Amplitudes and Energy Fluxes of Simulated Decayless Kink Oscillations

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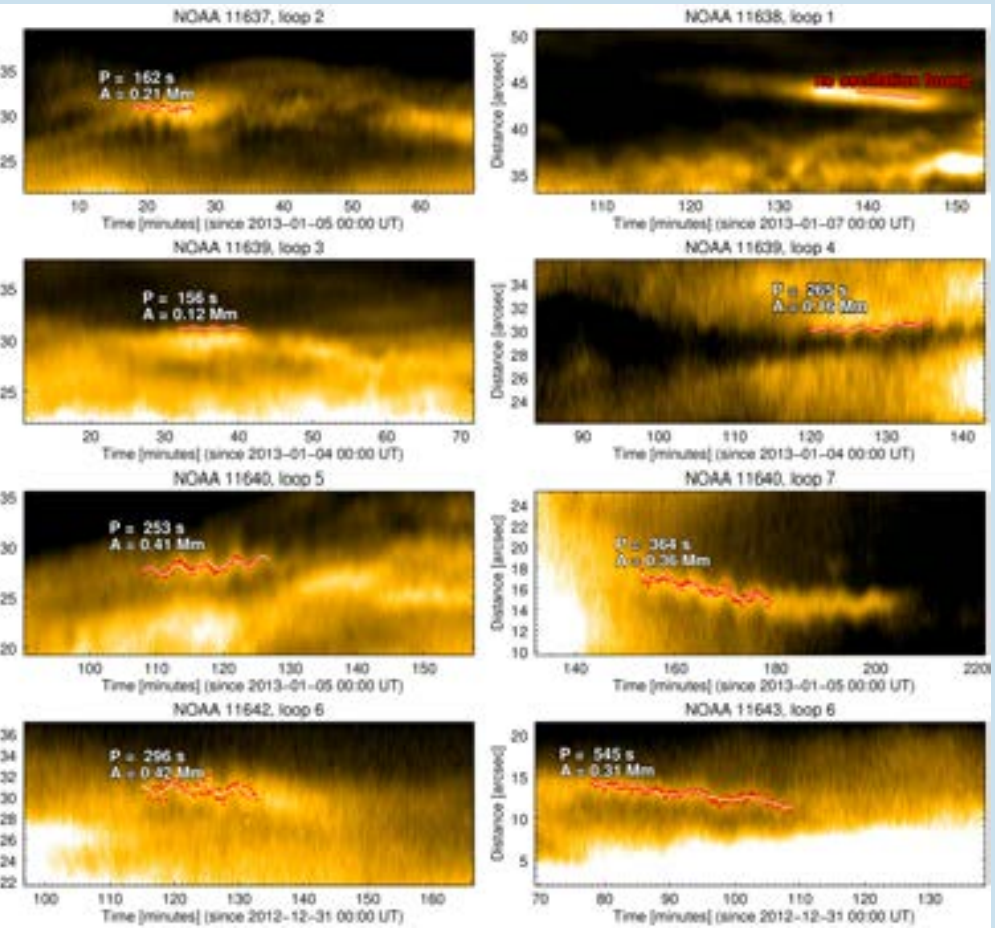
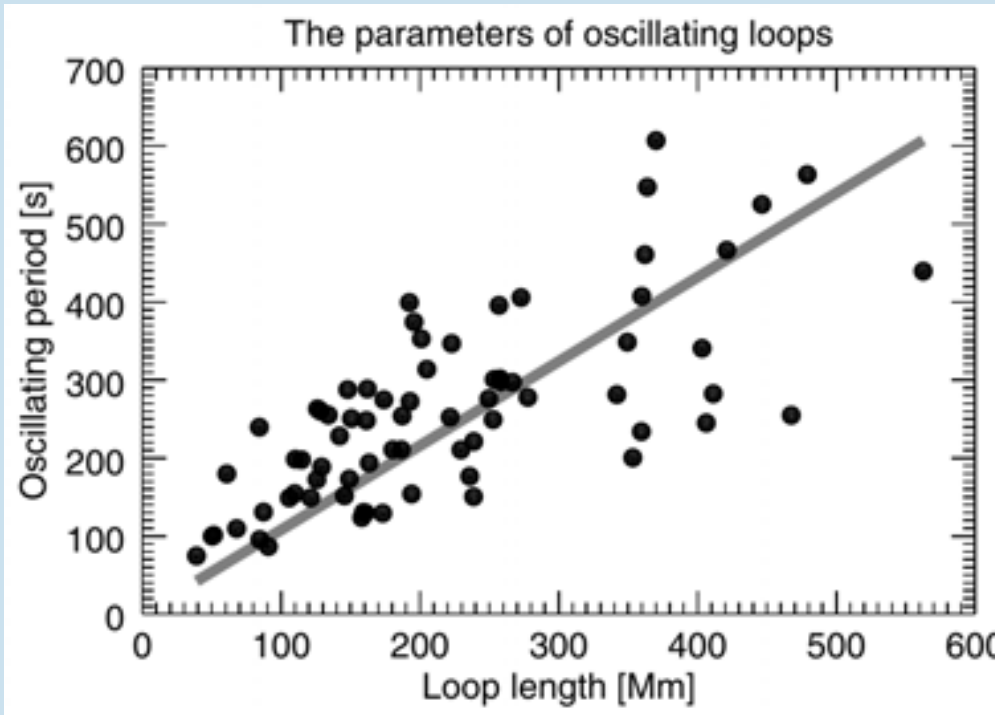
Decayless waves

