

Detection of long period waves in the polar coronal holes

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Motivation

- Coronal Holes (CH) \Rightarrow Source region of Fast Solar Wind
- Recent results suggest that more blue shifts inside CH as compared to Quiet Sun
- CH are often *peppered* with vertical radial structures called , *plumes* , structures seen upto $30 R_0$ (DeForest et al. 2001)
- Coronal plumes occur near regions of mixed magnetic polarity \Rightarrow
- Plume formation by small bipoles within a CH reconnect with unipolar flux concentrations at network boundaries (Wang 1995, Young 1999)

Earlier observational results

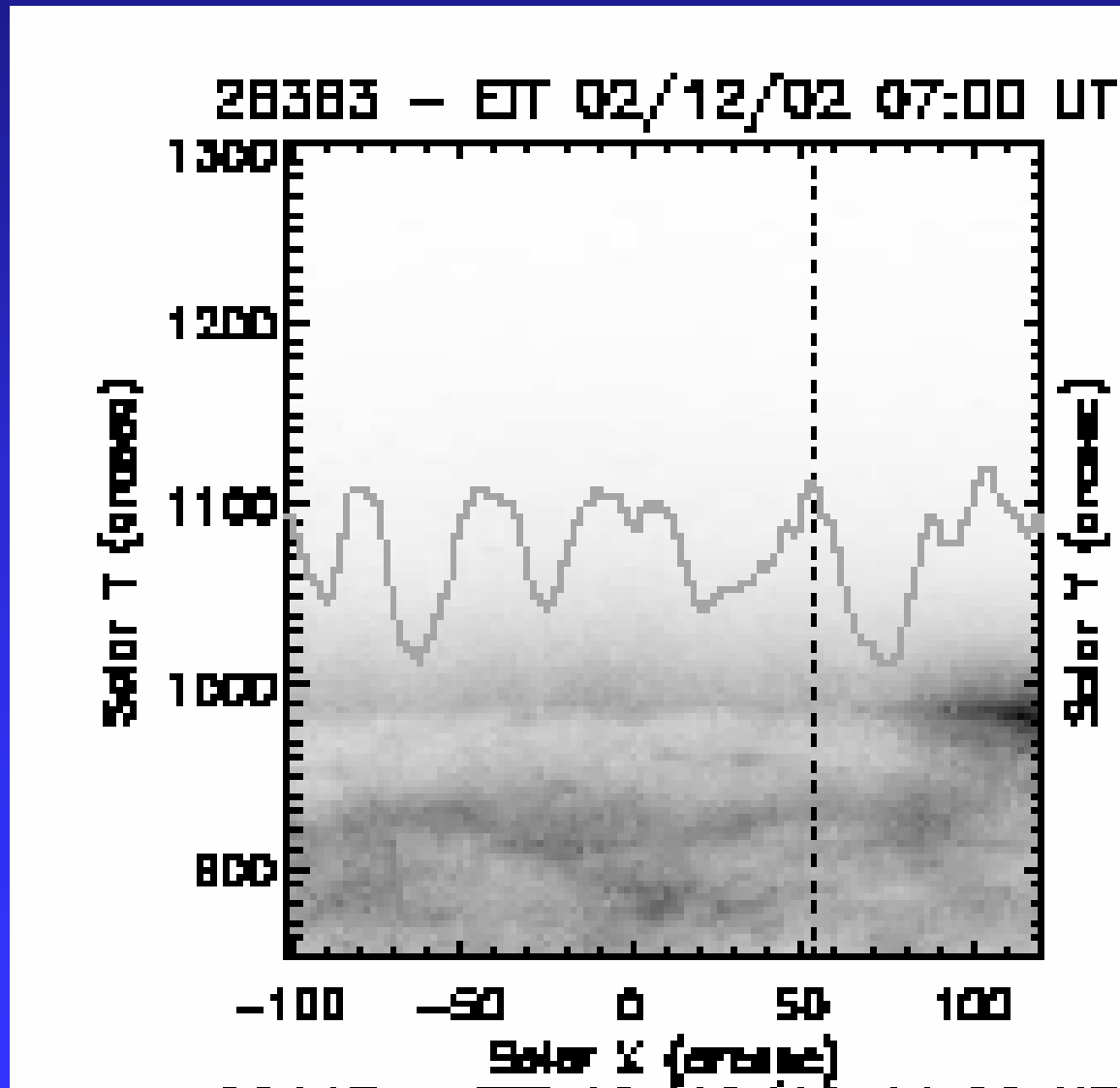
- Quasi-periodic fluctuations with periods of 10-15 mins in polar plume (from EIT/SoHO), they interpreted these as due to sound or slow magnetoacoustic waves, propagating along the plumes with speeds 75-150 km/s (DeForest & Gurman 1998)
- Density fluctuations in the white light channel of UVCS at $1.9 R_0$ in plumes with time scales 10 mins (Ofman 1997)
- Quasi-periodic variations in the polarization brightness at $1.9 R_0$, at both plume and inter-plume (Ofman, 2001)
- Banerjee et al 2002a,b, reported intensity and velocity oscillation with Chromospheric and TR lines with periods 10-30 mins in plumes, inter-plumes and also in the disk part of the CH

Observational log:

- Coronal Diagnostic spectrometer (CDS/SoHO)
- Long temporal series sequence for 11 TR and coronal lines formed between 2.5×10^5 to 2.5×10^6 K.
- We will present only results from O v 629Å (2.5×10^5), coronal lines Mg x 609,625 Å & Si xii 520 Å
- Slit width 4 x 240 arc sec
- Exposure time 60 sec

