Letters to the Editor

PUBLICATION of brief reports of important discoveries in physics may be secured by addressing them to this department. The closing date for this department is, for the issue of the 1st of the month, the 8th of the preceding month and for the issue of the 15th, the 23rd of the preceding month. No proof will be sent to the authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents. Communications should not exceed 600 words in length.

Corona from Fine Positive Points

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THE work of A. F. Kip[1] has been extended to needle points of 0.002 mm radius of curvature. Three oscilloscopes were used to minimize the effect of amplifier pass band—a Navy type TS 28/UPN synchroscope and amplifier AM 73/UPA-1 (1000 cycles to 5 megacycles), a Dumont type 241 (20 cycles to 2 megacycles), and a Dumont type 171 (15 cycles to about 100 kilocycles) as used by Kip. Kip's observation of the degeneration of streamer pulses with decreasing point size, until indistinguishable from burst pulses, was found to be instrumental. Such pulses were clearly resolved on the synchroscope for the finest points, and very similar in duration and shape to streamer pulses for large points, when reduced to the same amplitude.

Dust-free points finer than about 0.01 mm radius of curvature gave no observable bursts or streamers. Corona onset was then evident on the oscilloscopes only by a slight and voltage-critical irregularity of the trace. Fine positive points dusted with MgO gave bursts and/or streamers at the onset voltage of the intermittent regime and above until steady corona occurred. The amplitude and frequency of the streamers varied somewhat from one dusting to another, and usually decreased with time, presumably because dust specks were removed from the critical region. This dust effect has been observed by Hudson[2] for smooth negative points as large as 0.25 mm radius.

Photographs of the discharge at the point were taken to establish a connection between the synchroscope pulses and "visible" (i.e., photographable) streamers. Some of these are shown in Fig. 1 while the corresponding synchroscope pulses are drawn to scale in Fig. 2. It is noteworthy

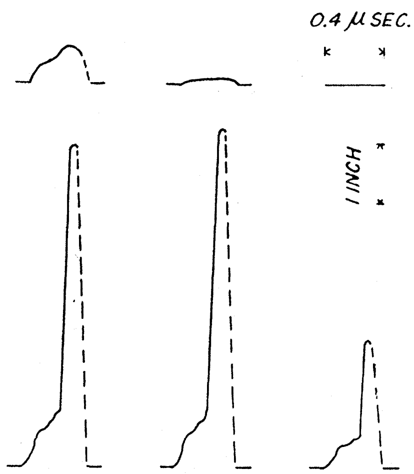

FIG. 2. Synchroscope pulses at 6000 × amplification corresponding to photographs in Fig. 1. Sweep from right to left.

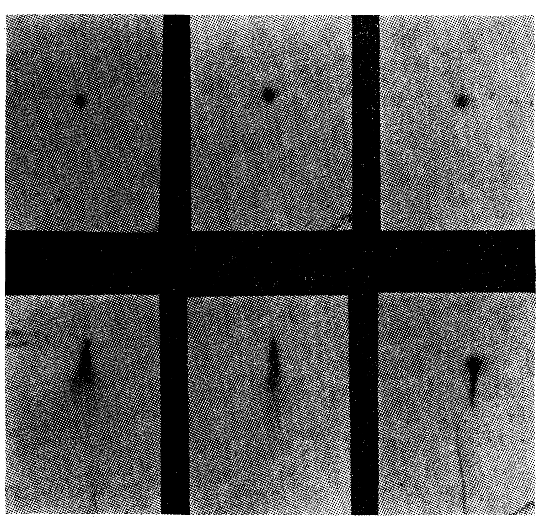

FIG. 1. Photographs of positive point streamers. Right to left, point radii of curvature: −0.002, 0.003, 0.003, 0.04, 0.1, 0.25 mm. Exposures 5 to 10 minutes at f:2.

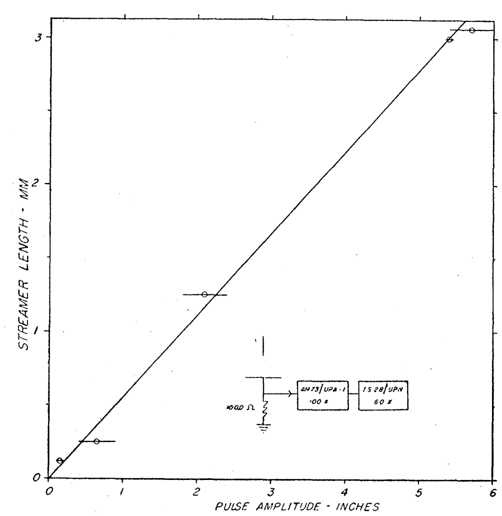

FIG. 3. Streamer length on photograph plotted against amplitude of synchronoscope pulse at 6000 × amplification. Observed variation in pulse amplitude is indicated.

that all the streamer pulses are very closely of the same duration, 0.4 microsecond. A plot of pulse amplitude against "visible" streamer length, Fig. 3, shows that the charge per cm of streamer is essentially constant and independent of streamer length. Using an estimated pulse input impedance of 50 ohms, the slope of the curve gives a value of the charge per cm length of "visible" streamer of 10^{10} ions. This agrees well enough with the value found by Kip of 5×10^9 ions per cm.

The radius of curvature of the steel needle points was measured from micro-photographs with up to 4500 times magnification. Values were checked among the points by plotting the onset voltages for intermittent corona. The experiments were done in room air at atmospheric pressure, with a 6-cm gap, and with 50 grams of thorianite ore at 12 cm from the point.

