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Research Report:

DATA ACQUISITION AND STUDY OF He SPECTRUM UNDER ELECTRIC AND MAGNETIC FIELDS

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ABSTRACT

Data acquisition system for the spectrum of ionized gases is developed and the spectrum of He gas under electric and magnetic fields are studied. The results are shown through captured photographs, which shows that the spectrums are shifted and their intensities varies with the increasing intensity of the electric and magnetic fields.

Key words: data acquisition, gas discharge, ionized gases, He spectrum, electric field, magnetic field.

I. EXPERIMENTAL EQUIPMENT

1. Spectrometer
2. Grating
3. He, Ar, H discharge tubes
4. Two electrodes around the discharge tube
5. Power supply for discharge tube
6. DC voltage power supply for electrodes
7. Magnetic coil
8. Magnetic compass
9. PC-VGA camera
10. Web camera
11. USB cable
12. Desktop computer

II. BLOCK DIAGRAM OF THE EXPERIMENTAL SET-UP

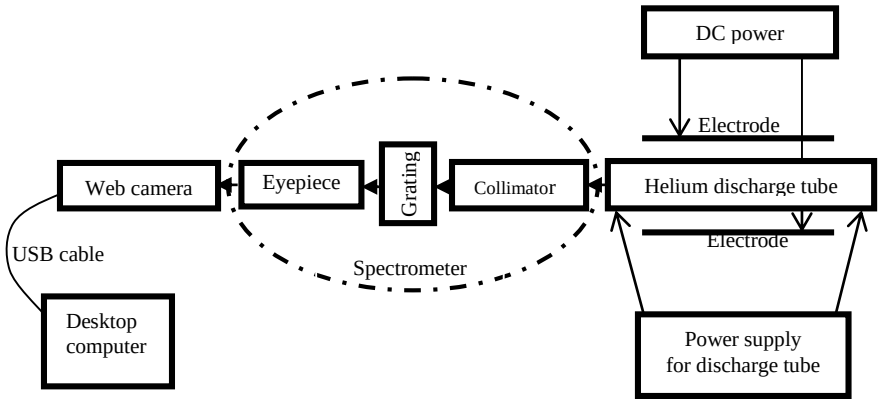

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Photo 1: The Experimental Laboratory

III. EXPERIMENTAL PROCEDURE

Photo 2: Plasma Spectroscopy with Electric Field

In order to analyze the spectrum of He discharge in the presence of electric field, a tube holder was placed in front of the collimator of the spectrometer. The discharge tube was fixed at the top and bottom points of the tube holder and wires from both the holder points were connected to the power supply which discharged He inside the tube to glow brightly.

A diffraction grating with 15000 lines per inch was placed on the prism table of the spectrometer. After passing through the collimator slit, parallel light rays fall on the grating and diffracted from their original direction of propagation to deviated angle depending on the frequency of the color of the spectral lines. These spectral lines were observed by adjusting the eyepiece in an appropriate orientation. A webcamera was then fixed in front of eyepiece with the help of a laboratory made stand/holder which was firmly fixed with eyepiece. An USB cable connected the webcamera to the CPU of a computer where software for the web camera was installed before the experimental set-up. Using the software we observed the spectrum from the He discharge tube in the monitor of the computer successfully.

Beside all this, two electrodes with appropriate diameter were attached parallel in the middle position of the discharge tube with some local laboratory technique. A voltage supply was placed near the discharge tube which supplied continuous voltage difference across the electrodes.

