MYP PERSONAL PROJECT- Exploring the Universe

PLANNING

Learning Goal
My learning goal for this project was that, *"I want to program a blog that contains interactive and educational content for amateurs, students, or professionals of astronomy, including my experience with collecting my own data."* Personally, I would have loved to expand my knowledge on astrophysics, and particularly the world of exoplanets in other solar systems. I wanted to learn about the methods of detecting exoplanets, calculations associated with finding out information about them, their general behaviours and characteristics, and finally answer the deep question, is our earth typical, and is it alone? Personally, I have always been fascinated by the world of astronomy, and its vastness. There is a lot of "unknown" associated with this field of knowledge, and that excites me, especially when we deal with questions like other Earths. This interest in astrophysics, which I could pursue in the future, as well as a strive to become a better programmer in a world where that is really important lead me to this goal. I hope that other students who are just genuinely interested in this field of study would find my site interesting and educational as well, and answer some questions that they may have, while providing a different perspective on the topic through graphics and tables also.

Product Goal
My product goal for this project was to program a blog on exoplanets where I would include a page on the methods of detecting exoplanets, and therefore documentation of my own visit to an observatory, and how I was able to detect one myself. This would include a video. Then an article that I write about the general characteristics of exoplanets, and graphs that I program comparing these and finding correlations, answering deep questions not only about them but also about our Earth, and a catalogue where the user could search for any exoplanet, and see information about it, or type in any two parameters and see them graphed. I planned on making this blog educational to students and useful for astronomers. As seen, this goal at first was very vague, however, I created a very specific success criteria table that can be seen below, and that helped to guide me as I developed the constraints of this product.

Success Criteria

Product Success Criteria	***Details***	***Testing Methods***
OBJECTIVE CRITERIA		
The product should be a working website that can be navigated without glitches by the user.	Overall, this means that my final product (the website), and the app or embedded function of the catalogue also, should be able to work well with the user not experiencing any functional problems, glitches, and difficulties.	*Can a user run through the website and do whatever they want without the site crashing?*
The final Blog should contain a page documenting observations that I have made of at least	This is the section for which I will go to an observatory, and collect my own data. I have done extensive research on this during the past 2 months, and therefore should be ready for such an endeavour. I have also already written to many observatories and am in the process of arranging	*Is the user able to see valuable documentation of my observations made through an observatory?*

one existing exoplanet, proving its existence with data. This section should also contain a video of this process.	times.	
The Blog should contain a page on the analysis of my data, with explanations on how I can calculate actual parameters of that (an all other) exoplanet(s) with that data. Bottom line: any high school student should be able to understand it, while maintaining an academic standard.	The bottom line for this section would be that it will be an article that can be understood by any high school student, so that it is educational, and in depth with explanations. However, the article / paper should conserve an academic standard, and relevant scientific information.	*Was the user able to learn about how physics ties into astronomy through parameter calculations?* *Was the information scientific?*
Include a third page analysing parameters (particularly those calculated in the second section) of all existing exoplanets, through the use of graphs exploring correlations.	The bottom line is the same as for the previous section, but here I will analyse correlations between different exoplanet parameters. I will create my own graphs, with the user of *MatPlotLib* through Python. The data will be from a CSV file through the Kaggle website (*Exploring the Exoplanets*).	*Can the user find information about the relationship of different exoplanet parameters on the site, and learn about that?*
Embed into the blog a working catalogue that is able to find basic parameters of most existing exoplanets by a simple search.	This might be in the form of a downloadable app, or built into the site. It will be like a database. I will again use the same Kaggle data that I used for the data science article in the previous section, but this time incorporate it into an understandable catalogue.	*Does the site have a catalogue on most exoplanets, and is it usable by the audience?* *Does the data the catalogue provides make sense to the user?*
SUBJECTIVE CRITERIA		
The colour scheme of the website should be visually appealing to the user, and related to the theme.	This is subjective, but rules out any abstract or out of the ordinary design that is hard to understand for the user, and confusing, like a red font on a black background.	*I could create a SURVEY at the end of the project, and survey a sample group of the target audience:* *1) Was the website visually appealing?* *2) Was the layout confusing or straight forward?*

The website should be educational to any high school student (target audience) wanting to learn about exoplanets.	Should include relevant information, and also make sense to anyone, not only high school students, but also adults.	*Again include in a SURVEY:* *1) Did you learn something new about exoplanets on the site?* *2) Was the site too confusing?*
Adding on to objective criterion 5, in terms of the catalogue, the data that it presents should make sense, and should be a visually appealing system.	Since the catalogue will almost work as a little mini program of its own, I would want to make sure that the user also understands this, and all of the information that it provides makes sense (doesn't just spit out meaningless numbers). This will also create a programming challenge.	*SURVEY could be used again:* *1) Did the catalogue portion of the website make sense, and could you interpret all the data that was given to you?*
The website, even though it is not professional, should contain information that looks, and is reliable.	This is important because even though this is not a formal academic paper, since I would like to align the website with my target audience which is more amateurs and students, it is important that the information is reliable. I could use some citations, a bibliography, or also just explain where I got some information, or how I made what I made.	*SURVEY again:* *1) Did you find that the information on this site was reliable:* *- Yes (I would use this as a research source)* *- Neutral (like any other site on exoplanets)* *- No, I would never use a site like this for research.*

Action Plan
After I had finally come up with the constraints of what my project would actually include, that being observations by myself, analysis of the observed data to calculate parameters, a section looking at what we can learn from this data with programmed graphs, and a catalogue, I was ready to set out my plan to achieve this. For this again, I created a table where I displayed my plan for certain time benchmarks, and then what I completed out of that. This can be seen below:

