Planetary Transits

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Abstract

Our objective was to determine if there was an observable drop in light due to a planetary transit. We used the Skynet telescopes in La Silla, Chile to observe a planetary transit across the star HD168746. We recorded five and eighty second images of this star and three reference stars during the time of the transit. Using MaximDL, we calculated the brightness of HD168746 in comparison to the brightness of the comparison stars. We then compared this difference in brightness to the expected difference in brightness. It was determined that the transit significantly decreased the brightness of the star in comparison to the brightness of two of the three reference stars. It was concluded that the brightness of HD168746 did drop during the transit due to the blockage of a portion of its light by the planet.

Introduction

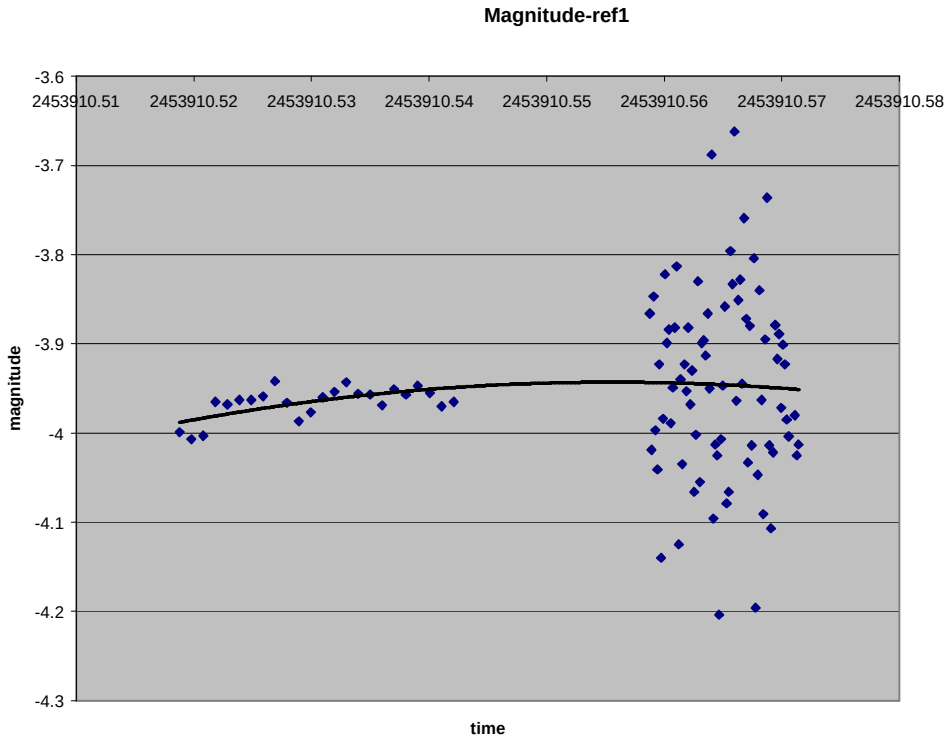
There are one hundred ninety-four known extra solar planets. If a planetary system is not oriented ninety degrees to our line of sight, the planet will pass between us and the star during its orbit. This is called planetary occlusion or a transit. Our group set out to observe an exosolar planetary transit. Our objective was to measure the drop in magnitude when the planet was transiting and create a light curve based on our data.

Method

In order to carry out our observations, we had to look up all the stars that have been observed to have planets orbiting them. Through an online catalog we found approximately 40 planets that would be good candidates for transit observation. Since the planet search that was used did not give us the minute and second coordinates of the stars, we utilized the SIMBAD website to obtain the last coordinates. We then plugged the coordinates into PARI's Maxim DL and Sky 6 systems to determine whether or not we could actually see any of these objects from PARI. Due to inclement weather and certain stars not being in our horizon, we were not able to observe any of the transits from PARI, and had to turn to the PROMPT system of telescopes located in La Silla, Chile to be able to properly observe our transits and collect the necessary data. However, we were unable to request that our observations be taken at a specific time. The telescopes PROMPT 4 and PROMPT 5 took exposures from between 8:26:23 pm on the 23rd to 4:16:14 am on the 24th. We ended up with 75 five second exposures in the V band, 24 80 second exposures in the V band, and 3 five second exposures in the R band. Using MaximDL, the images were then processed. Bias was subtracted from each frame and they were then calibrated using flat field and dark images. Photometry was then preformed on each frame using GSC 5685:3808, GSC 5685:2388, and GSC 5685:2926 as reference stars. This data was then used to determine if a change in relative brightness occurred during the transit period.

