Schmidt, T., Elsässer, H. Interplanetare Elektronendichte und Zodiakallichtspektrum, *Z. Astrophys.*, **56**, 31, 1962.
Smiley, C. H. Observation of the zodiacal light from an F-104, Proceedings of Project APEQS Symposium, December 1963, and Douglas Aircraft Co. *Rept. no. G*–36443, 55, March, 1964.
Southworth, R. B. On S. H. Dole's paper "The Gravitational Concentration of Particles in Space Near the Earth", *Planet. and Space Sci.*, **11**, 499, 1963.
Tanabe, H. A photoelectric study of the gegenschein, Tokyo Astronomical Observatory, unpublished manuscript, 1961.
Tanabe, H. Photoelectric observations of the gegenschein, Tokyo Astronomical Observatory, unpublished manuscript, 1964*a*.
Tanabe, H. Zodiacal light and airglow components at 5300 Å, Tokyo Astronomical Observatory, unpublished manuscript, 1964*b*.
Tanabe, H. An evidence of the existence of an airglow radiation near 5300 Å independent of 5577 Å line, Tokyo Astronomical Observatory, unpublished manuscript, 1964*c*.
Weinberg, J. L. White-light versus narrow-band observations of the polarization of the zodiacal light, *Nature*, **198**, 842, 1963*a*.
Weinberg, J. L. Photoelectric polarimetry of the zodiacal light at λ5300, Ph.D. Dissertation, University of Colorado, 206 pp., 1963*b*.
Weinberg, J. L. The zodiacal light at 5300 Å, *Ann. Astrophys.*, **27**, no. 6, 1964*a*.
Weinberg, J. L. The Agung eruption, atmospheric extinction, and zodiacal light, Hawaii Institute of Geophysics, unpublished manuscript, 1964*b*.

APPENDIX. SPECTRAL INVESTIGATIONS OF THE NIGHT AIRGLOW IN U.S.S.R.

(prepared by N. N. Shefov)

During the IGY and the later years spectrographic and photometric investigations of the airglow have been performed in the U.S.S.R. Observations were obtained at: the Loparskaya (at Murmansk), Roshchino (at Leningrad), Zvenigorod (at Moscow), Yakutsk, Tiksy, Alma-Ata, Ashkhabad, Abastumani and Simferopol. Spectrographs SP–47, SP–48, and SP–50 (**1**) were used for spectrographic investigations. For the photography of spectra in the infra-red, the photocontact image converters FKT–1 (**2, 3**) proved to be very sensitive. Reliable records of the hydroxyl band emission from 8000 Å to 13 000 Å are being obtained now (**4**) with the aid of spectro-electrophotometers with the resolving power about 5 Å within several tens of minutes.

At present, from the Zvenigorod observational data, N. N. Shefov obtained photographs of the night airglow spectrum with hydroxyl bands within 5000 Å–12 500 Å. From these data, he determined the intensity of the OH bands in this interval, among them the OH (10·4) band (**5–9**). The wavelengths of these OH bands have been determined by L. V. Mironova and N. N. Shefov (**10**). The intensities of some OH bands have been measured in Yakutsk by V. I. Yarin (**8, 11**), in Alma-Ata by V. I. Kariuguina (**12**), in Abastumani by L. M. Fishkova (**13–16**) and in Loparskaya and Simferopol by V. I. Moroz (**17, 18**). The mean distribution of the population in the vibrational levels of the OH molecules is well represented by the Boltzmann distribution with T_k about 10 000°K. However, from V. I. Yarin's data (**19**), a deviation from such distribution is sometimes observed. Observations obtained at a number of stations discovered a change in the relative populations of the vibrational levels (**7, 8, 11, 12, 15, 19**). N. N. Shefov (**9**) and V. I. Yarin (**19**) have shown that the distribution in the vibrational levels of the newly formed excited OH molecules is not uniform.

Interesting results have been obtained from the comparison of the intensity and the rotational temperature of the OH bands. From the Yakutsk observations, V. I. Yarin (**8, 11, 19, 20**) discovered their evident interrelation at $T \geqslant 250°K$, corresponding to the two-component reaction with an activation energy of 2,7 kcal.mol^{-1}. The dependence vanishes with T lower than 250°K. According to the data by N. N. Shefov (**7, 8**), Z. V. Kariaguina (**12**), L. M. Fishkova (**15**), this dependence is practically absent for the 9th level. From the Zvenigorod observations, M. A. Berg and N. N. Shefov (**21, 23**) found that for bands with the initial vibrational levels from 3 to 9 this dependence is absent for the levels $v = 3$, 4 and 5, for the levels $v' = 6$ and 7 there appears a very weak tendency of a dependence between lgJ(OH) and $1/T$, disappearing again for the level $v' = 9$. The determination of the rotational OH temperature from the different initial vibrational levels has shown their systematic difference. As it was shown by N. N. Shefov (**24**), the mean value of the temperature of the upper level bands is systematically higher than the one for the bands from the lower vibrational levels. This result was confirmed by V. I. Yarin (**20**) and Z. V. Kariaguina (**12**). The same was concluded in Ashkhabad from the data by G. I. Salova (**25**) and Wallace in the Yerkes Observatory. A comparison of the intensities and rotational temperatures of the bands from different levels has shown, according to the data by M. A. Berg and N. N. Shefov (**23**), that the bands from the $v' \leqslant 5$ levels, as well as from the $v' \geqslant 6$, are well mutually correlating. The correlation between the bands from the upper and the lower vibrational levels is however much weaker.