Time to Complete	***Task***	***Completed or not?***
Nov. 1st	Finish all needed organisation for the documents surrounding my final project plan, send all emails that need to be sent, and make sure that I have a robust plan going forward. Start to create a bibliography.	*Yes, I did create a finalised action plan (this document) and also sent my email to Christen Menou, who I hope will provide me with ways to move forward with observations, or provide me data at least.*
Nov. 12th	Through observatories, have times set and objects being observed defined. Have a clear plan of how these observations will take place, through meetings beforehand with York University and U of T.	*It is now finalised that U of T will not be able to provide observations for me. They will however provide raw data for processing, just like Ms. Boon has provided a data fitting challenge at our meeting (Oct. 29th). They provided 51 Pegasi b raw data. So, I will*

		analyse raw data for observations. York U. also sent me some observations that they did recently on the photometry of Mascara 1. I hope to incorporate this too.
Nov. 30th	Have my 3rd meeting with my PP supervisor (Ms. Boon), presenting my learning goal ATL skill activity complete. Present that I have started my blog product, its skeleton, and started to write up the information that will go onto the blog eventually (observations, parameters, data analysis, and catalogue).	*I had my 3rd meeting a little earlier on Nov. 24th. There, we discussed the learning goal ATLs and what I should do for them. I completed these on the 25th. Then, I showed that I have started my website, and that I have links for my write-ups that I started yesterday on the 23rd. Also, I created a bibliography on the 26th in order to keep in track of my sources, and also added a page for that in the website.*
Dec. 17th	Preferably have observations from observatories, and the data collection process complete before Christmas (if there is any data collection). By this time, I should have a working catalogue embedded in the site, and my introduction, observations, and data analysis mostly written up, with all visualisations complete. Have a 4th meeting about this.	*I had decided that I would not have an observations section after meeting 4. I think that there would be value in doing that next year. For now, I will take and analyse existing data into the parameters. This was pushed a little but I had the article written by December 20th, luckily before Christmas. My data analysis with graphs was successfully finished, along with my bibliography. All of this was embedded into the site, with not a lot of design yet. I have a working catalogue, but still need to embed it. I will set the goal of this as Jan. 3rd, and find time to do it over the break, along with cleaning up the site.*
Jan. 3rd	Over the Christmas break, work on the finishing touches on putting together my website base and catalogue into one workable website. This will mostly be creating a responsive and well designed website, with the catalogue working and responsive. Have the product almost finished.	*Over the winter break, I was able to finish another section about exoplanet detection methods that we decided in meeting 4 would hold the place of the observations section, since I am not able to collect my own data. However I realised that I needed to do a lot more research, especially about stars for my parameter calculations, so I spent the rest of the break with research, and decided to push the parameter calculations and catalogue embedding sections to Jan. 14th.*
Jan. 14th	Have my 5th meeting with the PP supervisor, and present my ATLs for my product goal. By this time, I should have finished my product. Show that there is progress with the report documents.	*Due to the extra time that I needed with finishing the parameter calculations documents, meeting 5 got pushed to Jan 26th. At the meeting, I was finally able to show that all of my sections were complete and on the site, except for the catalogue, that still needed work. We decided that I should try to finish the*

		website by Feb 1st, and tidy it up, so that I would work on the reflection phase after.
Feb. 4th	Have all of my reflecting documents (Criterion C) for my product completed.	*Finally, by this time, after some delays, I was finished with my product with all the styling except for the catalogue. Since the catalogue would have still involved intensive coding, I decided that I would stay with the base Python catalogue that I had already programmed, and would move on. I would leave this as a next step. So therefore I was only starting the reflecting documents that I was hoping to have completed, like the evaluation, and impact. However, I still have 10 days, so I will use this time to have all of my reflection phase completed and then everything embedded into the report.*
Feb. 11th	Have the final report completed, putting together all documents into the final document, and submit (DUE).	*Completed the report. The due date got pushed to the 15th. Overall satisfied, since I learned a lot myself, and got motivated for next year's EE. Definitely have next steps.*

APPLYING SKILLS

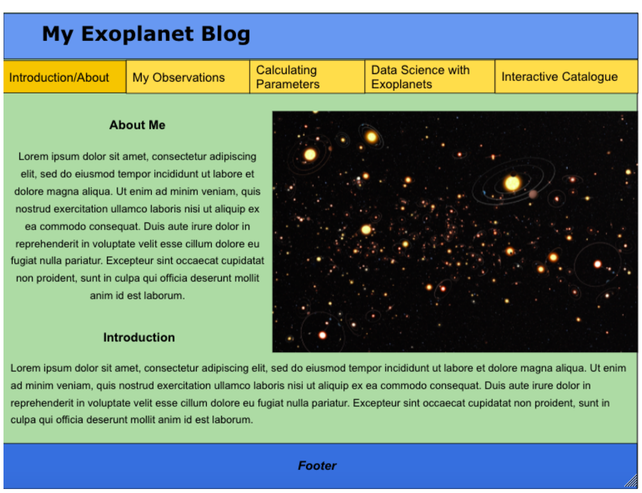
Learning Goal ATL - RESEARCH
1) Make connections between various sources of information

For my research, which is probably the ATL that I most developed during this period from September to now, I was able to greatly improve and diversify my learning and also the creativity of my product by the combination of a variety of different sources, whether it be primary or secondary, coding, physics, or astronomy. First of all I had to do some research in coding, reminding myself first of some things that I learned in school from last year (including web development for my website which involved skills in HTML, CSS, and JS), and some things that I am doing this year in school, such as data processing through Python for the first unit that we had this year. This is a skill that I used greatly for creating my own scientific graphs and figures, that were all embedded along with my articles to show my findings, and display them visually to the user, something that is very important in my success criteria (interface). Furthermore, I came into contact at the beginning of my research process with various professors and universities, mostly observatories for data and sources. Most of this communication was done through emailing, but I also met with a Princeton astronomy professor Gaspar Bakos in a google meet for 30 minutes back in October to discuss my product (an image of this is attached below), and also so that he would give me some suggestions. That is when I came up with the idea that I could potentially look into doing a section not just on calculations, but also on the data analysis of exoplanet data that is already known (this is one of the sections on my site). I was then able to take all of these different sources, and connect them into a working document with all of my sources organised. I cannot embed this here, but it was a 13 page document that included sources, evidence for these, meetings, and research with dates.

2) Collect, identify, and verify data
Out of all of these different sources, I then identified what sources of information were the best for which parts of the project. For example, I saw that the raw data I got fram U of T, although not what I wanted (I wanted to go to the observatory myself), could be used for my "*observations*" section. I made sure to verify data by looking at multiple sources (included in my bibliography) and also credible sources, like universities, professors, and teachers.

