INTENSITY OSCILLATIONS

IN

UV BRIGHT POINTS AND UV NETWORK ELEMENTS

FROM

TRACE OBSERVATIONS

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BACKGROUND

DATA AND ANALYSIS

RESULTS AND DISCUSSION

CONCLUSIONS

1. BACKGROUND

Solar oscillations provide a unique method of studying the interior structure of the Sun.

The neutral and singly ionized iron lines (FeI and FeII) have been used to study the photospheric features, and the well-known 5-min oscillations.

Since its discovery by Leighton (1961), the 5-min oscillation has been the subject of a large number of observational and theoretical investigations.

The CaII H and K lines are widely used to study the dynamics of different chromospheric features and their contribution to oscillations and heating of the chromosphere.

A two-dimensional images obtained in H & K lines demonstrate that the main features which are responsible for chromospheric emission are:

(i) bright plages,

(ii) network elements, which are co-spatial with the boundaries of supergranular cells, &

(iii) intranetwork bright points.

One-to-one spatial correspondence between the chromospheric features and the underlying corresponding photospheric magnetic features. (Skumanich et al.,1975, Sivaraman et al. 2000)

80 % of the chromospheric bright points - relationship with the dark intergranular regions of the photosphere.
(Kariyappa, 1996)

It is well known from the observations of Jensen and Orrall (1963) that the solar chromosphere oscillates with a period of 180-200 s.

The chromospheric bright points are seen under high spatial resolution in CaII H & K lines, and a very extensive studies have been done on their dynamical evolution and their contribution to chromospheric oscillations and heating, & to UV irradiance variability.
(Liu, 1974; Cram and Dame, 1983; Kariyappa et al. 1994, Kariyappa, 1994 & 1996, Kariyappa and Pap, 1996, Kariyappa, 1999, Kariyappa, 2000, Kariyappa et al. 2005, Kariyappa et al. 2006)

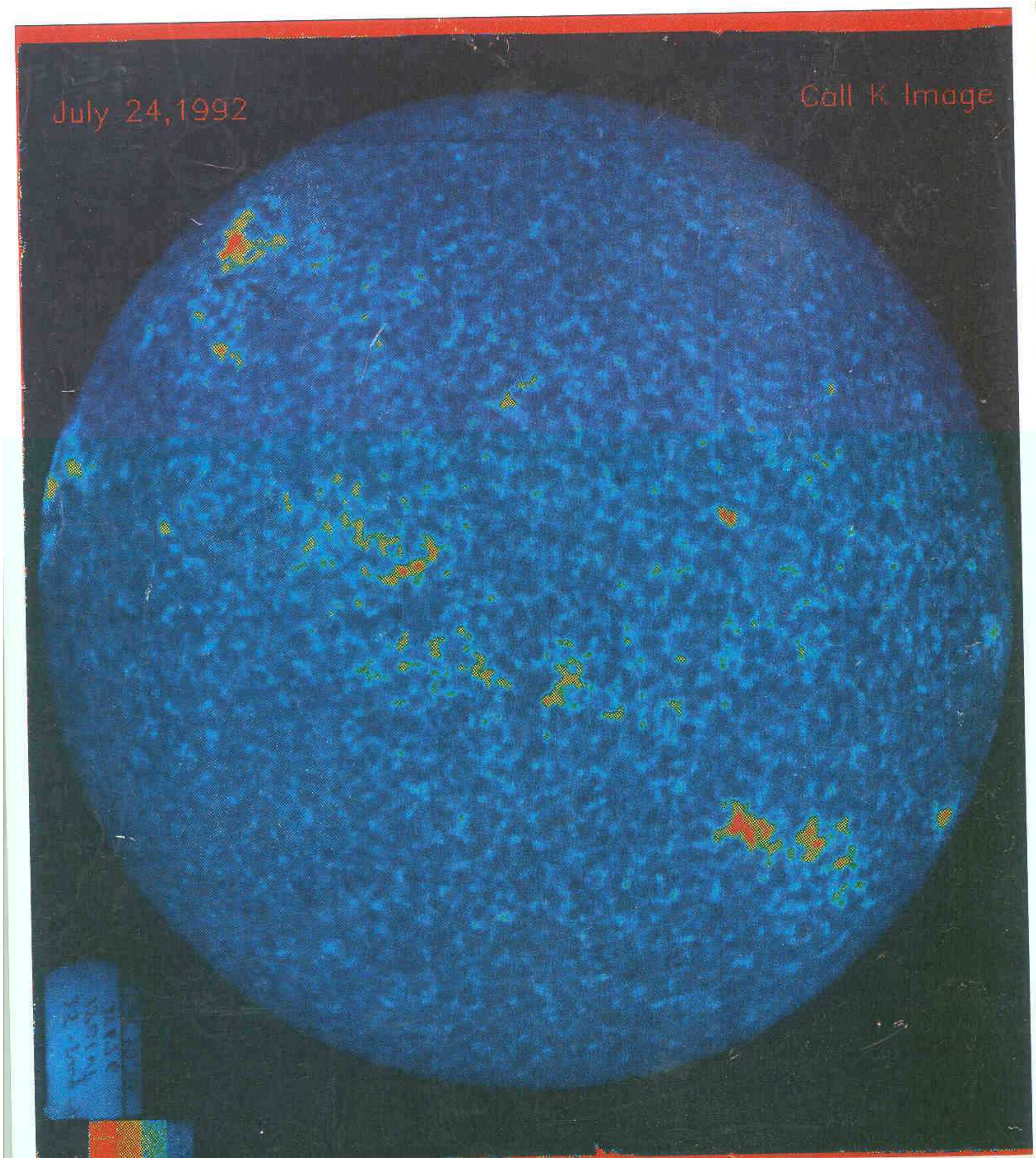

Figure 1: CaII K Image from National Solar Observatory, Sac Peak

Recently using SOHO/SUMER Lyman series observations, the oscillations of the network and bright points at the higher chromosphere have been studied.
(Curdt and Heinzel, 1998; Kariyappa, Varghese, and Curdt, 2001)

From all these studies, it is found that the bright points and network elements are associated with 3-min & 5-7 min period of intensity oscillations respectively and they contribute quite significantly to maintain the chromospheric temperature.

