LETTERS TO THE EDITORS

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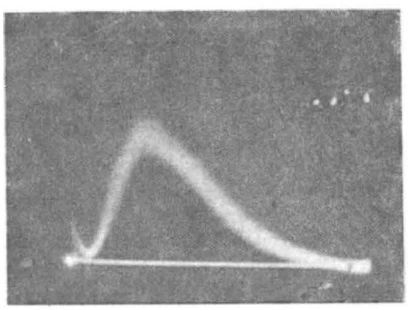
Observation of Spectral Lines with Electron Multiplier Tubes

CONSIDERABLE interest has been shown within the last two or three years in technical developments relating to spectroscopic analysis. Since the advent of several new controlled sources[1,2], including a circuit devised by Mr. C. J. Braudo, in this Laboratory and recently described briefly[3] (a full communication has been prepared), great importance has become attached to observations of any residual fluctuations in spectral-line intensities, because the irregularities in breakdown voltage of the test gap have been almost entirely eliminated by these new circuits.

A descriptive paper, giving details of multiplier observations of certain dynamic gas discharge effects, has recently appeared[4], and was followed by details of a multiplier technique for spectroscopic analysis[5]. It is therefore considered worth while to give a short summary of the experiments carried out in this Laboratory since 1943.

The development of reliable sealed-off triggered spark gaps[6] enabled us to use controlled spark sources for spectroscopic and other experiments some three years ago. Despite the accurate repetition of breakdown voltage and current (observed oscillographically) in the spark discharges then used, it was noticed that considerable fluctuations in light emission from argon spark discharges occurred[7,8].

This work led to several developments: among them were (*a*) the more refined spectroscopic source unit[3], (*b*) work on the accurate determination of ion concentrations in hydrogen spark discharges[9,10], and (*c*) some new observations of the excitation of metal electrode vapour in spark discharges.



The accompanying typical record for the Cd line 5085 A. is a photographic reproduction of the oscillograph screen. The vertical axis gives line intensity, using the amplified current from an electron multiplier excited from the sparks via a spectrometer, while the time axis is horizontal. The pulse is about 4 microsec. long, and is therefore that of a pure spark source. The circuit[3] mentioned above provides, if required, a follow current to give a discharge of arc type. Some preliminary multiplier measurements with this compound source were made early in 1946 and are to be extended.

We have observed fluctuations in the intensities of electrode vapour spectral lines (the thickness of the trace in the trace reproduced compared with that of the zero line is illustrative) which do not appear to be explicable on the grounds of circuit variations from spark to spark, and it appears possible that these fluctuations (now being studied) are linked with those observed in 1943[7] for purely gaseous (argon) discharges.

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Sept. 11.

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[4] Dieke, G. H., Loh, H. Y., and Crosswhite, H. M., *J. Opt. Soc. Amer.*, **36**, 185 (1946).
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Changes in Cosmic Ray Intensity Associated with Magnetic Storms

IT is usually supposed that the world-wide changes in cosmic ray intensity associated with a magnetic storm are due to variations in the earth's magnetic field produced during the storm. This seems to be excluded, however, by recent observations by Lange and Forbush[1], who have found that the intensity varies (decreases *and increases*) even at Godhavn, which is situated at so high a geomagnetic latitude (80°) that the earth's magnetic field cannot possibly affect the intensity. Further, the variations cannot be due to changes in the solar magnetic field, because they are observed even at Huancayo, which has a low geomagnetic latitude (0·6°) so that it is reached only by the high-energy particles which are certainly not influenced by the solar magnetic field. Then the only possible explanation seems to be that the variations in cosmic radiation are due to changes in the earth's electrostatic potential.

There are strong arguments in favour of the view that magnetic storms are caused by ionized clouds emitted from the sun. As the time of travel from the sun to the earth is about one day, their average velocity is of the order of $1{\cdot}5 \times 10^{13}/0{\cdot}864 \times 10^5 = 2 \times 10^8$ cm./sec. The solar magnetic field at the distance of the earth is likely to be 3×10^{-6} gauss (assuming a dipole field with about 50 gauss at the pole). Any electrical conductor (and the ion cloud is certainly conducting), which moves in a magnetic field, becomes polarized, the electric field strength being $E = vH/c$, which in our case gives $3 \times 10^{-6} \times 2 \times 10^8/3 \times 10^{10} = 2 \times 10^{-8}$ E.S.U. $= 6$ μvolt/cm. As storms often endure for, say, two days, the breadth of an ion stream emitted from the sun (and sharing the solar rotation, as shown by the 25-day recurrency of storms) should be $2/25 \times 2\pi \times 1{\cdot}5 \times 10^{13}$ cm. at the distance of the earth ($1{\cdot}5 \times 10^{13}$ cm.). This means that there must be a difference in potential between the two sides of the stream of $6 \times 10^{-6} \times 8 \times 10^{12} = 50 \times 10^6$ volts, the east (advancing) side being negative. As indicated by a