Date	Dataset	Pointing (X,Y)	Region	Start time	End time
29/11	26348	116,1085	polar plume	18:42	21:32
29/11	26349	115,1223	polar plume	21:33	00:14
02/12	26363	54,1070	polar plume	07:50	10:41
02/12	26364	54,1213	polar plume	10:41	13:21
06/12	26406	-1,1070	polar plume	07:00	09:51
06/12	26407	-1,1215	polar plume	09:51	12:31
11/12	26438	-19,1070	polar plume	16:29	19:19
11/12	26439	-21,1214	polar plume	19:19	21:59
12/12	26447	56,1070	polar plume	16:30	19:20
12/12	26448	56,1215	polar plume	19:21	22:01
17/12	26478	59,1071	polar plume	18:03	20:54
17/12	26479	60,1213	polar plume	20:54	23:34
18/12	26482	-1,-1076	Inter-plume	06:58	07:36
18/12	26483	-1,-1218	Inter-plume	07:36	10:27
27/12	26542	0,1070	polar plume	18:10	21:00
27/12	26542	-1,1215	polar plume	21:01	23:41

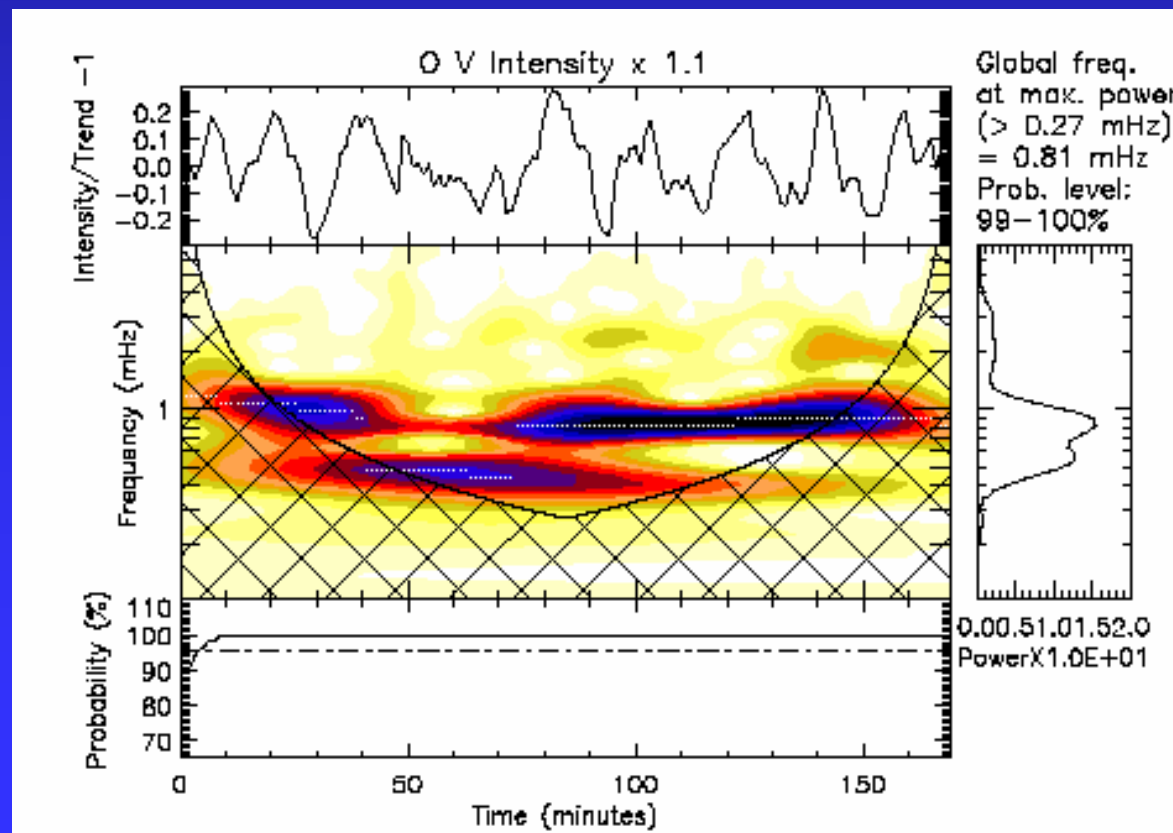
Location of the slit:



