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Title: Discovery of Exoplanet 7-b and its Properties

Problem Statement: Using the data provided by NASA, determine your assigned exoplanet's period, radius, and orbital distance from its nearest star. Then create a plot that shows the relationship between the flux data (percent change) of your planet and time in days. Afterwards, create a page report detailing your findings and analysis while comparing your results to the results found in NASA.

Response: In recent years, NASA has discovered the existence of exoplanets in our galaxy [1]. These exoplanets are planetary bodies that orbit stars in a habitable zone of influence. NASA has observed the behavior of approximately 150,000 stars in the galaxy and have discovered thousands of transiting planets occupying a space next to these stars. Many of these planets are similar to the size of Earth and reveal likewise similar conditions, which appeal to the people who wish to occupy other planets besides Earth.

How do NASA scientists tell when a planet is next to a star in the habitable zone? Using highly advanced scientific technology, NASA personnel constantly view the activities of a star. Each star constantly releases a certain amount of light, which gets disrupted slightly once a planet crosses the star [2]. This disruption is highly minute, and when read on a graph is measured in the tenths or hundredths depending on the star and planet passing over. The data collected from this transit can be used calculate numerous forms of data such as the period of the planet, mass of the star, size of planet, size of star, etc.

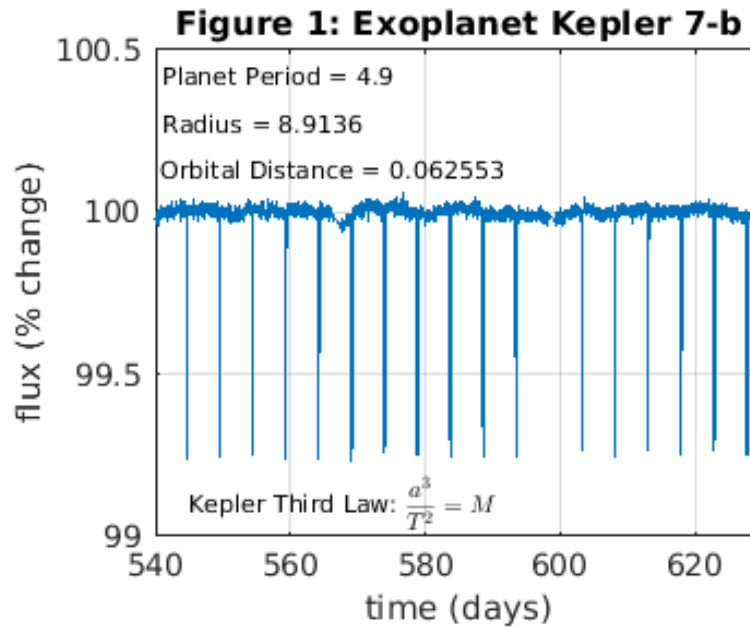
Pulling data from the NASA archives [3], exoplanet 7-b was determined to be a habitable planet. With some calculations from the pulled data, exoplanet 7-b was calculated to have a period of 4.9 days, a radius of 8.9136 earth radii, and an orbital distance of 0.062553 AU. These calculations were computed on MATLAB through code and portrayed as a plot in percent change of flux to time in days. The plot is referred to as figure 1 and reveals 17 minima where the data fluctuated from the normal level of 100 percent change of flux to about 99.3.

The calculated period for exoplanet 7-b was slightly higher than the known period found in the NASA archives [4], which came out to be 4.8854892 ± 0.0000009 in days. The calculated radius on the other hand was significantly smaller than the known value of 18.18 ± 0.15 in earth radii, which is almost double the calculated value. The calculated orbital distance is very similar to the known value of 0.06067 AU with only a few thousandths separating the two answers from one another [5].

The answers calculated were different than the values found in NASA largely due to the calculated answers being derived from the plot of figure 1. The period was done between two minima on the graph which doesn't account for all the minima or any outliers. The radius was skewed since it was calculated using the maximum percent change of flux which gets disrupted by the outliers from the plot. The orbital distance answer was relatively similar since the answer was very small overall. NASA also uses greater mathematical equations, computations, and computer programs to calculate their known value which MATLAB can't compare to.

