# CHARACTERISTICS OF SPATIAL DISCONTINUITIES IN THE λ 5577 Å EMISSION OF ATOMIC OXYGEN IN AIRGLOW

G. A. Nasyrov

*ABSTRACT: Based on observations in Ashkhabad, the characteristics of the green line emission were studied. The most characteristic size of the patches is 60-90 km. The distribution of patch velocities has two maxima: about 75 m/sec and 150 m/sec. These velocities increase with growth in the K-index. Periodic oscillations are revealed in the intensity of the patches with periods of 5.5 and 15.5 minutes.*

In order to clarify the characteristics of the spatial discontinuities in the green line of atomic oxygen, we used the observations of airglow conducted in January, May, and June of 1964, on a five-channel scanning electrophotometer [1-3]. The structure of the apparatus was changed so that both the informativeness and the accuracy of the materials obtained were increased. The rate at which the sky was surveyed varied from 15 to 5 min, and, during certain nights (June 10-11 and 11-12), to 2 min. Recordings were made of the zenith distance and the azimuth at the point of observation and noted on the record simultaneously with a recording of the emissions observed. The purpose of the observations was to study the characteristics of the distribution of the atomic oxygen emission line OI λ 5577 Å over the sky during one night. In this case, substantial significance was given to a correct calculation of the integral continuum, since it had rather significant oscillations in intensity and in spectral distribution, in relation to the coordinates of /5*

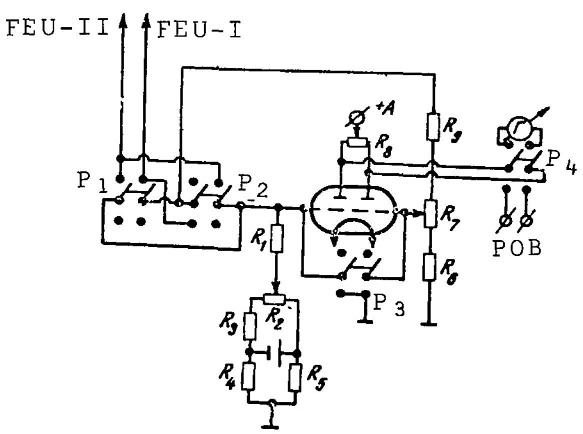


Fig. 1. Bridge Circuit for Determining Intensity of the Atomic-Oxygen Emission by the Two-Filter Method.

* Numbers in the margin indicate pagination in the foreign text.

the sky-region being observed [3-5]. Therefore, in order to determine the intensity in the λ 5577 Å region, the method of two interference filters, similar to Barbier's method for the oxygen red line λ 6300 Å [5, 6], was used.

This method guarantees a rapid and accurate determination of the emission intensity without making any assumptions on the value and the spectral distribution of the integral continuum. The application of this method, with the aid of the scheme shown in Figure 1, provides for recording directly, in absolute units (Rayleighs). The schematic in Figure 1 is the bridge circuit for calculating the signals coming from two different channels with different interference filters. The signals are preliminarily rectified for the background current with the aid of the unit in the scheme, consisting of the following: $R_1$ = 100 milliohm, $R_2$ = 1.3 kohm, $R_3$ = 4.5 kohm, $R_4$ = $R_5$ = 2.3 kohm. The unit also consists of batteries of the type "Saturn" ($U$ = 1.5 V). These signals are divided in relation to which one brings about a zero rejection of the galvanometer (after combining the signals) during the regular entry into both channels of the light from a source with a continuous spectrum. This is done with the aid of the divider with $R_6$ = 36 milliohm, $R_7$ 4.7 milliohm, and $R_9$ = 120 milliohm. The zero-balance of the amplifier is accomplished by the potentiometer with $R_8$ = 100 kohm. /6

## The Azimuths of the Drifts in the Spatial Discontinuities of the Atomic Oxygen Green Line

As a result of analyzing the materials obtained for 22 nights of observations in January, May, and June of 1964, we constructed more than 1100 isophotic diagrams. The diagrams were constructed at five-minute intervals, and at two-minute intervals for the nights of June 10-11 and 11-12. The intervals for the change in intensities were 40 and 50 Rayleighs in those cases when the intensity did not exceed 400 Rayleighs. A comparison of the positions of the isophotic lines and the points for maximum and minimum patches, whose contour stayed within the limits of the sky-region being examined by the photometer, at various sequences of time, shows that both the isophotic lines and the patches migrate (drift). Figure 2 shows histograms of the azimuths of migrations for the isophotic lines and the points of maximum (minimum patches. The frequency of drift at a given azimuth is con-