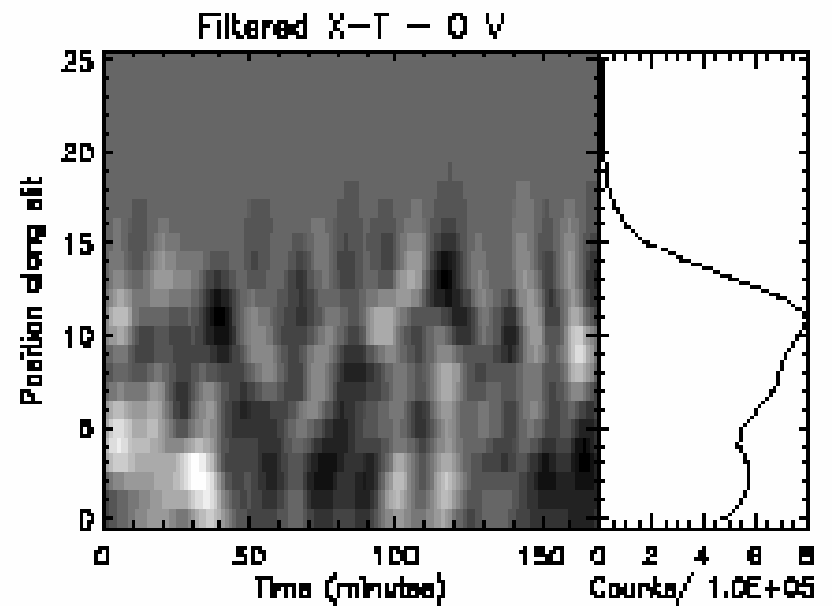
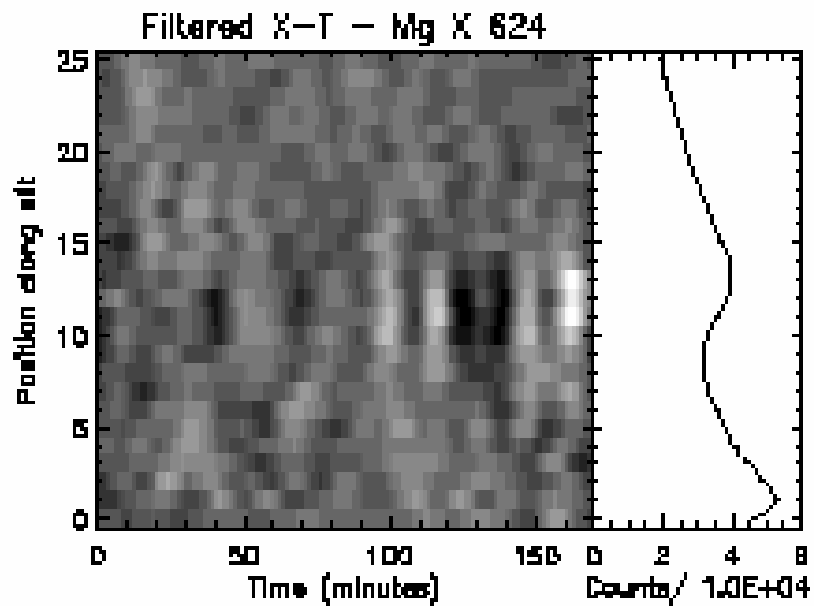
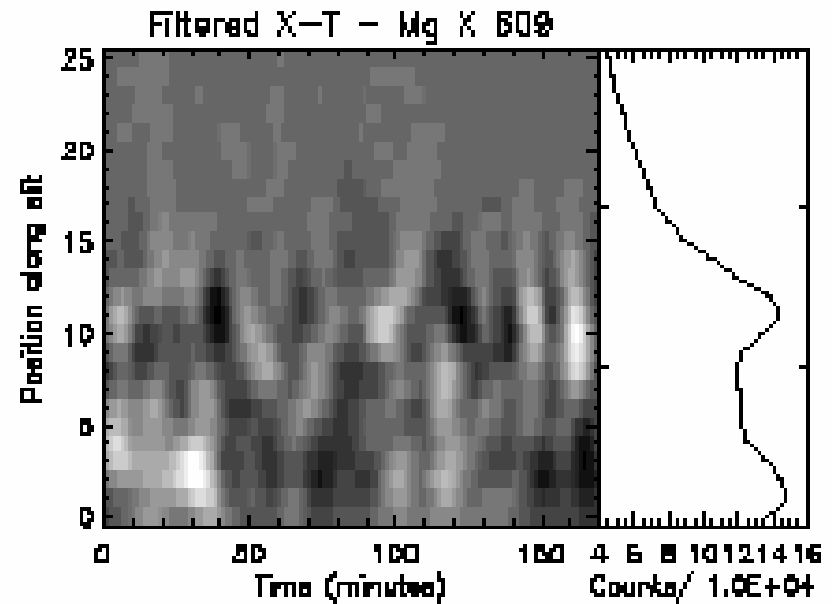
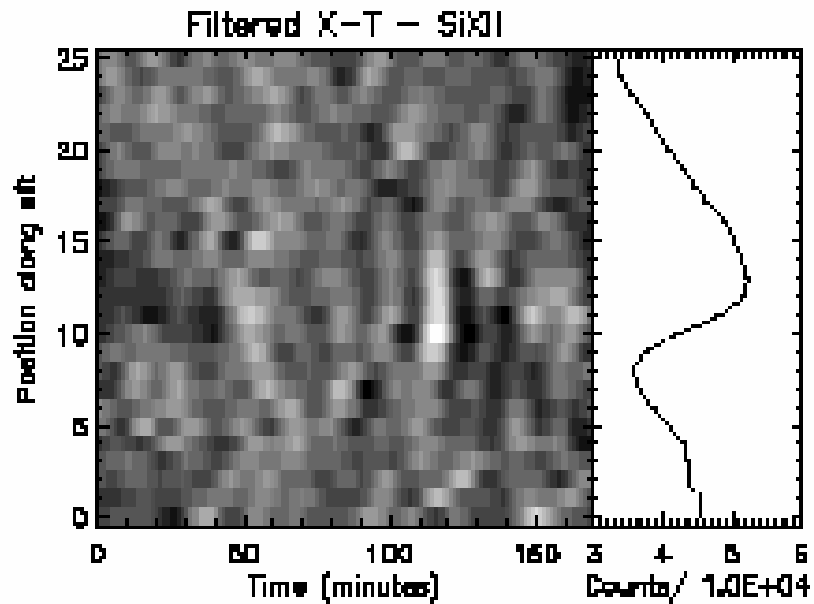
Plume