In addition to these smaller period of oscillations, there are evidences for longer period of intensity oscillations indicating the presence of atmospheric gravity waves at the chromospheric level.
(Damé et al. 1984, Kneer and von Uexkull, 1993, Rutten, and Krijger, 2003, Kariyappa, et al. 2006).

In the present study, we report a very preliminary results of the analysis of long duration of observations from TRACE (Transition Region And Coronal Explorer) in 1600 Å UV Continuum, particularly on UV bright points, UV network elements and background regions at the transition region.

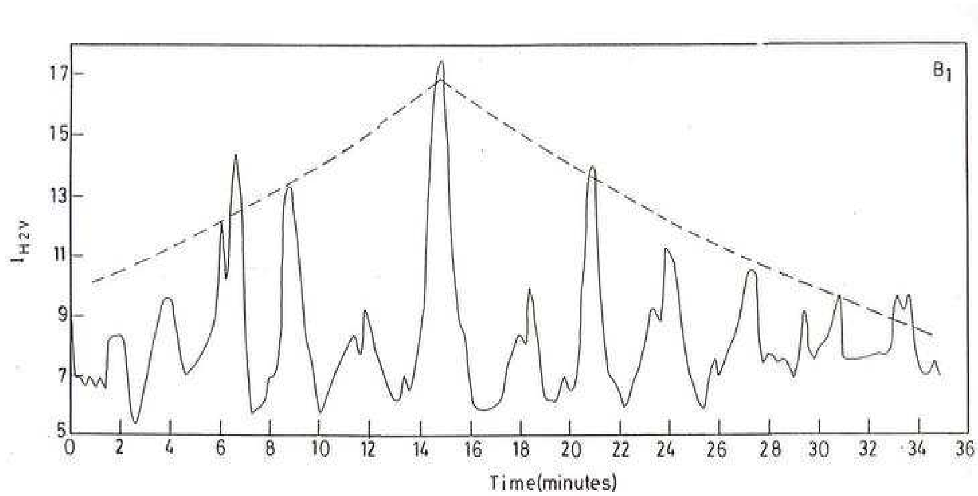

Figure 2: The light curve of a bright point. The thick and dotted lines represent the 3-min and a suggestion of longer period of oscillations respectively (Kariyappa et al., 2006).

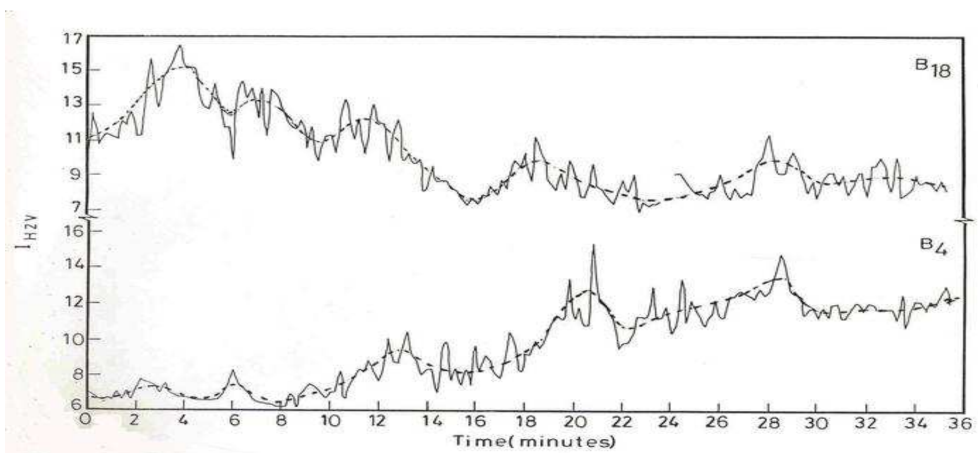

Figure 3: The light curves of the two network elements. The dotted line represent the mean curve of the intensity fluctuations showing 5-7 min periodicity. Note that there is an indication of longer period apart from 5-7 min in both the network elements (Kariyappa et al., 2006).

2. DATA AND ANALYSIS

Coordinated and Simultaneous Observations: May 18-24, 2003 with TRACE, SOHO/MDI and SOHO/CDS experiments.

High Spatial and Temporal Resolution Images at the Center of the Solar Disk.

The Solar Rotation Correction - Taken care during the observations.

The TRACE observations are obtained in three wavelength regions: 1550 Å, 1600 Å and 1700 Å.

Images have been analysed in IDL using SolarSoftWare (SSW).

Chosen 15 uv bright points (UVBPs), 15 network elements (UVNWs), and 15 background regions (UVBGs).

We have used the square/rectangular boxes covering the selected features for the study.

Then, summed up all the pixel intensity values covered by the box and extracted the cumulative intensity of a chosen feature for the entire 6-hours duration of observations.

The light curves of all the UVBPs, UVNWs, and UVBGs have been derived and plotted them as a function of time.

We have done a power spectrum analysis on the time series data to determine the period of intensity oscillations associated with all these features.

