and is also in good agreement with the first ionization potential of O_2, 13.0 volts.

For X/p less than 90 there may be very strong electron attachment in O_2. If the region near the anode is a plasma, X/p would certainly be no greater than 10 for the present conditions, and it might therefore be assumed that strong electron attachment is very probable. Because of this, the anode is bombarded chiefly by O_2^- ions and slow electrons. When the current density is sufficiently great for the development of an anode glow, or anode sheath, then the value of X/p may exceed 90. In this case, when O_2^- ions enter the glow, the electrons readily detach and gain sufficient energy to ionize by collision. Within the sheath, the field strength would be too great for attachment so that a positive space charge would be expected here.

The spots observed on the auxiliary electrode were about 2 mm in diameter at 0.80 mm pressure. If one assumes that the edge of the sheath is spot boundary and that the entire potential drop through the spot is 13.0 volts, an X/p of 160, well above the value for electron detachment, results. These calculations confirm the plausibility of the reasons suggested for the absence of anode spots in oxygen glows.

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Fast Neutrons and Particles with High Specific Ionization in the Cosmic Radiation at High Elevations

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In a series of flights the number of particles producing large amounts of ionization was measured in the stratosphere with proportional counters. The counters were so adjusted that they did not record pulses produced by ordinary beta- or gamma-rays, but only those produced by particles possessing more than an assignable minimum of specific ionization. In two flights, boron trifluoride counters were used and in two others, different gases were employed.

A proportional counter, filled with boron trifluoride, and adjusted not to detect electrons, will count, in the stratosphere, at a rate equal to the sum of three quantities, A, B and C. A is the number of slow-neutron-induced boron disintegrations, the resulting alpha-particles being counted. B is the number of recoil nuclei produced by fast neutrons traversing the counter, and C is the current of other particles of high specific ionization passing through the counter. In this case it is evident that:

$$A = VN_B\rho\sigma_c v_c$$
$$B = VN\int_{v_2}^{v_1} i(v)\sigma(v)dv \qquad C = S\int_{v_4}^{v_3} I(v)dv, \tag{1}$$

where V is the volume of the counter, N_B the number of B^{10} nuclei per cc, ρ the density of neutrons per cc with energies in the $1/v$ region, σ_c the capture cross section for B^{10} for neutrons of velocity v_c, N the total number of nuclei per cc in the counter, $i(v)dv$ the current of fast neutrons of velocity between v and $v+dv$, σ the recoil cross section of the nuclei of the gas used for neutrons of velocity v, S the cross-sectional area of the counter and I the current per cm², of particles of high specific ionization. The limits of integration, v_1 is the highest and v_2 the lowest neutron velocity producing measurable recoils; v_3 the highest and v_4 the lowest velocity of a particle traversing the counter and producing enough ions to record as a count.

The factor A will be zero for counters using gas other than BF_3. Factor B is proportional to the number of nuclei in the counter (pressure times volume), while C depends on the cross-sectional area of the counter. Hence the use of counters of different sizes and pressures will permit a separation of the effects. Inserting in Eq. (1) the observed counting rates on the four flights, the known S, V and N, taking $(\sigma_c v_c)$ as 10^{-16} and σ as 10^{-24}, we obtain values for ρ, i and I. These are, respectively, at 2 meters of water equivalent below the top of the atmosphere: $\rho = 1\pm 1\times 10^{-6}$ per cc; $i = 5\pm 2$ per cm² and $I = 1.4\pm 0.7\times 10^{-3}$. These values of ρ and i are in substantial agreement with those previously established by ourselves[1] and others,[2] while no previous measurements exist for I. It is quite impossible to account for the observed results on the basis of fast neutrons alone, by assuming that C is zero, unless the fast neutron flux be supposed increased by a factor of several hundred.

It was necessary to show that gamma-rays had no influence on the counting rate. Before each flight the counter was tested with and without a quantity of radium nearby, which produced in the counter an amount of ionization between 2 and 5 times that encountered in the stratosphere. The backgrounds were thus determined, as was the counting rate in the presence of a known flux of neutrons, with and without the additional gamma-rays.

It seems improbable that large showers could account for the results since (a) it would require over 200 electrons passing simultaneously through the counter to make it discharge, and (b) there was no shower-producing material nearby, the batteries being far below and only the thin glass wall and cardboard container above.

Further tests were made by operating the counter at two voltages during a flight, each voltage being maintained constant for 3 minutes. This, in effect, may be considered as varying the lower limit of the integral in B and C by known amounts. The counting rate could be compared with the previously calibrated rates when the same arrangement was operated in the presence of a known neutron source.

It seems necessary to conclude that fast neutrons alone cannot account for all the observed counts, but that a flux of fast particles of high specific ionization exists. These may be primary protons at the ends of their ranges, or other nuclear particles produced by the radiation. Further details will be published shortly.

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