also reported by Nishina, but the assignment of the 26-minute palladium as the parent of the 7.5-day silver was not made. We have established this genetic relationship by means of successive extractions of the silver from the palladium.

The isotopic assignments in the first chain are based upon the identification[5] of Ag^{112}. The isotopic assignments in the second chain are based upon the identification[6] of Ag^{111}. By deuteron bombardment of palladium, Kraus and Cork[6] have found a period of 17 minutes which they assign to Pd^{111}. We have found a 26-minute palladium in the palladium fraction of the fission products of uranium and thorium, and repeated extractions of silver from neutron irradiated thorium shows that the 7.5-day period grows from a 26-minute parent. Our neutron irradiation of palladium (no chemical separation) also shows an activity of about 26 minutes half-life. The reason for the discrepancy between these results and those of Kraus and Cork is not yet clear.

The cross sections for the production from thorium of these two chains are comparable and are of the order of one-tenth of the cross section for the formation of the 77-hour tellurium under identical conditions. The comparatively low intensity of these activities makes it imperative to purify the products very carefully in the chemical separations.

We have also looked for radioactive ruthenium among the fission products of uranium and thorium and have found an activity of ~4 hours half-life. An investigation of this region is being continued.

Worth mentioning here is the observation, made during our neutron bombardments of palladium, that a 40 second $Ag^{107*,\ 109*}$, which may be the same as the 40-second silver formed as the product[7] of the decay of the 6.7-hour $Cd^{107,\ 109}$ also grows from the 13-hour[6] $Pd^{107,\ 109}$.

We wish to express our gratitude to the Rockefeller Foundation and the Research Corporation, whose financial support made this work possible.

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Anode Spots in Oxygen

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December 27, 1940

It has been shown[1] that anode spots appear in N_2 glow discharges when a certain minimum anode current density is exceeded. Anode spots have never been observed in O_2, and various reasons[2,3] have been proposed for their absence. In these explanations, however, the authors neglect the possibility that in their experiments a sufficiently high anode current density to permit the appearance of the spots might not have been established. Since a method[1] was developed for attaining considerable anode current densities in N_2, it appeared that an application of this same procedure to O_2 might provide the conditions under which anode spots would appear. Should this be the case, it would provide an excellent opportunity to test the conditions proposed as essential for the formation of anode spots.

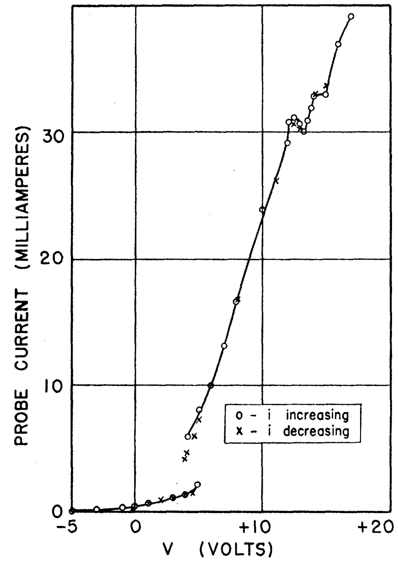

Fig. 1. Current-voltage characteristic for the growth of anode spots in O_2.

The experiment was performed in an oxygen glow discharge maintained in the same apparatus previously described. For O_2 in the same pressure range under which anode spots appeared spontaneously in N_2, neither anode spots nor even a well-defined anode glow could be observed for drift currents up to 500 ma so long as the flat probe auxiliary electrode was maintained at the anode potential. However, when the probe was 5 volts or more positive with respect to the anode, a bright, pale green glow covered the surface of the flat probe, and the probe current rose discontinuously. Holding the drift current constant at 300 ma the current-voltage characteristic curve shown in Fig. 1 was obtained.

It is seen that the current rises discontinuously at 5.0 volts and then increases to a sharp maximum. When the minimum at 13.2 volts was attained, the uniform glow on the auxiliary electrode changed to four brilliant hemispherical spots equally spaced around the probe edge. When the probe potential was further increased, the spots rotated. From these observations, which are similar to those in N_2, we conclude that anode spots might form spontaneously in an oxygen glow discharge at sufficiently great current densities. By dividing the probe current, when the spots appeared, by the probe area, a lower limit for the current density should result. This was found to be of the order of 100 ma/cm², a value which would be difficult to obtain in conventional discharge tubes.

The probe potential at which the current maximum occurs, 12.7 volts, is nearly the same as the value found by Guntherschultze and Keller[4] for the anode fall in O_2, 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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December 7, 1940

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: $\rho = 1\pm1\times10^{-6}$ per cc; $i = 5\pm2$ per cm² and $I = 1.4\pm0.7\times10^{-3}$. 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.

Acknowledgment for support is made to the Carnegie Institution of Washington.

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