The rotational temperature of the OH bands shows a distinct dependence upon the geographical latitude: this dependence was studied by Prokudina (**26**), N. I. Fedorova (**27**), N. N. Shefov and V. I. Yarin (**28, 29**). Besides, according to the comparison of the Zvenigorod and Yakutsk data, the presence of simultaneous large variations in the rotational temperature of the OH bands is being revealed. By comparing the Yakutsk observational data with the ones of the Japanese stations, V. S. Prokudina established that the variation of the mean night intensities of the OH bands is synchronous.

The Herzberg bands of the O_2 molecule were studied by V. I. Yarin in Yakutsk. He determined the absolute intensities of the majority of the observed bands, compared the relative theoretical and measured probabilities of the transitions (**30**), obtained the correlations of the intensity of these bands with the intensities of other emissions (**30–32**). The Herzberg bands were also studied by Z. V. Kariaguina (**33**).

The atmospheric system of the O_2 molecule was investigated by M. A. Berg and N. N. Shefov (**21, 23**), the intensity and the rotation temperature of the (0,1) 8645 Å band were measured. As discovered, the intensity of this band correlates with the rotational temperature of the OH bands. The relation shows a fair correspondence with the bicomponent reaction with the activation energy about 2·7 kcal. mol^{-1}, i.e. the same has been obtained for the OH bands in Yakutsk by V. I. Yarin (**8, 11, 19, 20**). This relation is better expressed for the rotational temperature of the OH bands from the upper vibrational levels.

With the aid of the scanning Ashkhabad photometer Yu. L. Truttse (**34, 35**) observed the bright spots in the 5577 Å emission, exceeding up to three times the intensity of the surrounding sky background in the [O I] 5577 Å line. The spots appear only during the first half of the night. They gradually disappear before dawn. The spots are not always in a drift, but can retain their position during several hours. The minimum dimensions of the spots have been about 30 × 30°. However the spot phenomenon is not only observed in the [O I] λ 5577 Å line, but also in the continuum near 5577 Å. At the same time and in the same place of the continuum no increase of the intensity is being observed near 5300 Å, i.e. that a sharp change in the spectral distribution of the continuum is observed in different sky areas which is caused by the atmospheric component of the night airglow continuum.

The variations in the intensity of the Hα emission discovered by V. S. Prokudina (**36**) have been studied by L. M. Fishkova and G. V. Markova (**14, 37–40**) in Abastumani. Owing to their data the chief maximum of the Hα intensity occurs in July-August, the least maximum in the Spring, in March, which is, however, explained by the influence of the galactic component of the Hα emission. Observations of the Hα emission by means of the Fabry-Pérot interferometer were obtained by P. V. Shcheglov (**41, 42**). The observations by L. M. Fishkova and P. V. Shcheglov have shown the existence of the intensity decrease of Hα emission in the anti-solar point taking into account the tropospheric scattering for about 30%.

The line of the atomic nitrogen 5200Å has been observed in the night airglow many times in the absence of signs of aurorae and geomagnetic disturbances. Such cases were noted by A. V. Mironov (**43**) and V. I. Yarin (**44**), who also obtained the mean diurnal variations of this emission. The absolute intensity of the line 5200Å was 3–10 R.

Basing upon the data on the properties of separate emissions obtained by different investigators, the emissions have been compared mutually and with the other characteristics of the Earth atmosphere. The comparison of some properties of the OH and O_2 molecules have already been mentioned. Besides the above correlations it has been discovered that the intensities and the rotational temperatures of the OH bands and the O_2 atmospheric system are also mutually correlating, this correlation being expressed more clearly for the OH bands from the upper vibrational levels (**21–23**). According to the observations by V. S. Prokudina (**45, 46**), the OH and Na emissions are also correlating, as well as the OH and [OI] 6364Å ones. The data by V. I. Yarin (**31**) confirm these correlations. However, according to the Yakutsk data, the correlation between OH and 6364Å has only been observed for the rotational temperature of the OH bands less than 260°K.

