

Comparison of QPPs characteristics in Lyman- α and SXR solar measurements

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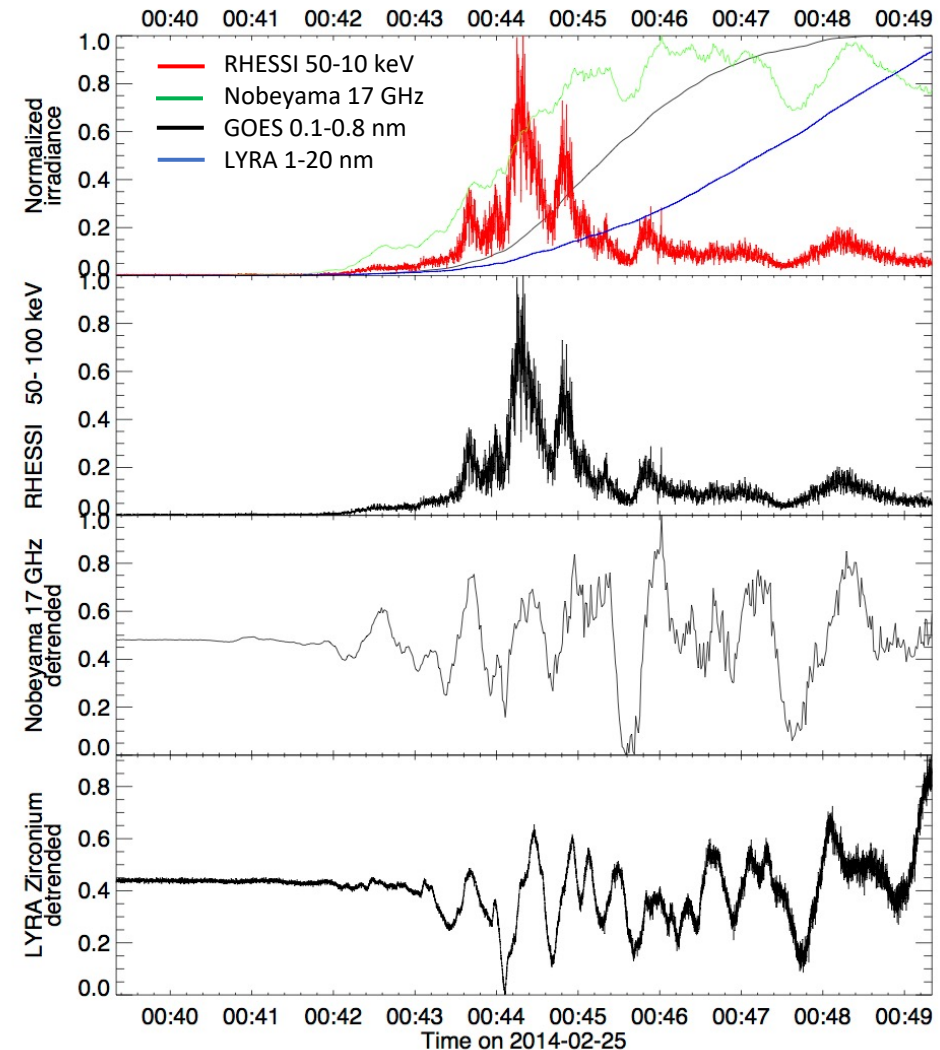
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Quasi-periodic pulsations (QPPs)

X4.9 flare 25/02/2014

- Seconds to tens of minute oscillations of the flare irradiance,
- Observed all over the spectrum from Hard X-rays to radio,
- Amplitude of the oscillatory pattern is wavelength-dependent.
- Present in most flares of class M or X



Quasi-periodic pulsations (QPPs)

Several mechanisms modeled, mainly grouped in three families (Kupriyanova et al. 2020):

1. Direct emission modulation by MHD oscillations,
2. Periodic modulation, via MHD oscillations, of the efficiency of energy release processes,
3. Spontaneous quasi-periodic energy release.