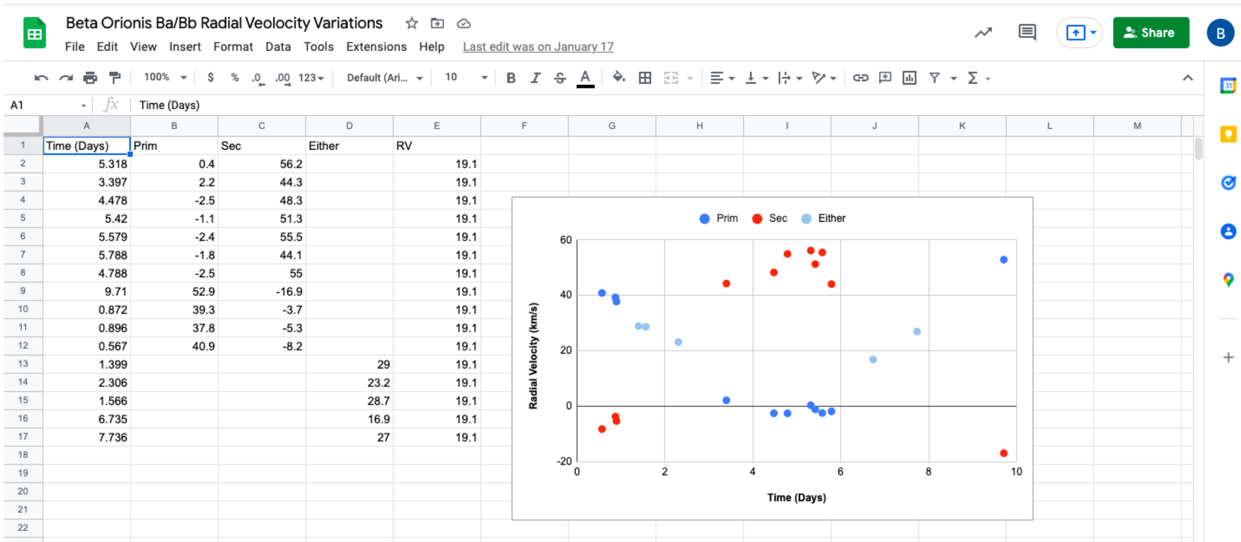
3) Access information to be informed and inform others
Based on my goal on educating, while learning a great deal myself, I wanted to make this learning I went through simpler for other amateurs (providing a catalogue, information, sources, etc.). Most student enthusiasts do not have the time to go through the process of this project themselves, and also professors don't have the time to answer all of their questions, and therefore I created a learning goal which is centred around informing others through all of the research that I gained.

Product Goal ATL - THINKING SKILLS
1) Transfer Skills
One of the most important skills that I developed while creating my final product (the website) was transferring the all of the information that I was able to collect through my research (also my learning ATL), and then make it into a logical and interactive website that anyone can use, learn from, and also use to connect to different sources (all in my bibliography that I also have on my site). The first great task right around October at the beginning of the project was to be able to put all of the data that I had into an interactive framework. Since my project revolved around exoplanet data collection, calculation, and presentation, I decided to have 3 main sections: collecting data, calculating the different parameters for the exoplanets (mass, radius, distance), and analysing datasets of this data to look for patterns. Then, I also decided to add a catalogue to make the site also interesting for amateurs, who just want to maybe look up information on certain planets, and also an introductory page. Finally, the 6th and final page of the site (product) is the bibliography, since my supervisor and I thought that it would be also valuable to embed the sources too.



← Early planning for putting the site together (without bibliography yet) - Google Draw

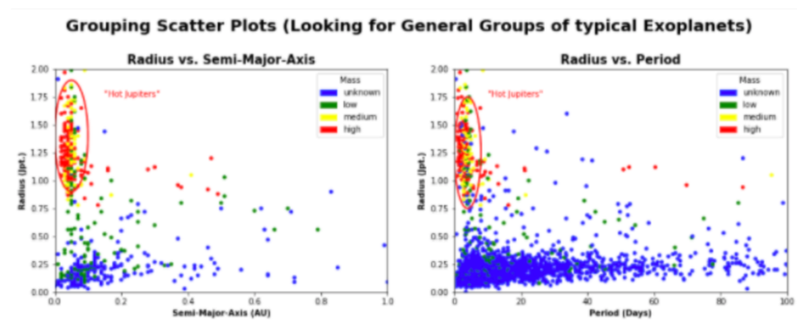
Processing data was also a large part of this project, particularly in the coding sense. First, I created many google sheets to try to create visualisations from CSV files that I downloaded from the internet. The image below shows an example of some google sheet work that I had to do before I was ready to move onto Python Matplotlib. Here, I used my knowledge from coding class and some extra knowledge that I learned from my research in order to create the best graphs in my ability. The screenshot is an example of the radial velocity variations for Beta Orionis, in the Orion constellation.



Time (Days)	Prim	Sec	Either	RV
5.318	0.4	56.2		19.1
3.397	2.2	44.3		19.1
4.478	-2.5	48.3		19.1
5.42	-1.1	51.3		19.1
5.579	-2.4	55.5		19.1
5.788	-1.8	44.1		19.1
4.788	-2.5	55		19.1
9.71	52.9	-16.9		19.1
0.872	39.3	-3.7		19.1
0.896	37.8	-5.3		19.1
0.567	40.9	-8.2		19.1
1.399			29	19.1
2.306			23.2	19.1
1.566			28.7	19.1
6.735			16.9	19.1
7.736			27	19.1

Google sheets work

After google sheets worked with the data, I was able to use matplotlib in order to create visualisations that included way more features than the features that google sheets would be able to offer. The example on the right is a figure from the data analysis section of my site, where I am looking at isolating a specific type of exoplanet (a Hot Jupiter). This is an example of how I processed raw researched data, and converted it into valuable results.