From the observations by V. I. Yarin (**30, 32**), the intensity correlations of the Herzberg O_2 bands with the intensities of the bands OH have been obtained, [OI] 6364Å and the continuum near 4700Å and 5200Å.

Different twilight emissions have also been discovered during the recent years. I. S. Shklovsky predicted in 1957 (**47, 48**) the existence of OI 8446Å emission in the twilight airglow, originating in consequence of fluorescence resulting at the absorption by the atomic oxygen of solar radiation in the $L\beta$ line. From the Zvenigorod observations, this emission has been discovered by N. N. Shefov (**49**). Its mean intensity is 13 rayleighs, i.e. for an order less than predicted by I. S. Shklovsky and an order more than calculated by Brandt. The increase of the continuum near 6000Å was discovered by V. I. Yarin (**50**). The maximum in this interval is most probably connected with the reaction between the nitrogen oxide and the atomic oxygen.

As known, in the sunlit aurora of 1958 February 10–11 in Zvenigorod, A. V. Mironov, V. S. Prokudina and N. N. Shefov discovered for the first time the helium emission 10 830Å (**51**). The further observations by N. I. Fedorova (**52, 53**) in the Loparskaya confirmed its presence. Basing upon the properties of the appearance of 10 830Å helium emission, N. N. Shefov (**54, 55**) assumed that helium emission is caused by the fluorescence of the metastable helium atoms in their 2^3S state under solar radiation. The analysis of the excitation processes of helium emission has shown that it must arise in ordinary twilight in the absence of aurorae. Electrons with energies of about 25 eV, the collisions with which are the most effective processes in the formation of metastable helium atoms, can originate in the upper atmosphere as a result of different processes, as for instance at the expense of the ionization of atoms and molecules by the corpuscules or ultra-violet solar radiation. The intensity of the 10 830Å emission in the sunlit aurorae can reach 50 kR and 1–2 kR in usual twilight (**56–59**). P. V. Shcheglov (**41, 42, 60, 61**) observed the 10 830Å emission in twilight by means of the étalon Fabry-Pérot and estimated its line width to be less than 0·15Å. The study by E. V. Kononovitch and N. N. Shefov (**62**) of the relation between the 10 830Å intensity and the solar activity shows the possibility of a correlation between the 10 830Å intensity and the area of the solar calcium flocculae. The processing of the observational data obtained in Zvenigorod confirms such correlation. The observation of the intensity variation of the 10 830 Å emission during twilight permits also to determine the flux of the ultra-violet solar radiation and the temperature of the upper atmosphere (**63**). Observations by N. I. Fedorova of 10 830 Å emission in aurorae have shown some correlation with geomagnetic activity (**64**).

During the solar eclipse of February 1961 it was succeeded to record helium emission with intensity about 4 kR. According to the data by F. K. Shuyskaya (**65**) the intensity of the oxygen lines 6300 Å, 6364 Å constituted about 30 kR, Na 5893 Å about 100 kR. F. K. Shuyskaya discovered also in the spectrum of the day airglow the atomic oxygen line 4368 Å with the intensity about 11 kR. The maximum intensity of the (0,0) ING N_2^+ 3914 Å band was estimated to be about 28 kR.

BIBLIOGRAPHY

Sbornik in the references is for 'Spectral, electrophotometric and radar researches of aurorae and airglow' (from no. 7 entitled 'Aurorae and airglow') series 'The IGY results' published by the Academy of Sciences of the U.S.S.R.

