LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

The Doppler Effect and Field Distribution in the Hailer Canal-Ray Tube

Recently C. Hailer[1] has made a systematic study of various forms of discharge tubes in the endeavor to find one that would give a more intense beam of positive ions. Twelve different arrangements of the electrodes were tried, and in some cases thermionic emission from a hot cathode was also employed. The tube shown in Fig. 1 was found by

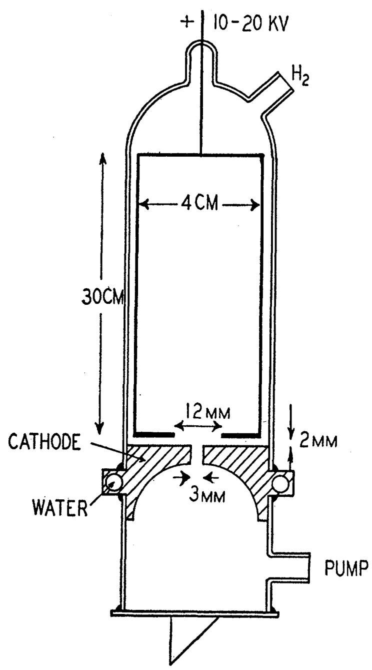

FIG. 1. Hailer canal-ray tube used in observations.

him to be much superior to the others; with this tube he obtained, for example, a positive ion current of one milliampere with 17 milliamperes in the main discharge. He ascribes the increased efficiency to a concentration of the ions in the center of the tube and to an increase in the field just before the cathode.

In this paper observations of the luminous canal-ray bundle in this tube are reported. The luminosity was much more intense than with the ordinary discharge tube. Doppler effect photographs were made, as it was thought possible that the concentration of the field over a short space in front of the cathode might give a homogeneous velocity.[2, 3] This was found not to be the case. The intensity distribution in the displaced wave-lengths showed no appreciable difference from that observed in Doppler effect photographs with an ordinary discharge tube. With 16,000 volts across the tube, most of the radiation in hydrogen, as shown by the Doppler effect at H_β and H_γ is emitted by hydrogen atoms which have been accelerated by potentials that vary from 150 to 5000 volts. It is well known that the intensity in the Balmer series lines from the atoms in motion is very small for velocities above that corresponding to 3000 volts, although some intensity is emitted from atoms with energies up to 50,000 volts or more.[4]

The field distribution near the cathode was measured by observing the Stark effect at H_β and H_γ at right angles to the rays. With 16,000 volts applied to the tube displacements of 6.15A were found on photographs at H_γ. The intensity was so great that the splitting up of the lines could be easily observed visually. The field distribution as computed is shown in Fig. 2, curve A. For comparison the field distribution observed by Krefft in an ordinary discharge tube is shown in curve B. In curve A the total potential was 16,000 volts, while in Krefft's tube the potential was 47,000 volts. For comparison his curve B is plotted with ordinates reduced in the ratio of the applied potentials. There is thus a concentration of the field intensity in the neighborhood of the cathode as suspected by

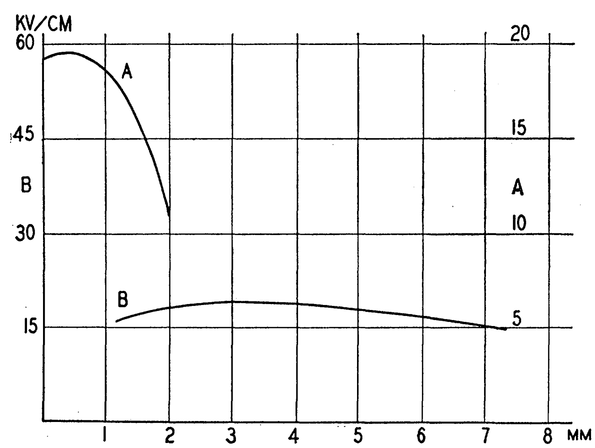

FIG. 2. Field distribution at various distances in front of cathode. A, with Hailer tube showing concentration near cathode. B, Krefft's observations with ordinary tube. Ordinates adjusted in ratio of the total potential on tube.

Hailer. The total potential drop in the two millimeter space as computed from the Stark effect was however only 3000 volts, when the applied potential was 16,000 volts. This is approximately what would be expected from the theoretical electrostatic field with the opening used. Since the larger part of the potential drop occurs inside the hollow anode we would expect to find ions of a great range of velocities, and thus explain the large spread in velocities observed in the Doppler effect photographs.

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February 24, 1939.