Anfinogentov et al. (2015): decayless transverse waves in coronal loops are ubiquitous and standing

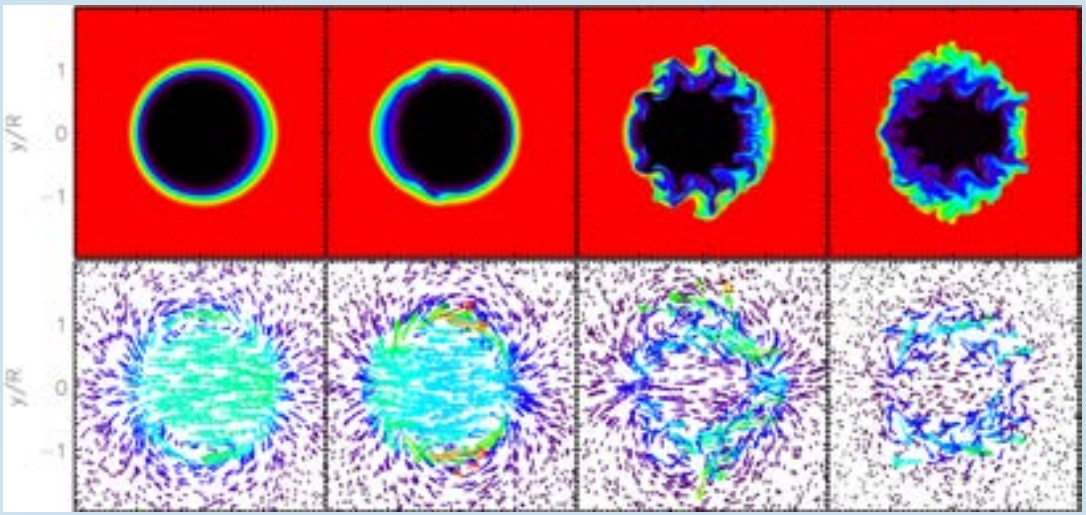




TWIKH rolls

Terradas et al. (2008): large amplitude standing kink waves experience Kelvin-Helmholtz instability