1. Gerasimova, N. G., Jakovleva, A. V. *Pribory i tekhnika eksperimenta*, no. 1, 83, 1956.
2. Volkov, I. V., Esipov, V. F., Shcheglov, P. V. *Dokl. Ak. N. SSSR*, **129**, 288, 1959.
3. Volkov, I. V., Esipov, V. F., Shcheglov, P. V. *Astr. Zu.*, **39**, 323, 1962.
4. Vaisberg, O. L. *Sbornik*, no 10, 54, 1963.
5. Shefov, N. N. *Sbornik*, no. 1, 25, 1959.
6. ,, *Sbornik*, no. 2–3, 57, 1960.
7. ,, *Sbornik*, no. 5, 18, 1961.
8. Krassovsky, V. I., Shefov, N. N., Yarin, V. I. *J. atm. terr. Phys.*, **21**, 46, 1961.
9. Shefov, N. N. *Sbornik*, no. 6, 21, 1961.
10. Mironova, L. V., Shefov, N. N. *Sbornik*, no. 8, 11, 1962.
11. Yarin, V. I. *Sbornik*, no. 5, 10, 1961.
12. Kariaguina, Z. V. *Sbornik*, no. 8, 6, 1962.
13. Fishkova, L. M., Markova, G. V. *Abastumanskaja astrof. Obs. Bjull.*, **24**, 161, 1959.
14. Fishkova, L. M., Markova, G. V. *Sbornik*, no. 2–3, 49, 1960.
15. ,, ,, *Sbornik*, no. 6, 17, 1961.
16. Fishkova, L. M. *Sbornik*, no. 9, 5, 1962.
17. Moroz, V. I. *Astr. Zu.*, **37**, 123, 1960.
18. ,, *Astr. Zu.*, **38**, 998, 1961.
19. Yarin, V. I. *Sbornik*, no. 9, 10, 1962.
20. ,, *Sbornik*, no. 8, 9, 1962.
21. Berg, M. A., Shefov, N. N. *Sbornik*, no. 9, 46, 1962.
22. ,, ,, *Planet. and Space Sci.*, **9**, 167, 1962.
23. ,, ,, *Sbornik*, no. 10, 19, 1963.
24. Shefov, N. N. *Sbornik*, no. 5, 5, 1961.
25. Salova, G. I. *Sbornik*, no. 9, 44, 1962.
26. Prokudina, V. S. *Izv. Akad. Nauk SSSR, Ser. geofiz.* no. 4, 629, 1959.
27. Fedorova, N. N. *ibid*, no. 6, 836, 1959.
28. Shefov, N. N., Yarin, V. I. *Sbornik*, no. 5, 25, 1961.
29. ,, ,, *Sbornik*, no. 9, 19, 1962.
30. Yarin, V. I. *Sbornik*, no. 9, 34, 1962.
31. ,, *Sbornik*, no. 5, 33, 1962.
32. ,, *Sbornik*, no. 5, 35, 1962.
33. Kariaguina, Z. V. *Sbornik*, no. 10, 15, 1963.
34. Truttse, Yu. L. *Sbornik*, no. 10, 8, 1963.
35. ,, *Planet. and Space Sci.*, **9**, no. 12, 993, 1962.
36. Prokudina, V. S. *Sbornik*, no. 1, 43, 1959.
37. Fishkova, L. M., Markova, G. V. *Astr. Cirk.* no. 196, 8, 1958.
38. ,, ,, *ibid*, no. 208, 14, 1959.
39. ,, ,, *Dokl. Ak. N. SSSR*, **134**, 799, 1960.

40. Fishkova, L. M. *Sbornik*, no. 10, 35, 1963.
41. Mulyarchik, T. M., Shcheglov, P. V. *Planet. and Space Sci.*, **10**, 215, 1963.
42. Shcheglov, P. V. *Sbornik*, no. 10, 40, 1963.
43. Mironov, A. V. *Sbornik*, no. 2–3, 66, 1960.
44. Yarin, V. I. *Sbornik*, no. 9, 53, 1962.
45. Prokudina, V. S. *Sbornik*, no. 2–3, 68, 1961.
46. ,, *Sbornik* no. 5, 32, 1961.
47. Shklovsky, I. S. *Astr. Zu.*, **34**, 127, 1957.
48. ,, *Ann. Géophys.*, **14**, 419, 1958.
49. Shefov, N. N. *Sbornik*, no. 9, 55, 1962.
50. Yarin, V. I. *Sbornik*, no. 9, 61, 1962.
51. Mironov, A. V., Prokudina, V. S., Shefov, N. N. *Sbornik*, no. 1, 20, 1959.
52. Fedorova, N. I. *Sbornik*, no. 5, 42, 1961.
53. ,, *Planet. and Space Sci.*, **5**, no. 1, 75, 1961.
54. Shefov, N. N. *Sbornik*, no. 5, 47, 1961.
55. ,, *Planet. and Space Sci.*, **5**, 75, 1961.
56. ,, *Astr. Cirk.* no. 222, 11, 1961.
57. ,, *Ann. Géophys.*, **17**, no. 4, 395, 1961.
58. ,, *Sbornik*, no. 8, 50, 1962.
59. Shefov, N. N. *Planet. and Space Sci.*, **10**, 73, 1963.
60. Shcheglov, P. V. *Astr. Zu.*, **39**, 158, 1962.
61. ,, *Sbornik*, no. 9, 59, 1962.
62. Kononovitch, E. V., Shefov, N. N. *Geomagnet. i Aeronomii*, **3**, no. 1, 1963.
63. Shefov, N. N. *Sbornik*, no. 10, 56, 1963.
64. Fedorova, N. I. *Izv. Akad. Nauk SSSR, Ser. geofiz.* no. 4, 538, 1962.
65. Shuyskaya, F. K. *Sbornik*, no. 10, 44, 1963.