

Automating a Pre-Analysis Tool for Oscillations in the Solar Corona

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Corona

The solar corona consists of high temperature (>1MK) plasma and has structures such as coronal loops and flares. Observations have shown that oscillations are abundantly present. By analysing these oscillations and doing coronal seismology we can find out more about the physical parameters in the corona such as the magnetic field strength and density. Observations have been carried out by TRACE (Transitional Region And Coronal Explorer), a satellite that takes images in the 171Å and 195Å wavelengths of plasma with a temperature of 1MK.

Periodmap code

- The periodmap program is a *pre-analysis* tool to flag potentially interesting oscillations analyse the data and then allows the user to investigate the data in more detail if required. This program had already been written for me.
- The periodmap program calculates whether there is a possible oscillation by creating a Fourier Map of each pixel with respect to time.
- If the peak value of the oscillatory power in a pixel with respect to frequency is a prescribed number of times greater than the mean value (this number is user specified but is usually 3) then the pixel is flagged as a possible oscillation.
- The colour the pixel is given is black if the oscillation is not considered significant or the colour corresponding to the peak frequency if it is considered significant.

Aim and motivation

My task was to speed up the analysis of the data by *automating* the pre-analysis procedure using the periodmap code. The aim is to construct a tool where the user has to select a particular time interval. The constructed tool will download, pre-process and pre-analyse the data automatically. As a result of the tool, periodmaps of the desired time interval will be created. The motivation for this task is that an automated detection method is needed. With the upcoming missions studying the solar corona, the data flow will be too large to allow a "manual" inspection of the observations.

Automating periodmap

My program works in three stages:

- Aim of the first stage: find an observation with a good cadence time and enough images. The first stage reads a data file that contains a catalogue of all observations of the corona taken by TRACE that I was given at the start of my project and then finds the date and time of the requested observation. This part of the automated procedure is written in IDL.
- Aim of the second stage: download the required data from the remote data storage centres. The date and time would then be passed onto the second part of my program which was written in Bash script; this script downloaded the images from the website using the wget command.
- Aim of the third stage: pre-process obtained data and create periodmaps. The final stage of my program then merges the individual image files into a 3D datacube, a 2D image with time as the third dimension, and used special existing functions to remove noise from the data. The datacube was then passed onto the periodmap program.

User enters time interval
(IDL)

Look up date and time of event requested by user
(IDL)

Connect to the TRACE data centre and searches for the correct files
(Bash script)

Download the required files from the internet
(Bash script)

Pre-process the data by merging and removing the noise from the image files
(IDL)

Pass the merged data to the periodmap code. That creates a map like the one in Figure 2.
(IDL)

Periodmaps are stored for later investigation by the user
(IDL)