Temporal series

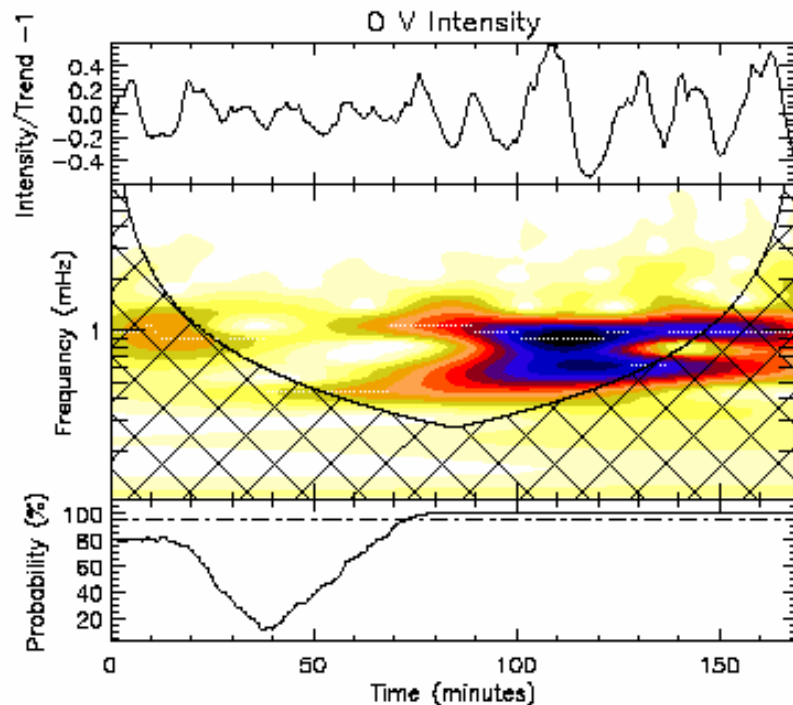
- We use wavelet transform for period analysis Decomposes a time series in time-frequency space, determines both the dominant modes of variability and how these modes vary in time and the statistical significance of the oscillations are estimated by using a randomization method



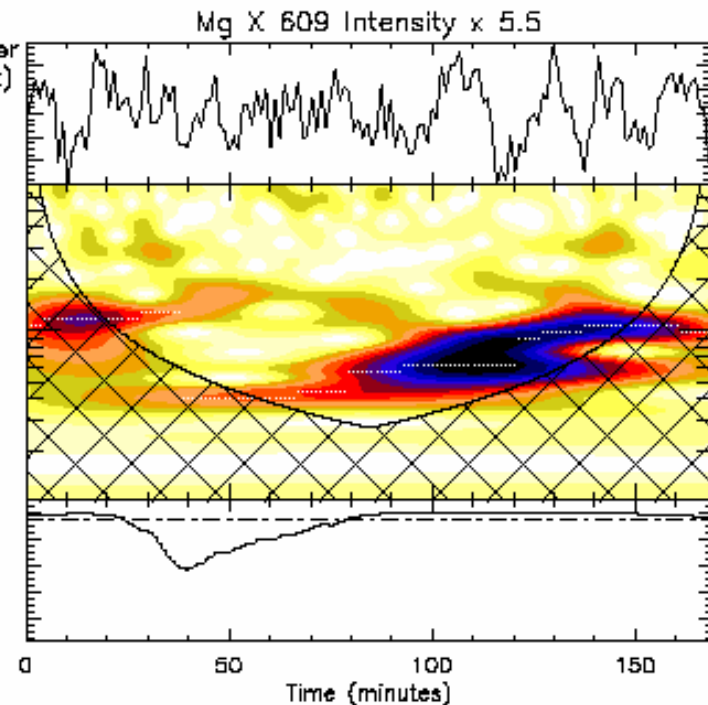
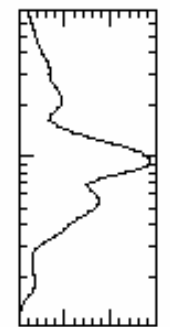
For 26363 dataset, plume



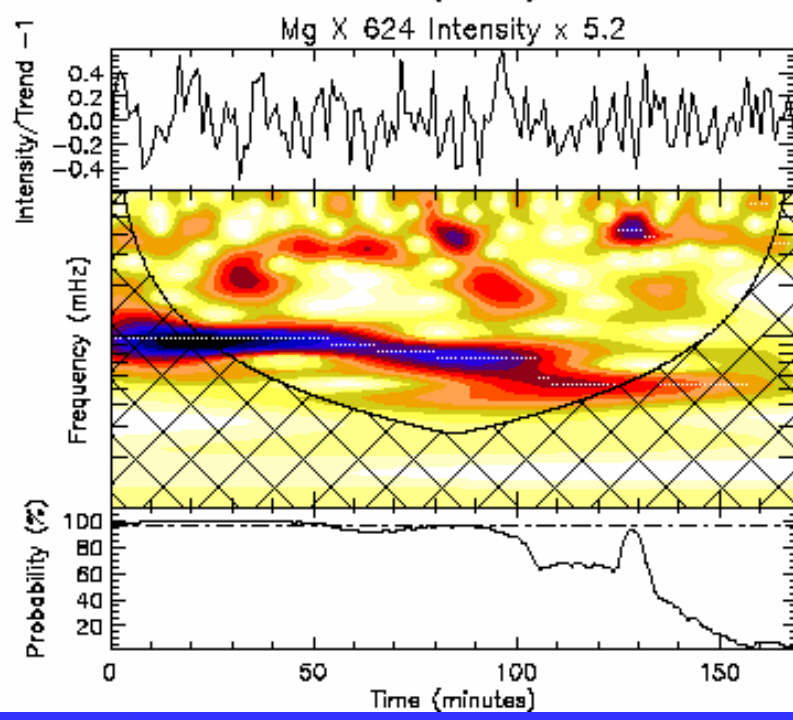
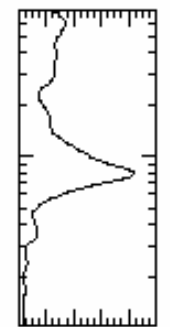
For 26363 dataset and pixel 15



