CHARM

Update on quasi-periodic pulsations in solar flares

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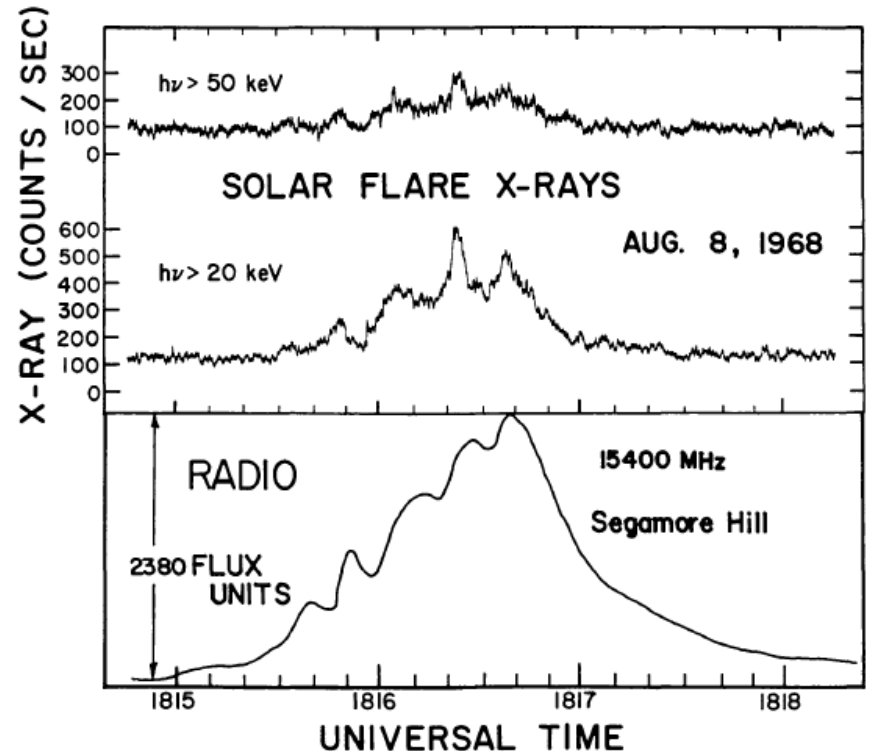G. Lapenta, KUL
D. Ryan, NASA-GSFC
L. Hayes, Trinity College Dublin

CHARM meeting, March 10 2017, Brussels

What are QPPs?

- Oscillations during stellar and solar flares

- Periods ranging from sub-second to minutes

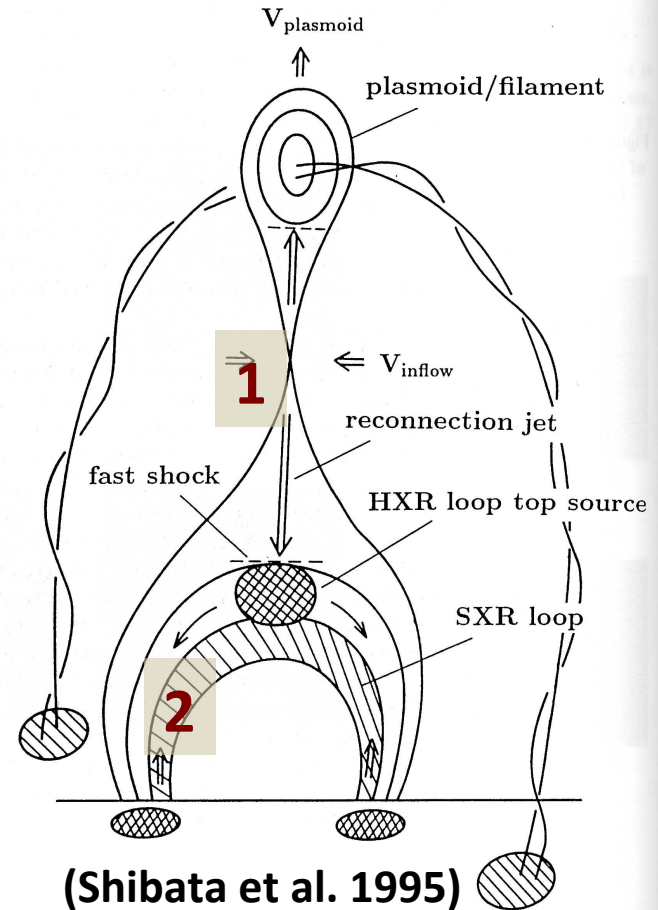- Some confined to the impulsive phase, others also covering the decay phase