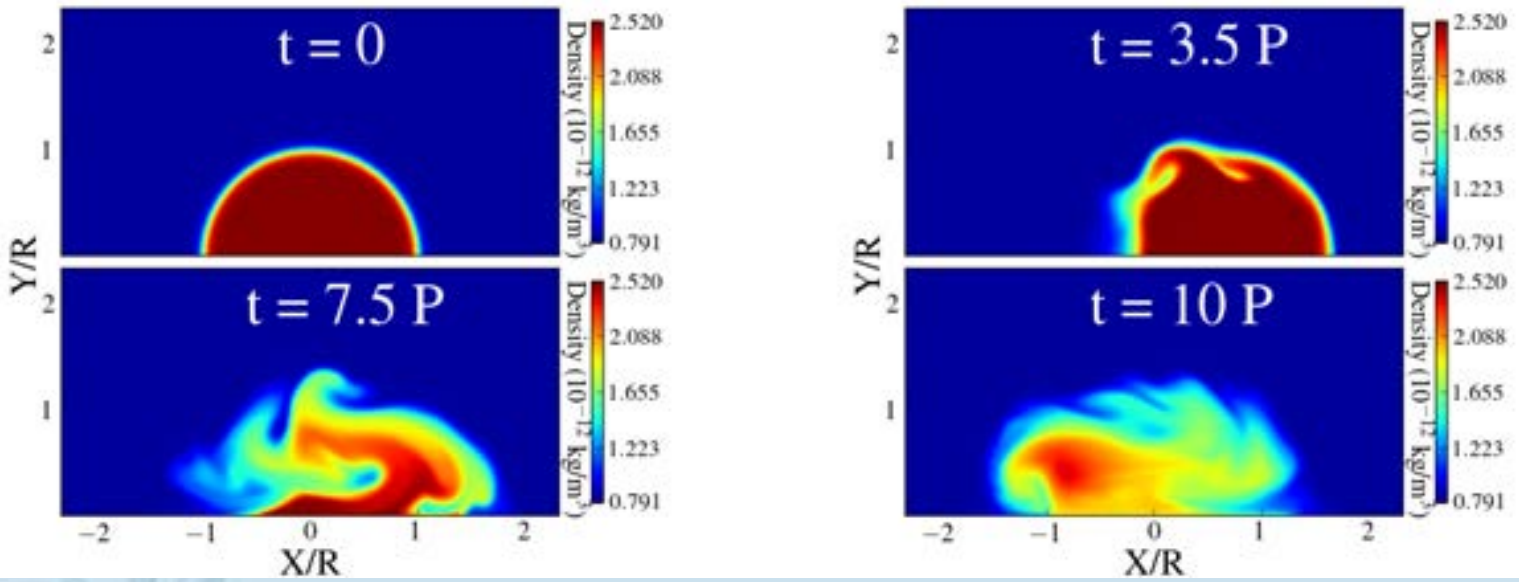
Antolin et al. (2014): perform modelling of impulsively excited waves (cross-sections) in overdense loops, initial velocity excitation



Resonant absorption and Kelvin-Helmholtz instability forms so-called Transverse Wave Induced Kelvin-Helmholtz rolls (or TWIKH rolls):
idea for heating $\rightarrow$ cascade energy to small scales to dissipate

