University of Science and Technology at Zewail City

Report VI

Observational Astrophysics Laboratory (PEU-327)

Lab VI

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Contents

Experiment XI: Balmer Series of Hydrogen Atom Classifications of Stars

1.1 Task 1:

1.1.1 Wavelengths of Balmer and Lyman series:

The Rydberg formula,

$$\frac{1}{\lambda_{if}} = R_H \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$\because R_H = 1.0973731 \times 10^7\,\mathrm{m}^{-1}$$

Transition	Wavelength (Å)
$\lambda_1 \to 2$	1215.02
$\lambda_1 \to 3$	1025.18
$\lambda_1 \to 4$	972.01
$\lambda_1 \to 5$	949.24
$\lambda_1 \to 6$	937.30
$\lambda_1 \to 7$	930.25
$\lambda_1 \to \infty$	911.27

Table 1: Lyman Series

Transition	Wavelength (Å)
$\lambda_2 \to 3$	6561.12
$\lambda_2 \to 4$	4860.09
$\lambda_2 \to 5$	4339.37
$\lambda_2 \to 6$	4100.70
$\lambda_2 \to 7$	3969.07
$\lambda_2 \to \infty$	3645.07

Table 2: Balmer Series

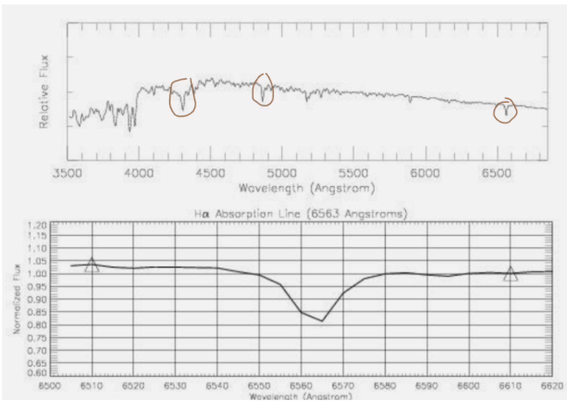
1.1.2 Explanation:

Due to the large energy differences involved in these transitions, the emitted or absorbed photons have high energy and short wavelengths. According to the electromagnetic spectrum, short wavelengths correspond to higher energy photons, which are characteristic of the ultraviolet region. Therefore, the Lyman series requires ultraviolet photons for its transitions.

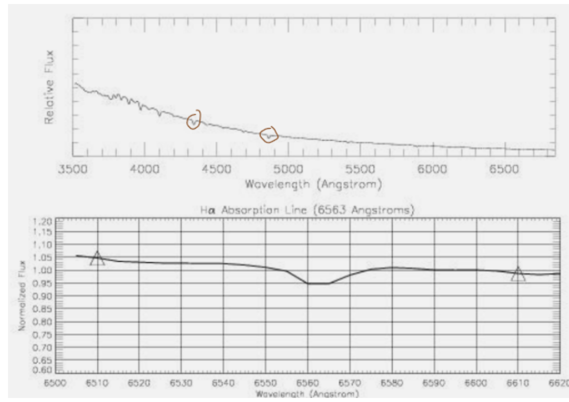
1.2 Task 2:

(a) Because λ_{Lyman} & λ_{Paschen} are not in the visible light range.

