ASTR:1070 (Stars, Galaxies, and the Universe) Lab

Independent Observing Project Description

For your observing project, you will study an astronomical object in greater detail than we’ve done in class or in lab, taking on the role of an amateur astronomer. You will work in groups to perform your project, developing an experimental plan and scientific presentation together as a collaboration. However, you will submit a final project paper written by yourself.

In science, we strive to explain how we collected our data and how we analyzed it as clearly as possible. This is so that other scientists can reperform our experiment and (hopefully!) confirm our results. We communicate how we collected the observations, analyzed the data, and arrived at a conclusion as part of a publication in scientific journals. Professional journals are “peer-reviewed”, meaning they are vetted by other scientists for clarity and correctness. *A goal throughout your final project is to offer enough details that your work could be peer-reviewed – if a classmate looked at your paper or presentation, they should follow it closely enough to be able to reproduce your work.*

For your project, select an object from the list below. You will then examine observational data of that object taken with the Iowa Robotic Observatory. All data products are contained in the LabImage directory on the computers in your lab room, and supplemental materials are available online. You will then produce an astronomical data product (e.g. a tri-color image, a light curve, or animation) with your selected observations, with the help of the online tutorials and other labs performed in class. You’ll lastly make a calculation based on that data, and report your results to the class and your instructor.

**Your final project (40% of your grade) consists of three components: an experimental plan (10%), a short paper (15%), and a scientific presentation (15%).** Details for each aspect of the project are below. Due dates are:

* Experimental Plan: start of class on Nov 15
* Final Project Paper: start of class on Nov 29
* Final Project Presentations: during class on Dec 6

Table 1: Potential Objects to be Studied --

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| --- | --- | --- | --- |
| Object Type | Objects Within Type | Data Product  (^ means requires all three) | Calculations Available Based on Type  (\* means requires additional literature search) |
| Nebula | * Crab Nebula * Dumbbell Nebula | Stacked Tri-color Image | Size\*  Approximate Peak Temperature |
| Galaxy | * Whirlpool Galaxy * NGC 2905 | Stacked Tri-color Image | Size\*  Approximate Peak Temperature  Redshift\* (Hubble’s Law) |
| Variable Star | * AB Andromedae * BU Vulpeculae * XZ Andromedae | Light Curve | Total Brightness Change |
| Asteroid | * 40 Harmonia * 45 Eugenia * 6 Hebe | Animations^  Light Curve | Speed\*,^  Orbital Period\* |

Experimental Plan (10%):

*Your experimental plan should be a report detailing the steps you took to analyze your observations. As a general rule, the experimental plan should be approximately 3 pages (double spaced, 12 pt. font) in length; however, there are no strict length guidelines. Instead, this experimental plan should be long enough to be clearly reproducible, but not so long as to be boring.*

As a part of a “peer-reviewed” astronomy journal, the observations and the process of making any resulting data products are described. Your experimental plan fulfills that same function for your project.

*Your experimental plan will clearly identify your object, the identifying information about your observation (date performed, filters used, exposure times, etc.), the procedures/steps you employed in MaxIm, and a picture or graph of the resulting data product[[1]](#footnote-1).* The picture/graph of your data product should be further explained in the text so that someone unfamiliar with your project will understand what it means (i.e. your explanation should explain what is plotted, what color choices symbolize, what the units are, how big in angular size your object might be, etc.). Additional pictures explaining the steps you took are helpful, but not required. Clear communication is a high priority – ideally, another group working on a different project should be able to take your experimental plan, do exactly what you describe, and end up with the same data product.

**Your experimental plan is submitted as a group.**

Final Project Paper (15%):

*Your final project paper should be a 3 page (double spaced, 12 pt. font) description of the object you studied and the calculation you performed.*

As an introduction, you should provide interesting background related to the object. Possible topics include: historical discovery, when to observe it, what constellation it is in, could you observe it with your eyes, other names for the object, interesting discoveries recently made relating to the object, etc. This portion should include several citations from books or online sources[[2]](#footnote-2) supporting the information you present. *Since you can write about a broad range of topics related to this object, write about something you find interesting. A good goal is to teach your instructor something he/she doesn’t know about the object*. This portion of your paper should be 2 – 5 paragraphs in length.

Your paper should also explain a calculation related to your object. Acceptable calculations per object type are listed in the rightmost column of Table 1. Some calculations require information that you cannot get from the observation or your data product alone – in this case, you must look up and cite the external information you are using. This explanation of the calculation should clearly explain each step of the calculation, define any variables, and explain any relevant formulas.

*You should assume your reader is familiar with your submitted experimental plan – you can cite it without needing to explain your data analysis process in detail again.*

Similar to the experimental plan, “showing your work” is expected – a classmate should be able to adopt your numbers, follow the logic and formulas you presented, and end up with the same result.

**Your final project paper is submitted as an individual.** *While it is expected that you are your group members may have similar citations, assumptions, and calculated numbers, the language and communication within the paper should be yours alone.*

Final Project Presentation (15%):

*Your final project presentation should be a 6 - 8 minute presentation given in front of your lab class.*

Similar to your individual papers, you should provide some interesting background related to the object, with citations when appropriate. Listing the type of object and explaining what it is necessary, but insufficient. *This information should be more than a list of facts – it is your chance to convince your classmates that they should have studied your object instead.* This is expected to be anywhere from 30 – 50% of your presentation.

Next, you should briefly describe what you did for data analysis. Your audience is your classmates, so explain in an appropriate level of detail without providing a full “recipe” (i.e. your classmates understand what you did, but they might not be able to do it without also reading your experimental plan). As a rule of thumb, this is 30 – 90 seconds.

You should then show and explain your resulting data product, and walk us through the calculation you performed. Think of this an opportunity to do a problem on the blackboard in front of the class like your instructor: explicitly state any assumptions you’re making and show your work.

You should be prepared for 1 – 2 minutes of questions/answers at the end of your presentation. Polite asking of questions and engagement with your peer’s work is also encouraged and incentivized.

**Your final project presentation is submitted as a group, but you should take turns presenting so that everyone in your group is represented.** *As your paper is submitted 1 week prior to your presentation date, any background or calculation done as part of your group’s papers can be presented.*

|  |  |
| --- | --- |
| Calculation Type | Resources |
| Size | Angular Size lab / Small Angle Formula |
| Approximate Peak Temperature | Wien’s Law (21st Century Astronomy, 5.3 “Working It Out”), Image Analysis / Filters for the VAO |
| Redshift | Astronomical Redshift Lab / Hubble’s Law (21st Century Astronomy, 21.1 “Working It Out”) |
| Total Brightness Change | Magnitude Scale (21st Century Astronomy, 13.2 “Working It Out”) |
| Speed | Image Analysis II |
| Orbital Period | Kepler’s 3rd Law, JPL Minor Planet Database |

1. For those doing asteroid animations, please include a picture of one observation within your experimental plan as “example data” and email all animations to your instructor. [↑](#footnote-ref-1)
2. Online sources must not include Wikipedia. Citations of articles outside Wikipedia are fair game, however. Online articles should meet standards for credibility, but do not have to be academic papers. Examples include: Popular Science, Sky & Telescope, NASA websites, etc. [↑](#footnote-ref-2)