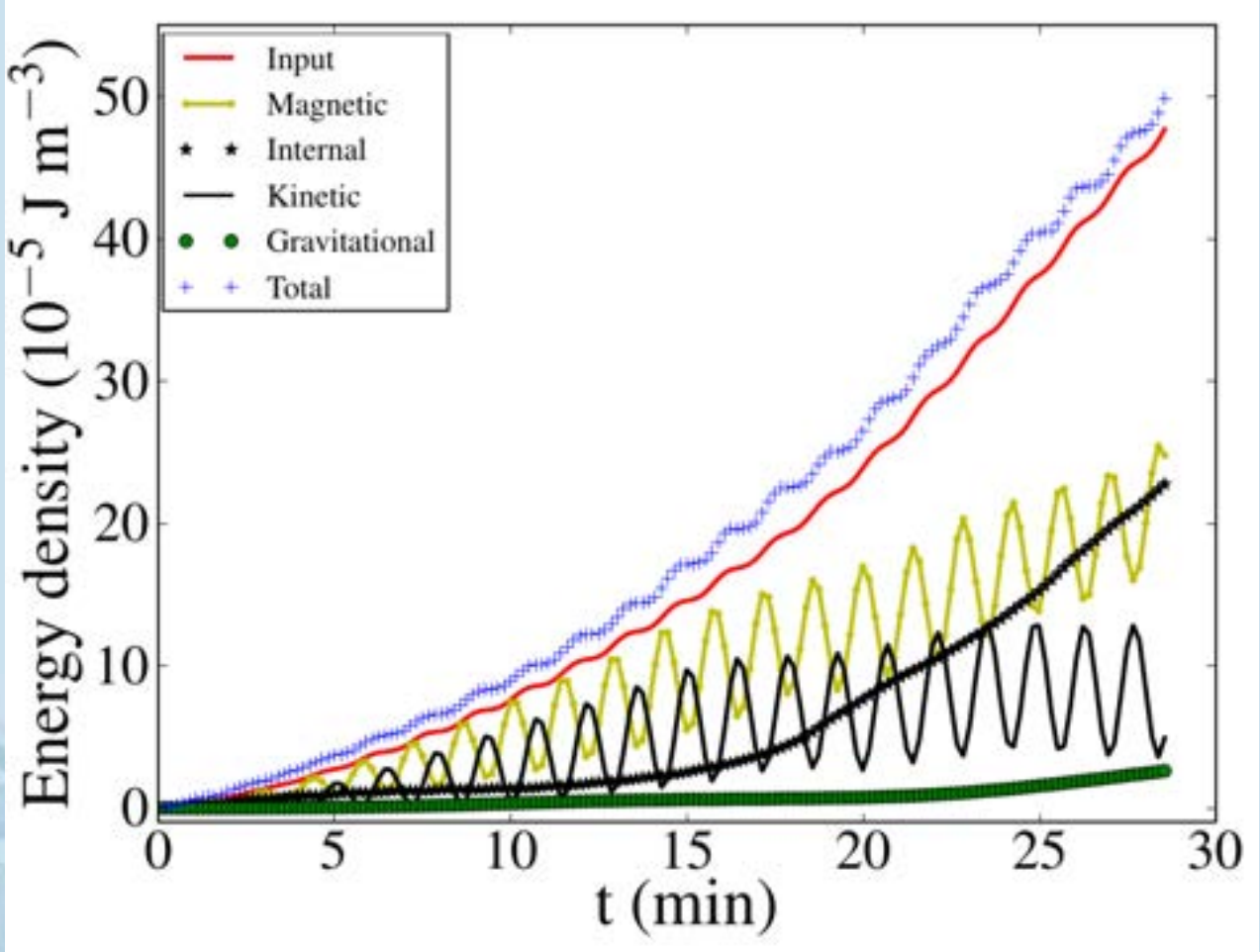
Footpoint driven transverse waves

Karampelas et al. (2017), Karampelas & Van Doorsselaere (2018):
model for decayless oscillations
loop with (mono-periodic) footpoint driver
becomes fully turbulent (KHI)



Footpoint driven transverse waves

Karampelas et al. (2019a): energetics of decayless oscillations



Reach steady state after $10 - 20P$

Footpoint driven transverse waves

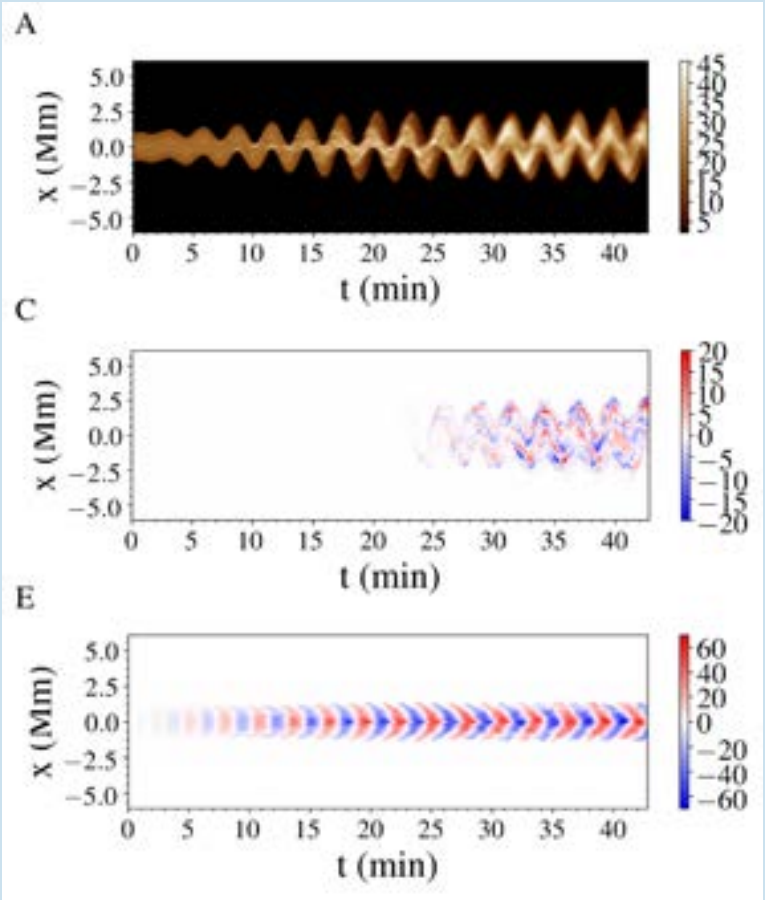
Karampelas et al. (2017, 2018, 2019a): idea for heating

