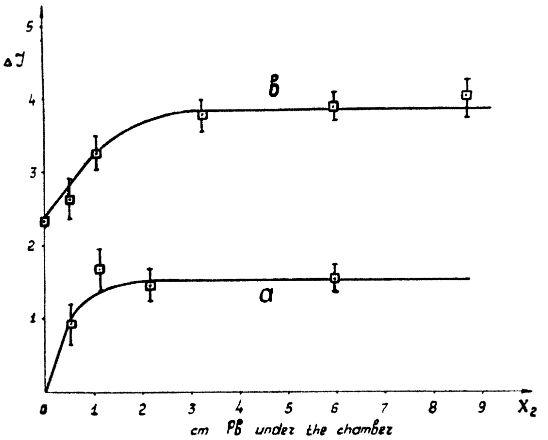

FIG. 2. Increase of ionization due to lead X_2 beneath the chamber (0.4 mm Al), Elbrus glacier: (a) No lead above chamber ($X_1=0$), (b) 1 cm Pb above the chamber.

In order to observe transition curves not distorted by scattering, special methods of measurement must be applied. We used a measuring instrument (ionization chamber or counter) with thin walls and completely surrounded the instrument by a lead screen. Under these conditions the number of particles lost in the lead above the apparatus will be compensated by those scattered upwards from the lead.

Measurements of the transition curves of the soft component by this method were carried out by one of us at an altitude of 4200 m on Mt. Elbrus[4] (1940) and at an altitude of 3860 m in the Pamir Mountains (1944). In the Pamirs three instruments were operated simultaneously: two flat ionization chambers (40×40×5 cm) with aluminum walls of 0.4 and 0.02 mm thickness and a counter 2 cm long, 0.7 cm in diameter and with 0.3 mm Al walls. On Mt. Elbrus measurements (with the first chamber) were carried out on a glacier and this permitted us completely to exclude the influence of radioactivity on the ionization currents measured. The results are shown in Fig. 1.

The transition curves obtained by us have a very sharp maximum and in this respect strongly differ from those of Schindler and Young and Street (Curve III of Fig. 1). Under 1 cm of lead the intensity of the soft component obtained by using a foil chamber exceeds by a factor of 3.8 the value obtained when no lead is placed above and below the chamber. In the chamber with 0.4 mm Al walls the increase in the maximum turned out to be 2.1 while the counter yielded an increase of 2.6 times.

The result of measurements of the "back current" (increase of ionization when lead is placed below the chamber) carried out in 1940 on a glacier at Mt. Elbrus are shown in Fig. 2. These measurements clearly illustrate the importance of the scattered radiation from lead which increases the ionization in the 0.4 mm Al chamber by almost 40 percent of that of the soft component when no lead is employed; this result accords with the theory.[9]

On transition from lead to aluminum a considerable decrease of intensity should take place because absorption of cascade electrons in thin layers of aluminum is much stronger than their reproduction by photons. It can be seen from Fig. 1 that the intensity of the soft component under the lead appreciably decreased when the wall thickness of the ionization chamber was changed from 0.02 to 0.4 mm Al (Curves II and III of Fig. 1). Special investigations of the lead-to-aluminum (thin layers) transition effect carried out in the Pamirs are in good agreement with the cascade theory calculations of Tamm and Belenky.[8,10]

The air-to-lead transition curve obtained by using the counter is similar to that obtained with the ionization chamber (of approximately the same wall thickness), its maximum, however, being somewhat higher. This may indicate that an appreciable part of the ionization of the soft component in air is owing to heavily ionizing particles.

According to Alichanov[11] an even greater fraction of the ionization by the soft component should be ascribed to heavy particles. On the other hand, comparison of the experimental transition curve obtained with the foil chamber with the cascade curves computed on basis of present knowledge of the electron spectrum in air[8,12] permits one to estimate the upper limit of the fraction of ionization due to non-multiplying heavy particles at about 50 percent of the total soft component.

Measurements carried out in aerostats to altitudes of 8–9 thousand meters showed that on surrounding the ionization chamber by 1 cm of lead the intensity of the soft component increased by 2 times (the thickness of the chamber walls being 0.4 mm Al). Multiplication was insignificant when the lead absorber covered a solid angle of only about one steradian.

This once more points to considerable scattering of the soft component in lead and the necessity of taking this scattering into account in all experiments in which the soft component is investigated.

* Deceased.

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Evidence for the Reaction $O^{17}(n, \alpha)\ C^{14}$

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IN 1944 a search was made by A. N. May and the writer for the reaction $O^{17}(n, \alpha)C^{14}$ by exposing oxygen samples in a pressure ionization chamber to a high thermal neutron flux. Two samples were compared, one being enriched (3 times normal) and the other impoverished (0.5 times normal) in the isotope O^{17}. The pulses produced in the chamber were amplified and counted by a kicksorter or pulse amplitude analyzer. Differences between runs with the two samples showed a significant increase in the number of pulses between 1 and 2 Mev in the case of the enriched sample, with a peak at about 1.4 Mev. The effect proved to be caused by thermal neutrons, and has been attributed to the above reaction.