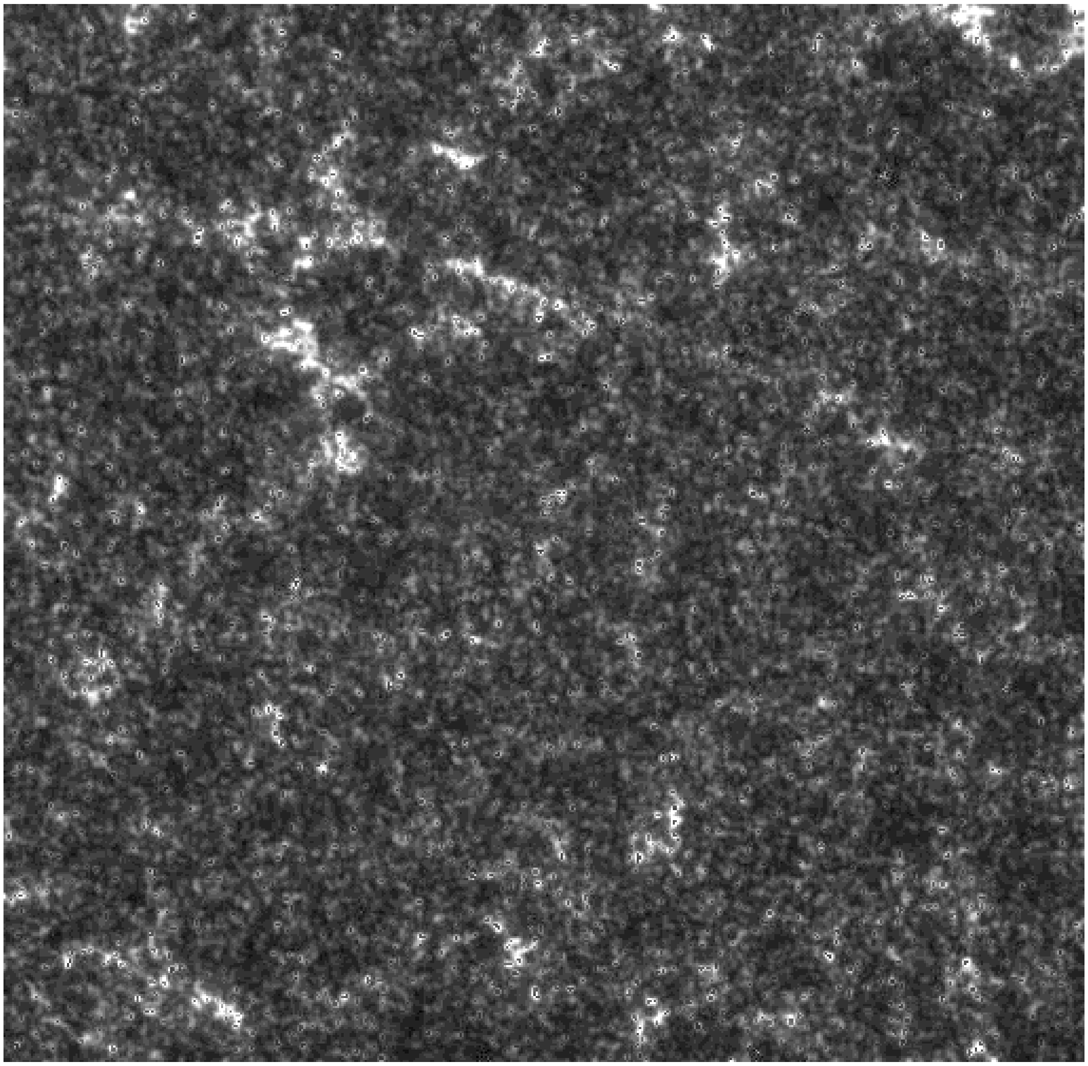

Figure 4: Sample image obtained by TRACE in 1600 Å UV continuum on May 24, 2003

3. RESULTS AND DISCUSSION

The chromospheric bright points and network elements show 3-min & 5-7 min intensity oscillations.

Observational evidences: Chromospheric emission features are related to underlying photospheric magnetic elements.

Comparison: UV emission features & Photospheric magnetic features

Comparison: Photospheric magnetic features, transition region uv features and coronal features have one-to-one spatial correlation.

There was an indication of the existence of longer-period of oscillations in chromospheric bright points and network elements from 35-min CaII H-line observations (Kariyappa et al. 2006).

In order to confirm on the existence of longer period of oscillations, in this paper, we have