Different observational signatures (see table 1 in Zimovets et al. 2021):

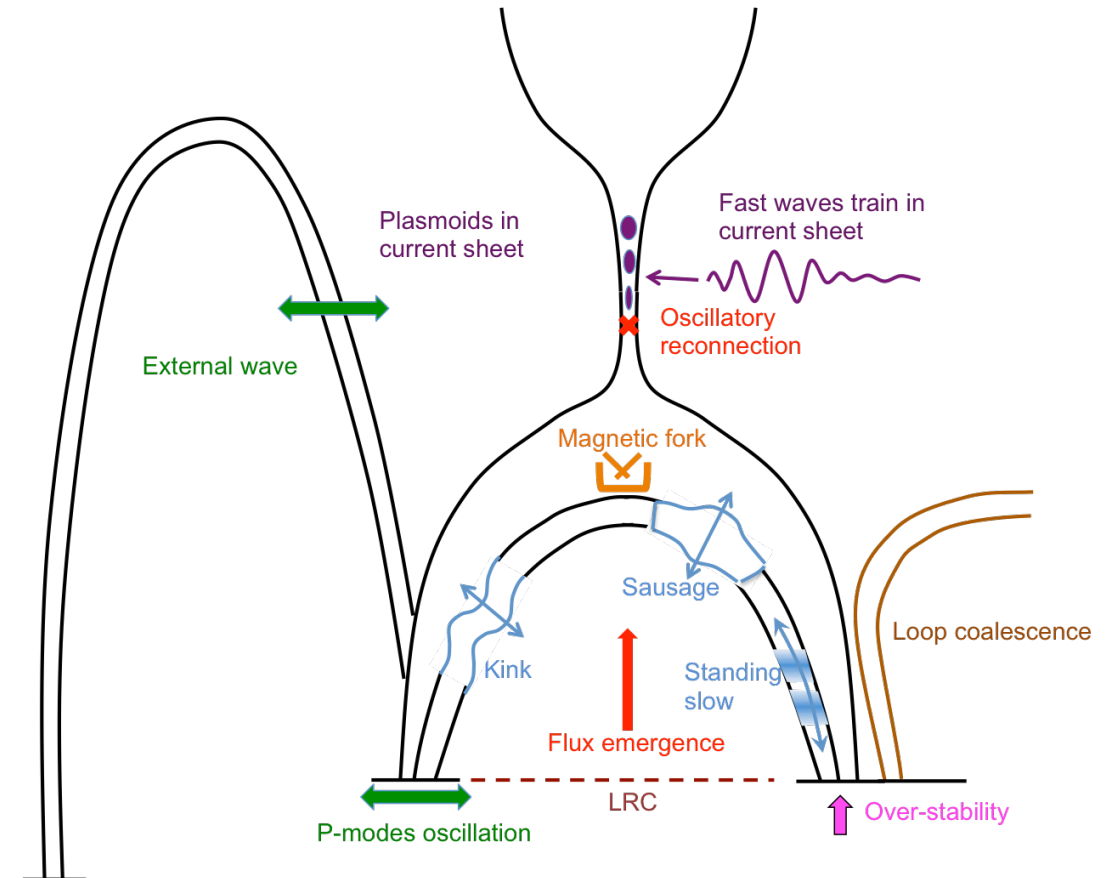
wavelength affected, range of period, evolution of the period, damping, etc.

