
$$\beta = \frac{p}{p_{mag}} = \frac{nk_BT}{B^2/(2\mu_0)}$$



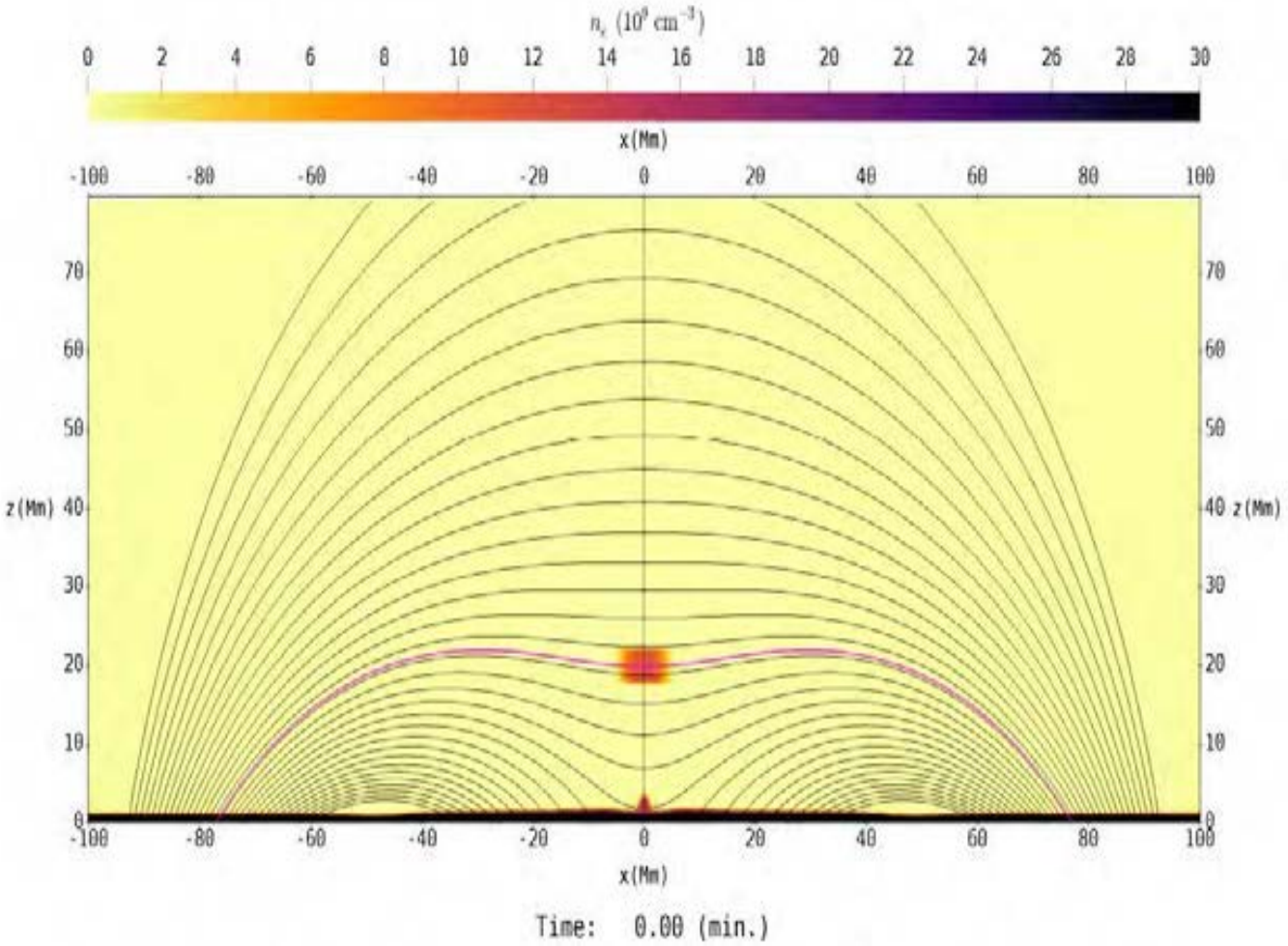
Can Gravity Change the B-field?