Parks and Winckler, ApJ, 1969
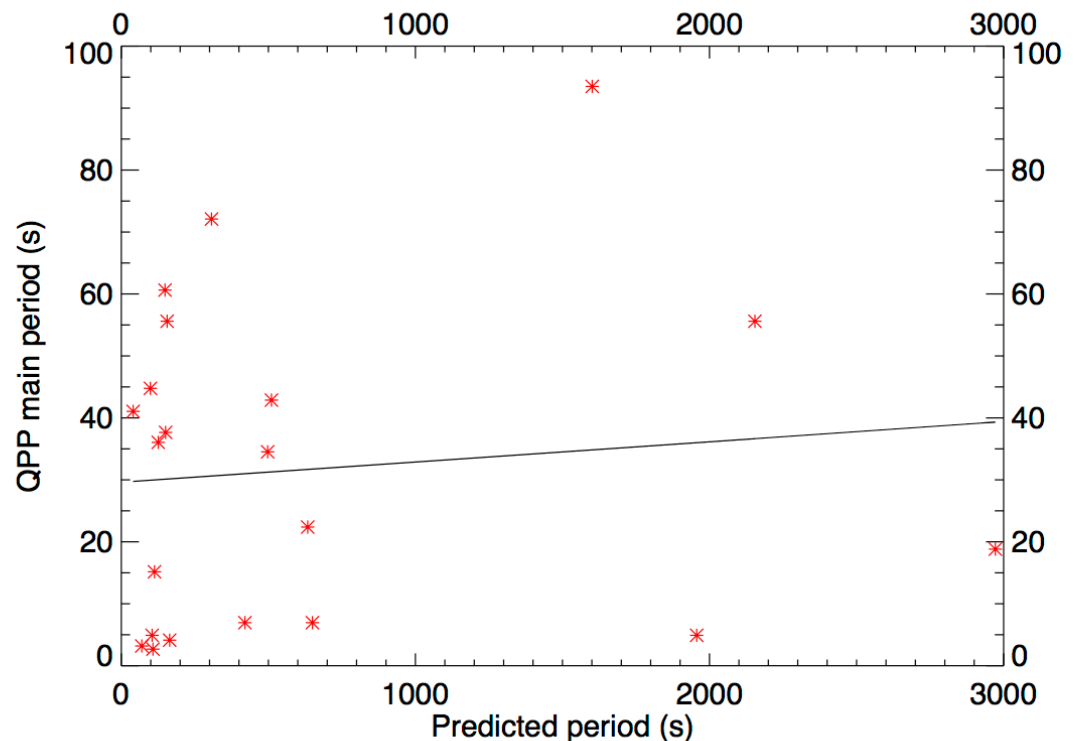
Origin of the QPP

Two main mechanisms are evoked:

1. Fluctuating reconnection process
2. MHD wave
   1. Modulation of the electron beam
   2. Modulation of the heated plasma in the post-flare loops

(Shibata et al. 1995)

So far …

- Detection of QPPs in EUV -> PROBA2/LYRA and SDO/EVE

- Analysis of M5+ flares of cycle 24 : 72 flares analyzed, of which 55 were confirmed to display QPPs with periods between 8 and 100s

- No obvious correlation between the detected periods and
  - Alfvén speed
  - Plasma β

