contain two macromolecular substances giving sharp boundaries with the analytical ultracentrifuge. The more rapidly sedimenting boundary (*b* of photo.) is due to virus protein; the lighter component (*a*) is present in the juice of healthy as well as diseased plants. Purified solutions of the virus proteins have been obtained after two quantity ultracentrifugations[7], using saline for re-solution of precipitated protein and a time of centrifugation that would sediment only a negligible amount of the lighter component. Under the conditions of our experiments, the two heavy components were almost completely separated by applying a centrifugal field of 40,000 times gravity for not more than half an hour. The proteins of cucumber viruses 3 and 4 differ from unaltered tobacco mosaic virus protein in being practically insoluble in pure water. Saline dissolves them and facilitates the breakdown of traces of the smaller high molecular weight substances (corresponding to (*a*)).

Cucumber mosaic viruses 3 and 4 do not lend themselves so well to quantitative work as viruses giving necrotic local lesions. Nevertheless, Bawden and Pirie[2] have demonstrated that infectivity was concentrated in their chemically isolated virus protein preparations. Our heavier components are highly infectious and without doubt they are essentially the same as Bawden and Pirie's proteins. Fresh preparations of the proteins of cucumber viruses 3 and 4 give single sharp boundaries in the analytical ultracentrifuge (Photo. 2); their sedimentation diagrams are indistinguishable from each other and from that of unaltered tobacco mosaic virus protein[8]. As nearly as can be determined, these three proteins sediment at the same rate and thus probably have substantially the same molecular weights; sedimentation constants averaged from several closely agreeing photographs are $s_{20} = 173 \times 10^{-13}$ cm. sec.$^{-1}$ dynes^{-1} for the cucumber virus 3 protein, and $s_{20} = 175 \times 10^{-13}$ for the cucumber virus 4 protein. A recent determination[8] for the tobacco mosaic virus protein gave $s_{20} = 174 \times 10^{-13}$. Tobacco mosaic virus protein derived from plants infected for more than four weeks and purified by quantity ultracentrifugation with phosphate buffer as solvent shows[8] a second more rapidly sedimenting component with $s_{20} = 200 \times 10^{-13}$. Similar components (Photo. 4) were found in purified preparations of cucumber viruses 3 and 4 that were subjected to repeated ultracentrifugations.

Special interest is attached to the presence in cucumber plants of a homogeneous high molecular weight substance other than the virus protein. Purified solutions from either healthy or diseased plants sediment with a single fairly sharp boundary corresponding to $s_{20} = 77 \times 10^{-13}$ (Photo. 3). They have given the usual qualitative tests for proteins and have always had a clear chlorophyll-green colour. Water solutions can be kept in the icebox for several days; in saline, decomposition is more rapid. Considerable molecular damage follows repeated sedimentations in the quantity ultracentrifuge, but in this respect this macromolecular substance is not unique. When repeated ultracentrifugations were made of saline solutions of purified cucumber mosaic and tobacco mosaic virus proteins, the proteins were denatured and rendered insoluble.

As milder methods of extraction and purification have been introduced, there have been found an increasing number of apparently non-infectious heavy substances[9]. They are comparable with virus proteins in homogeneity and rate of sedimentation, in stability, and in concentration in tissues. It is reasonable to expect that their further study may throw light on the nature and the origin of the virus proteins.

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Cosmic Rays and the Aurora of January 25-26

BETWEEN January 16 and 26, there occurred three violent magnetic storms; the storm of January 25 was accompanied by a magnificent aurora borealis which was visible nearly in all parts of Europe (see NATURE, Jan. 29 and Feb. 5).

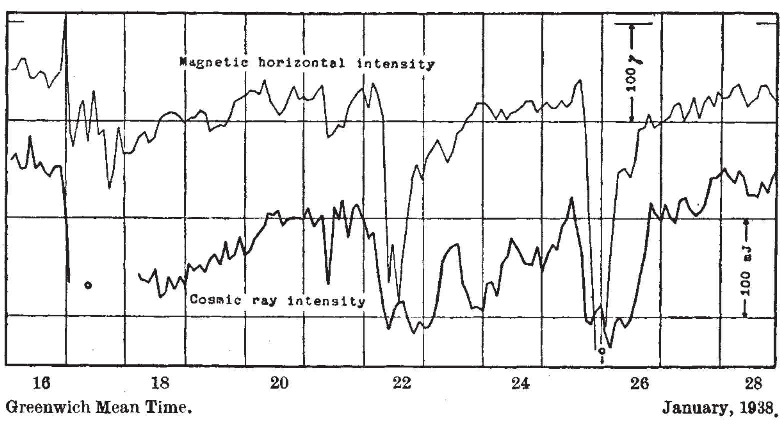

Fig. 1.

TWO-HOUR MEAN VALUES OF THE MAGNETIC HORIZONTAL INTENSITY AND OF THE COSMIC RAY IONIZATION DURING THE MAGNETIC AND AURORAL DISTURBANCES OF JANUARY 16–28, 1938. AVERAGE COSMIC RAY INTENSITY, 2356 MJ. AVERAGE HORIZONTAL INTENSITY 20,432 γ.