[1] C. Hailer, Wiss. Veroffentlichungen der Siemens-Werke 17, 115 (1938).
[2] H. F. Batho and A. J. Dempster, Astrophys. J. 75, 34 (1932).
[3] H. E. Ives and G. R. Stilwell, J. Opt. Soc. Am. 28, 215 (1938).
[4] H. Krefft, Ann. d. Physik 75, 75, 513 (1924).

Are There Multiple Charged Primary Particles in Cosmic Radiation?

William P. Jesse and Piara S. Gill have recently reported[1] a considerable latitude effect for very large cosmic-ray bursts (about 30 percent) the existence of which raises most interesting questions as to the manner of its origin. If, as suggested by their note, the burst frequency is a function of geomagnetic, and not of geographic, latitude, the implication is that this latitude effect results from the action of the earth's magnetic field on charged primary particles, essentially in the same manner as for the total radiation. It seems, however, quite certain that the energy involved in a large burst is at least of the order 10^{11} ev, or greater, so that, if the whole energy of such a burst is carried initially by a single primary particle, that primary cannot be an electron or a proton. This follows because the allowed cone for either is already completely open at all latitudes for energies about 7×10^{10} ev, and hence there cannot be any latitude effect for protons or electrons of energy 10^{11} ev. This suggests the very interesting possibility[2] that the primary particles responsible for the latitude effect of large bursts might carry a multiple of the electron's charge and presumably have large mass. For instance, stripped nuclei of atomic weight 11 to 13, even 16, and number 5 or 7, even 8, (e.g., boron, carbon, or even oxygen) of energy around 10^{11} ev would show a latitude effect of 30 percent (which would be very sensitive to a change of charge but rather independent of mass).

Doubtless there are still other alternatives that we wish to mention briefly. One, suggested by recent developments in nuclear physics, is that the energy of the burst is not the original energy of the primary particle. In this case the primaries might well be electrons of energy around 2×10^{10} ev. The problem would then arise as to why such energies give rise to bursts. Another, rather unlikely, alternative is that the observed latitude effect is not related to geomagnetism at all, but has to do, for instance, with atmospheric phenomena such as the bulging of the atmosphere at the equatorial belt as a consequence of the earth's rotation. Although this alternative is practically ruled out by the magnitude of the observed effect, the burst frequency should be, in this case, a function of geographic and not of geomagnetic latitude, which could be easily tested by comparing the measurements taken at two stations at the same geographic but different geomagnetic latitudes.

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February 27, 1939.

[1] W. P. Jesse and P. S. Gill, Phys. Rev. 55, 414 (1939).
[2] The possibility of a latitude effect for bursts, and the implication brought out here, were already discussed by Lemaitre and the writer at the Zurich Congress on cosmic-rays and nuclear physics, July, 1936.

NH Bands in the Night Sky Spectrum

In J. Gauzit's[1] recent list of ultraviolet radiations in the night sky spectrum there are two bands which are of particular interest when compared with a large number of observations made by me on the high pressure afterglow in nitrogen. These bands are λ3374 and λ3361, and Gauzit assigns to them the intensities four and two, respectively, on a list on which the strongest band has an intensity of five. On many of my afterglow spectra, a strong head appears on the short wave-length side of the strong second-positive band λ3371. This band has a wave-length of about λ3360 and a direct comparison with some old electrical discharge spectra on which both the 3240 and 3360 NH bands are present shows definitely that we are observing the NH band at λ3360 on our afterglow plates. The λ3240 band has not yet been detected in the afterglow, and no band of this wave-length appears on Gauzit's list. In view of these observations we propose to identify the λ3374 and λ3361 bands in the light of the night sky as the two Q branches of the (0, 0) and (1, 1) bands of NH at λ3360 and λ3370. This identification would be a sound one even if heavier exposures fail to reveal the NH band in the light of the night sky on my plates, since the λ3240 NH band requires more energy for its excitation than do λ3360 and λ3370, and there are a number of observations in which λ3240 is absent even though λ3360 appears with great intensity. These points have been adequately discussed by R. W. B. Pearse.[2]

The above identification is supported by the added observation that the λ3360 band increases in intensity as the relative intensity of the auroral ultraviolet line of nitrogen, λ3466.3, increases. This result indicates that a direct combination between atomic nitrogen and hydrogen takes place in the high pressure afterglow. Thus, the presence of NH bands in the light of the night sky, together with this observation, is added evidence for the existence of atomic nitrogen in the upper atmosphere.

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February 16, 1939.

[1] J. Gauzit, Ann. D'Astrophysique, 1re Année, 334 (1938).
[2] R. W. B. Pearse, Proc. Roy. Soc. A143, 112 (1933).