The results obtained indicate that streamers and bursts occur, and are clearly distinguishable for points down to 0.002 mm radius of curvature, provided dust specks are present on the point. With larger points the streamer pulses have much greater amplitude than the bursts (a factor of about 10, for 0.25 mm radius). Both streamer and burst pulses decrease in amplitude with decreasing point size until they are barely detected, but the streamer pulse maintains its form and 0.4 microsecond duration, while the burst pulse, which is a little bit of stable corona, can have any duration, usually 100 to 300 microseconds or greater.

The role of the MgO dust is not entirely clear. It may well be to provide triggering electrons, by the Paetow effect,[3] in the very small high field region. On the other hand, the variation of pulse size with different dustings suggests that the larger particles, which have a size comparable to the point size, may act to provide a less divergent field. This should cause a change in the intermittent regime onset, which has not been observed.

The writer is indebted to Professor L. B. Loeb for advice and encouragement.

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[1] A. F. Kip, Phys. Rev. **55**, 549 (1939).
[2] L. B. Loeb, A. F. Kip, G. G. Hudson, and W. H. Bennett, Phys. Rev. **60**, 714 (1941).
[3] L. B. Loeb, *Fundamental Processes of Electrical Discharge in Gases* (John Wiley and Sons, Inc., New York, 1939), p. 498

Inversion Spectrum of Ammonia

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April 5, 1947

COMPARISON of our[1] results on the frequencies of the lines in the $N^{14}H_3$ inversion spectrum, with those of Good and Coles,[2] show a discrepancy of 4.56 Mc/sec. in the $J=4$, $K=3$ line, which is well outside the experimental error. A study of our results has disclosed that a computational error was made in the reduction of the data, and our best value is 22,688.18 Mc/sec., which is in fair agreement with Good and Coles' value. This would change the value of the anomalous frequency shift for this line in Table II of reference 1, to +1.76 Mc/sec.

It is interesting to note that if the data for the $N^{15}H_3$ lines, given by Good and Coles, for the $K=3$ transitions, are analysed in a manner similar to that in reference 1 for the $N^{14}H_3$ lines, corresponding anomalous frequency shifts for the two isotopic molecules are obtained.

		ν_{measured}	$\nu_{\text{predicted}}$
J	K	$N^{14}H_3$	$N^{15}H_3$
3	3	−0.32 Mc/sec.	−0.30 Mc/sec.
4	3	+1.76	+1.83
5	3	−6.96	−8.

[1] Strandberg, Kyhl, Wentink, and Hillger, Phys. Rev. **71**, 326 (1947).
[2] W. E. Good and D. K. Coles, Phys. Rev. **71**, 383 (1947).

Nuclear Quadrupole Moment Effects in the Microwave Spectrum of Ammonia

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THE hyperfine structure first observed in the inversion spectrum of ammonia by Good[1] has been the subject of much recent work. Coles and Good[2] have reported measuring the satellite separations for many of the lines and have published a formula which gives the expected separations of the satellite lines from the main lines. Professor Van Vleck[3] has also developed a theory of the hyperfine structure. According to these theories, the satellite lines can be explained in terms of the interaction between the electrical quadrupole of the N^{14} nucleus and the electrical field of the NH_3 molecule.

The intensity of the satellite lines decreases rapidly as the rotational quantum number J increases. Dailey *et al.*[3] have reported measurements of the satellites of lines with J values as high as 4 and find these to be in excellent agreement with Van Vleck's theory; but they have reported their inability to detect satellite lines for J values higher than 4.

Recently, we have made a study of the ammonia spectrum and have been able to observe and measure the relative separations of satellites from main lines with J as high as 7. The results for lines 11, 22, 33, and 44 are in agreement with Dailey's results and the relative separations of all lines observed agree with Van Vleck's theory. Our preliminary results are summarized in Table I. A more detailed account of this work will be published in the near future.*

Table I. Observed and calculated ratios of satellite displacements.

Line JK	Observed ratio $\Delta\nu'/\Delta\nu$	Calculated ratio $\Delta\nu'/\Delta\nu$
11	2.55	2.50
22	1.56	1.56
33	1.36	1.35
44	1.28	1.26
55	1.21	1.20
66	1.18	1.17
76	1.19	1.14

[1] W. E. Good, Phys. Rev. **70**, 213 (1946).
[2] D. E. Coles and W. E. Good, Phys. Rev. **70**, 979 (1946).
[3] Dailey, Kyhl, Strandberg, Van Vleck, and Wilson, Phys. Rev. **70**, 984 (1946).
* This work is being done in connection with a research project sponsored by the Watson Laboratories of the Air Material Command, Red Bank, New Jersey.

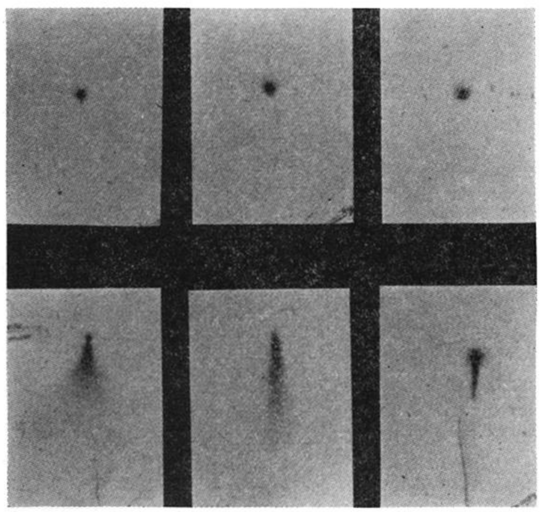

FIG. 1. Photographs of positive point streamers. Right to left, point radii of curvature: —0.002, 0.003, 0.003, 0.04, 0.1, 0.25 mm. Exposures 5 to 10 minutes at f:2.