From a scientific viewpoint, White Dwarf Stars prove to be one of the most useful objects in our galaxy for astronomical research. Many different projects can be performed on these dim stars, ranging from understanding dark matter to finding solar systems similar to our own. By understanding how these stars are crystallizing, we gain a better understanding of extreme physics. When we better understand extreme physics we will be more equipped to provide our world with clean energy that comes about by the use of such physics.

First, we must concentrate on something that we can relate to ourselves and proceed by applying it to these stars. Seismology on the Earth has helped us to understand many different things about our world and how it works. By using these waves we can determine many different things about the Earth, specifically its inner make-up. By looking at white dwarf stars that are pulsating we can use similar methods to understand their inner workings. The star, BPM 37093, is believed to be the first pulsating white dwarf star in which the interior is crystallized, as shown in Winget (1997). This makes it an extremely interesting star to study using asteroseismology, which looks at the pulsations of the star to determine information about it.

By using data taken on the 0.9m telescope at CTIO in Chile, I was able to obtain a light curve. After measuring the brightness of the target star, one can see that the brightness of the star will change, creating a complicated light curve that shows the pulsations of the star.

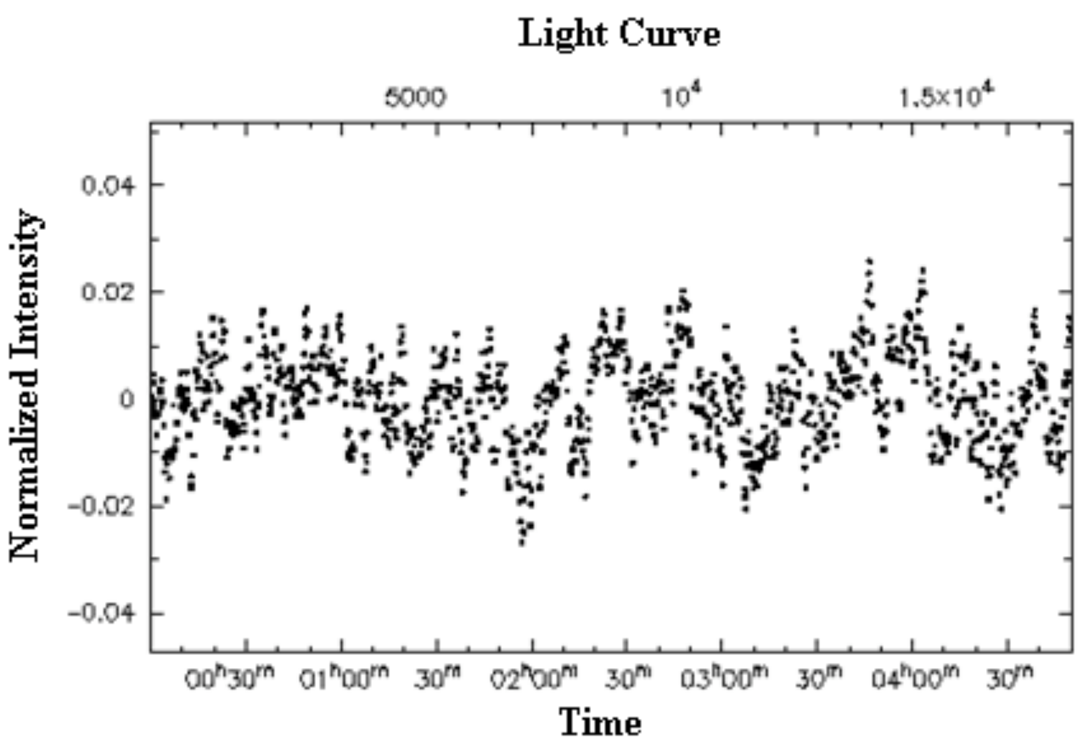

Figure : The light curve taken from the star SDSSJ1036+6522

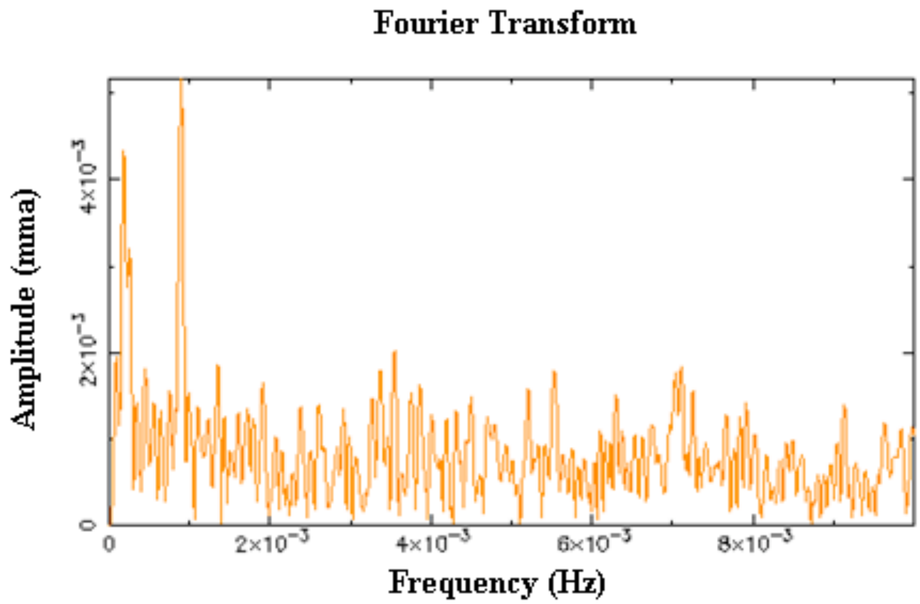

Figure : The fourier transform of the above light curve shown in Figure 1

From this information we can find a fourier transform which will tell us the frequencies in which the star is pulsating. We can only gather so much information in one night, therefore when we take multiple nights worth of data we can combine them giving us a more detailed fourier transform. Notice the increased detail in a small portion of the fourier transform shown below in Figure 3.