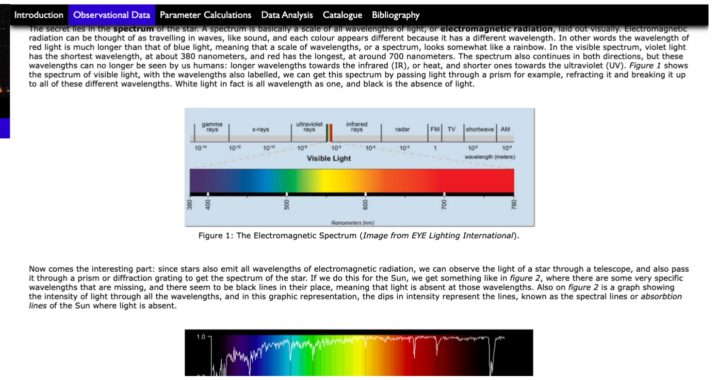


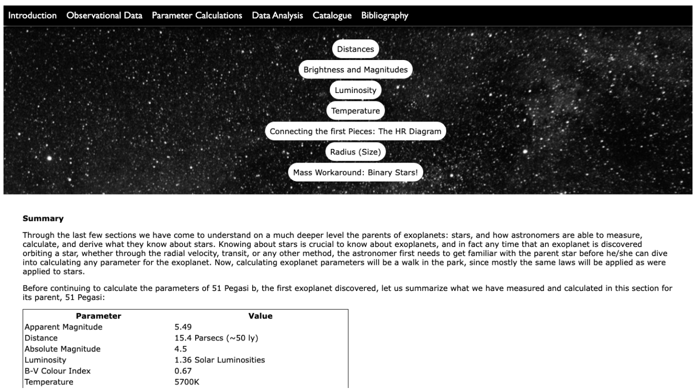
I believe that constructing the logical framework of a website that can be useful for others from this data and also processing raw (boring) data into visible elements that further add to my site and learning greatly influenced the creation of my product, and my development in transferring thinking skills such as raw research into something interesting.

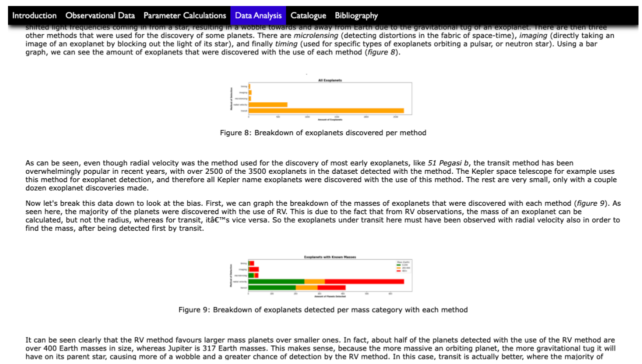
THE PRODUCT

After extensive research and skills development, I managed to complete the product. Some of the changes that need to take place for the full completion of this product are detailed in the right side column of the action plan section. I am very proud that I was able to actually upload the site onto the internet, and it can be viewed all around the world at: www.botondhorvath.ca.

Below are also a couple of images of how the website has now turned out:







Clockwise from top-left: top of landing page, part of the observational methods section, data analysis section with some of my graphs, parameters section (showing the menu for the different stellar parameters).

REFLECTING

Impact

Overall, I believe that the most important impact on creating this project was impact on my own learning. As I had mentioned in the learning goal, I was even before this project very passionate about the world of astronomy, and its awe inspiring nature. However, as I researched and learned more about this topic, and put together all of the articles that are now on my site, I really expanded this from an area that I was at first passionate about, to now an area that I strive to be an expert in. I can recall that back in October I had a conversation with Princeton astronomer Gaspar Bakos about this project, and he also had a lot of questions for me about what I am specifically interested in for this project. Back then, I actually did not know a lot about the field, and therefore was very confused and could not provide an objective answer. That is when I realised how difficult it really is to be good at something, and to truly understand. All that I got out of that meeting was a lot of sources, Bakos telling me repeatedly to research and learn before making any product. These sources led me on a very interesting research journey, and I am very thankful for this, since I could really develop my research skills through this process, but using a lot of different sources, and also combining knowledge from a variety of different areas, such as coding and math. As my learning and research deepended, I began to realise just how difficult the coding and also some of the things that I had originally planned in my product goal were. With this, I was able to narrow down my approach with the development of my action plan, and this meant letting go of the initial plan for collecting my own data, and also the programming of the catalogue. Regardless of this, my site turned out great with sections for how observations are made, deducing parameters, and also an analysis of exoplanet data, accompanied all by creative visualisations that I coded from raw data. Now, I am determined that some of the things (like collecting my own data) will in fact be possible next year with my Extended Essay, since I feel that now I am more at home in this field. Only this shows how worth it it was to do all this work. With this, other than my own learning, I was able to represent my learning in a way that was useful to others, and also a proper product. With this, I hope that I achieved my goal of programming a website that is interesting for amateurs, but also useful for professionals. Through my product, I wrote articles for example about calculating exoplanet parameters, and was able to find the mass of a binary star system, and even of a single star: 51 Pegasi, of which I found the mass, size, temperature, type, and many other parameters only from raw data. Then, again from raw data, I proved the existence of 51 Pegasi b, an exoplanet, and figured out a lot of its own parameters. Finally, through the data analysis section, I was able to point out a lot of findings that I proved myself from raw data, which all deepened my understanding of the universe. Something that I found was that this topic was very difficult to research for only a high school student like me. I hope that my product has all that someone my age would want, all in one place to find, so that their job would be easier for the research. For this project, I may have had to cancel an observatory visit, but for the next one, I am now for sure ready to take the next step.

Product Evaluation

I learned a lot, and this project for sure had an impact on not just me but also the possible consumers (viewers of my product). However, how do I know the true extent of my success? Here is an evaluation of my original success criteria, where I hope to analyse each point for the extent of my success:

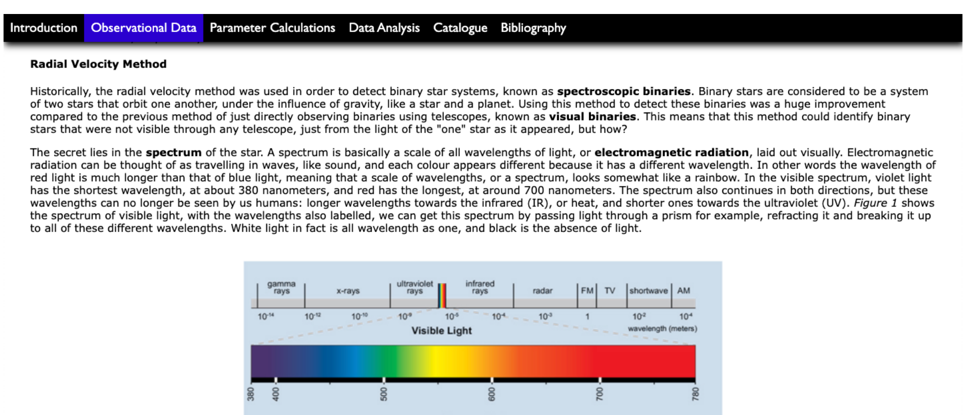
Objective Criteria

1) "The product should be a working website that can be navigated without glitches by the user".