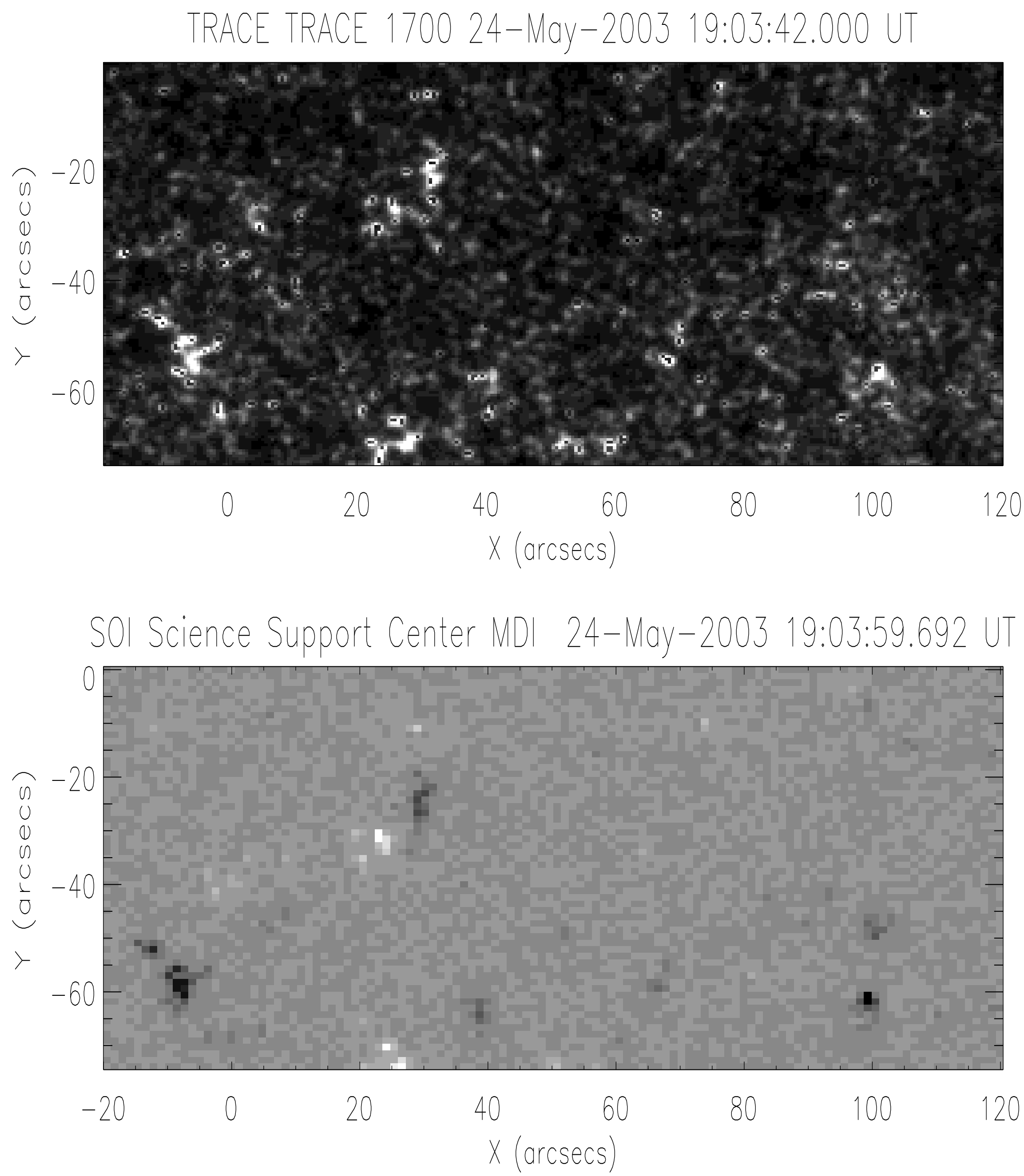

Figure 5: 1600 Å UV continuum and MDI Magnetogram Images

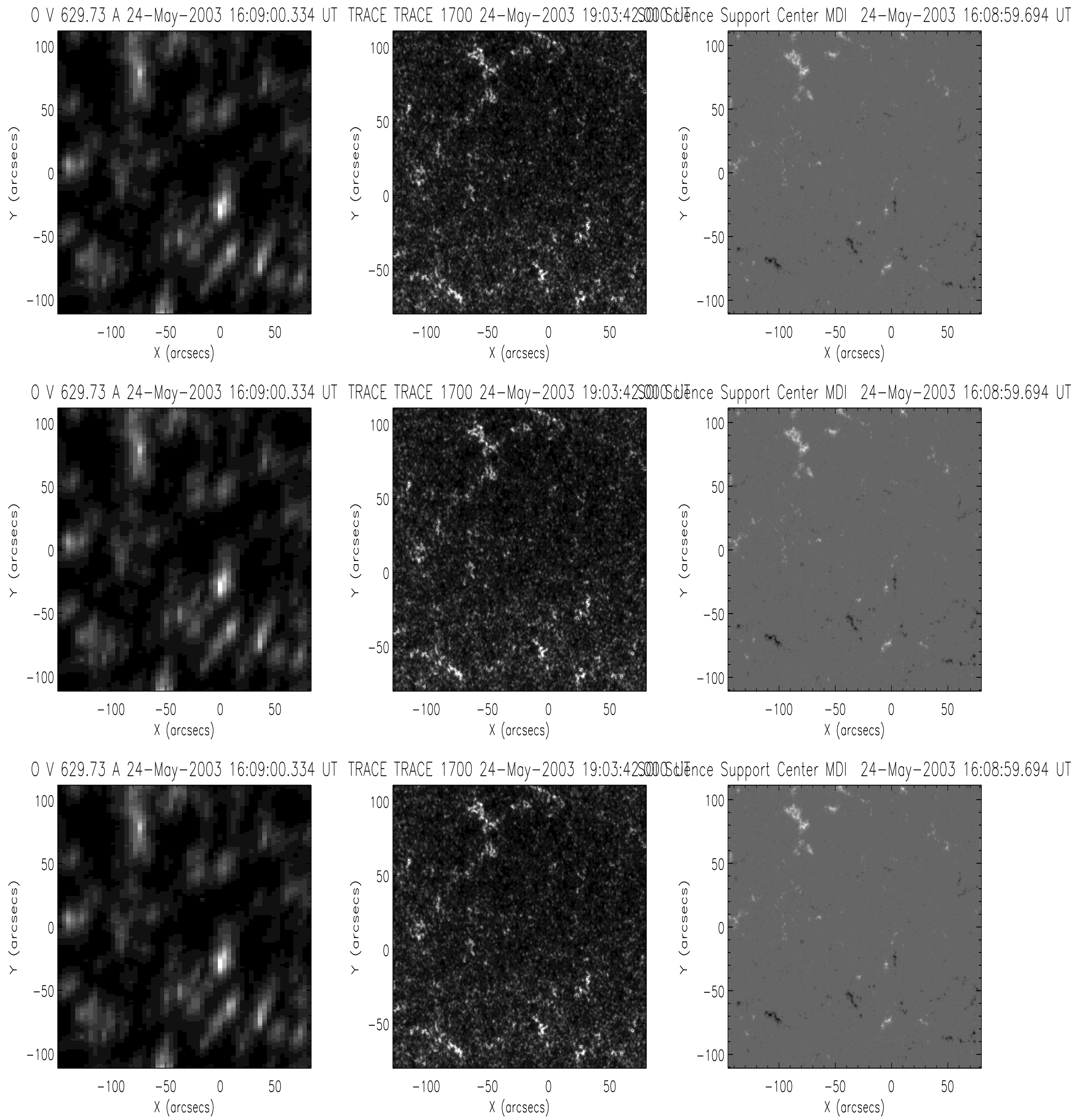

Figure 6: CDS Image, 1600 Å UV Continuum, and MDI Magnetogram

analyzed a long time sequence of uv images (6 hours of observations) obtained on May 18-24, 2003 with TRACE in 1600 Å UV continuum.