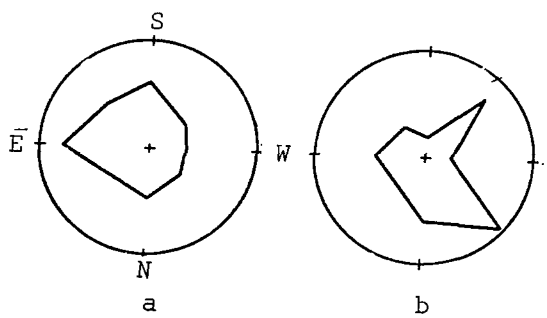


Fig. 2. Histograms of the Azimuths for the Migration of the Patches (a) and the Isophotic Lines (b) for January, 1964.

structed along the radius as a percent of the total number (87 measurements for the patches and 65 measurements for the isophotic lines). The radius of the circle shows 25% of the total number of measurements. We can see from this figure that the histograms constructed by the azimuths of drift for the isophotic lines and patches differ greatly. A gust of vertical wind can shift the luminescent layer in altitude and thereby cause an increase (or weakening) in the luminescence intensity and become the cause for a visible movement of the isophotic lines. Therefore, we could never consider that the real drift could be determined by the azimuths for the displacement of the isophotic lines. Moreover, it is impossible to determine the azimuths of the drift by the patches for these two cases: a dissociation of large-scale patches into several small ones, and a combination of small patches into large-scale ones.

We constructed the histograms for the azimuths of the patch drifts by two, three, and more successive determinations. However, we did not find any significant differences in the histograms.

Figure 3(a) shows histograms for the azimuths of patch drifts for an entire night. The numbers show the total amount of measurements. Figure 3(b) shows the same histograms, but for two periods: before midnight (evening) and after midnight (morning). The frequency of drift, as a percent of the total number of measurements, is constructed along the radius, and the radius of the circle shows /7
25% of the total number of measurements. In Figure 3(a), we can observe the seasonal path of the primary directions for the azimuths of the drift. The primary direction for the drift of the patches in January is the east, while, in May and June, it is northwest. We can see from Figure 3(b) that, before midnight, the primary directions for the drift are more sharply pronounced than after midnight, and, at the same time, there is noted a clock-wise turn of the azimuths of the primary drifts between the evening and the morning.

According to the data in articles [7-9],the discontinuities of the oxygen green line drift primarily in the eastern and western directions.

## Dimensions and Drift Rates of the Patches

The configuration of the patches can be rather complex, while the size of the patches in each individual case is determined on the basis of a calculation for the areas of the patches. In 22 nights, 1050 patches were recorded. Their distribution by size is shown in Figure 4(a). Here, the probability that the dimensions will be a percent of the total number is constructed along the abscissa. The dashed arrow shows the value for the average dimensions. As we can see from the figure, the most characteristic size is 60-90 km. The resolving power of the apparatus has a substantial effect on the spectrum for the dimensions. Therefore, we did not find any patches smaller than 20 km, although they do exist.

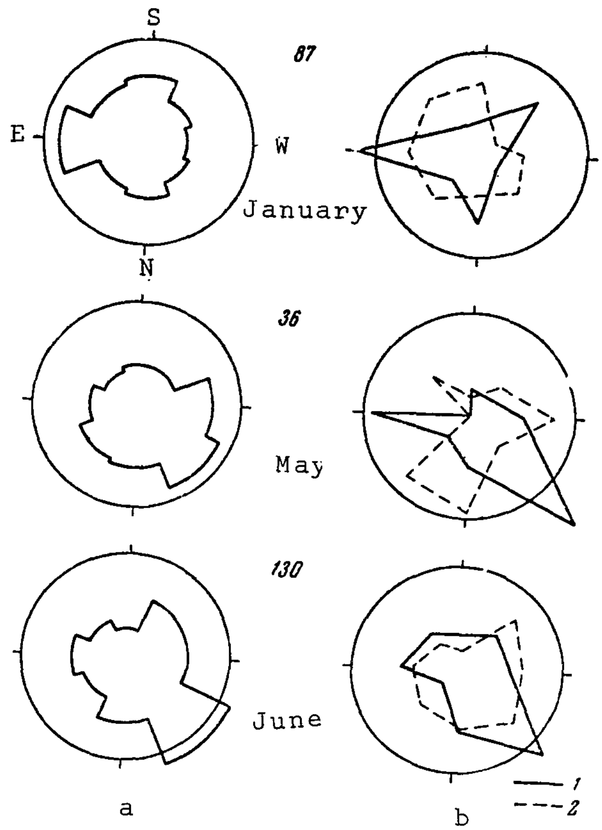


Fig. 3. Histograms of the Azimuths for the Patch Drifts. (a) For an Entire Night; (b) For Two Periods: (1) Evening; (2) Morning.