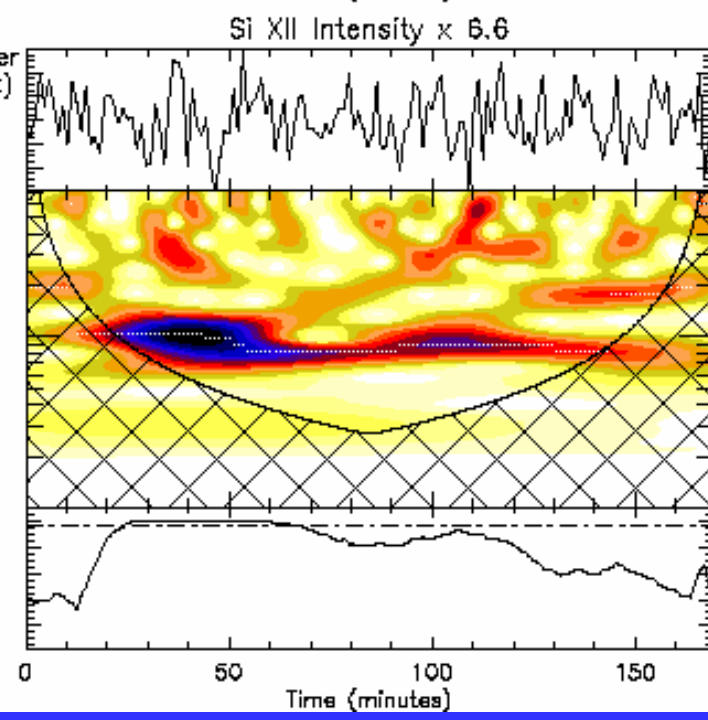
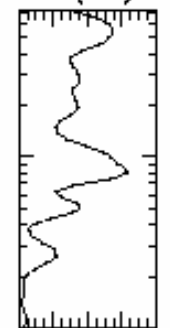
Global freq.
at max. power
(> 0.27 mHz)
= 0.97 mHz
Prob. level:
99-100%



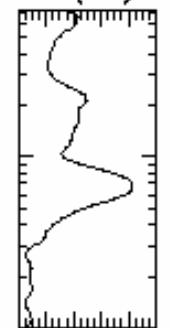
Global freq.
at max. power
(> 0.27 mHz)
= 0.63 mHz
Prob. level:
99-100%