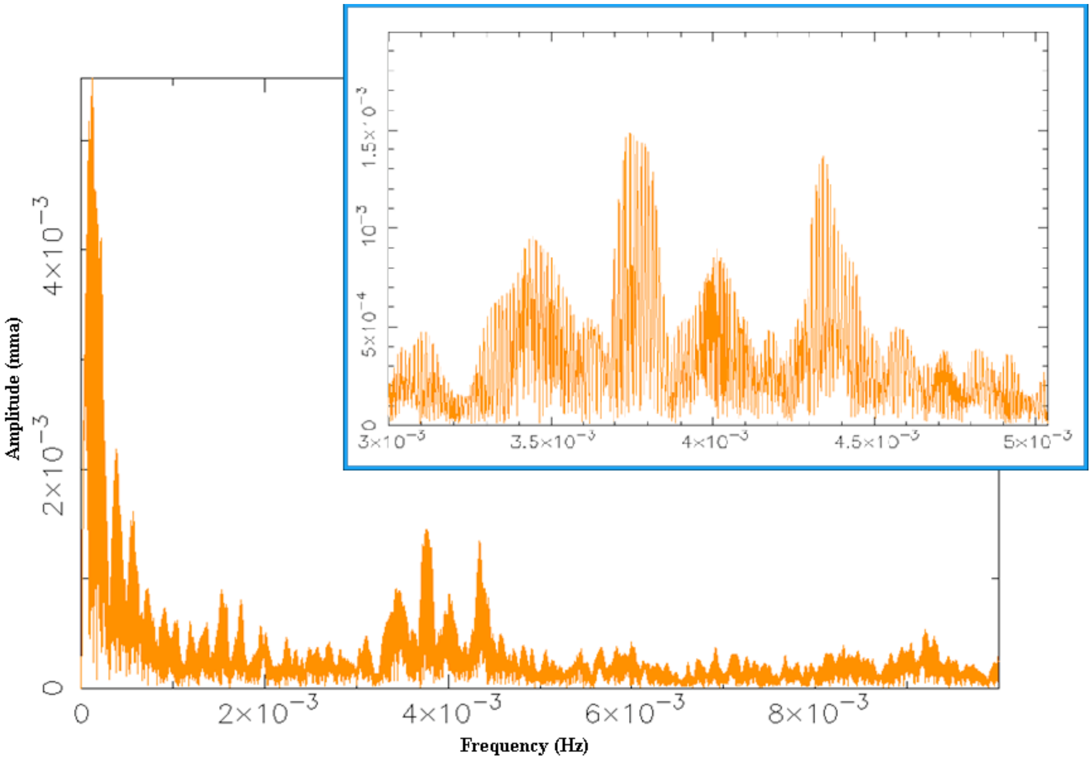

Figure : The Fourier Transform result for BPM 37093 from four nights worth of data

With this fourier transform we can now look for significant peaks that may be periods of the pulsations of the star (see the box shown in Figure 3 for an example of significant peaks). By prewhitening the significant peaks we can determine which peaks are real and which are aliases of the real peaks. Searching through the fourier transform we find a number of different interesting periods.

The periods of the powerful peaks in the fourier transform tend to change over time because the star itself is changing from a liquid to a solid, from the inside out. This solid core greatly affects the pulsations of the star, because the oscillations are confined to the liquid regions of the star, as stated by Montgomery. While this is occurring we will see two main things occurring: there will be a new class of modes, and the existing p- and g- modes will be changed (1999). After these modes are found in the fourier transform, a parallel genetic-algorithm-based fitting method is used to determine the amount in which the white dwarf star has crystallized. I have not been able to delve too deeply into this method as of yet, but I do plan on finding out more about it.

As of now, I have found similar frequencies in the star to those found in previous investigations of it that appear along with new frequencies which seem to have enough power behind them to be significant.

Figure : WET results from Kanaan (2005) are shown on the left in comparison to my results on the right

In Figure 3 you can visibly see that there are a number of peaks between 3,000-uHz and 5,000-uHz that appear to have significant power behind them. These frequencies are shown in Figure 4 as the last four frequencies in the second chart.

Currently, there is controversy in the scientific world over how much of this star is actually crystallized. According to Metcalfe, "[The] initial exploration of the models strongly suggests the presence of a solid core containing about 90% of the stellar mass, which is consistent with our theoretical expectations." (2004) However, according to Fontaine, "the solidified fraction of BPM 37093 lies between 32% and 82%." (2005) Therefore, with further exploration into this project we hope to determine a final amount of crystallization, and already we are seeing exciting periods that have not been found previously.

Cites

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