Zhou et al. (2018, ApJ, 856, 179)

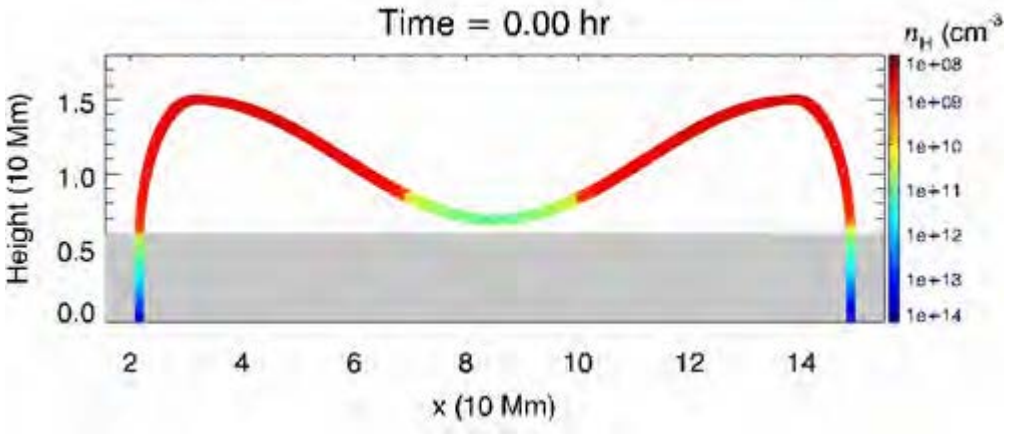
$$\delta = \frac{\rho g L}{B^2/2\mu_0} = 11.5 \frac{n}{10^{11}\,\mathrm{cm}^{-3}} \frac{L}{100\,\mathrm{Mm}} \left(\frac{B}{10\,\mathrm{G}}\right)^{-2}$$



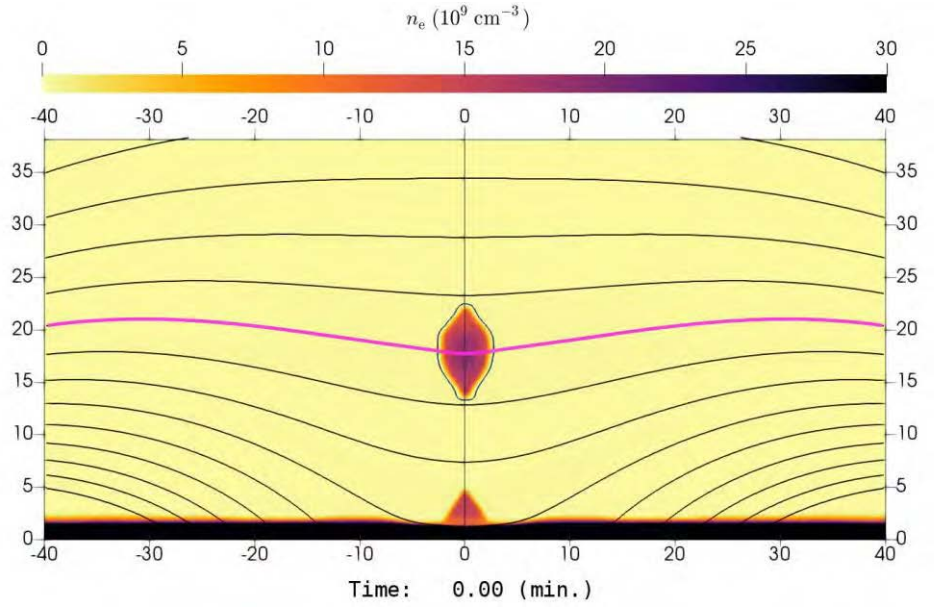
Radiation MHD Simulations



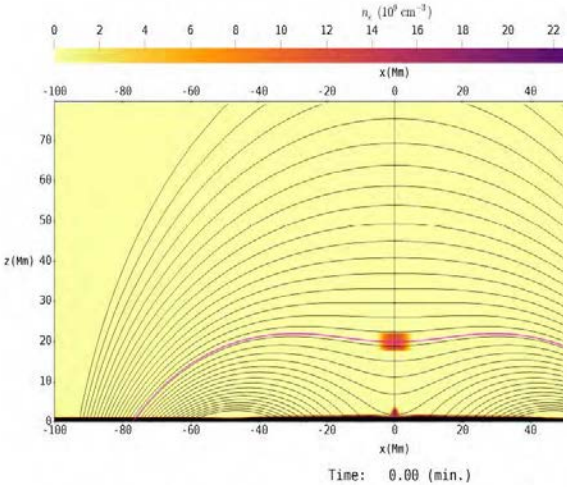
MPI-AMRVAC
(Keppens+12)

