Physics 10263 Lab #5:
Citizen Science – Variable Star Zoo

Introduction

The concept of Citizen Science is that some Astronomical databases are so large and the data so complex that computer algorithms cannot accurately or reliably sort through all of the data to find the kinds of interesting things that Astronomers are looking for. So Astronomers are recruiting citizen scientists to pitch in and help analyze data in these projects.

In return, citizen scientists get to study incredible data sets and photos of the sky that no one has seen before, and they have a chance to be the first to make some pretty incredible discoveries (and get credit for doing so). Basically, as a citizen scientist, you get to do all of the stuff that makes science fun without any of the tedious part (writing funding requests, serving on committees, etc.).

In this lab, we will first learn a little background about variable stars, then we will be identifying different types of variable stars in our own Milky Way Galaxy.   This work will help astronomers determine the luminosity, mass and age of these stars. With this information, astronomers can construct a more accurate three-dimensional map of the galaxy, learn more details about the process of stellar evolution, and reconstruct the history of star and cluster formation in the galaxy.

Introduction to Variable Stars

Use a browser to navigate to https://tinyurl.com/y7rnwxpf, and read through the introductory material, answering the questions below as you go.

Q1. Explain what is the Main Sequence on an H-R diagram, and <u>also</u> explain what all main sequence stars have in common (regarding their cores).

Q2. Explain what is a light curve for a star.

Q3. What two properties of a star's light curve determine which type of variable star it is?

Q4. Name two differences between the properties of Cepheid variable stars and RR Lyrae variable stars.

Q5. Name two differences between Long Period Variables (like Mira) and Semiregular Variables (like Antares).

Next, read through a more detailed discussion of Cepheid and RR Lyrae stars: **https://www.aavso.org/vsots_rrlyr**

Q6. Briefly describe one reason why the "binary hypothesis" for the variation in RR Lyrae stars was proven to be incorrect by Shapley.

In the section on the Instability Strip, we learn that RR Lyrae stars are sub giants, brighter than main sequence stars but dimmer than giant stars such as Cepheids.

Q7. What type of star is a ZZ Ceti variable?

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Q8. What type of star is a Delta Scuti variable?

_____

Q9. Explain what is the Leavitt Law.

Q10. Describe how Cepheids and RR Lyrae variables were used in order to establish the true size of the Milky Way galaxy.

Now, find out more about Delta Scuti stars by reading **https://www.aavso.org/vsots_delsct** and answer questions below.

Q11. Explain what is a radial pulsation for a star.

Q12. Describe two physical differences (besides amplitude of pulsation) between High-Amplitude Delta Scuti (HADS) stars and Low-Amplitude Delta Scuti (LADS) stars.

Q13. Explain what Astronomers hope to learn by carefully studying the the radial and non-radial oscillation modes of Delta Scuti stars and stars like our own Sun.

Now let's read some news related to the VVV survey we will be looking at in the Citizen Science project. Visit **https://tinyurl.com/ybshur4c** and answer below.

Q14. Two Cepheids from the survey are dubbed "The Twins." In what part of the Milky Way Galaxy are they located?

Q15.   Explain why Astronomer Sukanya Chakrabarti predicted that a dwarf galaxy would be found on the far side of the Milky Way from our location, about 300,000 light years from our galaxy.

Q16. There is also a story here about five Cepheid variables found by Astronomer Michael Feast and collaborators. Describe where these were found and what it tells us about the structure of the Milky Way Galaxy.

Now let's proceed to the Variable Star Zoo website:

https://www.zooniverse.org/projects/ilacerna/variable-star-zoo

Make sure you create an account and log in (please note your username and password for later labs) before you get started so that you can get an accurate count of how much data you've looked at! Once you are logged in, read through the information in the "About" tab and the "FAQ" tab to help you better understand the project, then click on the "Classify" tab and work through the short tutorial.

Before you get started classifying variable stars, one last task! Click on the Field Guide tab on the right-hand side of your screen. Below, describe the main characteristics of the three main types of light curves for variable stars you will be classifying.

Q17. Main characteristics of <u>RR Lyrae or Cepheids</u>:

Q18. Main characteristics of <u>Mira variables</u>:

Q19. Main characteristics of <u>Binary stars</u>:

You must classify at least 40 stars. Please split up the work so everyone gets to do the same amount. Once you have completed your contribution to the project, show your lab instructor your profile page (click your username on the top right, then select "Home"). The little ring around the circular icon can be hovered over to indicate how many data sets you have completed for any given project. Attach a screenshot showing your statistics page with the number of classifications for this project displayed to prove you completed this part of the lab.

I have provided a sample screenshot below. To get this shot, I moved the mouse so that my cursor hovered over the part of the ring associated with this project. If you just started a new account, your ring may only have one color, but that will change as we do more projects.

ilacerna/variable-star-zoo
57 classifications (6%)

Hello ingram527,
you have made 882 classifications to date.