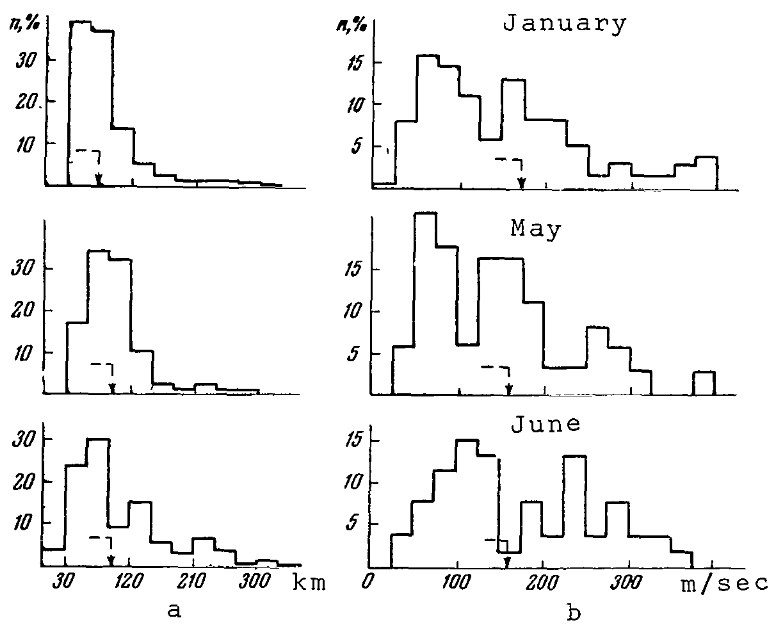


Fig. 4. Distribution of Patches by Dimensions (a) and Drift Rates(b).

The test observations on a scanning electrophotometer with an increased resolving power (5° by the azimuth and 2° by the altitude) for the segment $z$ = 30-60° and $A$ = 0-60° showed the presence of patches with such dimensions. The dimensions of the patches found during an entire night for January and May did not change, within the limits of accuracy for this method. In June, there was observed a decrease in the dimensions of the patches by morning, on the average by 18%. The dimensions of the patches can change substantially, according to successive measurements: large-scale patches can break up into several small ones, and small ones can be joined into large-scale patches. /8

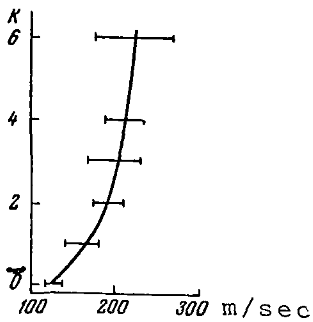


Fig. 5. Drift Rate of Patches Versus $K$-Index of Magnetic Activity.

Figure 4(b) shows a graph for the distribution of the drift rates of the patches [the symbols are the same as in Fig. 4(a)]. As we can see from the figure, the distribution of the rates has two peaks. The first occurs at 75 m/sec, and the second at 150-160 m/sec, for January and May. In June, both peaks are displaced at greater rates, which might be explained by the increased activity in the Earth's magnetic field.

If we construct a graph for the relationship between the drift rate of the patches and the condition of the magnetic field (the $K$-index of the magnetic activity) for all 22 nights, we can then see that, with an increase in the $K$-index, the rate of movements in the patches also increases (Fig. 5). The rate of migration of the isophotic lines, according to [8], is equal to the following:

$$V = V_{\perp} + \frac{\beta I \omega}{H \frac{\partial I}{\partial n}},$$

where $V_{\perp}$ is the wind velocity, normal to the isophotic lines; $\partial I/\partial n$ is the gradient of the brightness by the standard for the isophotic line; $H$ is the height of the homogeneous atmosphere; $\beta$ = 2.14 is /9 a constant; $\omega$ is the velocity of vertical drift; $I$ is the intensity of the IO $\lambda$ 5577 Å emission. According to a study in [8], $\omega$= 10 cm/sec. According to the data in [10], the value for $\omega$ can reach several meters per second, i.e., the error introduced by the natural movement of the isophots is greater than one-third of the values for the velocity obtained [8]. Therefore, the values for the velocities found in [7] and [8] can differ greatly from the real ones.

An examination of the isophotic charts, obtained at two-minute intervals, showed that certain patches periodically change their brightness. The reduction of brightness in the patches to one period, in a way similar to what is done for determining the period of oscillations in the brightness of variable stars, as well as an analysis of the periods, showed that there are periods for oscillation in brightness of 5.5 and 15.5 min. We could not find the minimum for the period of oscillations in brightness because of the insufficient time resolution of the apparatus. The amplitude of the change in brightness can reach 100 Rayleighs in individual cases. This phenomenon is also observed during other nights, but it is difficult to find it, because of the close proximity of the periods for the change in brightness, and because of the time needed to examine the entire sky with the scanning electrophotometer.

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