We identified and chosen 15 uv bright points (UVBPs), 15 network elements (UVNWs), and 15 background regions (UVBGs) from the time sequence of uv images. We derived the cumulative intensity values of the UVBPs, UVNWs, and UVBGs using SSW in IDL. To calculate the intensity we have put the rectangular or square boxes covering the selected features. We derived the intensity time series of all the ultraviolet bright points (UVBPs), uv network elements (UVNWs) and uv background regions (UVBGs).

The time series of UVBPs, UVNWs & UVBGs show a small fluctuations in their intensity values. In addition there is an indication of longer period.

To determine the period of intensity oscillations, we have done the power spectrum analysis using their time series data.

It is clearly seen from the power spectra of UVBPs the existence of significant & prominent peak around 5.5 hours.

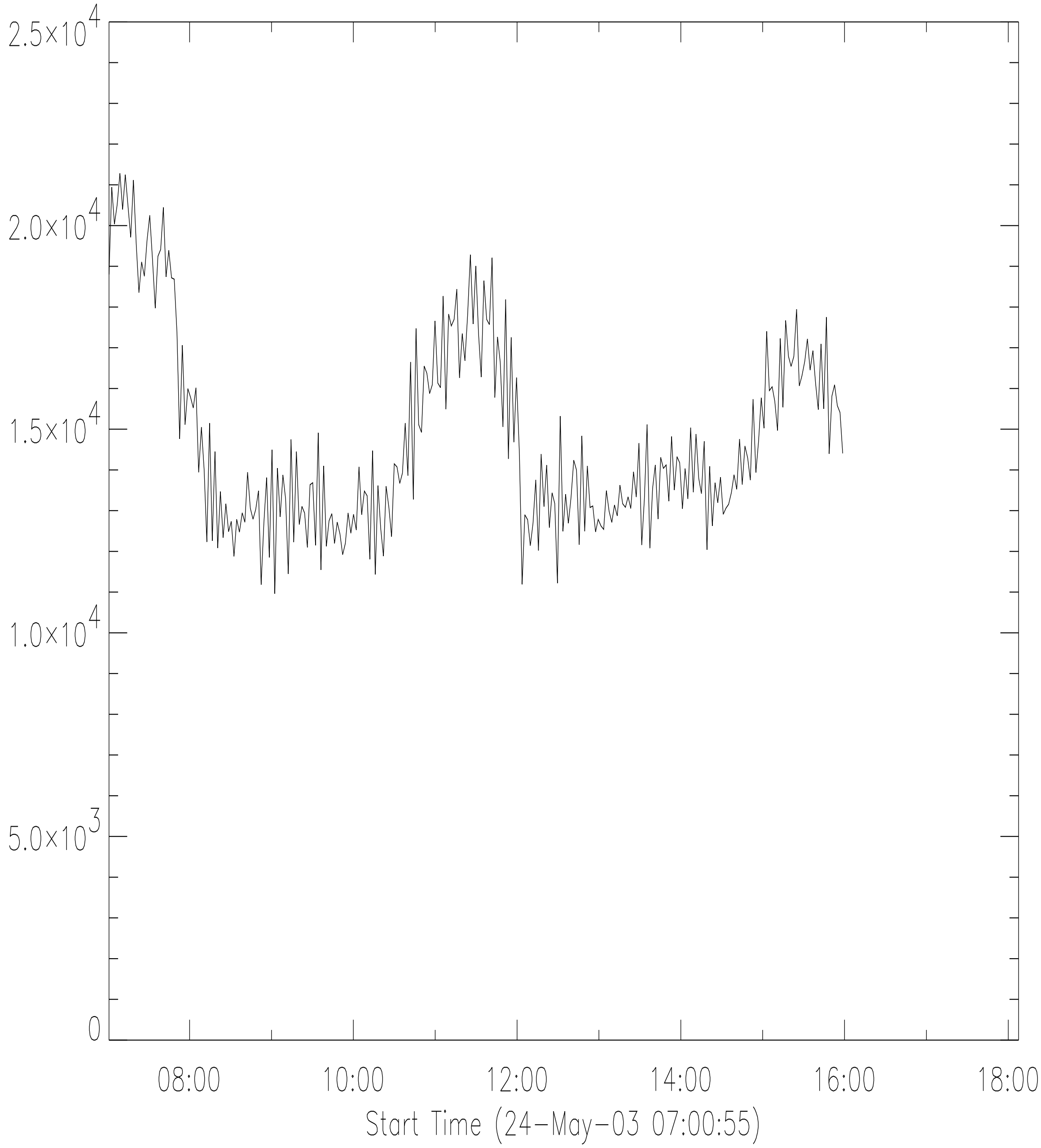

Figure 7: Light curve of a UVBP for 9 hour observations

The network elements exhibit around 4.6 hours of period of intensity oscillations.

The background regions will be associated with around 3.4 hours of period of intensity oscillations.

We have performed the cross spectrum analysis on the bright points and network elements for May 19-24, 2003 observations. We found that the data sets show a coherent in phase & there is a single dominate period associated with bright points (around 5.5 hours) and network elements (4.6 hours). Found that there is a good coherence in the signal due to these features among different days.

This suggests strongly for high-order atmospheric gravity waves. We can extend our argument of the chromosphere (Kariyappa, et al., 2006) to the transition region level that the longer period of oscillations seen in both chromosphere and transition region may be related to atmospheric g-mode oscillations.