References:

1. <http://keplerscience.arc.nasa.gov/objectives.html>
2. https://www.nasa.gov/mission_pages/kepler/overview
3. <http://exoplanetarchive.ipac.caltech.edu/cgi-bin/TblView/nph-tblView?app=ExoTbls&config=keplernames>
4. https://archive.stsci.edu/kepler/data_search/search.php
5. <https://efcms.engr.utk.edu/ef230-2020-08/projects/plotting-2020/KeplerData.pdf>



CODE

%Assignment name: Exploring Exoplanets Plotting Project

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%Section: Section A

%Date: 8/28/2020

%Description: Using the data provided by NASA, determine your assigned

%exoplanets period, radius, and orbital distance. Then create a plot that

%shows the relationship between the flux data of your planet and time in

%days. Afterwards, create a brief statement of your findings and analysis.

%Method: Using coding techniques, create various vectors and matrices to

%store the data from your assigned planet. Afterwards, use equations to

%find various pieces of information from your planet and store the results

%into variables, while plotting the results as a graph and having the

%physical numbers posted on the graph.

clear all clc;

```
Data = cell2mat(fitsread('Kepler7bQuarter6.fits','binarytable')); %stores the data table in an array and converts it to a matrix
```

```
Info = fitsinfo('Kepler7bQuarter6.fits'); %creates a table named Info.binarytable.keywords which shows the column headings and units in the datatable.
```

```
Data = Data(:,[1 8]); %retains only column 1 time and column 8 flux
```

```
Data=Data(~any(isnan(Data),2),:); % retains rows without NaN values
```

```
flux = Data(:,2); %contains all the data in column 2
```

```
time = Data(:,1); %contains all the data in column 1
```

```
median_flux = median(flux); %calculates the median of the flux data within the vector
```

```
percent_change = (flux/median_flux).*100; %Formula for percent change of flux
```

```
Period_in_days = (574-564.2)/2; %period of exoplanet in days over 3 minimum
```

```
plot(time, percent_change); %graphs the data of the percent change of flux with respect to time in days
```

```
xlabel('time (days)'); %labels the x-axis on the plot
```

```
ylabel('flux (% change)'); %labels the y-axis on the plot
```

```
grid on; %adds grid to the plot
```

```
title('Figure 1: Exoplanet Kepler 7-b'); %Puts the title of the graph on top of your plot while saying the name of your planet
```

```
ylim([99 100.5]); %sets the boundaries of the y coordinates
```

```
xlim([540 630]); %sets the boundaries of the x coordinates
```

```
Z = (100-min(percent_change)); %Z stands for average maximum percent change in flux. Equation that shows Z through minimum values on graph
```

```
radius_of_planet = 10.*(sqrt(Z)); %Equation that finds radius of the exoplanet in earth radii through the average maximum percent change in flux
```

```
Period_in_years = (Period_in_days)/365.25; %Converts period from units of days to earth years (accounting for leap year)
```

```
StellarMass = 1.360; %solar mass of exoplanet
```

```
OrbitalDistance = (StellarMass.*((Period_in_years).^2)).^(1/3); %Equation for exoplanets orbital distance from it's star in units of AU
```

```
text(541, 100.42, ['Planet Period = ' num2str(Period_in_days)], 'fontsize', 8); %text statement placed on the plot  
describing the answer received for the period in days
```

```
text(541, 100.27, ['Radius = ' num2str(radius_of_planet)], 'fontsize', 8); %text statement placed on the plot  
describing the answer received for the radius of the planet in earth radii
```

```
text(540.5, 100.13, ['Orbital Distance = ' num2str(OrbitalDistance)], 'FontSize', 8); %text statement placed on the  
plot describing the answer received for the orbital distance in AU
```

```
text(545, 99.1, 'Kepler Third Law: ', 'fontsize', 8);
```

```
text(577, 99.1, '$$\frac{a^3}{T^2}= M$$', 'interpreter', 'latex', 'fontsize', 8); %text statement placed on the plot  
detailing Kepler's third law alongside the previous line of code
```