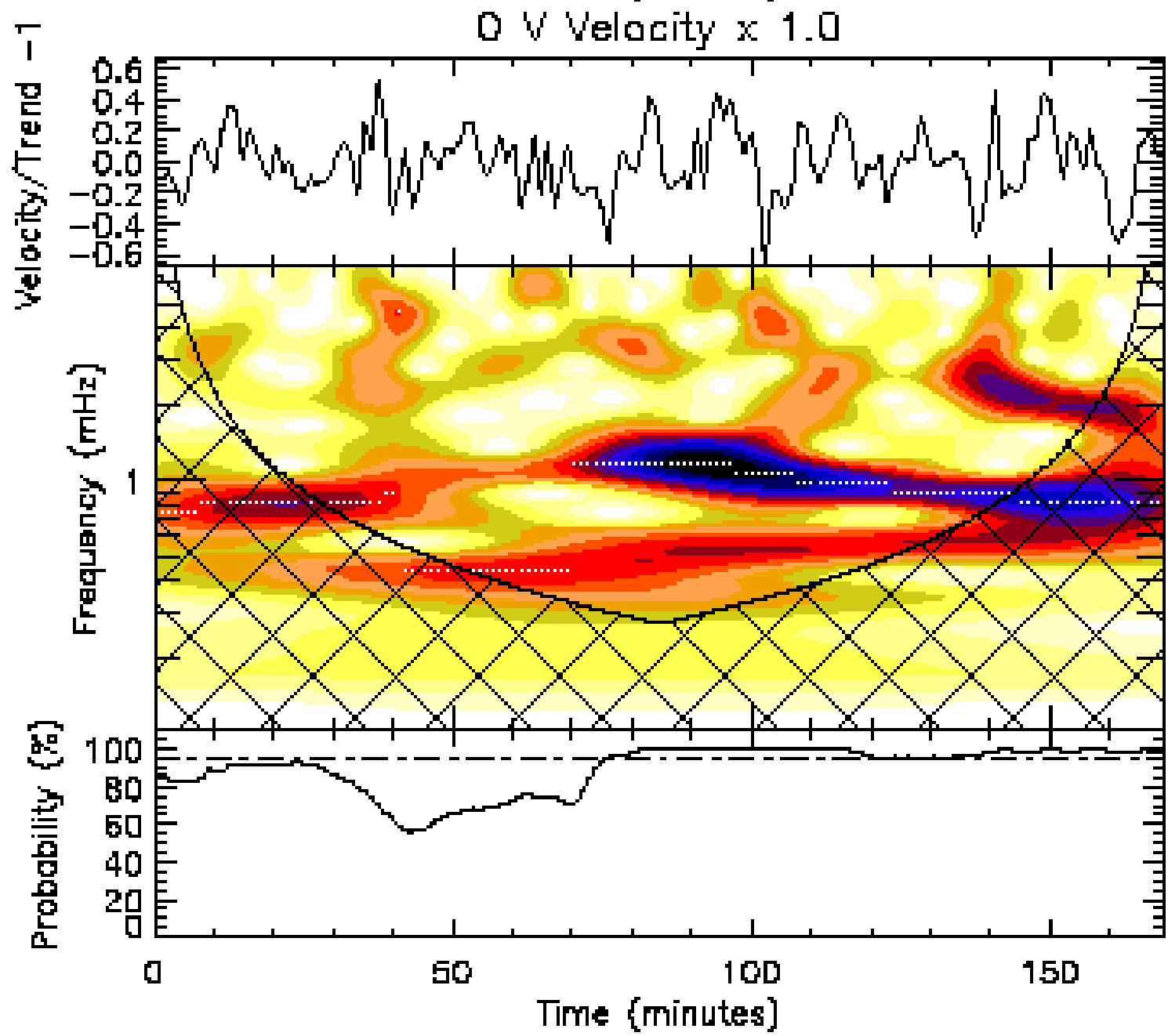


Global freq.
at max. power
(> 0.27 mHz)
= 0.89 mHz
Prob. level:
96.4(0.8)%

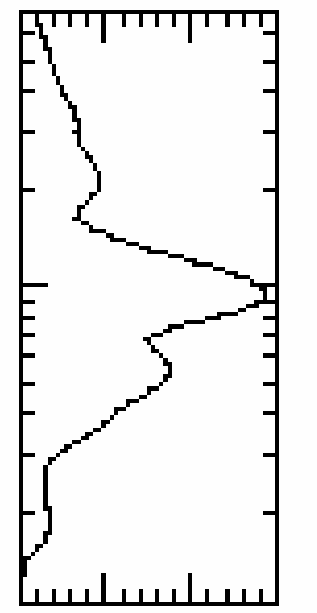


Global freq.
at max. power
(> 0.27 mHz)
= 0.89 mHz
Prob. level:
96.8(0.7)%