First of all evaluating this criterion is fairly simple, since it suggests that the final website, which is basically the placeholder for my project, should be able to work without any glitches. In other words, it should not crash. This criterion has been completely successful, since I managed to program a base functionality into the site so that it does not crash. I have also looked up *botondhorvath.ca* on many other devices, and in fact it seems to be working very well regardless of the device that it is running on. I am particularly proud that I was able to create this responsibility with the site, so that it has an acceptable look even on an iPhone for example. However, the preferred device is still a computer of some sort.

2) "The final Blog should contain a page documenting observations that I have made of at least one existing exoplanet, proving its existence with data. This section should also contain a video of this process."

I would have to say that this section was moderately successful. I think that I was too passionate about the topic when I first began, I sort of overextended myself to a point where I wanted to collect my own data, but still did not know a lot about exoplanets. Therefore, since I quickly found out that this was a very complicated field, I spent most of the time for this project doing research in a variety of different ways, and therefore by the time (now) that I do have enough knowledge to be able to collect my own data, it is too late. Only for this project though, since I am planning on extending this project in the future to an extended essay for example, where it would be more professional and more scientific. So, there was no data collection and no video of that therefore, however I made up for this, and rather wrote an article about how these observations are made, and how astronomers collect this data. I did not collect the data myself, but at least now know the answer to "*how?*". Below is a screenshot of one of the sections of this so-called "*methods*" section.



Introduction | Observational Data | Parameter Calculations | Data Analysis | Catalogue | Bibliography

Radial Velocity Method

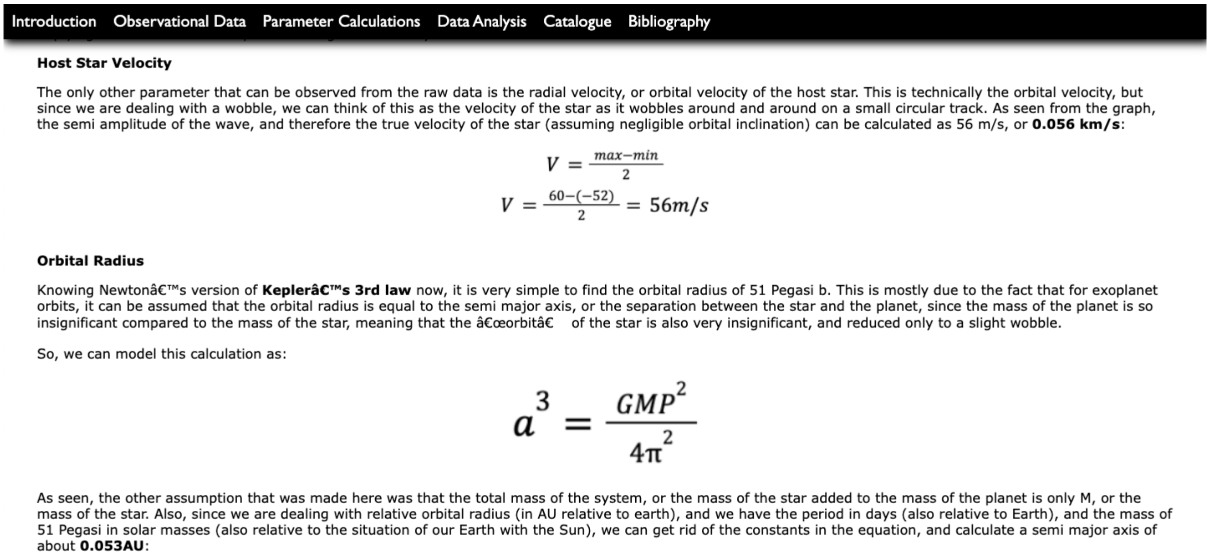
Historically, the radial velocity method was used in order to detect binary star systems, known as **spectroscopic binaries**. Binary stars are considered to be a system of two stars that orbit one another, under the influence of gravity, like a star and a planet. Using this method to detect these binaries was a huge improvement compared to the previous method of just directly observing binaries using telescopes, known as **visual binaries**. This means that this method could identify binary stars that were not visible through any telescope, just from the light of the "one" star as it appeared, but how?

The secret lies in the **spectrum** of the star. A spectrum is basically a scale of all wavelengths of light, or **electromagnetic radiation**, laid out visually. Electromagnetic radiation can be thought of as travelling in waves, like sound, and each colour appears different because it has a different wavelength. In other words the wavelength of red light is much longer than that of blue light, meaning that a scale of wavelengths, or a spectrum, looks somewhat like a rainbow. In the visible spectrum, violet light has the shortest wavelength, at about 380 nanometers, and red has the longest, at around 700 nanometers. The spectrum also continues in both directions, but these wavelengths can no longer be seen by us humans: longer wavelengths towards the infrared (IR), or heat, and shorter ones towards the ultraviolet (UV). *Figure 1* shows the spectrum of visible light, with the wavelengths also labelled, we can get this spectrum by passing light through a prism for example, refracting it and breaking it up to all of these different wavelengths. White light in fact is all wavelength as one, and black is the absence of light.

Figure 1: The Electromagnetic Spectrum (*Image from EYE Lighting International*).

3) "The Blog should contain a page on the analysis of my data, with explanations on how I can calculate actual parameters of that (an all other) exoplanet(s) with that data. Bottom line: any high school student should be able to understand it, while maintaining an academic standard."

After the methods section, this section, since it only involved theoretical calculations and research, went very well, and for me was a success far beyond what I imagined at the beginning of the project. It was also the hardest part to write, since there was just so much information out there, even on the basics on how we calculated parameters like the mass or size for an exoplanet. Further, we need to know the parameters of the stars, and just doing a study on stars took a lot of work. So, I would say that this section was a success.