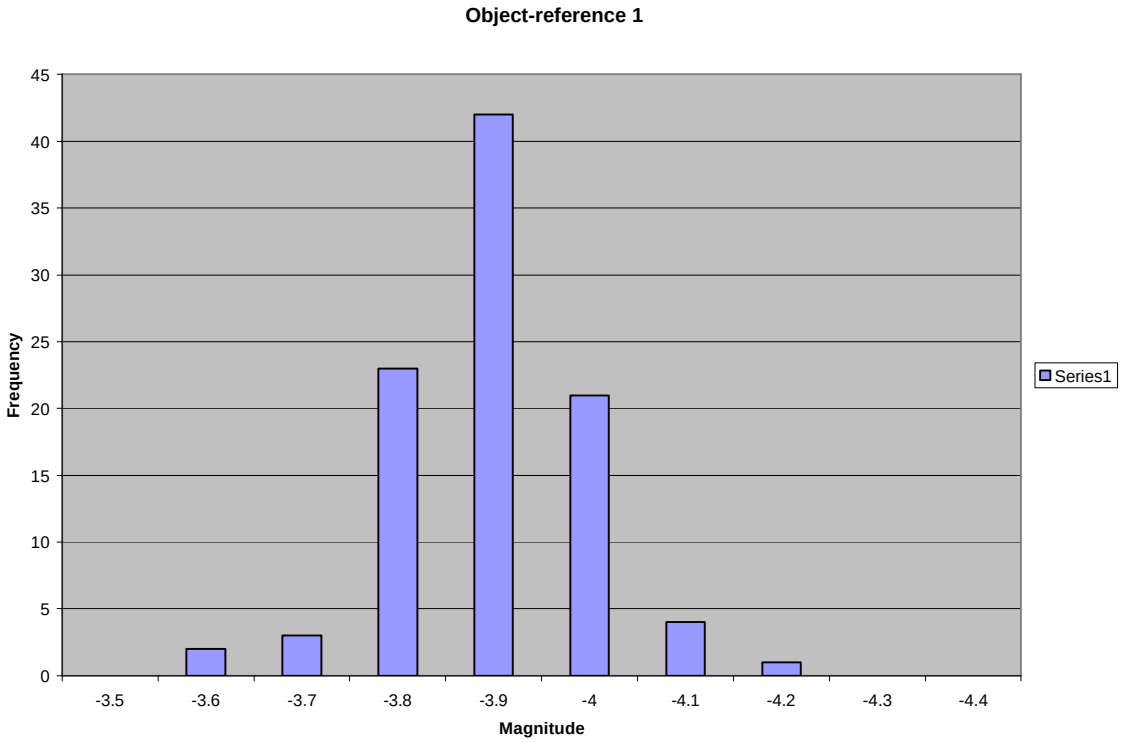
Data/Analysis

A transit was occurring during the time our data was taken. However, the measurements of magnitude were not begun until after the transit had started and ended before the transit did. This was due to the fact that the data was taken robotically and using the Skynet system the user is unable to specify what time to take the data. As the data was all taken during the transit, it was not possible to determine the total drop in brightness due to the planetary occlusion of HD168746. When the magnitude of the star, was plotted against time, scatter was observed and it was almost impossible to determine a trend line. However, during the period of 80 second exposures, the magnitude appeared to be decreasing (see 2453910.51-2453910.55 on Magnitude-ref1 below).

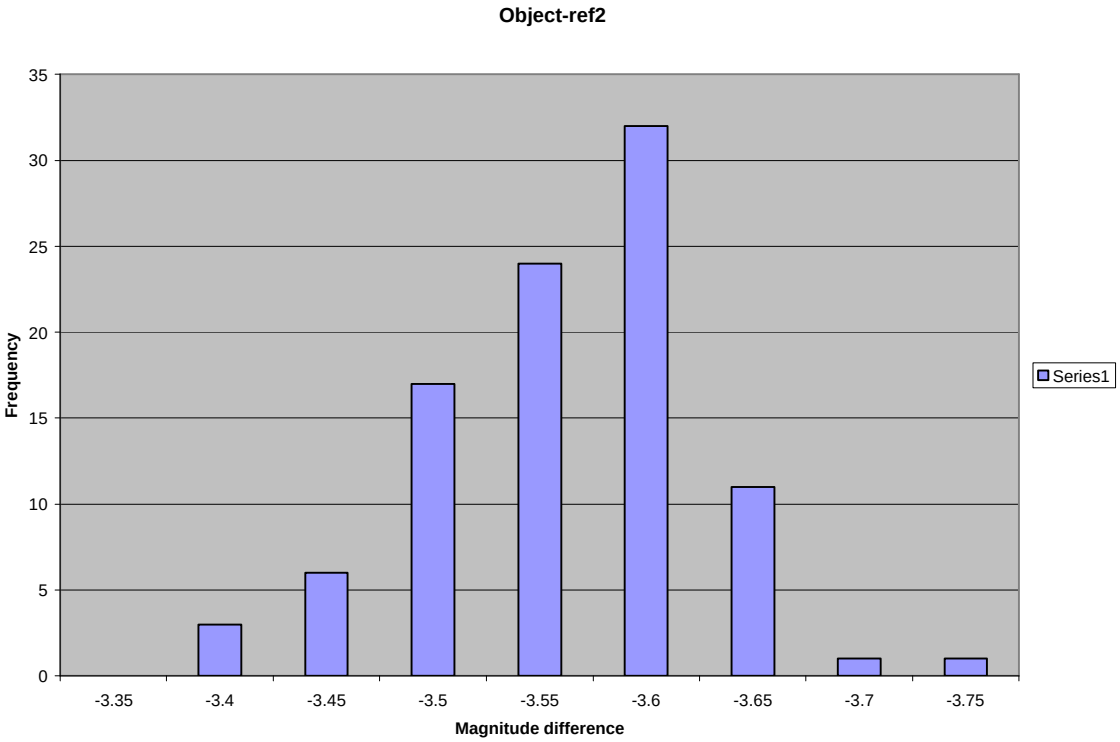


However, the five second exposures are too scattered to determine if the trend continues or reverses during the later half of the transit.

