DIURNAL VARIATIONS IN HELIUM EMISSION

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ABSTRACT: This paper gives a description of the reduction method of spectrophotoelectric observations of the twilight helium emission. The results of the measurements are presented.

Electrophotometry, with the aid of the spectrometer DFS-14 with a photoelectric attachment [1], guaranteed not only a rapid and high-quality recording of the spectra of hydroxyl emission for determining the rotational temperature, but also a determination with a satisfactory degree of accuracy of the intensity of the twilight orthohelium emission in the region λ10,830 Å. This was brought about by the linear characteristics of the spectroelectrophotometer and the relatively small errors in measuring the values. The time for recording the band of the hydroxyl emission, i.e., the spectral segment of Δλ300 Å, is about 5 min. The helium line is located near the line Q_1 of the band (5.2), and, for an operational spectral gap of Δλ10 Å, the helium line and the line Q_1 overlap. Therefore, in order to determine intensity of the helium emission, it is necessary to subtract from the total reading for the emission, around the branch Q_1, the real intensity of the line Q_1. /50

Thus, the helium intensity is determined by the following formula:

$$I_{\mathrm{He}} = \sum - kP_i,$$

where I_{He} ...* about λ10,830 Å; k is a coefficient equal to the ratio Q_1/P_i, and depends generally on T_{rot}; P_i is the intensity of any line in the OH band (5.2). In this study, we used the lines for P_1, since the ratio Q_1/P_1 is constant and does not depend on T_{rot}, and the coefficient k was determined according to the nocturnal spectra.

One of the principal problems in measuring the intensity of the helium emission is that of the accuracy of the values obtained. The relative error in the measured helium intensity is the following:

$$\frac{\Delta I_{\mathrm{He}}}{I_{\mathrm{He}}} = \frac{\Sigma}{I_{\mathrm{He}}}\delta_{\Sigma} + \frac{kP_1}{I_{\mathrm{He}}}(\delta_k + \delta_{P_1}),$$

* Translator's Note: Line missing in original text.

where ΔI_{He} is the absolute error in I_{He}; δ_{Σ}, δ_{k}, and δ_{P_1} are the relative errors in Σ, k, and P_1.

In the observations of the spectra for the OH Band (5.2), we made recordings every 5 min. Therefore, several tens of spectrograms of the band (5.2) are obtained during the course of one night, i.e., for each line Q_1, P_1, etc., we can construct the diurnal variations. The points on the graphs for the variation in the intensity of these lines have a certain variance [2]. During the analysis, we used the intensities of the lines which were leveled out by these graphs. The relative errors of Q_1 and P_1 are, in such case, on the order of 3-5% each. The relative error in δ_k is on the same order. /51
The character of the relationship between $\Delta I_{He}/I_{He}$ and the values of I_{He} and P_1 (or kP_1) are shown in Figure 1.

The different curves in Figure 1 correspond to different intensities of P_1.

Records of the solar spectrum in the region of the OH band (5.2), which were obtained with the aid of the same apparatus, are shown in Figure 2. They were recorded during the day, in a vertical

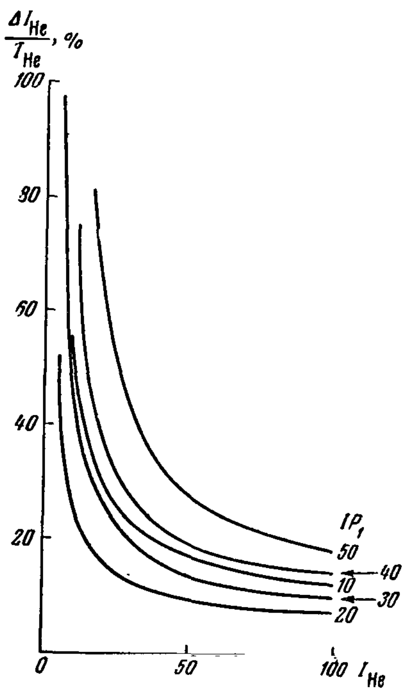

Fig. 1. Measurement Accuracy for the Intensity of Helium Emission Versus the Intensities of the Helium Line and the Line P_1.