Introduction Observational Data Parameter Calculations Data Analysis Catalogue Bibliography

Host Star Velocity

The only other parameter that can be observed from the raw data is the radial velocity, or orbital velocity of the host star. This is technically the orbital velocity, but since we are dealing with a wobble, we can think of this as the velocity of the star as it wobbles around and around on a small circular track. As seen from the graph, the semi amplitude of the wave, and therefore the true velocity of the star (assuming negligible orbital inclination) can be calculated as 56 m/s, or **0.056 km/s**:

$$V = \frac{max - min}{2}$$

$$V = \frac{60-(-52)}{2} = 56m/s$$

Orbital Radius

Knowing Newtonâ€™s version of **Keplerâ€™s 3rd law** now, it is very simple to find the orbital radius of 51 Pegasi b. This is mostly due to the fact that for exoplanet orbits, it can be assumed that the orbital radius is equal to the semi major axis, or the separation between the star and the planet, since the mass of the planet is so insignificant compared to the mass of the star, meaning that the â€œorbitâ€ of the star is also very insignificant, and reduced only to a slight wobble.

So, we can model this calculation as:

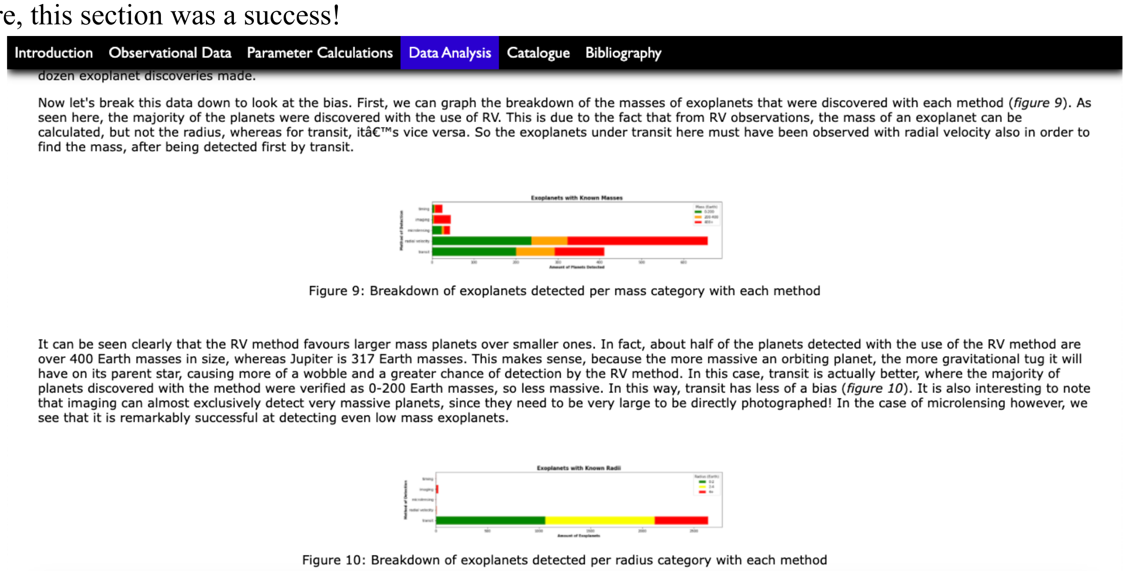
$$a^3 = \frac{GMP^2}{4\pi^2}$$

As seen, the other assumption that was made here was that the total mass of the system, or the mass of the star added to the mass of the planet is only M, or the mass of the star. Also, since we are dealing with relative orbital radius (in AU relative to earth), and we have the period in days (also relative to Earth), and the mass of 51 Pegasi in solar masses (also relative to the situation of our Earth with the Sun), we can get rid of the constants in the equation, and calculate a semi major axis of about **0.053AU**:

Sample from the exoplanet parameter calculations section of the site

4) "Include a third page analysing parameters (particularly those calculated in the second section) of all existing exoplanets, through the use of graphs exploring correlations."

Initially I thought that this would be a hard section, but since I did a similar project for my coding project, which involved data science through Python, this section turned out to be very fun and very interesting. What I did is I used Python also, but this time downloaded a dataset of exoplanets and created graphs comparing their parameters, and looking for general groups, relationships, and patterns in their overall existence. On this also (building a level up from the previous calculations section), I wrote a long article explaining my findings. Therefore, this section was a success!


Introduction Observational Data Parameter Calculations Data Analysis Catalogue Bibliography

dozen exoplanet discoveries made.

Now let's break this data down to look at the bias. First, we can graph the breakdown of the masses of exoplanets that were discovered with each method (*figure 9*). As seen here, the majority of the planets were discovered with the use of RV. This is due to the fact that from RV observations, the mass of an exoplanet can be calculated, but not the radius, whereas for transit, itâ€™s vice versa. So the exoplanets under transit here must have been observed with radial velocity also in order to find the mass, after being detected first by transit.