BUT

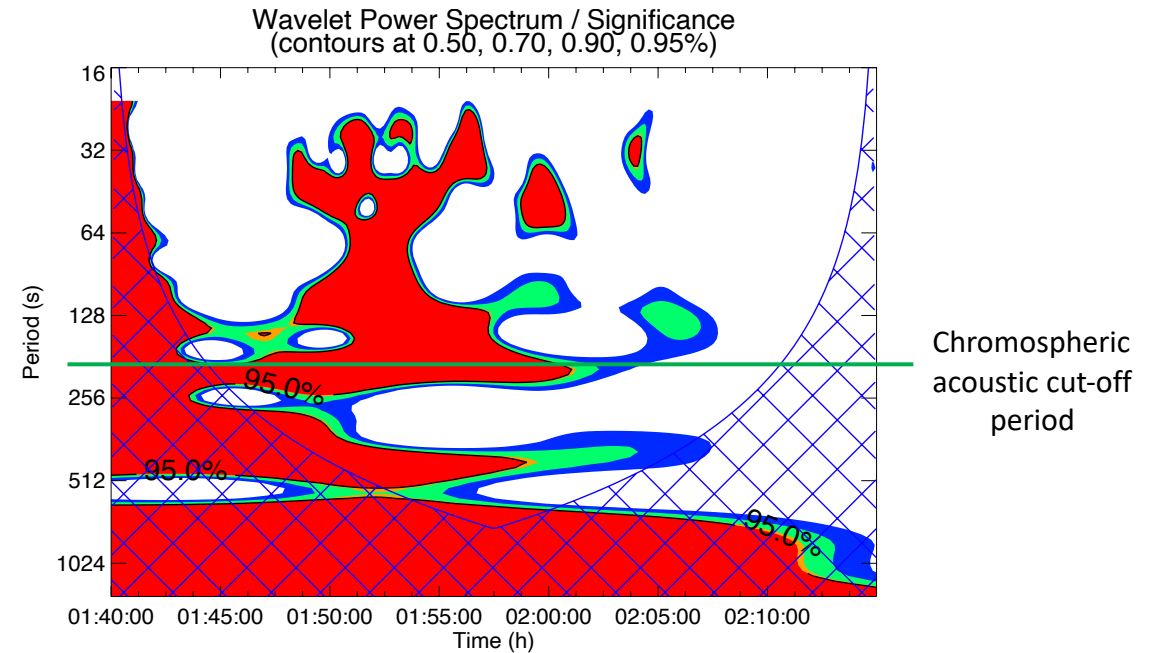
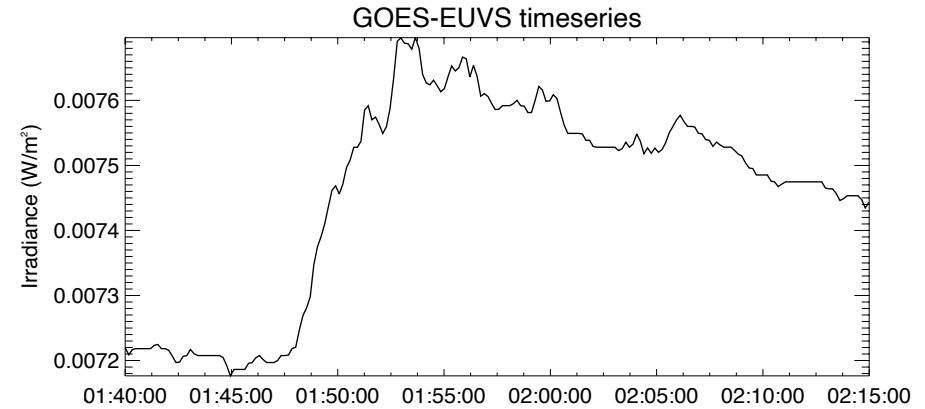
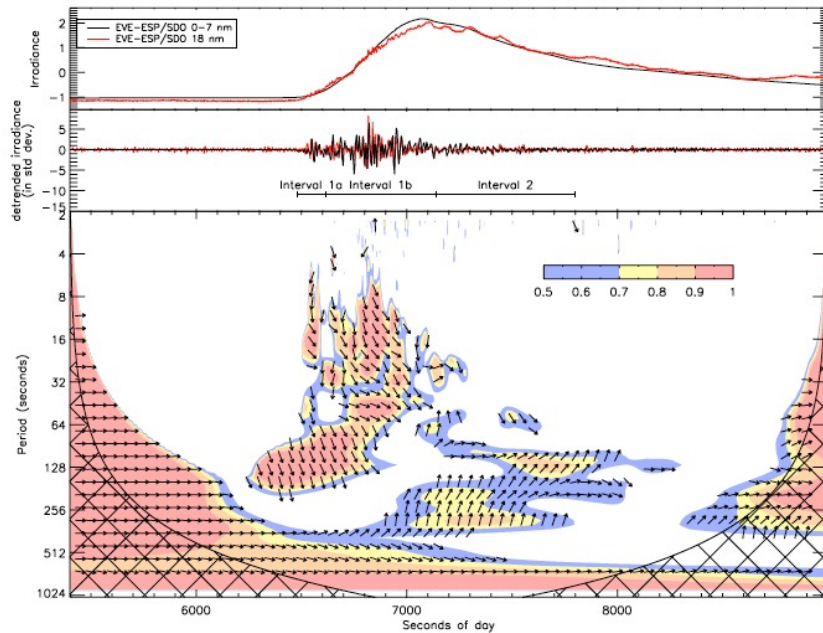
Rarely possible to disentangle between them.