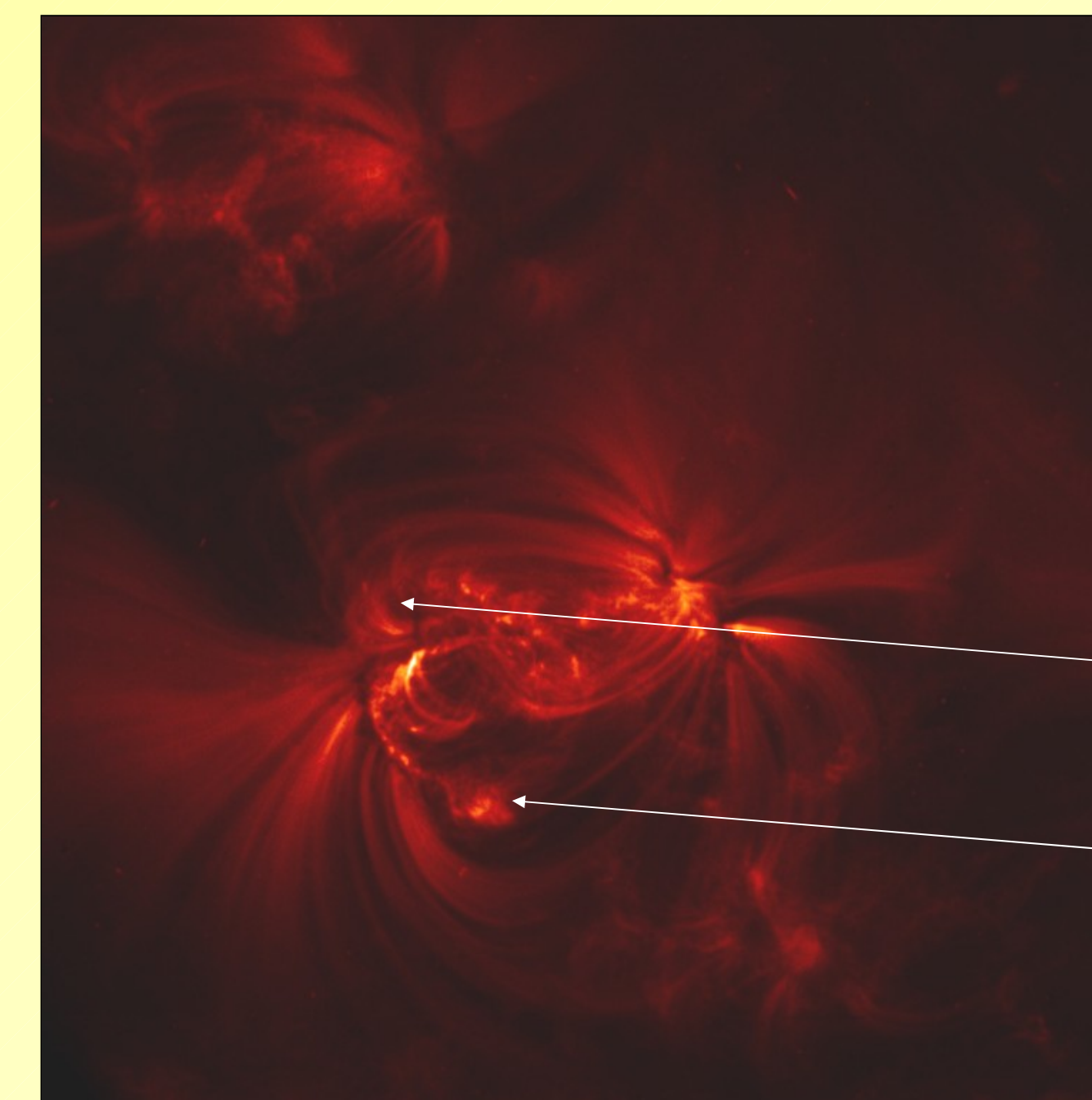


Figure 1: The original image

Figure 1 shows an active region with numerous coronal loops. It is believed that the loops follow the magnetic field lines. It is in these loops and flares that we hope to see coronal oscillations. In the left observation a flare occurs on the 14th July 1998. In the observations the loops arrowed are seen to oscillate.

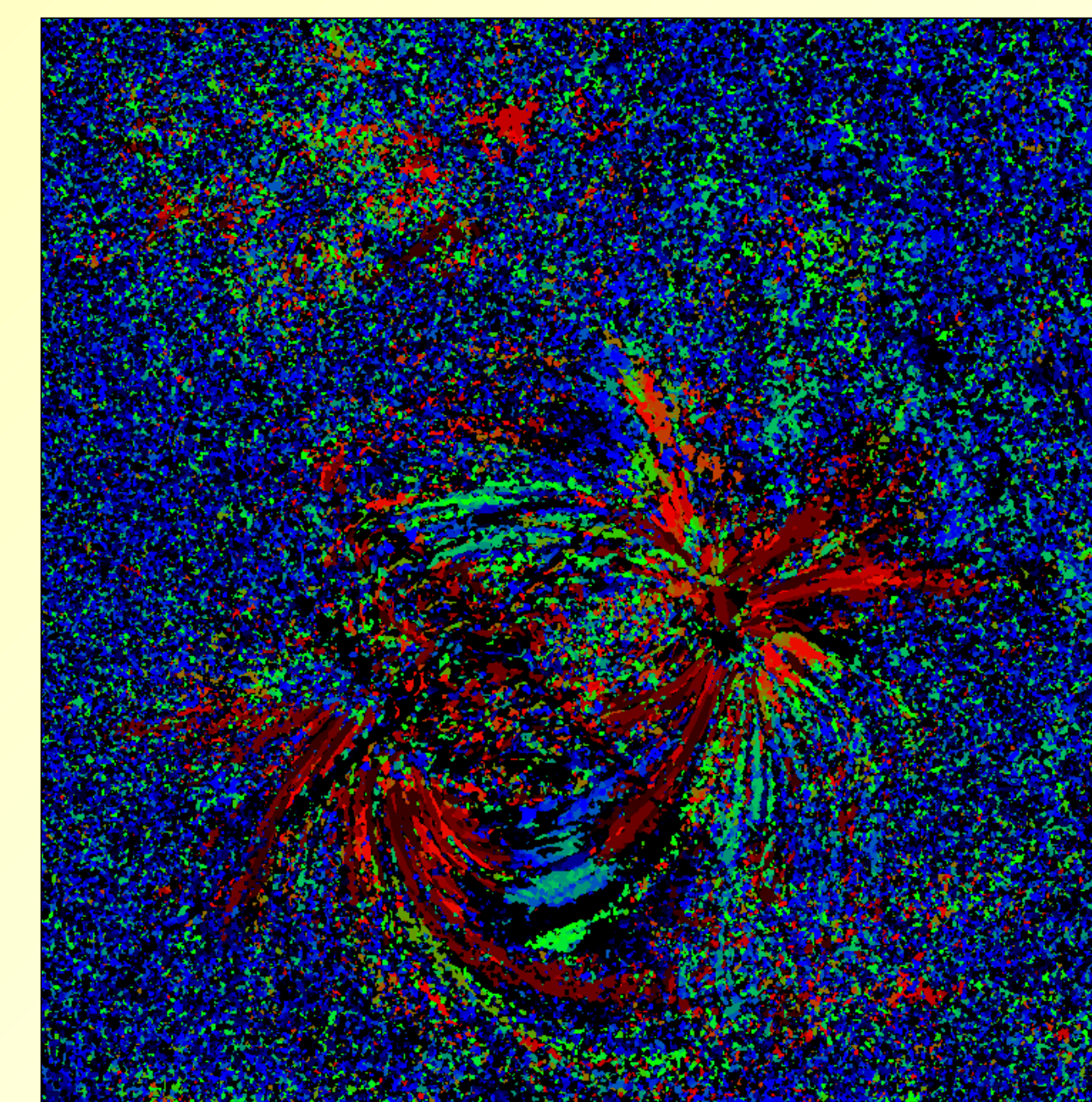


Figure 2: This is a map generated by the analysis program

This is the Fourier Map created by the periodmap program. By comparing it to the original above it is clear that there is a strong possibility of an oscillation in parts of the loop: the region coinciding with the loop tops show a patch where the same periodicity is found. This indicates that the period found may actually be physically present in the loops. The blue dots surrounding the loop are areas of high frequency noise.