Figure 9: Breakdown of exoplanets detected per mass category with each method

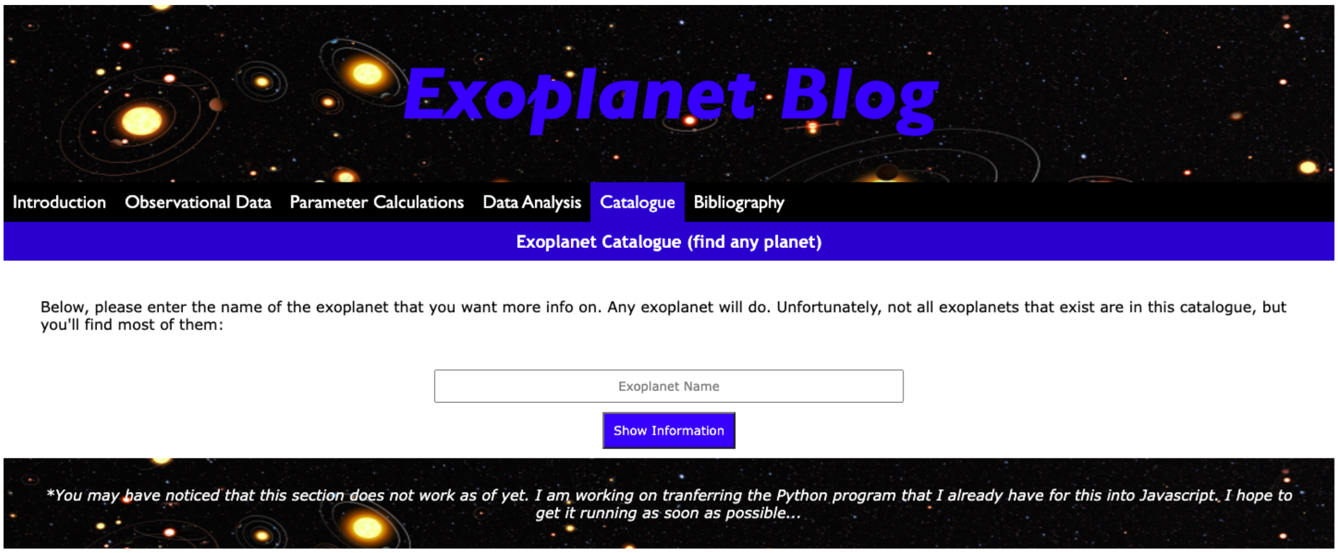
It can be seen clearly that the RV method favours larger mass planets over smaller ones. In fact, about half of the planets detected with the use of the RV method are over 400 Earth masses in size, whereas Jupiter is 317 Earth masses. This makes sense, because the more massive an orbiting planet, the more gravitational tug it will have on its parent star, causing more of a wobble and a greater chance of detection by the RV method. In this case, transit is actually better, where the majority of planets discovered with the method were verified as 0-200 Earth masses, so less massive. In this way, transit has less of a bias (*figure 10*). It is also interesting to note that imaging can almost exclusively detect very massive planets, since they need to be very large to be directly photographed! In the case of microlensing however, we see that it is remarkably successful at detecting even low mass exoplanets.

Figure 10: Breakdown of exoplanets detected per radius category with each method

Sample of the data analysis section

5) "Embed into the blog a working catalogue that is able to find basic parameters of most existing exoplanets by a simple search."

Again, this section was a half success, in the sense that I did manage to program an exoplanet catalogue that worked. In fact, this catalogue was based on the same dataset *csv* file that I used for my data analysis section. This is in fact one of the first things that I got done for this project, because I was still very fresh with Python during the fall. However, since I got so caught up in the research, I never managed to embed it into my proper product, or the website, since for that, I would have needed to rewrite the program in Javascript. However, I would say that this is for sure a next step for this project, just like getting my own observations done is. In fact, I am already working on embedding the catalogue, and as I have written on the site, I will aim to get it done by the end of this month. So overall, this section was incomplete, but I still got a lot of coding learning done, and did at least complete something for it that has the same concept. Below is an image of how the catalogue looks on the site, and below that is a screenshot of the catalogue that I have working. As seen, when I type in the name of an exoplanet into the program, all of the data that would be needed is displayed on that exoplanet.



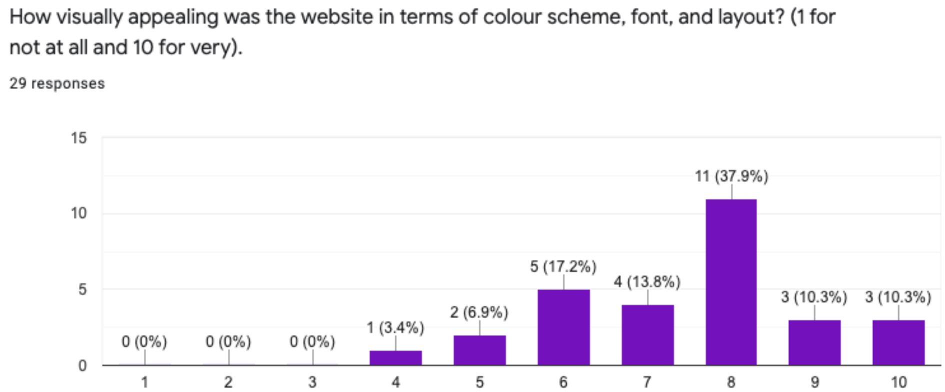

```
[FVHYK3CYJ1WK:Python botond.horvath$ python3 catalogue.py
Please enter the name of the exoplanet that you want info on:
kepler22b
Ok, here is all of the information that we know for Kepler-22 b :
MASS: unknown
RADIUS: 2.44 earths
DENSITY: unknown
PERIOD: 290.0 days
SEMI-MAJOR-AXIS: 0.85AU
ECCENTRICITY: unknown
TEMPERATURE: 249.6 kelvins
METHOD OF DETECTION: transit
YEAR OF DISCOVERY: 2011
Below is all of the infromation that we know of the star of Kepler-22 b:
MASS: 0.97 solar masses
RADIUS: 0.98 solar radii
METALLICITY: unknown
TEMPERATURE: 5510.0 kelvins (G-type)
AGE: unknown
```

So overall, I cannot say that this section was a success, but I have a solid program to build on. I am particularly proud of the fact that I managed to detect if a parameter was unknown and display that, and also display the units (which were not in the raw data). This all enhances user experience.

Subjective Criteria

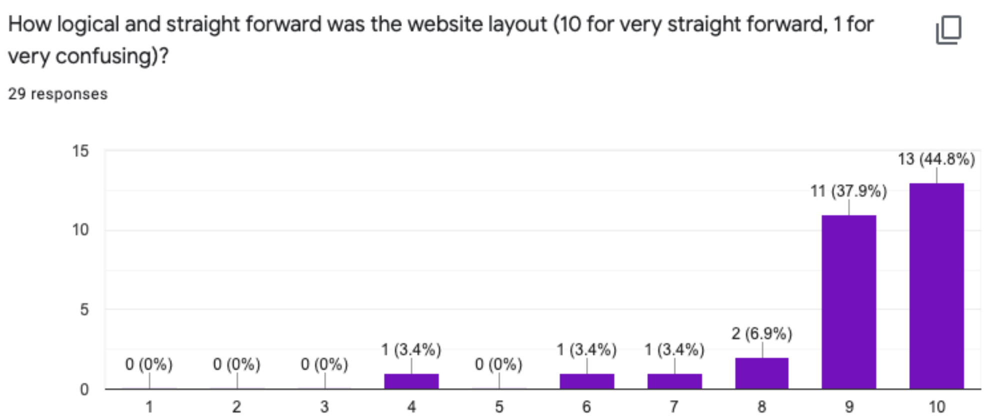
For this section, I needed a different approach than the previous section, since the criteria for this section are subjective, and therefore require more than just one voice judging success. For this reason, I created a Google Form with questions corresponding to each criteria point, and sent it out to the entire class of 2024. With this, I was sure to receive feedback from a variety of different people. Below is an analysis of all of these questions, the responses I received, and what that means for my success.