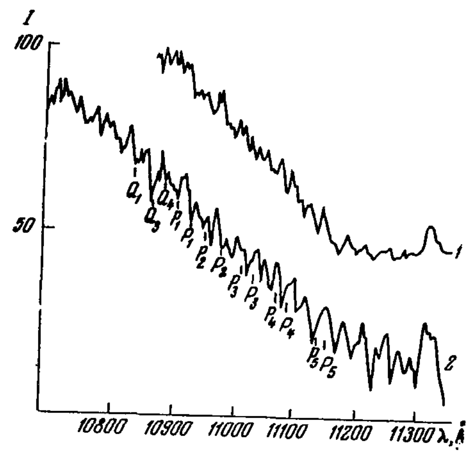

Fig. 2. The Solar Spectrum in the Region of the OH Band (5.2). The Upper Spectrum (1) Was Obtained by Observations at the Zenith (h = 90°); the Lower Spectrum (2) Was Obtained for a Height of 30°. The Position of the Lines in the OH Band (5.2) is Shown.

to the Sun. The upper spectrum was obtained during observations at the zenith, and the lower spectrum was obtained for a height of 30°; the height of the Sun was 60° during the recording. The spectra show the positions of the lines in the OH Band (5.2). As we can see from Figure 2, during observations at twilight (when the scattered solar light is present), the continuous background in the region of the OH band (5.2) is not smooth. During the night, the continuous background (when there is no Moon) is not recorded, since its intensity is lower than the marginal sensitivity of the apparatus.

A comparison of these recordings with the data of the solar spectrum in this region, with high resolution, shows that there is almost no real absorption of the lines in the OH band (5.2) in the lines of water vapors [3]. The effect of the absorption on these lines is found as a result of the blurring effect, since the width of the instrumental contour is rather great ($\Delta\lambda \sim 10$ Å). Thus, the intensities of all the lines in the OH band (5.2) are more or less distorted during the twilight. Lines P_2 and P_3 are not significantly distorted, and they can serve as the reference lines. A calculation of the intensity of the I_{He} line is possible by calculating the intensities of these lines and of the corresponding rotational temperature. However, it is always difficult to find the regular conduct of the background in the region of the line Q_1. This is caused by its presence in the near vicinity of the helium lines and /52 the OH lines of absorption. Since the percentage of water vapor in the atmosphere is not constant, it is necessary to have additional measurements in order to calculate the value for the absolute weakening.

In analyzing the twilight spectra, we considered only the relative weakening of the lines Q_1 and P_1. Figure 3 shows the twilight

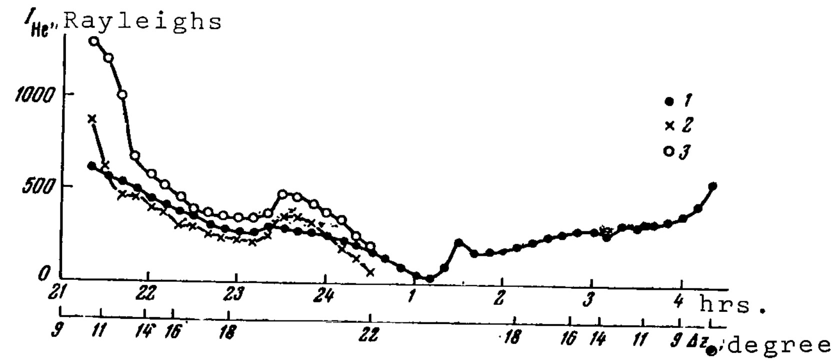

Fig. 3. Changes in the Twilight Intensity of the Helium Emission, on April 22-23, 1965. (1) The Intensities of Helium Emission by Analysis with a "Smooth" Continuous Background; (2) The Intensities of Helium Emission by Calculation of the Relative Absorption of the Lines; (3) The Intensities of Helium Emission by a Calculation of the Absolute Absorption in the Lines Q_1 and P_1.

distribution of helium intensity for April 22-23, 1965. We can see from the figure that, for large angles of subsidence, when the intensity of the scattered light of the Sun is low, a consideration of the weakening in the lines has practically no effect on the intensity of the helium emission. Figure 4 gives the average distribution of the intensity of helium emission for seven nights in April, 1965.

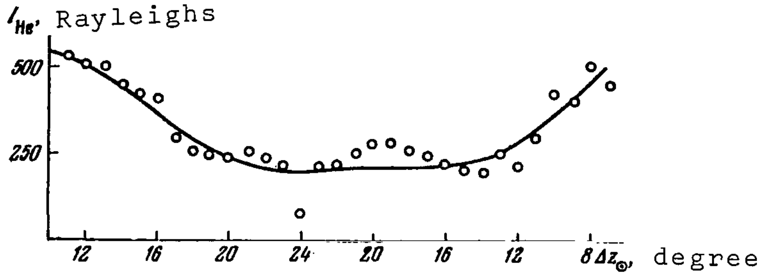

Fig. 4. Average Variations in Intensity of the Helium Emission, at Twilight, on April, 1965.

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