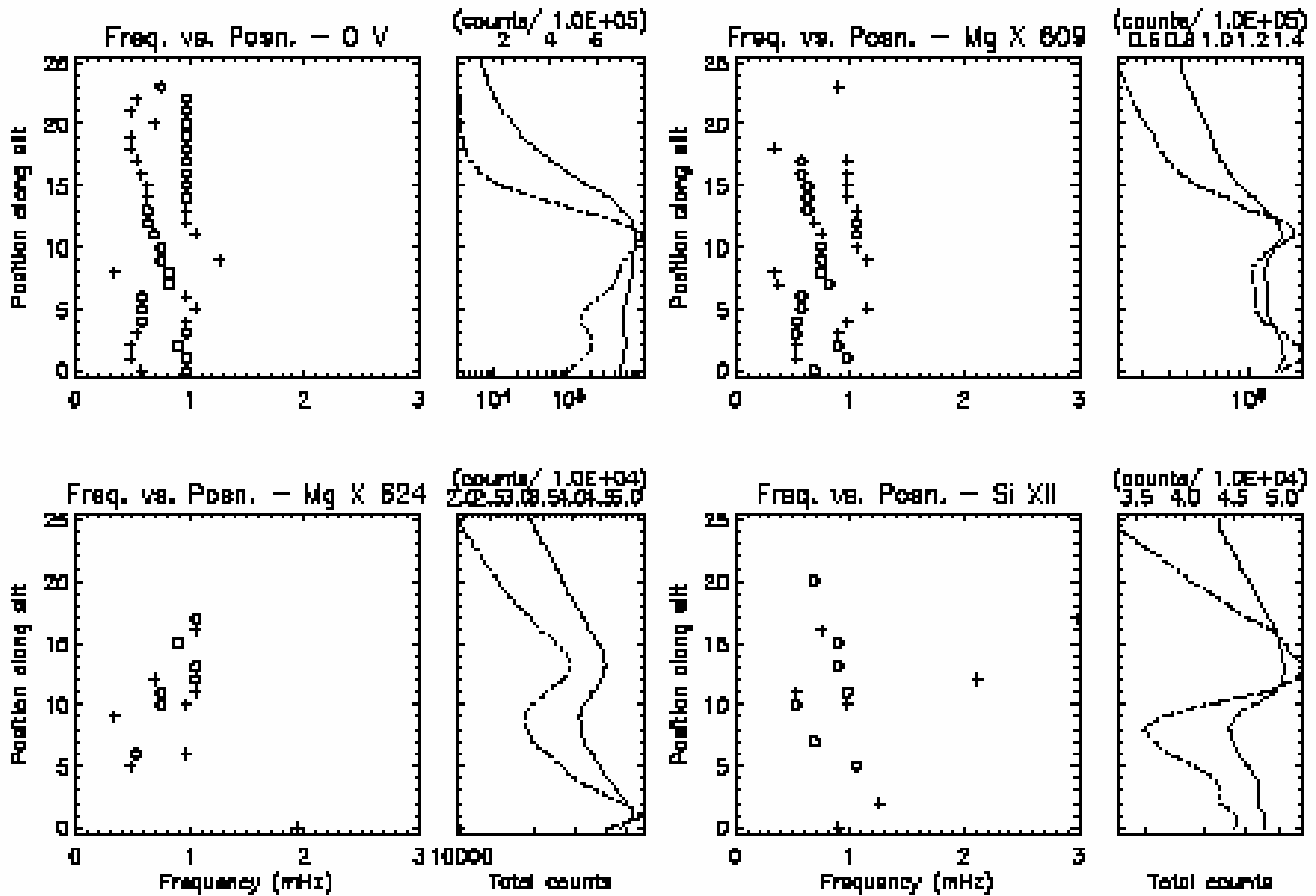


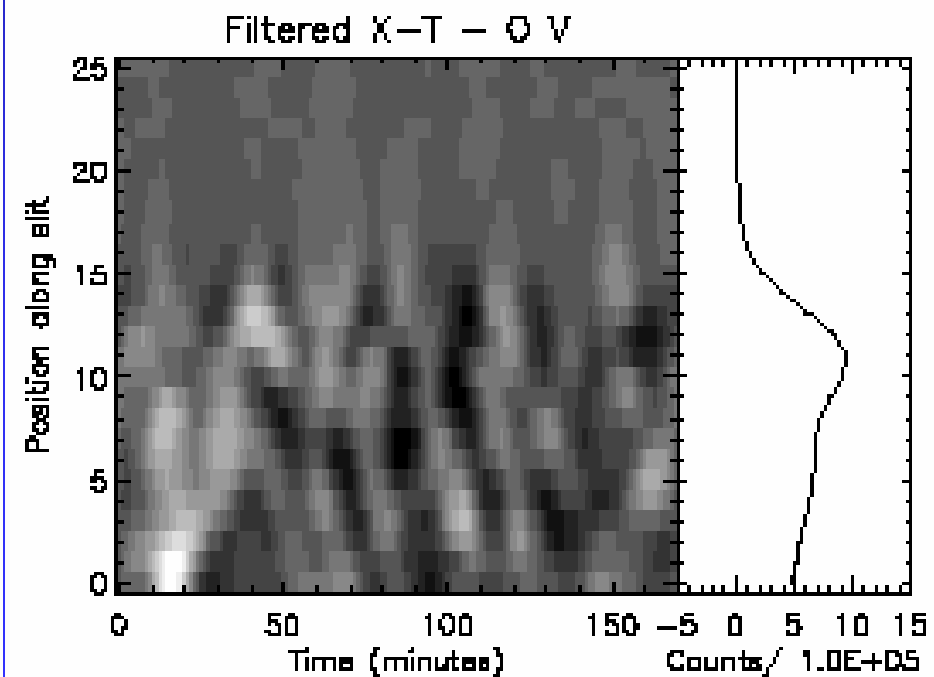
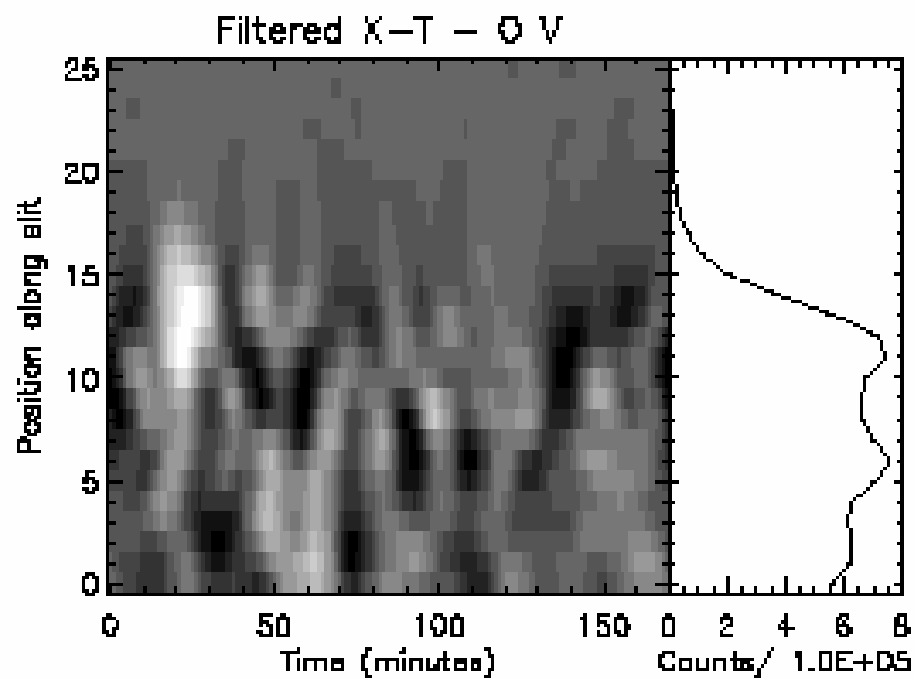
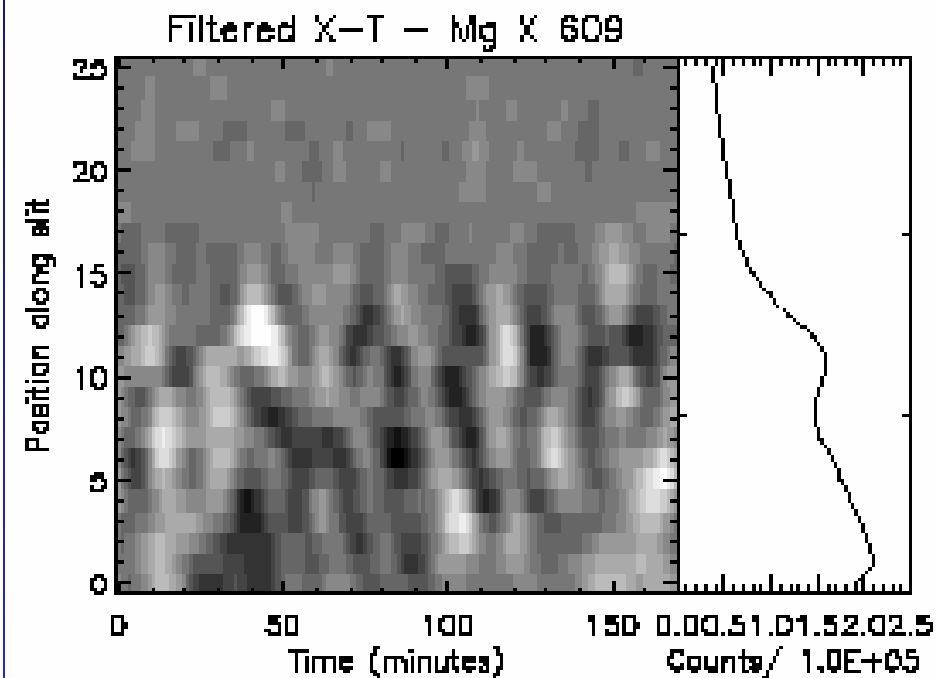
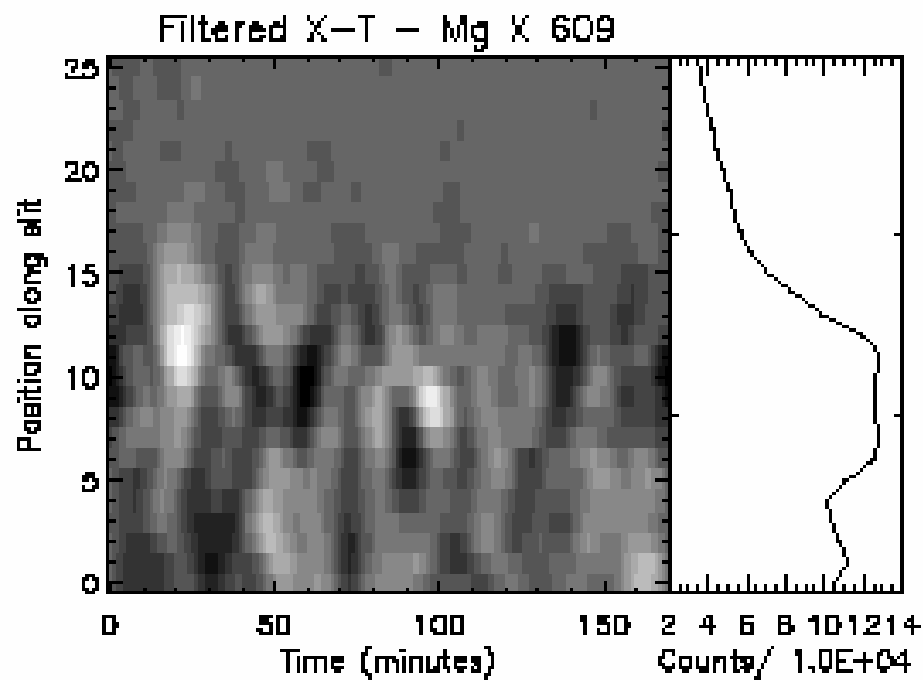
Global freq.
at max. power
(> 0.27 mHz
= 0.97 mHz
Prob. level:
99.2(0.6)%