In 1937, during the severe disturbances from April 25 until April 30, S. E. Forbush[1] and two of the present writers[2] found from simultaneous registrations in North America, Peru and Central Europe, that cosmic ray ionization was influenced all over the earth by the magnetic storm, and that a sharp decrease of cosmic ray ionization followed a decrease of the magnetic horizontal force. A similar effect was also noticed by J. Clay[3] in Amsterdam.

This parallelism between the variations of the horizontal magnetic intensity and the cosmic ray ionization was observed once more and even more strikingly during the recent aurora and the two preceding magnetic storms mentioned above.

In the accompanying graph, the two-hour means of the magnetic horizontal intensity (as observed at the magnetic observatory, Vienna-Auhof, for which we are indebted to Prof. von Ficker) and the corresponding values of the cosmic ray intensity (from the registrations of the Hafelekar Observatory near Innsbruck, Austria, 2,300 metres above sea-level) are plotted together. The cosmic ray ionization was registered by means of a Steinke standard apparatus, completely screened from local radiations on all sides by iron (7 cm. thick) and lead screens (10 cm. thick). All observations are reduced to the same barometric pressure.

From inspection of the curves, it can be said that there is a very close parallelism between the variations of H (magnetic horizontal force) and J (cosmic ray ionization). The correlation coefficient as calculated from the curves is $+ 0 \cdot 72$.

On the day of the aurora (January 25) the ionization decreased from noon to 4 h. a.m. of the following day by 170 mJ ($= 0 \cdot 170\ J$), that is, by about 7 per cent. Then an increase of the same amount followed, and on the evening of January 26 both J and H were quite normal. The recovery of J occurred some hours later than that of H, and this was also noticed after the disturbance of January 22.

During the magnetic storm in the night of January 16–17, the decrease of the cosmic ray ionization amounted to 5·7 per cent within the first five hours; the further decrease could not be measured since the image of the electrometer fibre disappeared from the field of view. For the sake of comparison, it may be said that on magnetically undisturbed days the average deviation of the hourly values of J amounts to not more than $\pm 0 \cdot 62$ per cent.

From our observations shown in the diagram, it was calculated by Charlier's method that on the average the variation of the ionization was 0·82 mJ for a change in the magnetic horizontal intensity of 1γ ($1\gamma = 0 \cdot 00001$ gauss). This magnetic effect corresponds to 0·3 per mille per γ. During the magnetic storm in April 1937, Hess and Demmelmair[2] found an effect of the same order of magnitude (1·4 mJ per γ) and from the correlation of daily mean values in periods when the correlation is positive a similar effect was calculated by us in our last publication[4].

The effect of the variation of H during magnetic and auroral disturbances on the cosmic ray ionization can be explained by the assumption of corpuscular ring currents encircling the earth at distances of a few earth radii and supplied by solar eruptions (S. Chapman[5]). If during a solar outburst these ring currents are increased, the magnetic dipole moment of the earth is strengthened for regions outside these rings or shells, while inside, near the surface of the earth, the magnetic field is reduced. The increase of the magnetic field in outer space causes a considerable deflection of the normal paths of the cosmic ray particles, thus reducing the observed cosmic ray intensity on the earth.

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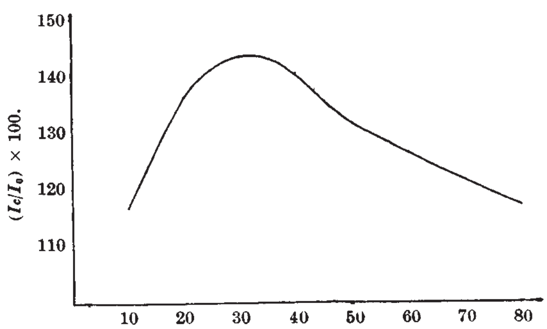
Canalization of Gamma Rays

In an earlier communication from this laboratory[1] a method of canalizing neutrons was described which made it possible to investigate the action of these particles at distances of a metre and upwards from weak sources. In the interval, apparatus capable of producing powerful beams of neutrons and penetrating X- or gamma rays has been developed in many laboratories.

This has made it desirable to investigate the possibility of canalizing electromagnetic radiations, and we have carried out such an investigation for the gamma rays from radium (B + C). For these measurements we have used the radiations from one, to ten or more, milligrams of radium filtered by 0·5 mm. of platinum, and canalized them by tubes of wax, lead, zinc, iron, etc., having lengths from 10 cm. to 1 m. and of varying wall thickness.



The ratio of the intensity of the canalized beam (I_c) to that of the direct uncanalized beam (I_0), is shown in the accompanying figure for iron canals of various lengths; the ionization being measured by a thin-walled ionization chamber. The internal and external diameters of these tubes were 70 mm. and 78 mm. respectively. Fuller details of these experiments, including the effects of varying the wall thickness of the ionization chamber, will be published elsewhere.

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