AST 201 FINAL ASSIGNMENT

Due: Friday. Apr. 24, 2020 at 5 pm

Please submit electronically via Quercus

Student name: *Student number:*

Instructions

The AST 201 FINAL ASSIGNMENT has two separate parts. Part 1, featured below, is a series of short answer questions to be answered using the form provided on Quercus and uploaded to Quercus by April 24, 2020 at 5 pm EST. Part 2 of the assignment is an on-line multiple choice quiz. Please log-in to Quercus and take the quiz sometime between April 9 and April 24, 2020. Once you start the quiz, you will have 180 minutes to complete it.

Honour Statement:

I ____________ acknowledge that this assignment was completed by me and me alone, with only the aid of AST 201 Course Materials (lecture and tutorial slides, the textbook, my personal notes). I am aware that obtaining or providing assistance on this assignment from another source, including my fellow students, is considered an academic offence according to the University of Toronto's Code of Behaviour on Academic Matters (see https://www.artsci.utoronto.ca/current/academic-advising-and-support/student-academic-integrity)

Signed: ________________________

Part 1: Short Answer Questions

Fill out the answers to these questions using the form available on Quercus.

Question 1:

The recently launched Hložek Space Telescope (HST) has just completed its first survey, studying thousands of stars spread out throughout the Milky Way. Data for one of the stars in the survey, ID1003858649, has been given to you for analysis. Given everything you learned in AST 201 this year, please answer the following questions:

a) The first set of data you receive is a spectrum of a main sequence star taken with the MacDonald Spectrometer onboard HST. Based on the fact that the star's spectrum has weak Hydrgen absorption lines and no molecular absorption lines, what spectral type do you believe this star to be? Explain. [3 marks]

b) Based on this star's spectral type, explain the evolutionary stages that it will go through after it completes the main sequence phase of its life. How will this star's life end? [3 marks]

c) HST is also equipped with the Williams Planetary Camera, which searches for planets around stars as their spectrum is being measured. Around this particular star, the camera detected three planets orbiting 6.2, 7.8, and 9.8 AU from the star. Their orbital periods are calculated to be 1.4, 1.5, and 1.7 years respectively. Are these measurements qualitatively consistent with the general trend predicted by Kepler's Laws? Why or why not? [2 marks]

d) Thanks to the Webb Photometric and Astrometric Instrument also onboard HST, we are able to determine that the star is 2.2 kpc from the centre of the Milky Way and travelling with an orbital speed of 111.3 km/s. Your classmates found other stars in the Milky Way that are 7.3 and 11.0 kpc from the Galactic centre travelling with orbital speeds of 220.0 and 220.6 km/s respectively. Are these measurements consistent with the Milky Way having a significant dark matter component? Why or why not? [2 marks]

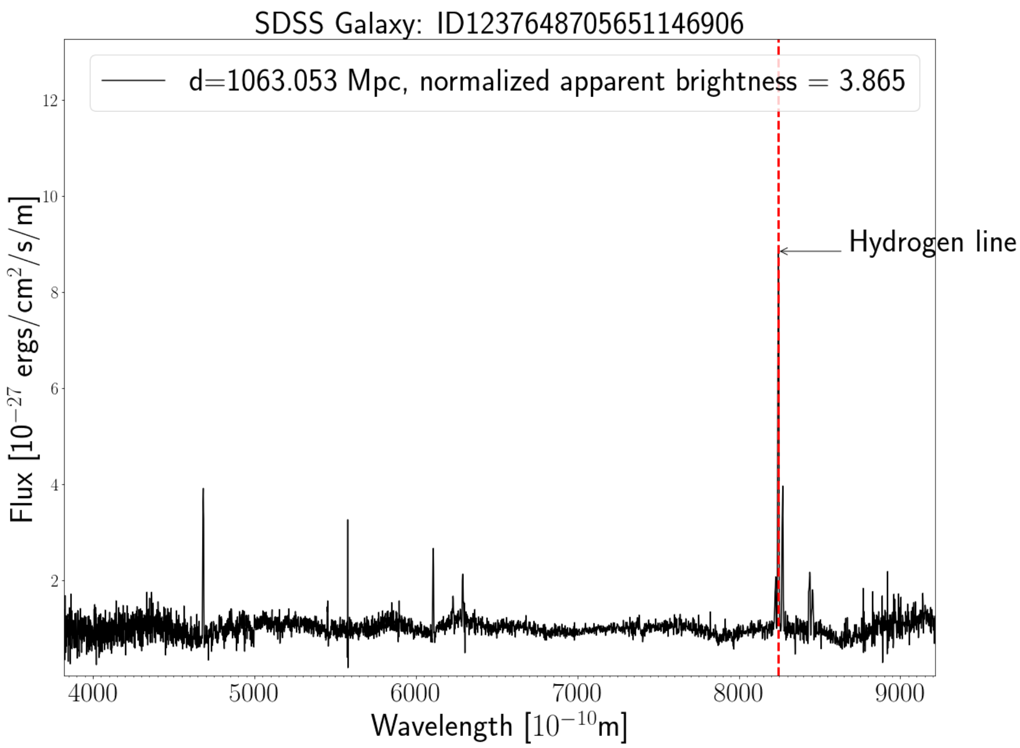

Figure 1: Spectrum of a galaxy from the Sloan Digital Sky Survey. The vertical line marks the location of a prominent Hydrogen emission line that we can use to measure the difference in the speed of this galaxy relative to our reference frame on Earth.

Question 2:

In Figure 1 you have a unique galaxy spectrum from the Sloan Digital Sky Survey (SDSS) telescope. The distance to the galaxy and the normalized apparent brightness are given in the legend. If there are any strange features in Figure 1, please contact ast201@astro.utoronto.ca.

a) Given the apparent brightness and the distance to this galaxy, we can figure out the intrinsic brightness of the galaxy (which is intrinsic to the galaxy and doesn't change). If the galaxy was double the distance away, how would the normalised apparent brightness of your galaxy change? [1 mark]

b) You can see that there is a continuous (flat) part of the spectrum, and bright emission lines. Discuss how you would get emission lines on this spectrum, and draw an example Hydrogen atom. [2 marks]

c) The wavelength (λ) of a bright Hydrogen emission line is shown as a vertical dashed line on the galaxy spectrum, in units of 10^{-10} m. Studying Hydrogen in a lab on Earth, this line occurs at a wavelength (λ_{Earth} = 6563 in units of 10^{-10} m. What is the difference in meters between the position on the wavelength axis of the Hydrogen line you see and the position of this line on Earth? [1 mark]

d) Is the line shifted to longer or shorter wavelengths than we see on Earth? [1 mark]

e) Based on a) and b) above, compute the redshift factor using :

$$z = \frac{(\lambda - \lambda_{\text{Earth}})}{\lambda_{\text{Earth}}}$$

[1 mark]

f) Hubble's Law relates the redshift of an object to its distance through how fast it is moving away from us. What does this relationship between the distance and the redshift tell us about how the Universe changes with time? [1 mark]

g) How does Hubble's Law support the Big Bang model of cosmology? [1 mark]

h) What other observations support the Big Bang model? [2 marks]