KU LEUVEN

Centre for Mathematical Plasma Astrophysics,
KU Leuven, Belgium

HIGH-FREQUENCY OSCILLATIONS IN EUI OBSERVATIONS

Elena Petrova (Elena.Petrova@kuleuven.be), Tom Van Doorsselaere, David Berghmans

INTRODUCTION

- The energy required to balance the coronal energy losses constitutes $100 - 200\ Wm^{-2}$ for a Quiet Sun and ~ $10^4\ Wm^{-2}$ for active regions (Withbroe et al., 1977)
- One of the possible mechanisms as a part of the AC heating theory – high-frequency oscillations

? What is detected already?

- Eclipse observations of fast magnetoacoustic waves with periods 6-25 seconds (D.R. Williams et al., 2002 ; T. Samanta et al., 2016)
- Decayless kink oscillations with periods of 1.5 to 10 min (S.A. Anfinogentov et al., 2015)

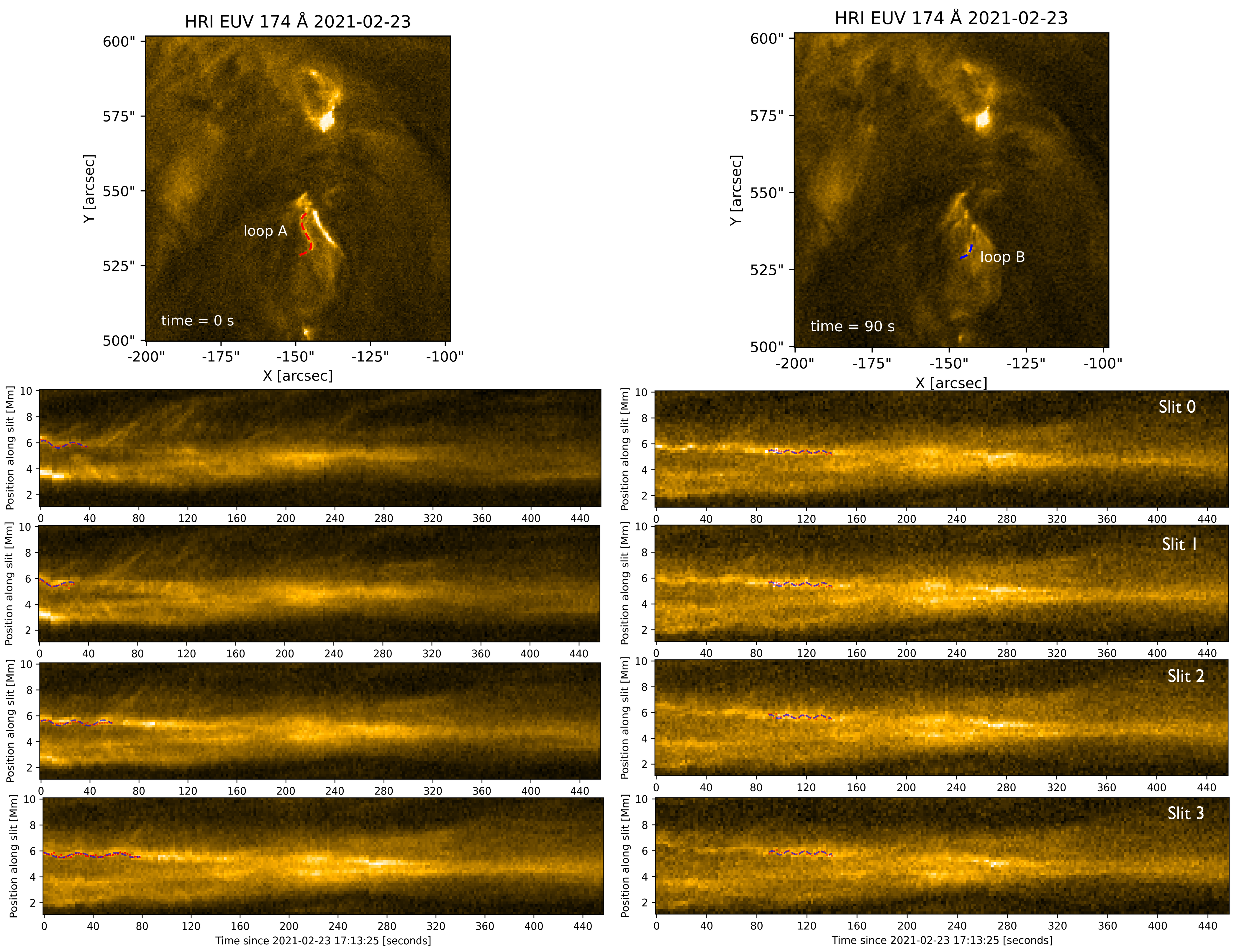
- Estimations of the energy content in the observed waves:
  - Waves in Quiet Sun region with periods of 150-550 s flux of 10-20 Wm^{-2} (S.W. McIntosh et al., 2011)
  - Alfvén waves in active region coronal loops with periods of 5 min flux of 0.01 Wm^{-2} (S.Tomczyk et al., 2007)

show that there is not enough energy to compensate for the losses

? What is the power budget at higher frequencies? For the lower frequencies there is a power law (R.J. Morton et al., 2016)

OBSERVATIONS AND DATA ANALYSIS

- The images were obtained on 2021 February 23 from 17:13:25 to 17:20:59, temporal cadence - 2 seconds.
- Instrument – Extreme Ultraviolet Imager (EUI) on board of the Solar Orbiter
- SolO was located at 0.52 AU distance from the Sun
- Spatial resolution: 1 pixel - 200 km on the Sun



Horizontal slits across the loops

↓

Fit gaussian to the intensity profile in time-distance map of each slit

Center positions, radius of the loop cross-section R

↓

Fit the sin function to the center positions

period P, amplitude A

Characteristics	30 s oscillations (loop A)	14 s oscillations (loop B)
Period P,s	30	14
Length of the loop L,Mm	11.7	4.53
Radius of the loop cross-section R,Mm	0.38	0.327
Displacement A, km	600	160
Velocity amplitude v,km/s	125.6	71.8
Phase speed V_{ph}, km/s	780.5	647.3
Energy flux E,W/m^2	3673	1120

RESULTS

- Interpetation of the detected oscillations – high-frequency decayless kink oscillations

- Energy flux is calculated according to E = $\frac{1}{2}v^2(\rho_i + \rho_e)$ (M.Goossens et al., 2013; T. Van Doorsselaere et al., 2014)

- The calculated energy budget can be compared to the radiative losses - one of the primary energy loss mechanisms in the corona.
- Modeled as $\chi\rho^2T^\beta$ (temperature dependence and specific values of the parameters are determined from the CHIANTI database)
- Value of the radiative losses approximately equals to $2 \cdot 10^{-4}\ Wm^{-3}$ which can be compared to the energy density of 30 s oscillating loop that constitutes $3.948 \cdot 10^{-4}\ Wm^{-3}$ and for the 14 s oscillating loop - $8.42 \cdot 10^{-4}\ Wm^{-3}$.
- This fact indicates that a substantial amount of energy is available on top of the radiative energy losses that can heat the plasma.

- Energy budget contained in the detected oscillations is sufficient to compensate for the coronal radiative losses
- Energy budget found in the analyzed oscillations is higher than what was previously found
- There is potentially a lot of energy at small scales and short periods