8. SOME NEW IONIZING AGENTS AND PROPERTIES OF THE IONOSPHERE

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The instruments with which we have obtained our results are displayed at the Industrial Exhibition (in Moscow), and therefore I shall not describe them here. I shall state briefly the results of those investigations in the upper atmosphere which are related to the interplanetary medium and are therefore of interest to astronomers.

We made an attempt to measure corpuscular fluxes by means of the third sputnik. For this purpose we used as indicators two fluorescent screens made of ZnS (Ag) (2×10^{-3} g cm^{-2}), covered with aluminium foil of different thicknesses (8×10^{-4} g cm^{-2} and 4×10^{-4} g cm^{-2}). There were three aluminium diaphragms 5 mm thick in front of screens 5 cm in diameter. Each diaphragm had a window for capturing all corpuscles with a solid angle of 1/4 steradian. The emission of the fluorescent screens was detected by photo-multipliers. The electrical signals so produced were transmitted to a storage device and then to the Earth by a radio-telemetering system.

The characteristic of the amplifier system was made non-linear so that currents of 10^{-11} to 10^{-8} amp/cm^2 would be registered by the thick-foil indicator from 10^4 eV electrons striking the screens perpendicularly.

Intense signals were registered by both indicators during the magnetic disturbances of 1958 May 15. Sometimes the signals were off-scale, and threshold signals were nearly always present.

The signal amplitude seems to be larger in high latitudes than near the equator, and also seems to be larger at greater heights than at lower ones. In many cases signal amplitude rapidly increased or decreased in less than a second even for intense signals. Signal intensity varied continually.

The data obtained has not yet been completely reduced nor compared with other observations. Therefore we have no final conclusions as yet.

In principle one can try to explain the signals registered in terms of the irradiation of the screen with ions (protons, for instance) or X-rays or electrons, so long as the energies involved are between a few keV to a few hundred keV.

Since we do not expect to find many highly energetic protons or electrons, preference should be given to the agent associated with the least energy flux. Therefore the most attractive agent is not-very-fast electrons.

When the emission-intensity from the thin-foil screen was higher than that from the thick-foil screen, the electron mean energy cannot exceed substantially 10^4 eV, and may be even less than this.

As indicated above, an off-scale signal for 10^4 eV electrons with the thick-foil indicator implies an electron flux in excess of 4×10^3 erg sec^{-1} cm^{-2} steradian^{-1}. A threshold signal implies an electron flux of about 3 ergs sec cm^{-2} steradian^{-1}. The respective numbers for thin-foil ones are 5×10^1 and 5×10^{-2}. Such an intensive irradiation, no doubt, will make the investigation of solar X-ray radiation and cosmic γ-radiation more difficult.

X-ray radiation caused by the electrons will be dangerous for living beings who travel in this region for a long time. On the other hand, powerful electron fluxes can strongly heat the upper atmosphere, increasing its scale height. This is interesting in view of multifarious new data concerning the upper atmosphere.

It is not the time yet to put forward any definite hypothesis on the origin of the observed corpuscles. We confine ourselves to some short comments. The usual delay time of geomagnetic disturbances as compared to the time that an active region passes through the centre of the Sun's disk does not allow us to make a supposition that electrons with energy of several keV might be solar corpuscles. It is also difficult to suppose that these electrons were formed near the Earth by a transfer of energy from some other type of primary corpuscles—for instance, protons moving with a speed of about 2×10^8 cm sec^{-1}. To expain the above indicated energy fluxes (more than 4×10^3 erg sec^{-1} cm^{-2} steradian^{-1})

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it was required that the proton density in the primary fluxes be 4×10^3 particles cm^{-3}; such fluxes have not yet been indicated by the auroral hydrogen emission studies.

It is of interest to point to the possibility of explaining the observed phenomena by the acceleration of electrons in the outer atmosphere by variable magnetic fields in the solar corpuscular fluxes. This acceleration would take place in the conduction loops along the Earth's magnetic force lines in the outer atmosphere and be completed through the ionosphere. The faster electrons are expected in this case to enter at the polar regions, rather than at lower latitudes, as the polar regions connect magnetically to a larger volume of space. The increase of the electron fluxes during the day-time might be explained by the ionization increase at the boundary of the exosphere. As a result of the ionization increase, a great number of ionized particles may get into the outer atmosphere. This may also happen due to magnetic variations P_c, which are more intense during the day-time. Acquiring some speed, the electrons may oscillate along the curved magnetic force lines of the Earth.

The group of Soviet scientists headed by K. I. Grinhauz since 1954 has been investigating the ionosphere by means of very high frequency-dispersion rocket-borne interferometers. The distribution of electron concentration up to the height of 473 km has been obtained. It has been found that above the maximum of the F_2-layer, at heights of 290 km and 473 km, the electron concentration is $1{\cdot}8 \times 10^6$ and $1{\cdot}0 \times 10^6$ electrons cm^{-3} respectively. Below the maximum of the F_2-layer, no strongly pronounced layers of the ionosphere had been found. In general the ionization continuously increases from the bottom up to the maximum of the F_2-layer with many small fluctuations. The F-region and the maximum of the F_2-layer are located 50–150 km lower than is indicated by the results of the usual ionospheric probings.

The group of research workers headed by K. I. Grinhauz has conducted an investigation of the ionosphere by ion traps and probes—the equipment carried by the third sputnik. For the time being the treatment of the experimental results is in its initial stage; thus only some preliminary information characterizing the measurements can be given.

We confine ourselves to considering the measurements at those points of the sputnik's orbit relating to the first day of its flight. These results are typical, although lower values were observed. At a height of 242 km, a density of $5{\cdot}2 \times 10^5$ cm^{-3} for the positive ions, and an effective electron temperature of 7000° K have been recorded during the daytime. At a height of 795 km on the same day the density of $1{\cdot}8 \times 10^5$ cm^{-3} for the ions and an effective electron temperature higher than 15,000° K have been registered.

The indicated investigations show that there exists a large scale height for ionized particles that agrees well with that of the upper atmosphere indicated by observations of the drag experienced by the sputniks. The increase of the electron temperature with height, as well as for the gaseous discharge, can be explained by the increase of the length of the electron mean free path, if electromagnetic fields are present in the ionosphere. Such fields can arise in the process of circulation of the electro-conductive upper atmosphere in the magnetic fields frozen into the corpuscular fluxes of the Sun and interplanetary gas passing by the Earth.

9. SOME RESULTS OF OUTER IONOSPHERIC STUDIES BASED ON RADIO OBSERVATIONS OF THE FIRST SPUTNIK

Y. L. ALPERT

ABSTRACT

The method and results of the study of the outer ionosphere based on the 'rise' and 'set' of radio signals of the sputnik are given in full in the paper of which this is an abstract. Results of the theoretical calculations of the maximum horizontal distance r_M of signal

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