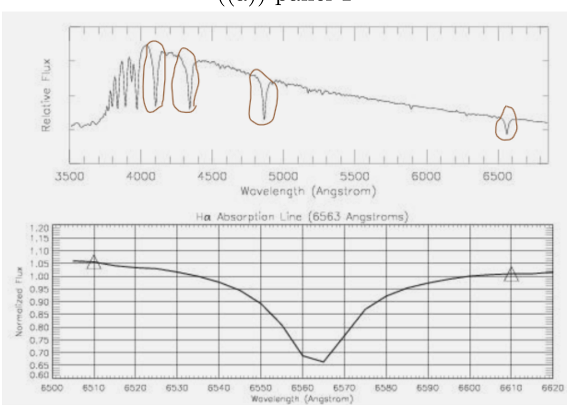
(b) The absorption lines on the panels,



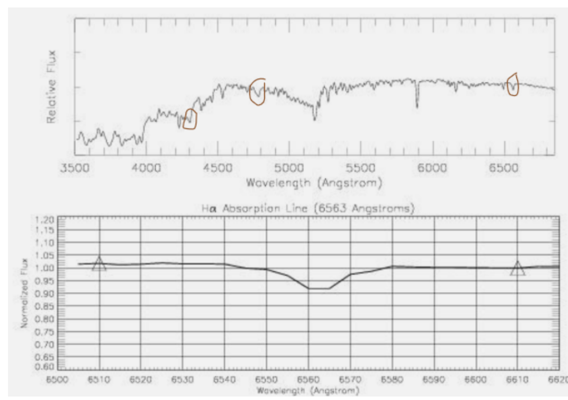
((a)) panel 1



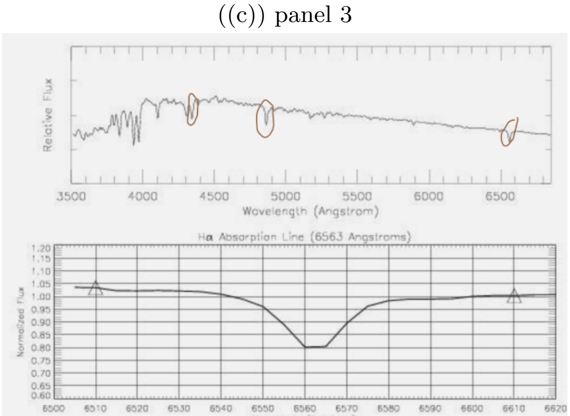
((b)) panel 2



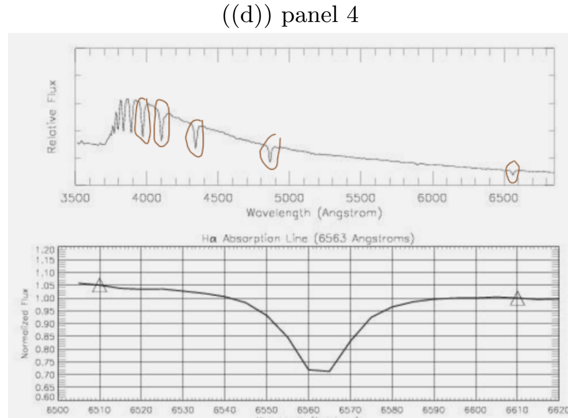
((c)) panel 3



((d)) panel 4



((e)) panel 5



((f)) panel 6

Figure 1: Six panels showing absorption lines.

1.3 Task 3:

Panel	Strength of H_α (number of boxes)
1	4.5
2	1.25
3	15.5
4	2
5	7
6	11.5

Table 3: Strength of H_α absorption line

1.4 Task 4:

Panel (from the strongest H_α to weakest)	Spectral Class
3	A
6	B
5	F
1	G
4	K
2	O

Table 4: Spectral classes (H_α)

1.5 Task 5:

$$T = \frac{2.9 \times 10^7}{\lambda_{\text{peak}}}$$

Panel	Peak Wavelength (Å)	Surface Temperature (K)
1	4500	6444.4444
2	3500	8285.7143
3	4040	7178.2178
4	5840	4965.7534
5	4500	6444.4444
6	3870	7493.5401

Table 5: Surface Temperatures

1.6 Task 6:

Panel (Hottest to coolest)	spectral class
2	O
6	B
3	A
5	F
1	G
4	K

Table 6: Spectral classes (Temperature)

1.7 Task 7:

Energy Level	Spectral Class	Temperature (K)
The Second Energy Level	A	7250

Table 7: Energy Level and Corresponding Spectral Class with Temperature

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1.8 Task 8:

In the hottest stars, most hydrogen atoms are ionized because of high temperatures, leaving few electrons for absorption, resulting in weak Balmer lines. Conversely, in cooler stars, although there are enough electrons for absorption, they lack the necessary energy to be sufficiently excited, leading to similarly weak Balmer lines.

1.9 Task 9:

O, B, A, F, G, K, M, L, T

1.10 Task 10:

The Stellar Classification Sequence is not in alphabetical order because it's based on temperature, not alphabetical arrangement. Stars are classified based on their spectral characteristics, which are indicative of their surface temperatures. This sequence starts with O-type stars, which are the hottest and ends with M-type stars, which are the coolest. Thus, the classification follows a logical progression according to stellar temperature rather than alphabetical ordering.