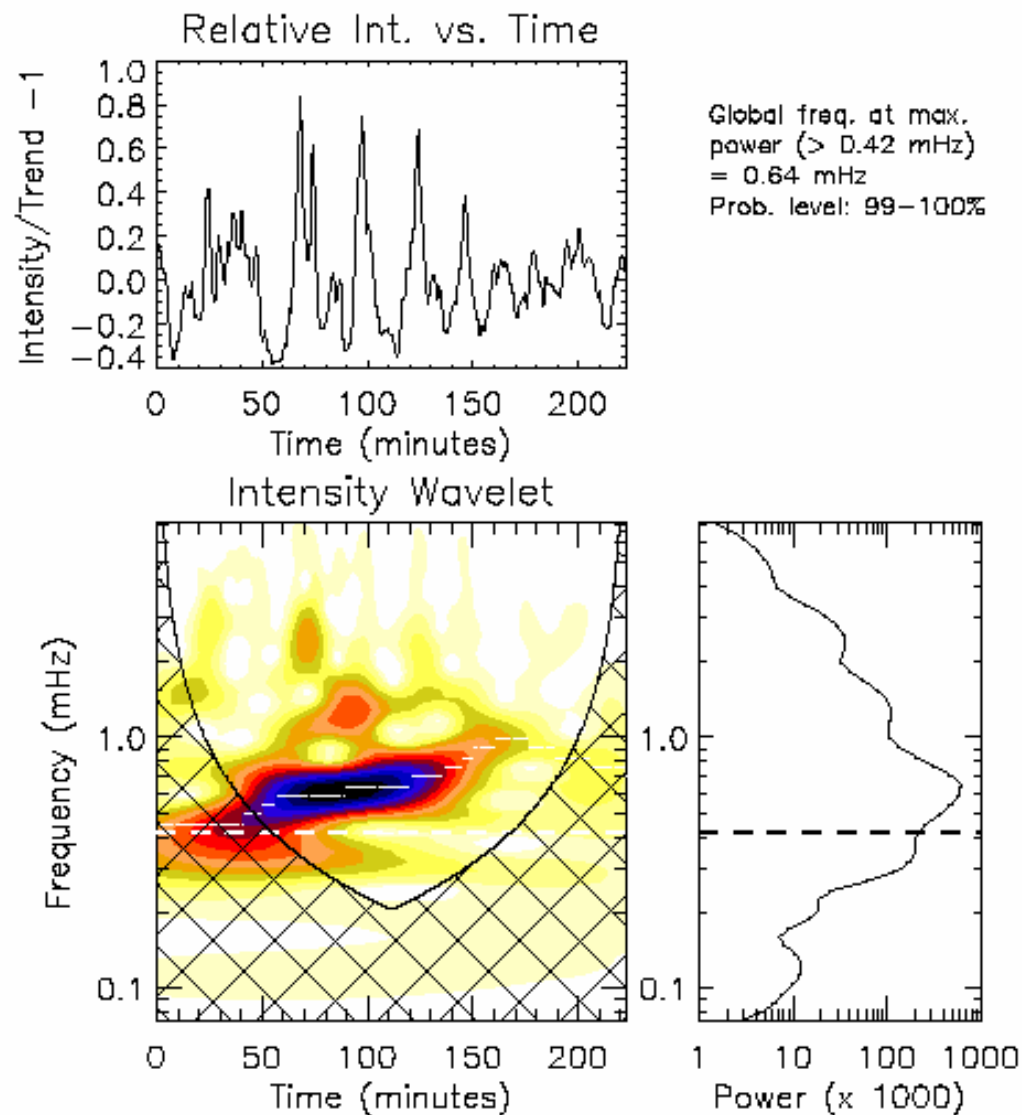


0.0 0.5 1.0 1.5
PowerX1.0E+01

X-F slice for same dataset







Intensity wavelet results for the O v 629 Å line and corresponding to the pixel location 28 of s18778r00

Summary

- ***Nature of wave ?*** We observe both intensity and velocity oscillations with a range of temperature lines from TR to corona
- ***Periods:*** 10-30 mins or longer
- ***Speeds:*** 5 –20 km/s
- ***Location:*** several locations in plume, and also on the disk part of coronal hole, no particular preference on network pixels.
- ***Origin ?*** May be related to certain blinker type of events in the CH, evacuation of plasma, leading to formation of plumes and also generates these long period waves??
- ***We propose that the modes are slow magnetoacoustic type***

Conclusion

- Most likely these are the same waves as seen by EIT and UVCS at very large distances
- Thus they are a good candidate for the acceleration of the fast solar wind

Time-delay (px9, 26447 dataset)