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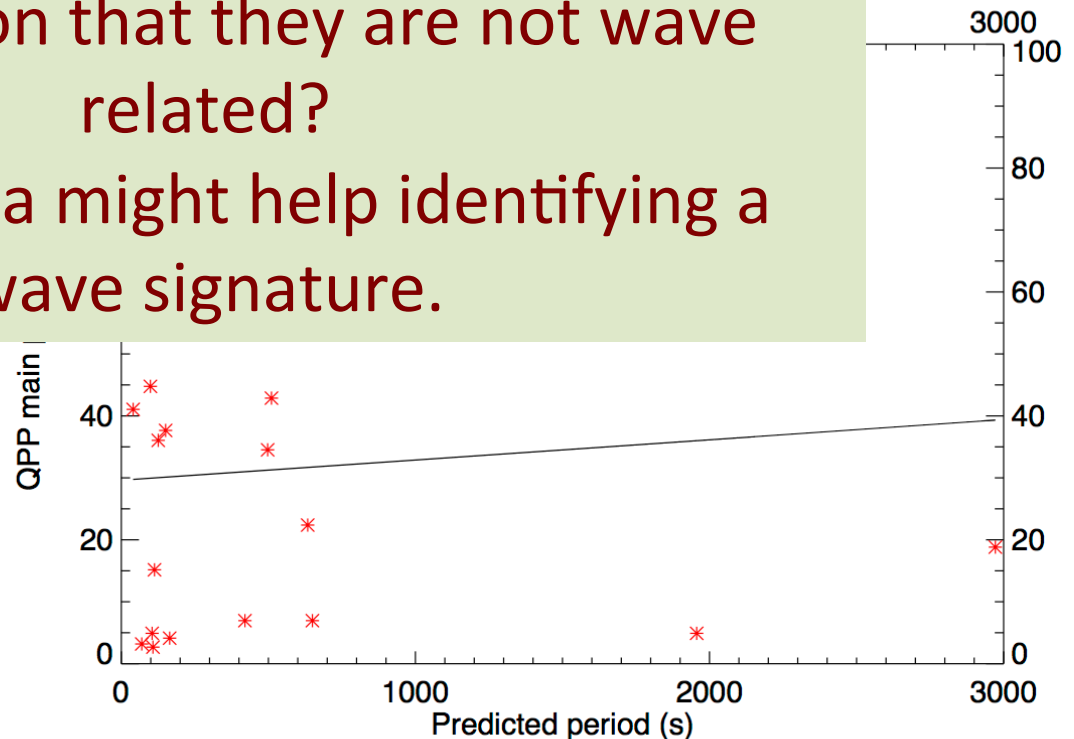
- No ob... correl... the de... and
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An indication that they are not wave related?
Spectral data might help identifying a wave signature.

New perspectives with IRIS?

- Spectrograph in raster mode is max. 130 x 175 arcsec^2

Band	Wavelength [Å]	Disp. [mÅ pix^{-1}]	FOV ["]	Pixel ["]	CEB	Shutter	EA [cm^2]	Temp. [log T]
FUV 1	1331.7–1358.4	12.98	175	0.1663	1	FUV SG	1.6	3.7–7.0
FUV 2	1389.0–1407.0	12.72	175	0.1663	1	FUV SG	2.2	3.7–5.2
NUV	2782.7–2835.1	25.46	175	0.1664	2	NUV SG	0.2	3.7–4.2

- Slit-jaw imager, 175 x 175 arcsec^2

| Band-pass	Filter wheel	Name	Center [Å]	Width [Å]	FOV ["×"]	Pix. ["]	EA [cm^2]	Temp. [log T]
Glass	1 T	5000	5000	broad	175^2	0.1679	–	–
C II	31 M	1330	1340	55	175^2	0.1656	0.5	3.7–7.0
Mg II h/k	61 T	2796	2796	4	175^2	0.1679	0.005	3.7–4.2
Si IV	91 M	1400	1390	55	175^2	0.1656	0.6	3.7–5.2
Mg II wing	121 T	2832	2830	4	175^2	0.1679	0.004	3.7–3.8
Broad	151 M	1600W	1370	90	175^2	0.1656	–	–

New perspectives with IRIS?