With air in the ionization chamber, the pulses due to the reaction $N^{14}(n, p)C^{14}$ were counted, thus permitting the cross section for the oxygen effect to be determined in terms of the nitrogen cross section. We found a value $\sigma_O/\sigma_N = (1.1 \pm 0.3) \times 10^{-4}$, where σ_O is the cross section per atom of natural oxygen. Lapointe and Rasetti[1] have found a value 1.2×10^{-24} cm^2 for σ_N which, however, is based on a value of 600×10^{-24} cm^2 for σ_B, the neutron capture cross section of boron. On the basis of a recently published value of $\sigma_B = 710 \times 10^{-24}$ cm^2,[2] the above value of σ_N should be increased to 1.4×10^{-24} cm^2. Assuming this figure, the cross section for the (n, α) reaction in O^{17} is then $(1.6 \pm 0.4) \times 10^{-28}$ cm^2 per atom of natural oxygen, or $(0.38 \pm 0.09) \times 10^{-24}$ cm^2 per atom of O^{17}.

Using the masses of O^{17} and C^{14} given by Mattauch,[3] we find that the reaction $O^{17}(n, \alpha)C^{14}$ should be exothermic, with $Q = +1.72$ Mev, in approximate agreement with our results.

A full account of the experiment will be submitted for publication to the *Canadian Journal of Research.*

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Three Unusual Cosmic-Ray Increases Possibly Due to Charged Particles from the Sun

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Several world-wide decreases in cosmic-ray intensity have been observed[1,2] during magnetic storms. These decreases have been ascribed[3] to ring currents, or their equivalents, required to account for the observed world-wide magnetic changes.

In about 10 years of continuous records of ionization in Compton-Bennett meters (shielded by 11-cm Pb) three obviously unusual increases in ionization have been noted. For Cheltenham, Maryland, geomagnetic latitude, $\Phi = 50°$ N, these are shown in Fig. 1, in which the bi-hourly means were corrected for barometric pressure. Curves very similar to the upper one in Fig. 1 obtain[2] simultaneously for Godhavn, Greenland, $\Phi = 78°$ N; and for Christchurch, New Zealand, $\Phi = 48°$ S. Except for the absence of significant increases on February 28, 1942; March 7, 1942; and July 25, 1946, the curves for Huancayo, Peru, $\Phi = 1°$ S, are otherwise quite similar to those for Cheltenham.

Figure 1 indicates each of the three unusual increases in cosmic-ray intensity began nearly simultaneously with a solar flare (bright chromospheric eruption) or radio fadeout (indicating a solar flare). Original records for February 28 and March 7, 1942, indicate increases in ionization which began within 0.3 hour after the commence ment of the radio fadeout. The record for Cheltenham on July 25, 1946, first indicated an increase in ionization 1.0 hour after the reported commencement of the solar flare and fadeout. All three fadeouts were complete for about five hours and the flare was reportedly observed for three hours until clouds obscured it.

Magnetic records from several observatories indicate that the magnetic changes during these fadeouts or flares were probably caused by an augmentation of the diuranl variation.[4] Thus the magnetic changes do not appear ascribable to a ring current as first supposed.[2] Magnetic records on the night side of the Earth indicate no significant change in field at the time of the fadeouts yet the cosmic-ray records show the increases occurred simultaneously on the day and night side.

The known small diurnal variation[5] in cosmic-ray intensity excludes the possibility that these increases could have been caused by an augmentation in magnetic diurnal variation.

During a period of several hours on March 7, 1942, when the cosmic-ray ionization at Cheltenham increased to well above normal, that at Huancayo was sub-normal. Also the

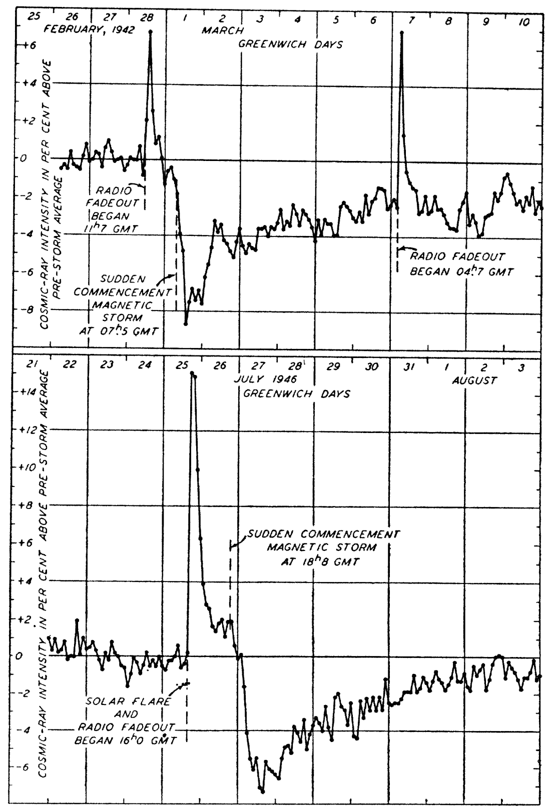

Fig. 1. Three unusual increases in cosmic-ray intensity at Cheltenham, Maryland, during solar flares and radio fadeouts.