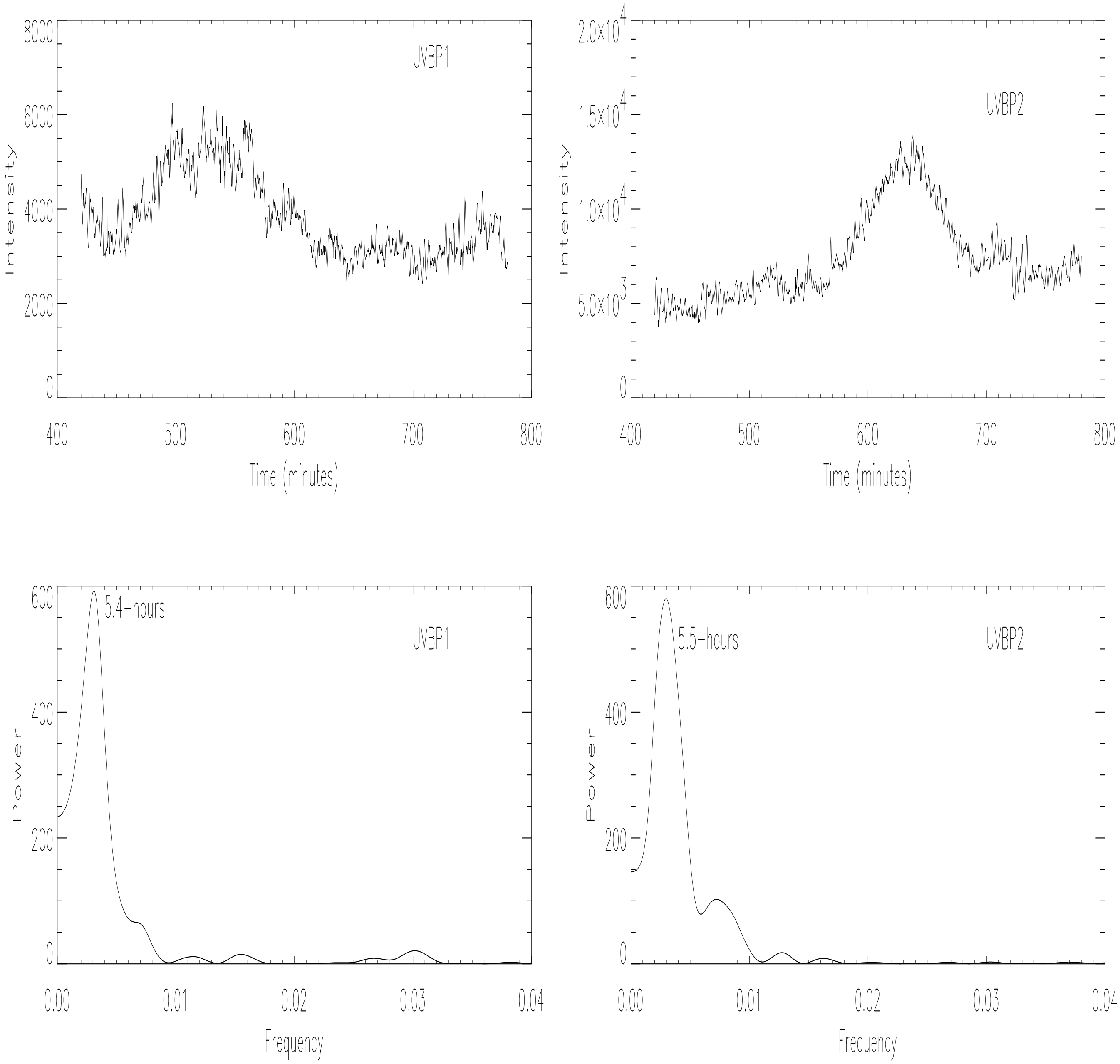

Figure 8: *Left upper box:* An example of the light curve of an isolated UV bright point (UVBP1) observed on May 24, 2003 (6 hours) with TRACE in 1600 Å UV continuum. *Left lower box:* The power spectra taken for the light curve of the UV bright point (UVBP1). *Right upper box:* The light curve of an another isolated UV bright point (UVBP2). *Right lower box:* The power spectra taken for the light curve of the UV bright point (UVBP2).