- Chromospheric observations
- Advantage: spatial (slit jaw images) and spectral (raster) observations
- So far, limited observation of flares with high cadence
- However, already a few detections of QPP published

| Date	Class	Periods	Source
18 April 2014	M7.3	95-125s	Brosius & Daw 2015
10 September 2014	X1.6	4min	Li et al. 2015
12 March 2015	M1.6	25s	Tian et al. 2016
16 October 2015	C3.1	32-42s	Zhang et al. 2016

A new case: X1.0 Flare of 2014/10/25

- Raster acquisitions at a cadence of 5.5s

- SJI acquisition at a cadence of 16s
  - Wavelengths:
    - C II 1336, log(T) = 3.7 - 7
    - Mg II k 2796, log(T) = 3.7 – 4.2
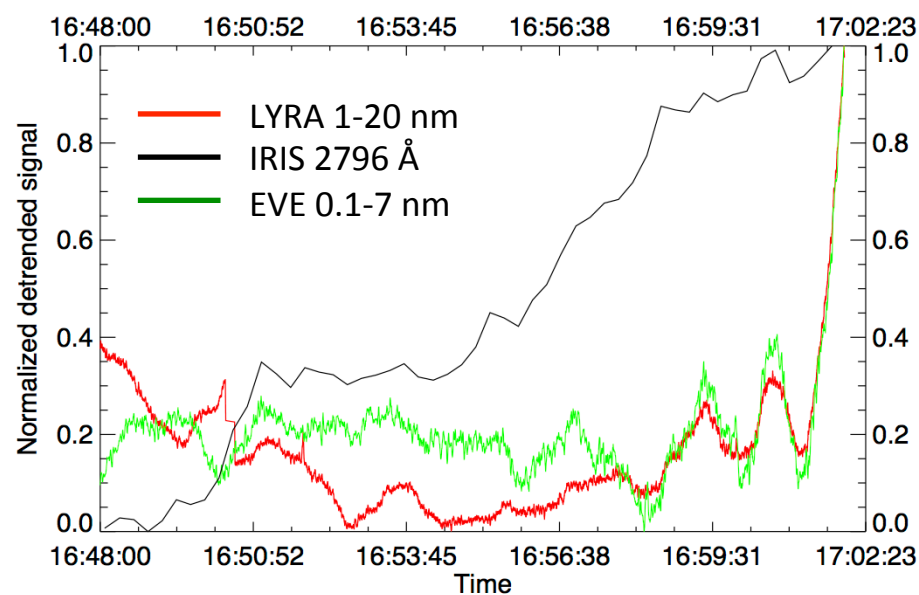   - Mg II wings, log(T) = 3.7 – 3.8
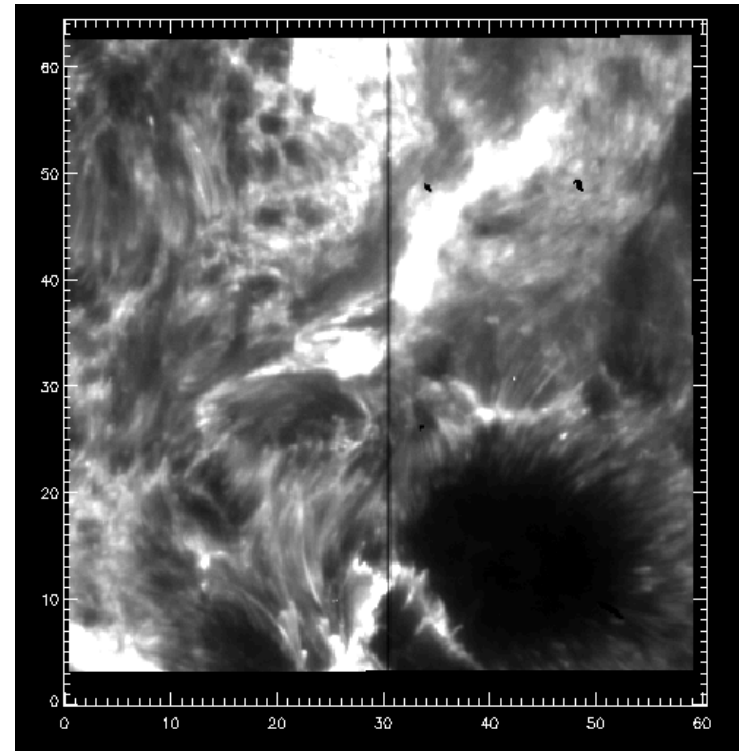
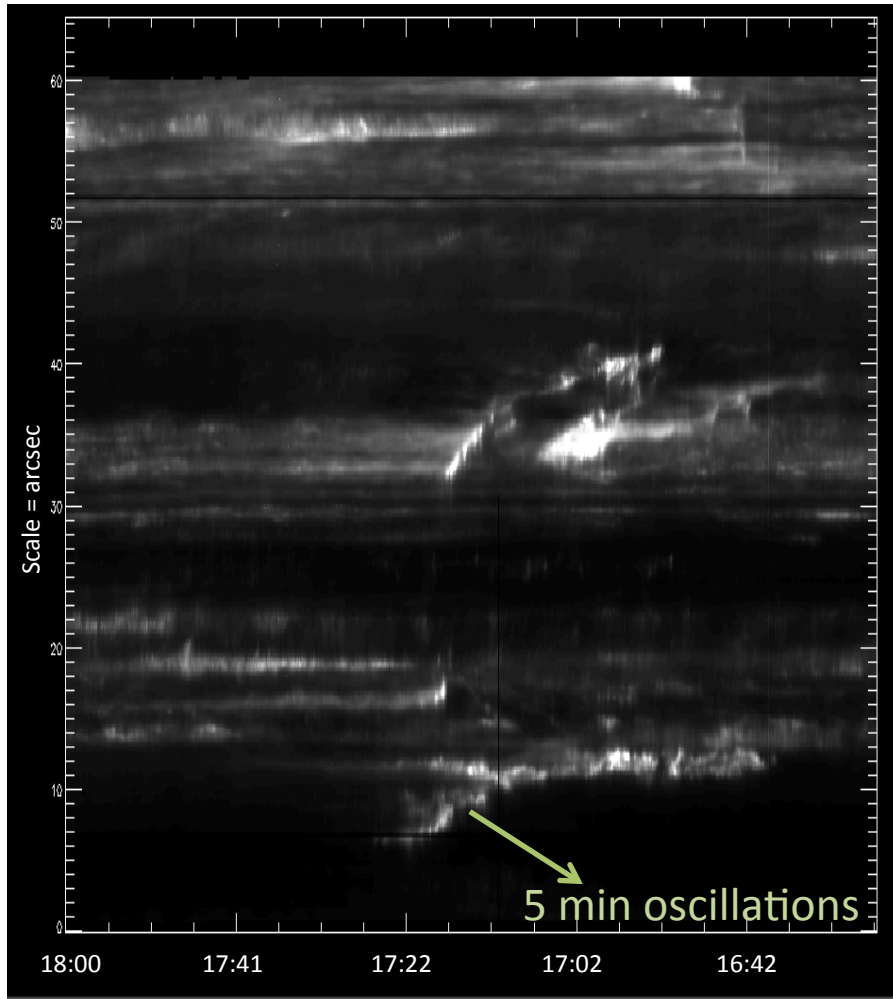# IRIS: X1.0 Flare of 2014/10/25