- Input energy drives waves (kinetic energy)
- Wave energy cascades to small scales
- Kinetic energy dissipated in turbulent layer (internal energy)
- Loop amplitude increases until KHI dissipation balances energy input
- This last stage corresponds to decayless regime

(similar to Poedts et al. 1990!)

Forward modelling of simulated decayless waves

Karampelas et al. (2019b): Observational consequences of model
Forward modelling with FoMo code (Van Doorsselaere et al. 2016)



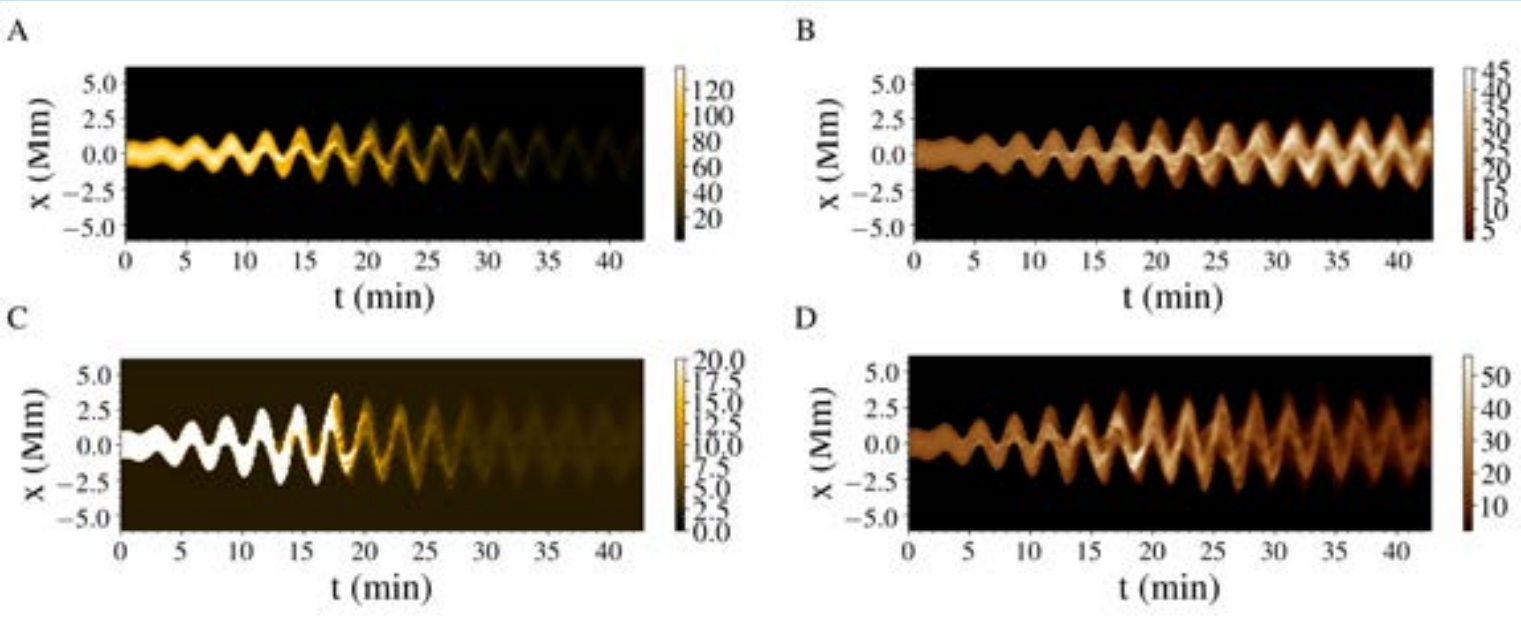
Despite fully turbulent structure: apparent loop in decayless regime