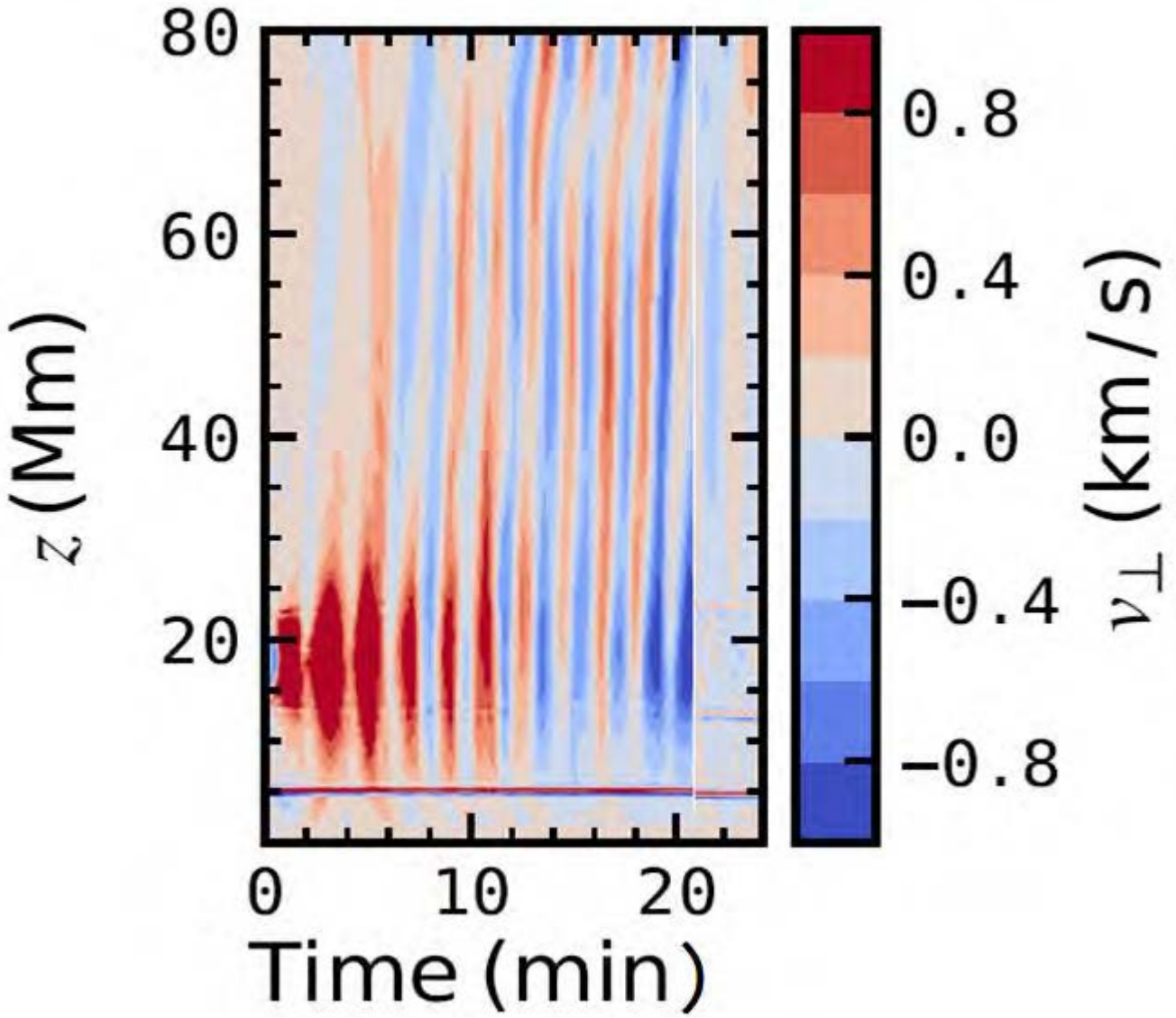


1D τ= 76 min



2D τ= 34 min





Wave leakage

Conclusions

Zhang et al. (2019, ApJ, 884, 74)

In filament longitudinal oscillations,

1. Radiation is the most important mechanism for the decay;

2. Wave leakage plays also an important role.