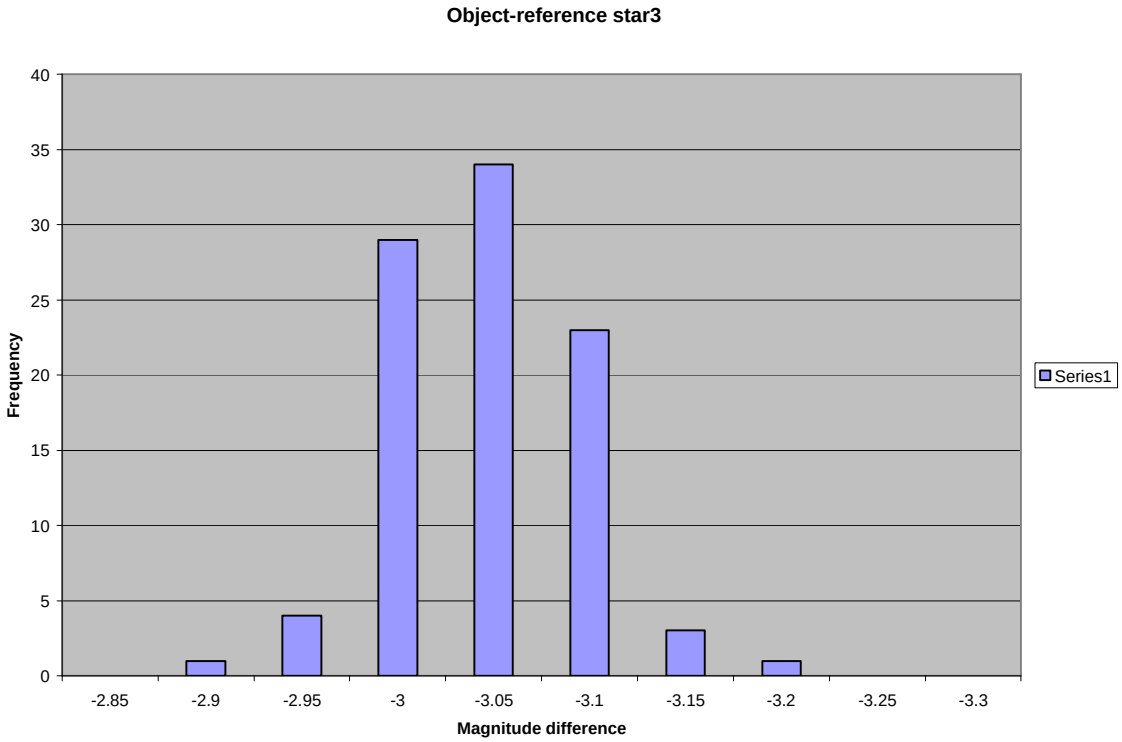
Therefore, it is necessary to use the difference in magnitude of the observed star and a reference star to determine if the magnitude actually dropped significantly during the transit.



When a range of differences in magnitude between the object and the first reference star is plotted against frequency, a Gaussian distribution appears. This distribution is centered at -3.95 and has a standard deviation of 0.09. This means that the star in question is about 3.95 magnitudes brighter than the reference star, on average. As HD168746 has a magnitude of 7.95 and GSC 5685:2926, the reference star, has a magnitude of 11.9, if there was not a transit occurring, the difference in magnitudes should be about 3.95. A t-test of significance shows that there is not enough evidence to show that the magnitude actually dropped during the transit.



When the object is plotted against the second reference star, GSC 5685:2388, however, the average difference in magnitude is less than the expected difference in magnitude. The expected difference would be -3.5 but the observed average difference is -3.62 and the standard deviation is 0.062. A t-test of significance shows that the difference in the magnitudes is significant on the .01 level.



When the object is plotted against the third reference star, GSC 5685:3808, the average difference in magnitude is also different than the expected value. The expected difference would be -2.96 but the observed average difference is -3.07 and the standard deviation is 0.047. A t-test of significance shows that the difference in the magnitudes is significant on the .01 level.

The object dropped significantly in brightness compared to two out of three of the reference stars. This is evidence that a transit was observed.

Conclusion

Based on our observations, we were able to observe a drop in magnitude in HD168746. Upon comparing the brightness of HD168476 to our three reference stars, we were able to conclude that the drop in magnitude was due to exosolar planet HD168746b orbiting HD168746.

References

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