Analysis of the Eclipsing Binary Star FZ Orion

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Abstract

During the nights of December 21st and 22nd, 2003, the variable star named FZ Orion was observed using the 18" telescope at the SFA Observatory. The researchers were collecting data using photometry to further illustrate that FZ Orion is a short-period eclipsing binary star, which the star is known for. The purpose of this continued research was to analyze this data by measuring the apparent magnitude of FZ Orion using commercial image processing software for each of the images acquired. Using the measured apparent magnitude, a light curve was constructed - a plot of the apparent magnitude versus time. This light curve portrayed that the orbital period of the stars in FZ Orion is 12.096 hours.

Figure 1. SFA 16" Telescope at the SFA Observatory.

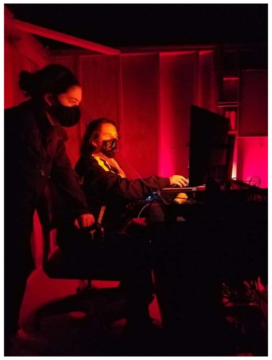

Figure 2. Madelyn Latiolais and Alexandra Hargon working with the 16" Telescope.

Procedure

To analyze the data of FZ Orion using Maxim DL:

- ❑ Open up all the images on Maxim DL.
- ❑ Gather information about the first and last images, as well as the dark frames and flat field images:

	12-21-2003	**12-22-2003**
Time for First Image (UT):	03:48:06 UT	03:30:30 UT
Time for Last Image (UT):	09:23:09 UT	09:47:12 UT
Exposure Time (seconds):	60.0 seconds	60.0 seconds
Chip Temperature (Celsius):	-5.232°C	-4.8178°C
Time FZ Orion observed (hours):	6.2508 hours	6.2894 hours

	12-21-2003 Dark Frame	**12-21-2003 Flat Field**
Time (UT):	06:49:11 UT	09:37:34 UT
Exposure Time (seconds):	60.0 seconds	2.00 seconds
Chip Temperature (Celsius):	-4.8178°C	-4.8178°C

- ❑ Calibrate the CCD images so that the images are cleaner.
- ❑ Click on Analyze, then photometry. For each of the images, the reference star and FZ Orion will need to be selected. The reference star will be used as a base of consistent light.
- ❑ Make a plot of the Julian date versus apparent magnitude. The stars in FZ Orion will orbit each other a couple of times during the day, so there will be a large gap in the data. To eliminate the gap, "fold" the data to construct one complete cycle of the light curve.
- ❑ Using this information, make a plot of apparent magnitude versus phase.

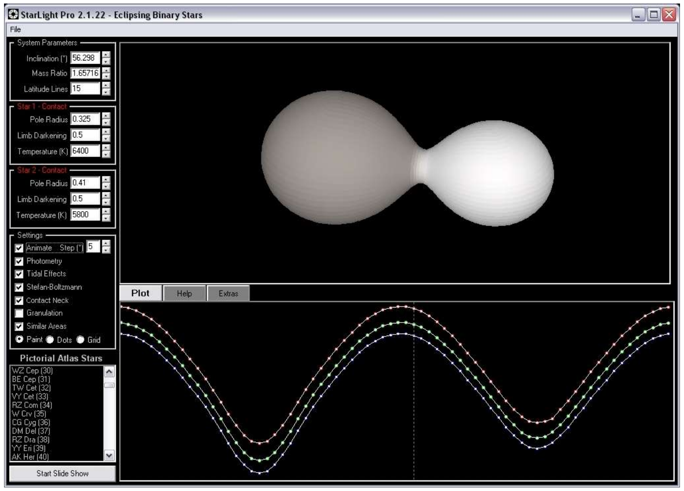

Figure 3. A computer generated 3-D model of the FZ Orion Star System.

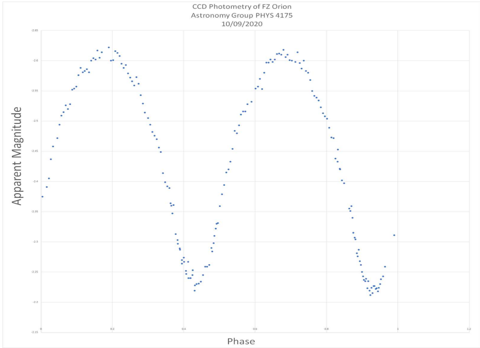

Figure 4. The light curve of the FZ Orion Star System.

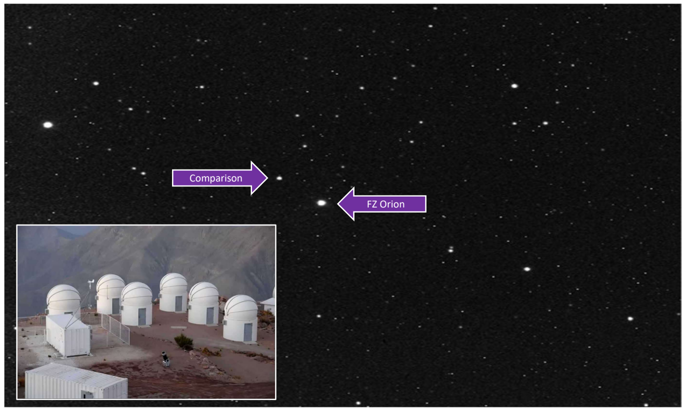

Figure 5. Location of FZ Orion and the Comparison Star from the SkyNet PROMPT Telescope.

Conclusions

The most common multiple star systems are binary stars. In fact, binary stars are the most common type of star in the universe as far as researchers can tell. Binary stars are star systems consisting of two stars that orbit around a common barycenter. The stars in the system can orbit each other at very large distances or short distances, like the FZ Orion system. Depending on the distance between the two stars, it is possible for the two stars to share mass or even 'steal' mass from one another.

In FZ Orion, researchers suspect that the stars engage in these activities due to the tight binary. These activities can be shown in Figure 3. The temperature of the 1st star is 6108 Kelvin and has a pole radius of 0.3855 au. The temperature of the 2nd star is 6055 Kelvin and has a pole radius of 0.3467 au. The inclination between the two is 67.085 degrees and the mass ratio is 0.79152. If one were very close to the system, this is what FZ Orion would look like.

A charge coupled device (CCD) is an integrated circuit on top of a silicon surface that forms light sensitive pixels. Photons hit the surface of the CCD generate a charge that can be read by the electronics and processed into digital copies of light patterns. FZ Orion appears as one star on the CCD images because the two stars cannot be resolved by any Earth based telescopes. The more distant the star, the larger chance that the CCD camera will not be able to show that there is more than one star in the area.

Photometry is the measurement of light in terms of perceived brightness to the human eye. Photometry measures the apparent brightness of light. For astronomy, photometry is employed by applying filters that restrict certain wavelengths of light to be able to measure desired wavelengths. Photometry can be used to find the orbital period between objects in the universe by looking at how the light behaves over time. With the light curve, there will be times that there are significantly more photons reaching the images and times where less will reach. This is due to the fact that whenever one of the objects passes in front of the other, there will be less light that reaches the Earth. In respect to the FZ Orion star system, using photometry to make a light curve (Figure 4) conveys that the orbital period of the stars is 12.096 hours.

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Wielding the power of photometry, the understanding of binary star systems, and how CCD imagining functions, researchers can prove that FZ Orion is a binary eclipsing star system. For the orbital period to be about half a day, the stars in the system must be exceptionally close together. The universe is a basket full of bizarre phenomena that scientists are only just starting to capture.

Acknowledgement

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