1) The colour scheme of the website should be visually appealing to the user, and related to the theme.



Attached above are the results that I received from a pool of a total of 29 responses on the opinion of those 29 people on the colour scheme, and visual aspect of my site. As seen, the results are not great but also not bad at all. I would say that they are good, but not outstanding. This is basically what I expected, since really the focus of this project for me was more on my learning and also the quality of the data and articles on the site, and less on the aesthetics. However, I am surprised that I still had an average of about 80% which is not bad at all knowing that I have limited experience in HTML and also did not make the primary goal of the product to be nice looking. So, I would definitely call this a success.

2) The website should be educational to any high school student (target audience) wanting to learn about exoplanets.

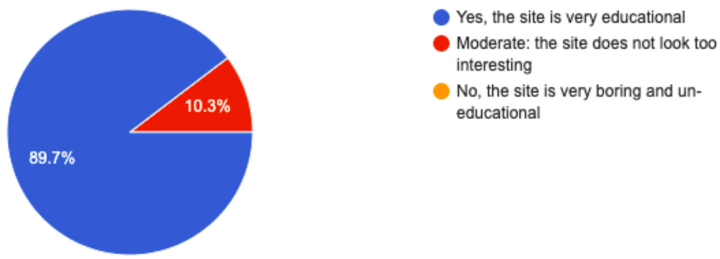


Above are the results that I received from the survey regarding my second subjective criteria point, that revolved around how education the site is, especially for a high school student or someone who is interested in the topic. This is more like what the goal of my product was, since my product goal originally was to program a blog that is educational, especially to my target audience of interested students and amateurs. As seen, I got an average of about 95%, so people thought that the site was educational. I am pleased to hear this since I now know that all that research that I put into this was not in vain.

Adding on to this point, I wanted to explore how educational and interesting the site is, since my main goal was to make this project educational to high school students. For a question on how educational the site was, I also got great results. As seen, 26/29 people thought that my site was highly educational, and that someone interested in the subject would have been able to learn a lot from it. However, 3 people still responded that the site did not look too interesting, and therefore was moderately educational. I think that these are great results, knowing that my articles are not really academic in nature. To improve these results to maximal, I would probably need to extend the quality of my work to academic content, like a research essay with my own data, and that is definitely on my bucket list, along with my own data collection at an observatory, as already mentioned.

Were you able to learn something from the site, or in other words would someone interested in exoplanets be able to find answers to their questions?

29 responses

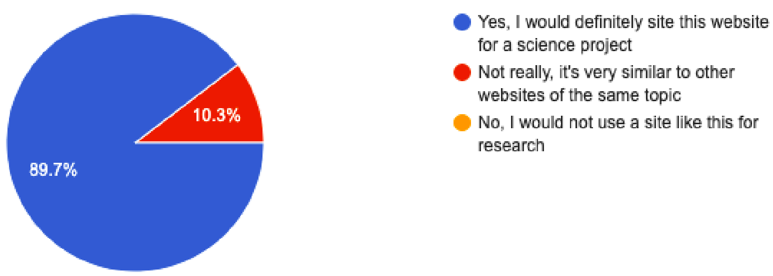


3) Adding on to objective criterion 5, in terms of the catalogue, the data that it presents should make sense, and should be a visually appealing system.
Since I did not yet complete the catalogue in the site, I cannot comment on this criterion, and therefore it is incomplete as of yet. This is definitely a next step that I will need to work on after submitting this project.

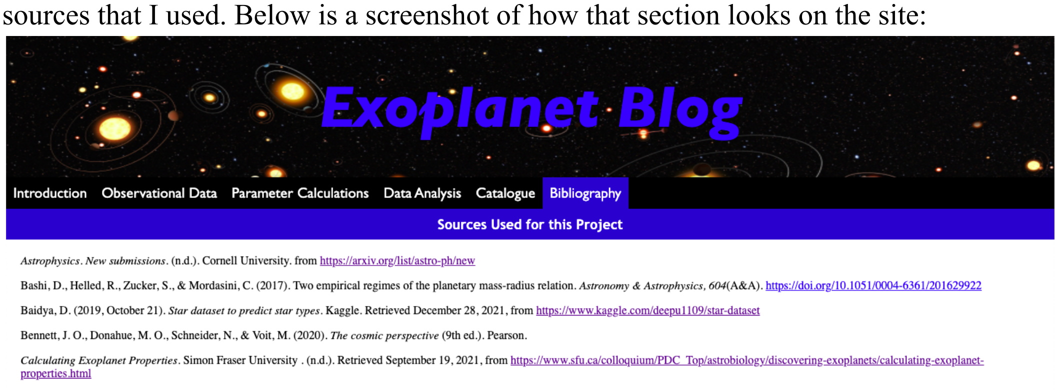
4) The website, even though it is not professional, should contain information that looks, and is reliable.
This is a very important point, since this is a scientific project after all, and therefore the readers of the site should be able to feel that the data they are reading is from reliable sources. Evidently, for this, just like the previous one, I did not expect perfect results, since my papers are not academic in nature and there are not always text citations present. The articles are more informal and engaging in nature. Regardless of this, I got very good results, just like in the previous section:

Do you find the information presented on this website reliable?

29 responses



I think that the fact that I had a bibliography really improved my score on this too. I thought that it was important to include the bibliography in the site too so that the readers there would also be able to be redirected to other sources that I used. Below is a screenshot of how that section looks on the site:



Continues downward…

Overall, I believe that my project was a success in terms of my own learning. In terms of the product, people were also generally very happy with it, and I think that it was a moderate success. However, things like the catalogue still need work, and that gives me options to continue this project in the future. Having now greatly improved my research skills and learned a lot, I think that I am ready to in the future move into new domains, and start to look into actually collecting my own data, like I initially planned, and writing my first real academic papers on the subject. All of this would prove very interesting next year.

- Botond Horvath