Different mechanisms could co-exist, even in a single flare.

Recent reviews: Mc Laughlin et al. 2018,
Kupriyanova et al. 2020, Zimovets et al. 2021



X2.2 flare on 15 February 2011



Dolla et al. 2012, Milligan et al.2017,
Farris & Mc Ateer 2020

- Observations in Lyman- α could offer an interesting complement of information to SXR and EUV for the QPP analysis but datasets are still scarce
- Biggest provider is GOES, but with a time resolution limited to 10s (GOES 15) and even 30 s (L1b data from GOES-R)
- Most QPPs have periods around 20-30 s

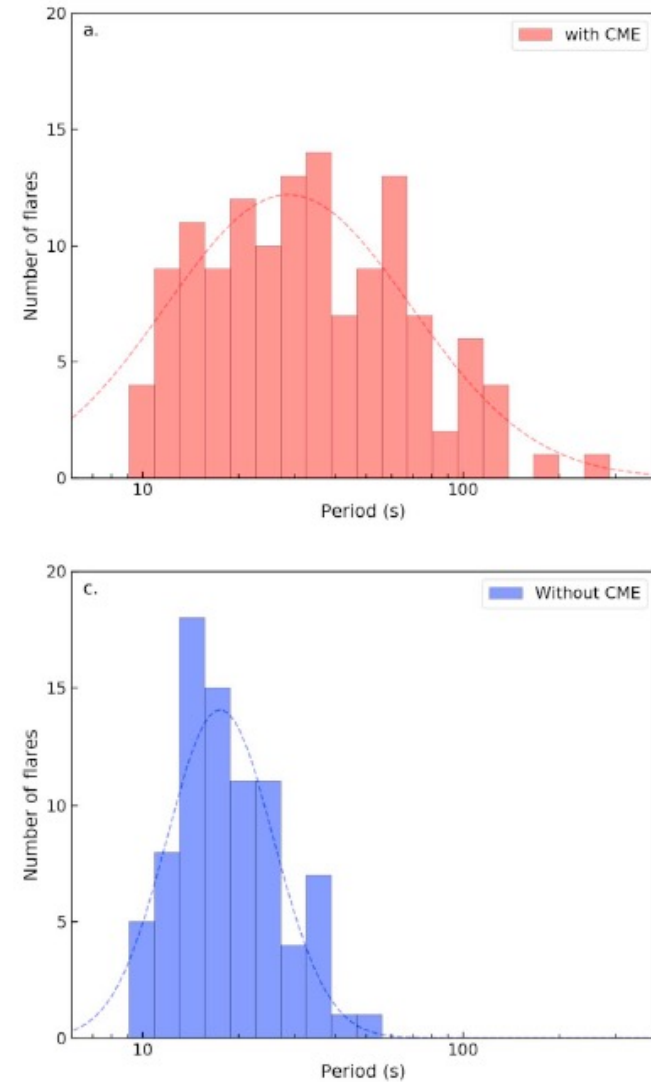
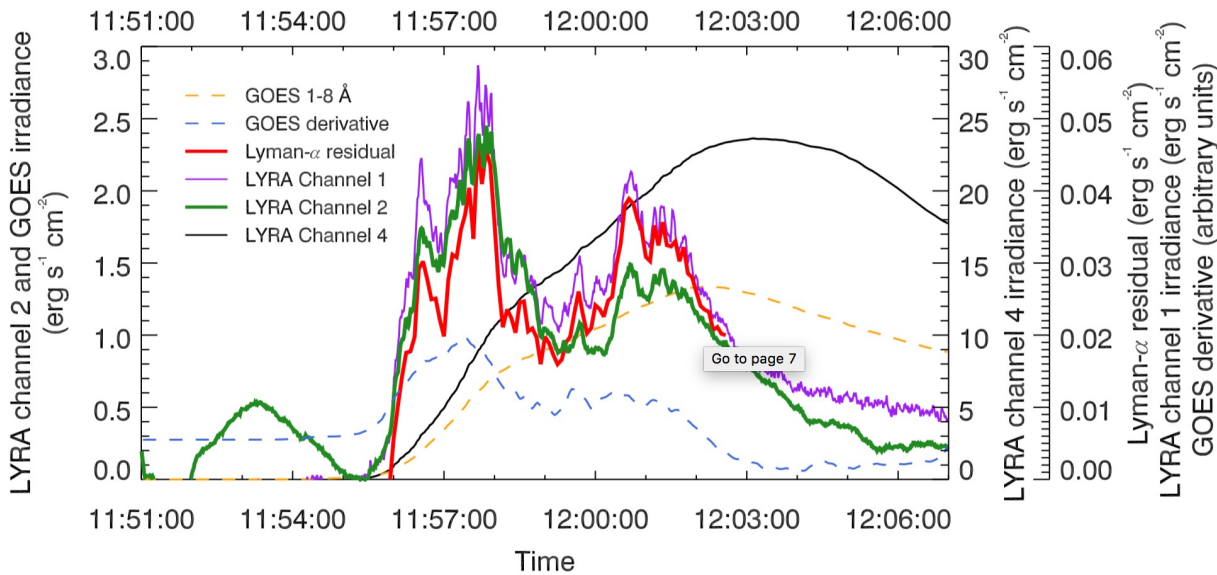