Forward modelling of decayless waves

Karampelas et al. (2019b): observations infer energy from amplitude (e.g. McIntosh et al. 2011)

Possible? Verify/calibrate with forward modelling?

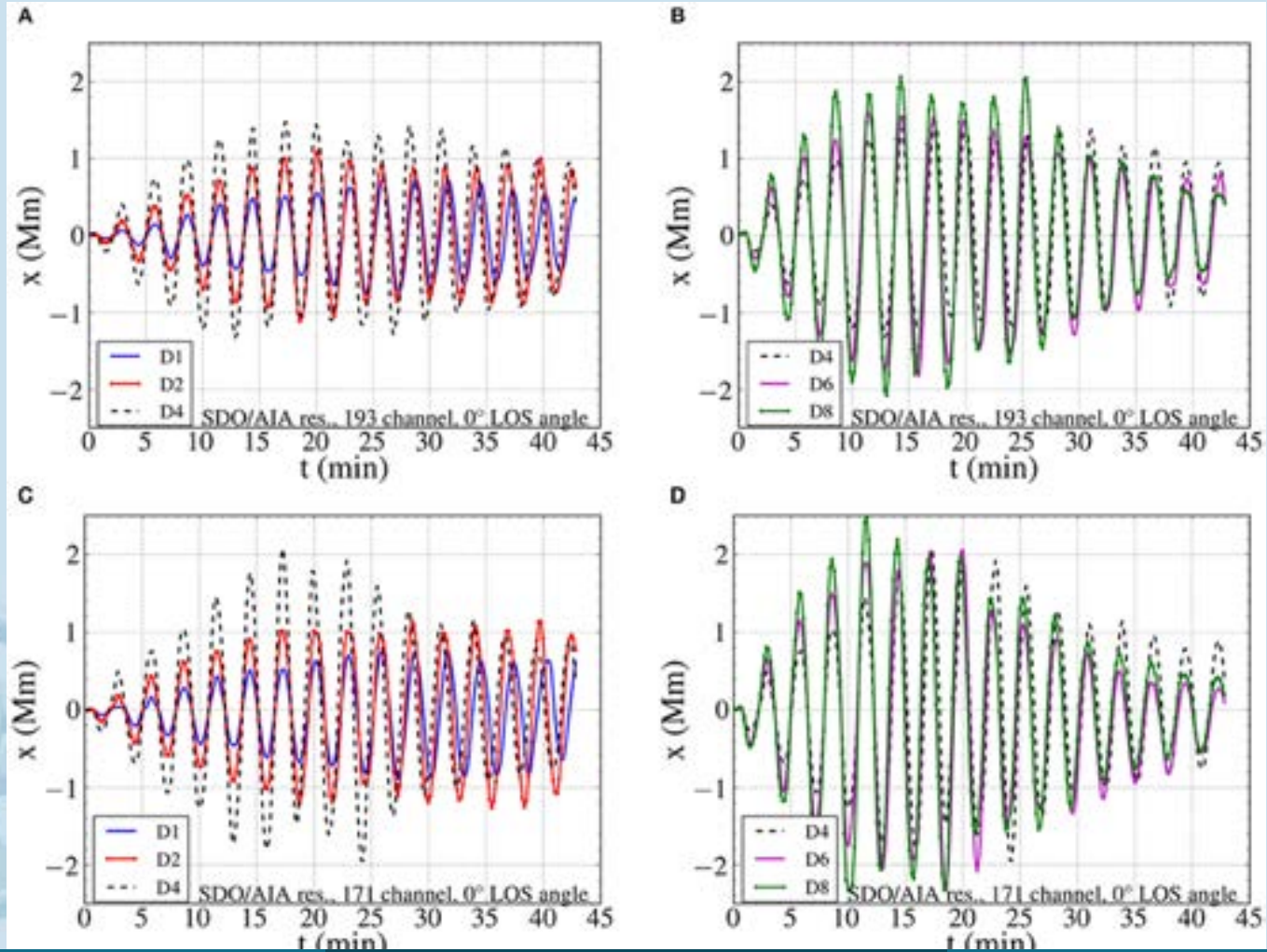
$\rightarrow$ run simulations with different driver amplitude (i.e. different Poynting flux): $1km/s$, $2km/s$ (top), $4km/s$ (bottom), $6km/s$, $8km/s$