IRIS: X1.0 Flare of 2014/10/25
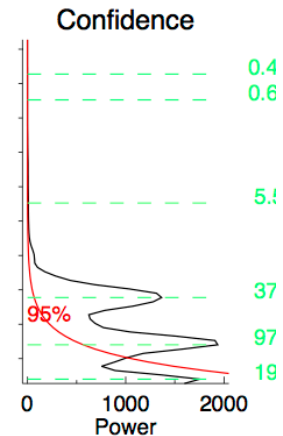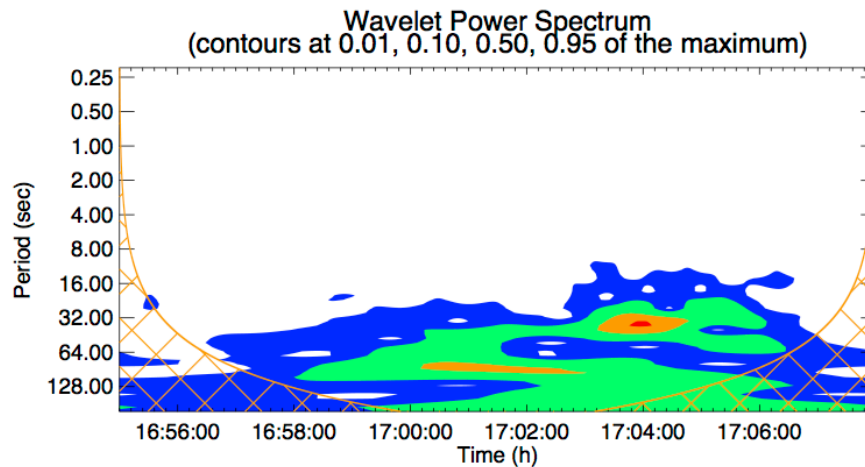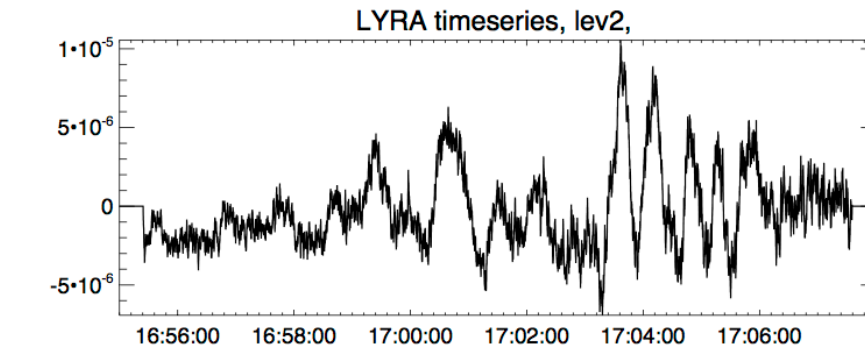
cadence IRIS SJI = 16s, wavelength = 2796 Å