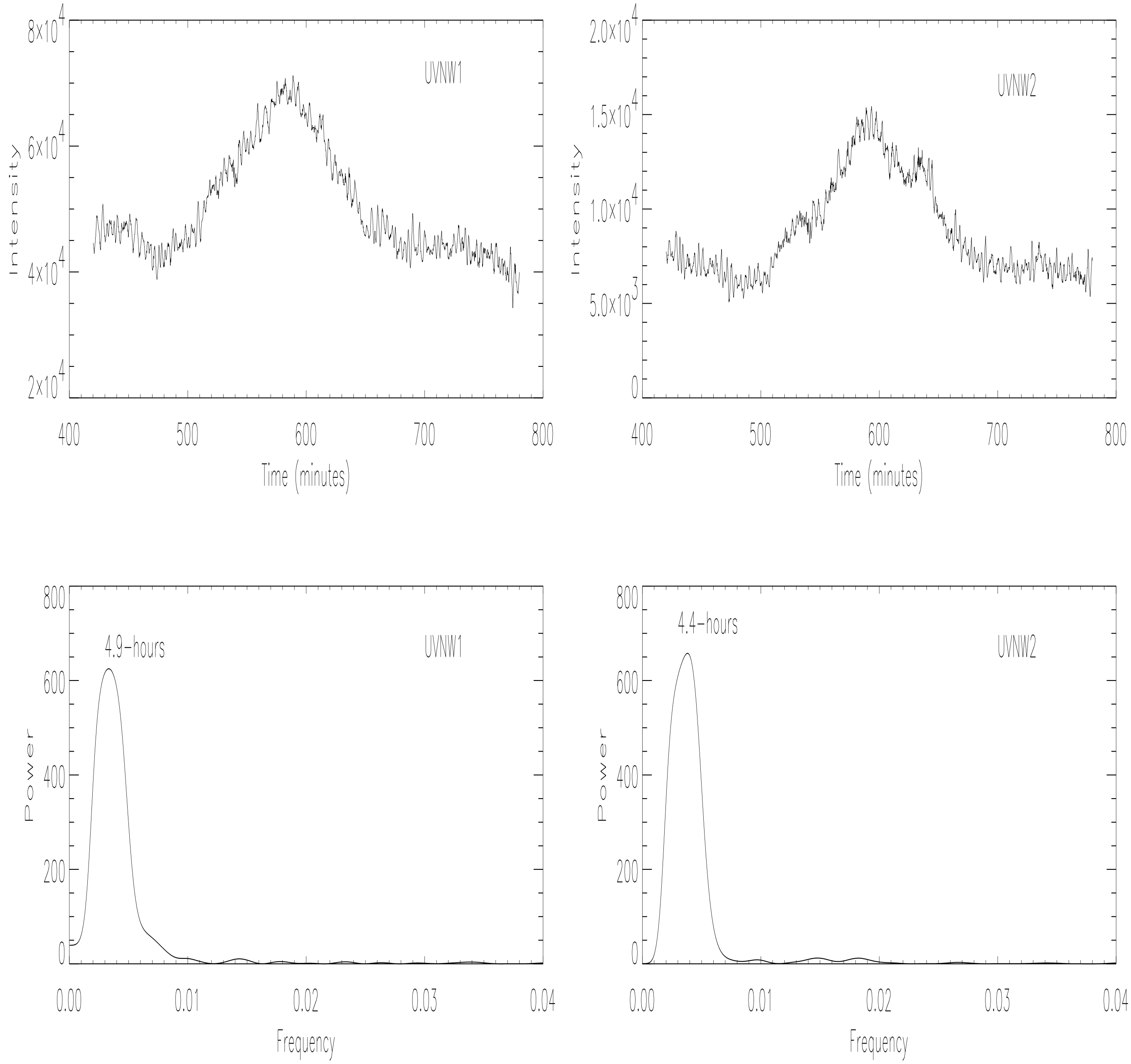

Figure 9: *Left upper box:* An example of the light curve of a network element (UVNW1) observed on May 24, 2003(6 hours) with TRACE in 1600 Å UV continuum. *Left lower box:* The power spectra taken for the light curve of the network (UVNW1). *Right upper box:* The light curve of an another network element (UVNW2). *Right lower box:* The power spectra taken for the light curve of the network (UVNW2).

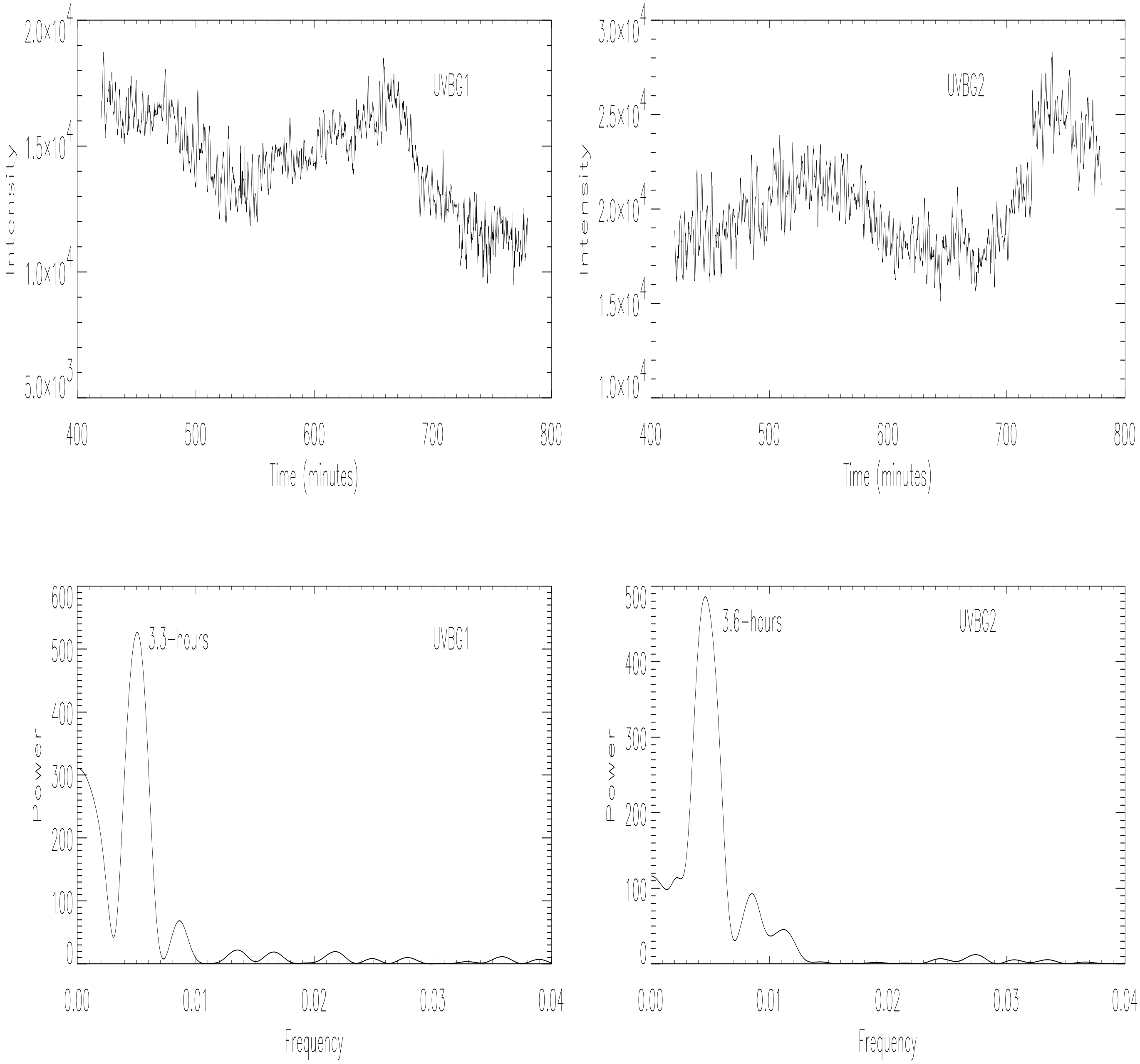

Figure 10: *Left upper box:* An example of the light curve of a background region (UVBG1) observed on May 24, 2003 (6 hours) with TRACE in 1600 Å UV continuum. *Left lower box:* The power spectra taken for the light curve of the background region (UVBG1). *Right upper box:* The light curve of an another background region (UVBG2). *Right lower box:* The power spectra taken for the light curve of the background region (UVBG2).