A coil was built locally to produce magnetic field and it was observed that the coil produced

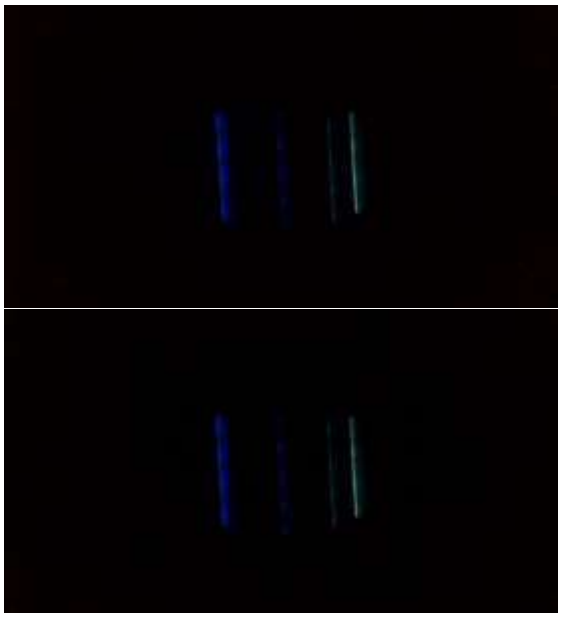
significant amount of magnetic field which deflected the north pole of a compass to the opposite orientation when 1.28 A current was applied from the power supply. The axis of the coil was placed perpendicular to the length of the discharge tube so that magnetic field remained perpendicular to discharge tube length.

Photo 3: Plasma Spectroscopy with Magnetic Field

IV. EXPERIMENTAL OBSERVATIONS

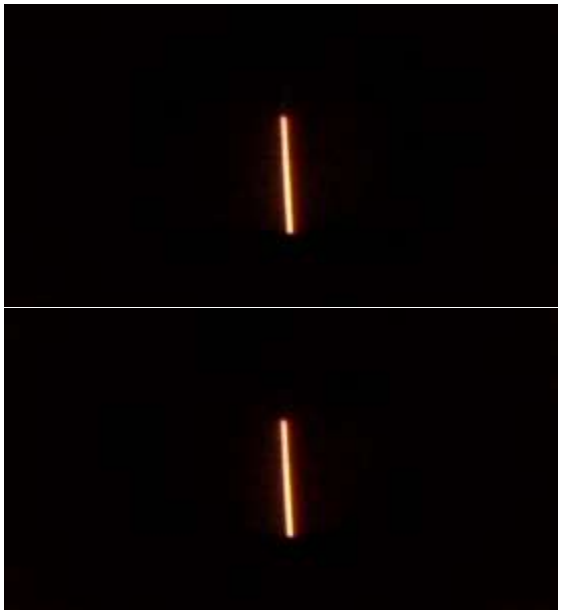
PICTURES OF THE SPECTRUMS

Captured Picture 1:
Violet, blue, green, and greenish He Spectrums without Electric Field



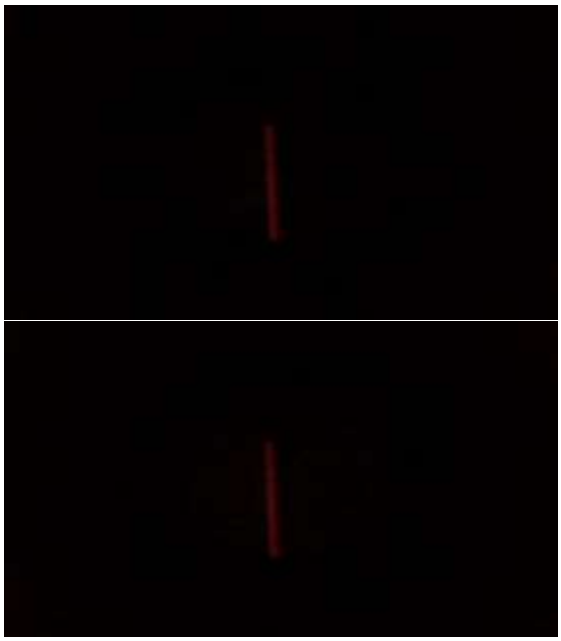
Captured Picture 2:
Violet, blue, green, and greenish He Spectrums with Electric Field