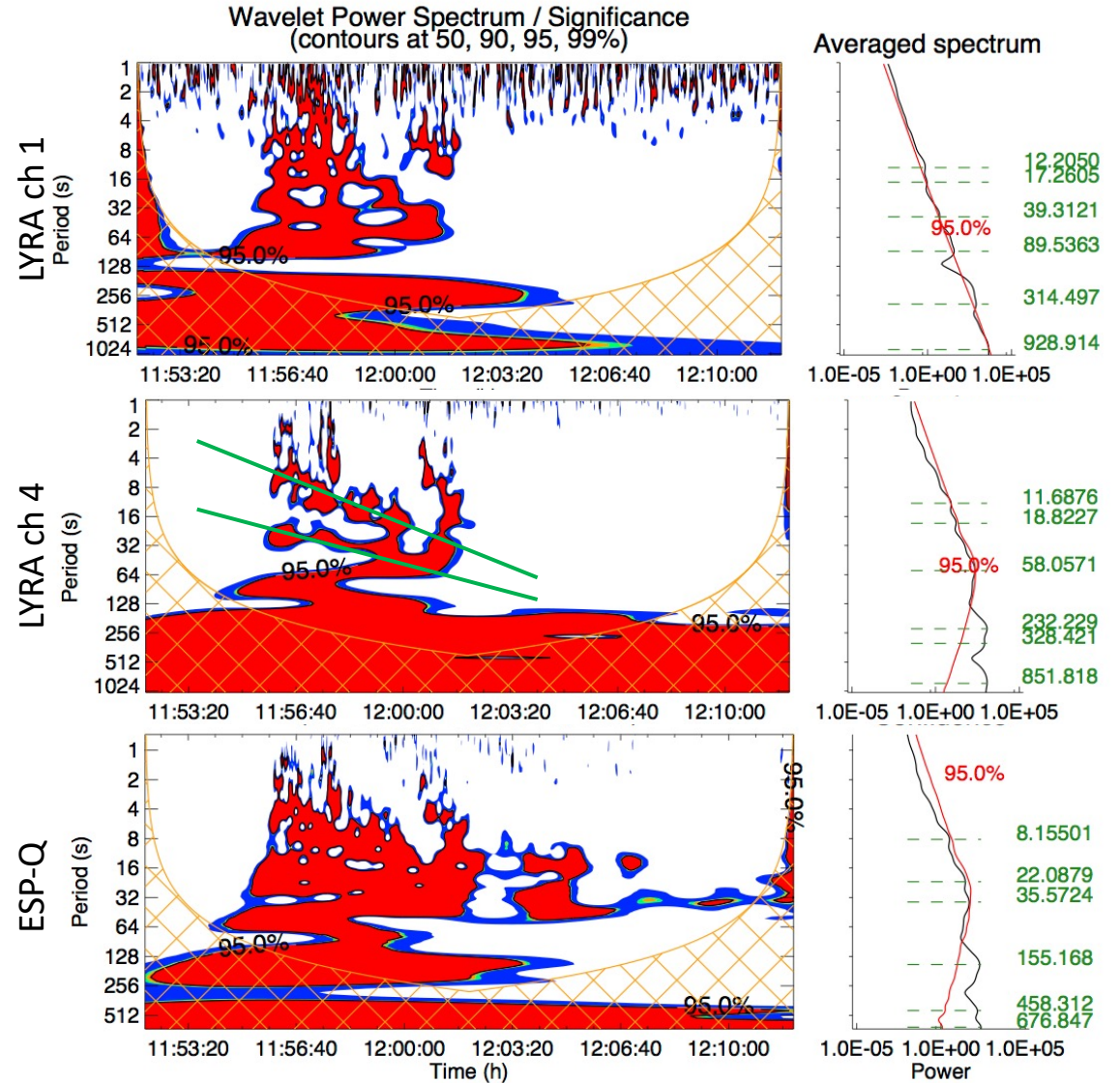
Figure from Hayes et al. 2020

X9.3 flare on 6 September 2017

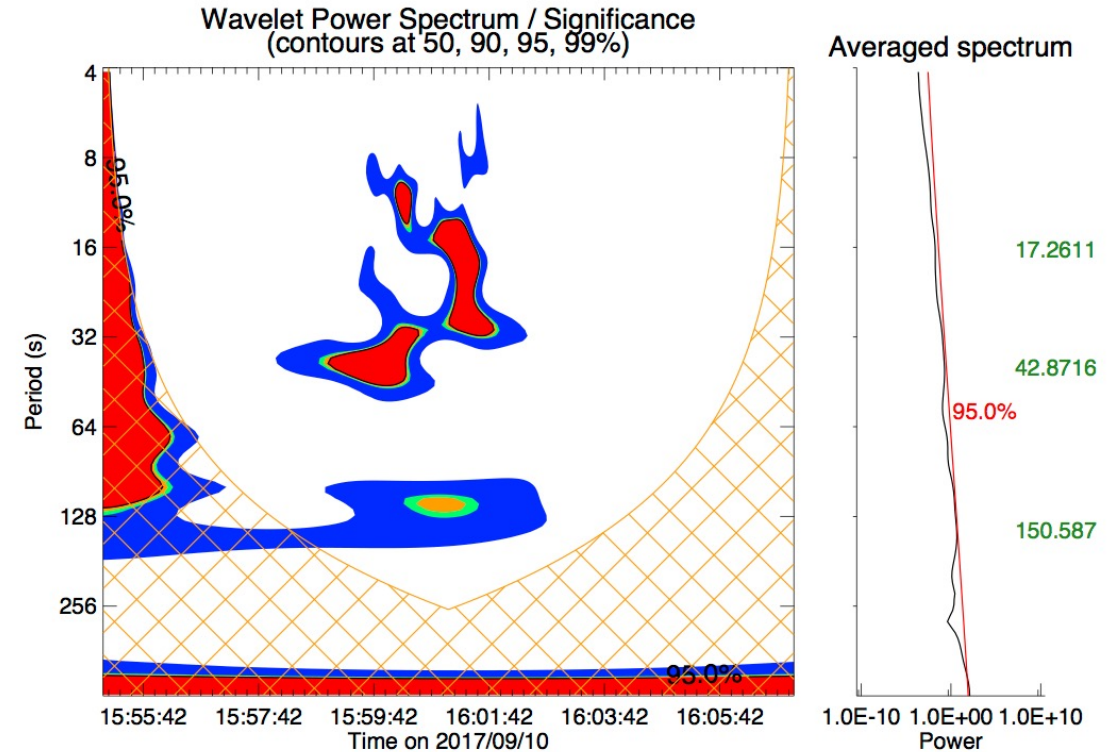
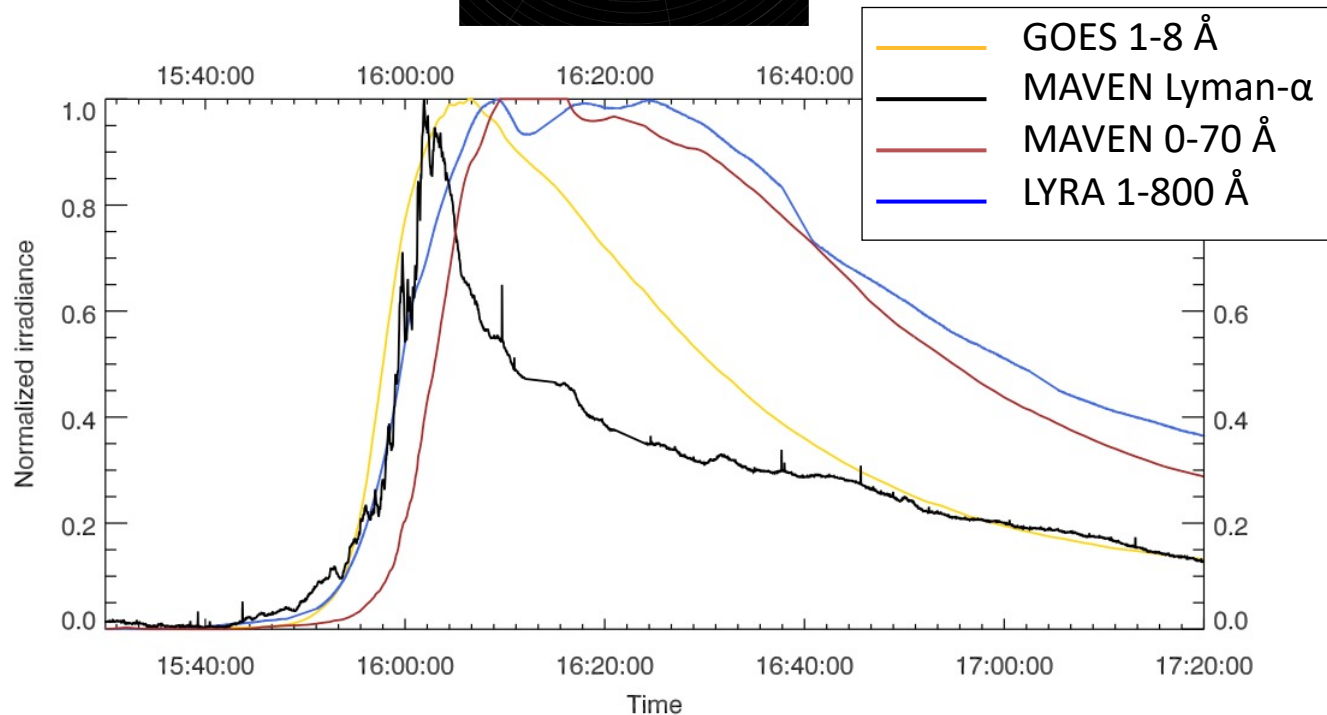
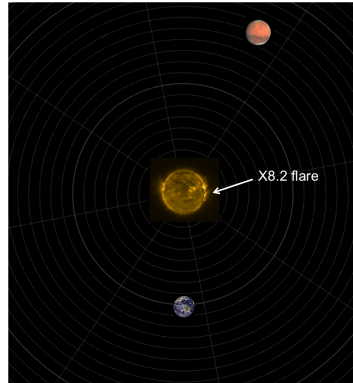
High sampling Lyman- α observations from PROBA2/LYRA (Dominique et al., 2018)



Clear detections, but unclear characteristics.
Is the period increasing? (see also Li et al., in press)



QPPs in the X8.2 flare on 10 September 2017



High sampling Lyman- α observations MAVEN/EUVM.
Allows characterization of QPPs for a flare behind the limb

Why analyzing QPPs in Lyman- α ?

- Up to 10% of the flare energy could be emitted in Lyman- α ,
- Emission tracks non-thermal emission,
- More and more often available in full-Sun instruments,
- Amplitude of QPPs more pronounced than in SXR or EUV.

BUT

- Not as easy to observe as SXR or EUV (instrumental problems),
- Important center-to-limb variation of the Lyman- α emission,
- The main provider of flare observations in Lyman- α (GOES) has a sampling rate limited to ~ 10 s .

No statistical analysis of QPPs in Lyman- α yet, but first results promising!

Coming soon...

- SOSPIM, a solar monitor on-board the JAXA mission Solar-C.
- Includes a Lyman- α channel, expected to acquire measurements at a sub-second cadence.
- Launch currently planned in 2026.