Forward modelling in AIA171 and AIA193

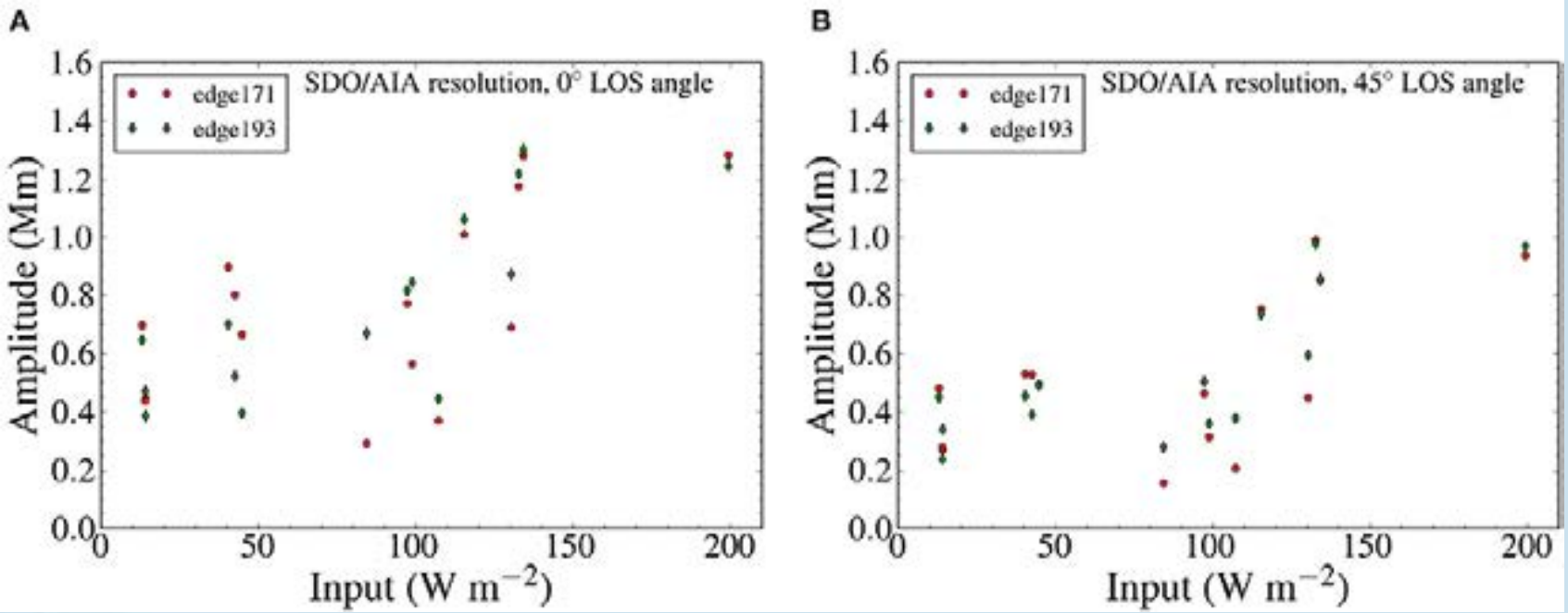
Forward modelling of decayless waves

Karampelas et al. (2019b): Use loop tracking method (bisect edges of loops) in AIA193 (top) and AIA171 (bottom)