Captured Picture 3:
Yellow He Spectrum without Electric Field



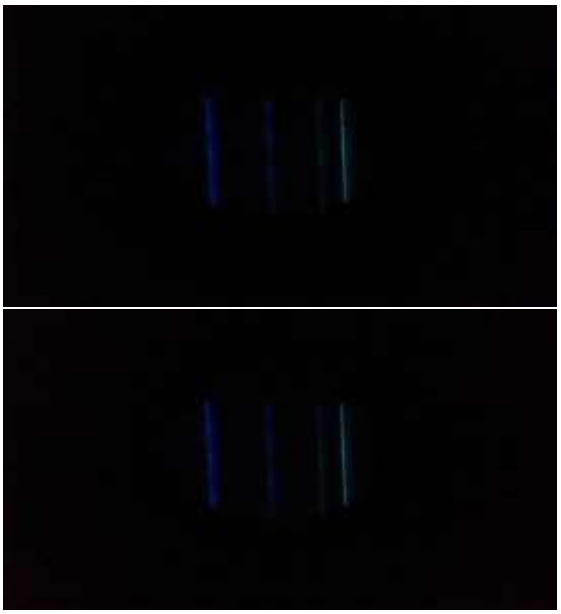
Captured Picture 4:
Yellow He Spectrum with Electric Field

Captured Picture 5:
Red He Spectrum
without Electric Field



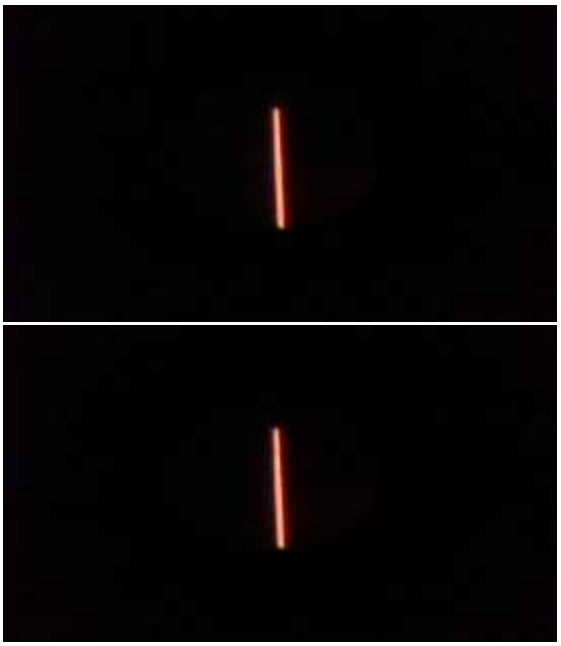
Captured Picture 6:
Red He Spectrum
with Electric Field

Captured Picture 7:
Violet, blue, green, and greenish He Spectrums without Magnetic Field



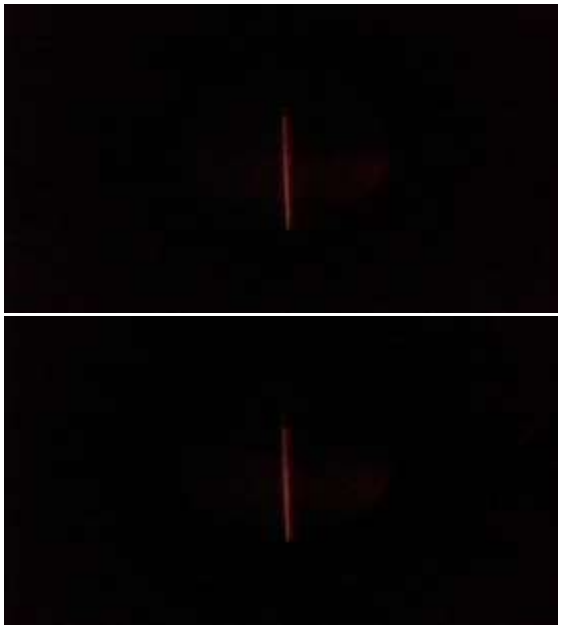
Captured Picture 8:
Violet, blue, green, and greenish He Spectrums with Magnetic Field

Captured Picture 9:
Yellow He Spectrum without Magnetic Field



Captured Picture 10:
Yellow He Spectrum with Magnetic Field

Captured Picture 11:
Red He Spectrum without Magnetic Field



Captured Picture 12:
Red He Spectrum with Magnetic Field

V. DISCUSSION

The basic idea behind the experiments done above, is to develop the computer based data acquisition system using the modern techniques and study of the spectrum of ionized gases (plasma) under electric and magnetic fields. Although these experiments were done earlier, known as Stark [1] and Zeeman [2] effects, but investigations of the same with the modern opto-electronic and computer based data acquisition system may reveal new information.