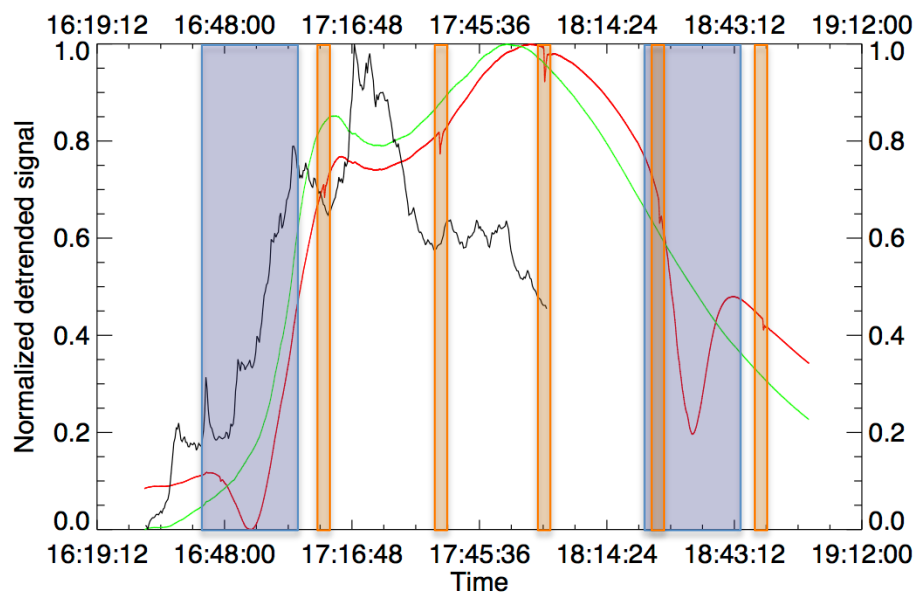
From the slit-jaw images, two periods seem to be present, even at the low emission temperature of IRIS.
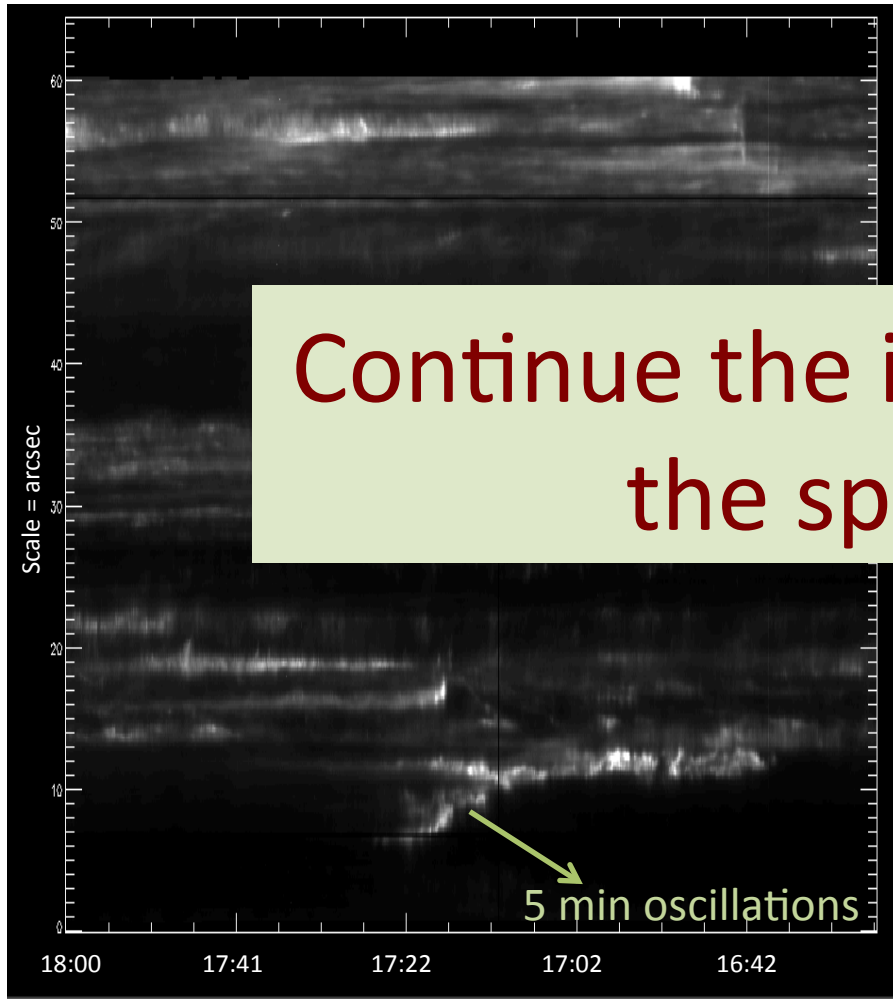
IRIS: X1.0 Flare of 2014/10/25