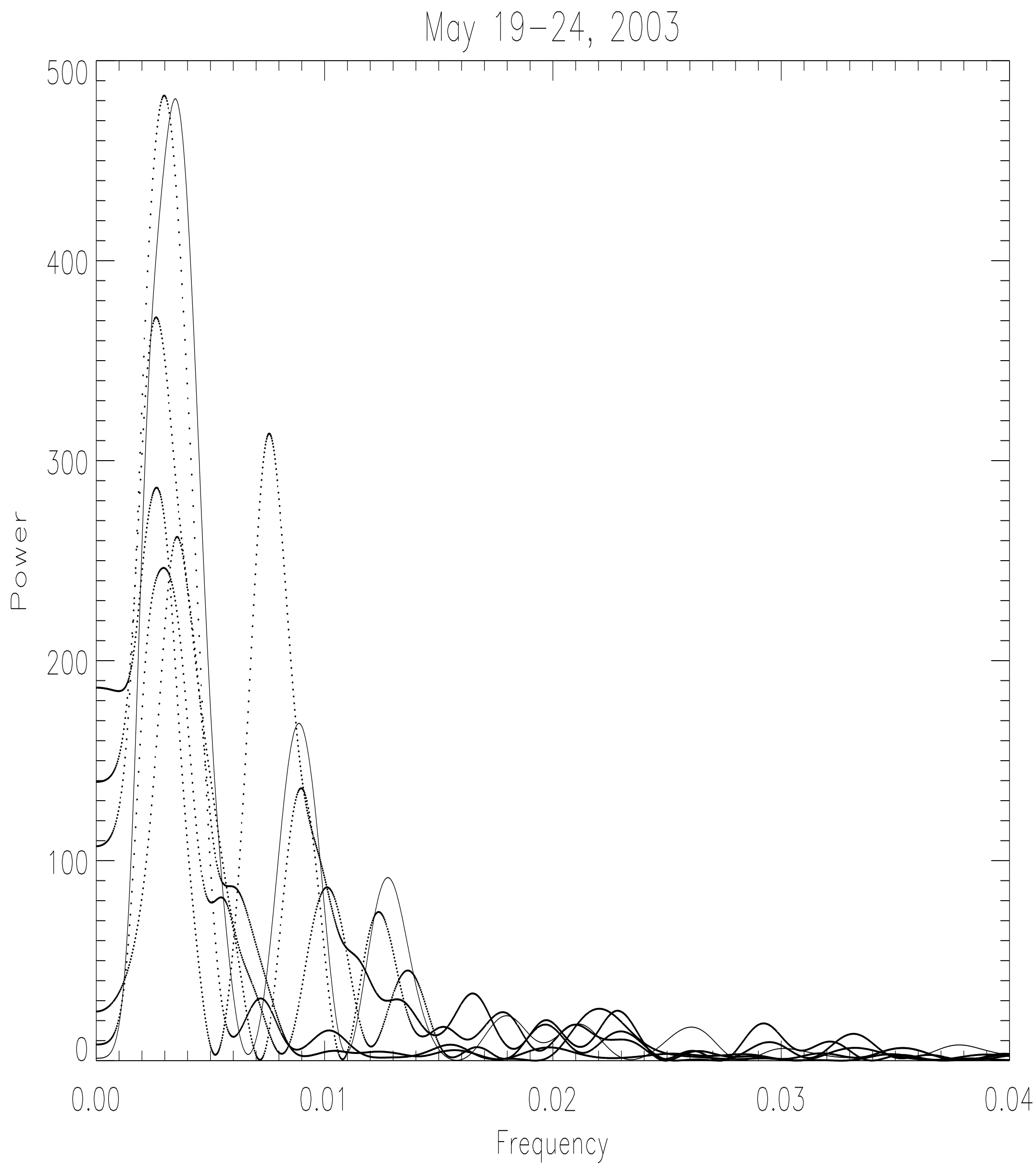

Figure 11: The power spectra taken for the UV bright point for May 19 to 24, 2003 to show that there is phase coherence in the data of different days.

The conclusions (preliminary) are:

(i) The uv bright points, uv network elements and uv background regions will exhibit a fluctuations with a smaller period in their intensity oscillations.

(ii) We find evidence from the power spectrum analysis for a longer period of oscillations: the uv bright points are associated with around 5.5 hours, the uv network elements exhibit around 4.6 hours, whereas the background regions show around 3.4 hours.

(iii) It is noted that the different features will have different period of intensity oscillations and the physical cause for the existence of different periods is still to be investigated.

(iv) We can argue that the longer period of oscillations associated with these three features may be related to g-mode oscillations of the chromosphere and transition region.

These results confirm the earlier findings that there is a signature of gravity waves in the chromosphere and transition region derived from the analysis of time sequence of filtergrams and

spectra obtained in CaII H & K, Mg b2 lines and from TRACE observations.
(Damé et al. 1984, Kneer and von Uexkull, 1993, Rutten, and Krijger, 2003, Kariyappa, et al. 2006).

(v) We find an observational evidence for the existence of one-to-one spatial correspondence between the photospheric (magnetic elements) features, the transition region uv emission features (1600 A UV image), and coronal features (CDS image).