Forward modelling of decayless waves

Karampelas et al. (2019b): Consider (decayless) steady state, relate energy input and observed amplitude



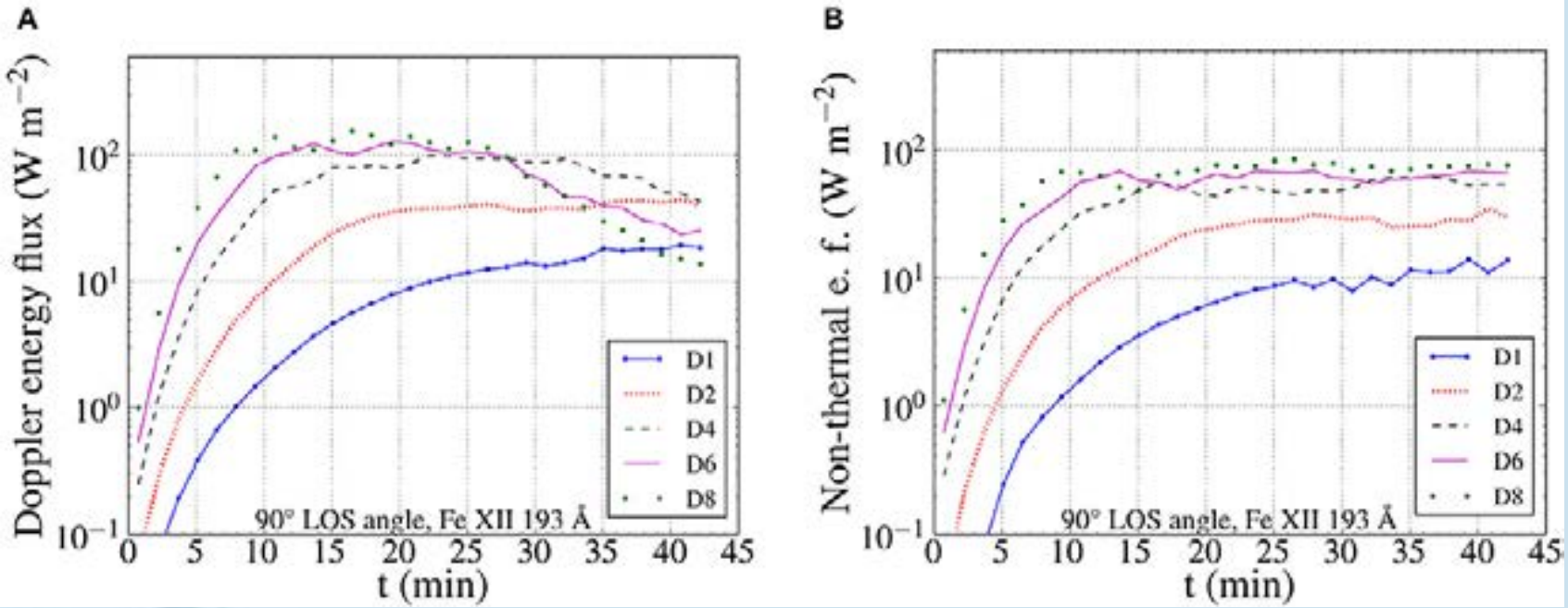
Observed amplitude (at best) weakly correlated with input energy

More energy can be present in the corona than currently measured (now $10 W/m^2$)

Observations ($.3 Mm$) compatible with fluxes up to $150 W/m^2$

Forward modelling of decayless waves

Karampelas et al. (2019b): Reliable estimator of energy flux line width or Doppler shift (even at coarse EIS resolution)



Observed energy correlated with input energy

Doppler influence by LOS direction: combination with POS motion solves issue

Conclusions

- Footpoint driven transverse waves
- Reach saturated regime
- Poynting flux balance with energy cascade rate of KHI
- Resembles decayless oscillations
- Estimate energy flux?
- Amplitude not well correlated
- Doppler/line width works better