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305 Final Project

1. The photometric data points you analyzed have uncertainties *σ* associated with them. How could you estimate the per-point uncertainty? Using your method, what is that uncertainty? How would you expect anomalously outlying data points to affect your estimate? What are some techniques you could use to mitigate the effects of outliers on your estimate?

**A black background with text

Description automatically generatedBecause we are using Poisson statistics, we can get the uncertainty from the equation**

**Outliers will skew the uncertainty because they will also skew the average. Outliers affect the mean more than they do the median. Having a larger sample size n would be better. It’s also better to use the median of the standard deviation than it is to use the standard deviation of the mean.**

1. Imagine you switched planets to observe a star that was 2.5 magnitudes brighter than your first target. Assuming Poisson uncertainties, how would you expect *σ* to change and by how much?

**From the equations , and , where , , and . The new uncertainty will decrease by a factor of 0.1**

1. Of course, the photometric uncertainty *σ* will impact your results, specifically the results you get for the estimate of each transit time, *t*c. The uncertainty on *t*c depends on the system parameters according to the following equation:   
   where *τ* is related to the ingress or egress duration, *Γ* is the sampling rate for your data (probably once every 2 minutes), *σ* is the per-point photometric uncertainty, and *δ* is the transit depth (how big the planet is compared to the star).   
     
   How would your uncertainty on the transit time change if you doubled the photometric uncertainty? How would it change if you doubled the transit depth (made the planet bigger compared to the star)? You can, of course, use the equation to make these estimates, but also explain qualitatively *why* you would expect that behavior? In words, why does the transit timing uncertainty go up or down as you change the photometric uncertainty and the transit depth?

**If the photometric uncertainty was doubled the uncertainty in the transit time would also double, as they are directly proportional from the equation, and it follows that if the uncertainty in the photometric data we get is larger the uncertainty in the other values that involve the photometric data we get would be larger as well. If the transit depth was doubled the uncertainty in transit time would be halved, as they are inversely proportional from the equation, and if the planet is twice as big the dip in flux would be much greater making it easier to find and give a smaller uncertainty.**

1. Now look at the period value reported on the Exoplanet Archive. We want to know whether your result is consistent (to within uncertainties) with their value. Look at your period value *P*yours and their period value *P*theirs, along with the corresponding uncertainties (*σ*yours and *σ*theirs, respectively). We want to consider the function *f* = *P*yours - *P*theirs, calculate the corresponding uncertainty for that function, and figure out whether the function might be equal to zero to within uncertainties. Consult Chapter 2 in Chromey to refresh your memory about how to propagate uncertainties.   
     
   If your result does not agree with the Archive’s, what are some possible reasons? Look at your transit model and compare it to the data. Does it look like a good fit to all the transits?

**My Orbital Period days is very close to the Period reported in the Exoplanet archive days. From the equation which reduces to which results in a uncertainty of . The difference is very small but might be due to some outliers not being removed completely.**

A screen shot of a computer program

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1. Using your period *P* and *T*0 value (called “ephemeris\_fit\_params[1]” in your python notebook), you will estimate the next time that your planet could be observed in transit.   
     
   First, you’ll need to figure when your planet will next be visible. One way to check this is to use Stellarium (<https://stellarium-web.org/>). Most of your targets are in the web version, but a few (WASP-10, HAT-P-19, and Qatar-1) seem not to be. For those, you’ll have to download and install Stellarium.   
     
   In Stellarium, run time forward from today and check when your object will next be visible at night. Record that date and convert it to Julian date using this online calculator - <https://www.aavso.org/jd-calculator>. Don’t worry about getting the exact instant the planet is visible at night; just get close.  
     
   Next, you’ll need to calculate the times in the future when your object will transit. You can calculate the transit time *t*c for the *E*th orbit using this equation: *t*c = *T*0 + *P* *E*. The first thing you’ll need to do is to convert your *T*0 value from your fit into Julian date. The fit value you get is in Julian date - 2457000, so start by adding 2457000 to your *T*0. Then determine the number of orbits you’ll have to wait until *t*c is greater than the date you estimated from Stellarium. That should give you the minimum orbit number *E* for when your object is both visible and transiting. Record the next date when your object could be observed transiting and include all your arithmetic (neatly written) as part of your answer to this question.

Julian Date **2460429.64882**

A computer screen shot of a code

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A blue and orange graph

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A blue and orange line with white lines

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Description automatically generatedA graph showing a number of numbers

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A graph of blue and orange dots

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