In the space-time diagram corresponding to the slit position, no structure periods of 37 or 97s. However, we can see a 5-min period oscillation.
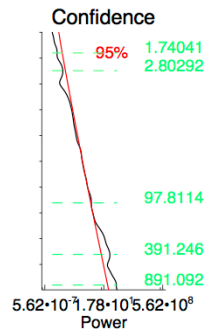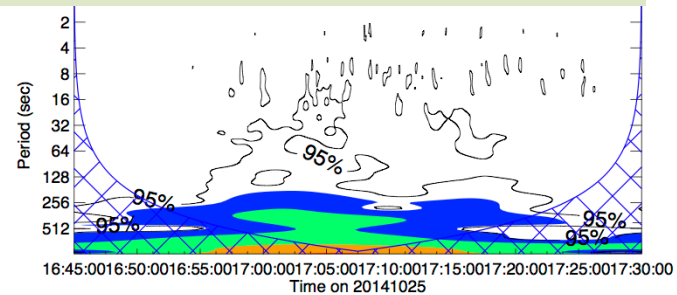
IRIS: X1.0 Flare of 2014/10/25

Scale = arcsec

5 min oscillations

In the space-time diagram corresponding to the slit position, no structure periods of 37 or 97s. However, we can ... ...illation.

Continue the investigation in the spectrum

Period (sec)

95%

Time on 20141025

Confidence

95% 1.74041
2.80292

97.8114

391.246

891.092

Power

Conclusions

- We have identified a new QPP case with IRIS
- Spatio-temporal analyses show several ranges of periods: 40s, 100s, 390s
- A wave signature exists for the 390s period
- Next step: search for wave signatures in the spectral data