We consider various discharge tubes such as: H, He, and Ar for these investigations. Spectral lines from different discharge tubes were observed almost clearly with bare eyes through the eyepiece of the spectrometer. But the intensities of spectral lines were not same for different gases. We have used a PC-VGA camera to capture the images of the spectral lines. The PC-VGA camera captured the direct bright light from the discharge tubes but failed to capture the spectral lines as their intensities were not sufficient enough for the resolution of the camera. Therefore, the apparatus was covered with black clothes to make it

completely dark. The camera then was connected by a low resistance USB cable to the computer to capture the images but no spectral lines were detected by the PC-VGA camera. Only direct bright lights from the H, He and Ar discharges were observed.

So, we used a Webcam and observed the spectral lines on the computer monitor. Spectrums from H and Ar discharges were not sufficiently intense to capture but spectrums from He discharge was sufficiently intense. So, we captured He spectrum under electric and magnetic fields, respectively.

The spectrum of the He discharge were violet, blue, green, greenish, yellow and red according to their angle of deviation from the central position of direct bright light. They were captured successfully. Initially, in the absence of electric field, we captured an image which includes violet to greenish-the four spectral lines. Keeping all the arrangement unaltered, we captured the same image in the presence of electric field by giving a potential difference of 20 V across the electrodes. Appling the same technique, we captured images from yellow and red spectral lines for both situations of without and with electric field. The captured photographs are shown in photos: 1-6, respectively.

The captured photographs show, with bare eyes, as if there is no change in the spectrum. But the minute observations with the computer analysis of the photographs show that there are some changes. The spectral lines are shifted and their intensities also change with the application of external electric field.

A small shifting of the spectral lines was observed along with the change in intensities. Spectral lines with small angular deviation (i.e. violet, blue and greenish) shifted more in the presence of electric field compared to the large angle deviated spectral lines (i.e. yellow and red), whereas the intensity changes were more, for spectral lines with large angle of deviations.

Then, we have applied external magnetic field perpendicular to the discharge tube and the images of the spectral lines were captured in a similar way as in the case of electric field. But the captured photographs show no significant changes; photos: 7-12. This may be due to the strength of the magnetic field which was not enough to observe the changes.

So, we are planning to do the same experiments with higher electric and magnetic fields with the development of image capturing techniques in near future, which will be reported later.

VI. CONCLUSION

With the available equipment and indigenous technology we have developed a computer based data acquisition system for experimental study. For a particular case of the experiment, we consider the study of gas discharge under electric and magnetic fields in the context of plasma astrophysics. Although the strength of the applied external applied fields is not sufficient enough to observe the significant change in the spectrum, but an initial attempt has been made for going to the experiment with higher electric and magnetic fields and to consider the combined effects [3].

Acknowledgements

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REFERENCES

1. J. Stark, *Beobachtungen über den Effekt des elektris chen Feldes auf Spektrallinien I. Quereffekt* (Observations of the effect of the electric field on spectral lines I. Transverse effect), Annalen der Physik, vol. 43, pp. 965-983 (1914). Published earlier (1913) in Sitzungsberichten der Kgl. Preuss. Akad. d. Wiss.
2. Zeeman, P. (1897). "*Doubles and triplets in the spectrum produced by external magnetic forces*". Phil. Mag. 44 (266): 55.
3. J. Stuart Foster: "*Effect of Combined Electric and Magnetic Fields on the Helium Spectrum*" Proceedings of the Royal Society of London. Series A, Vol. 122, No. 790, Feb. 1, 599-603 1929).