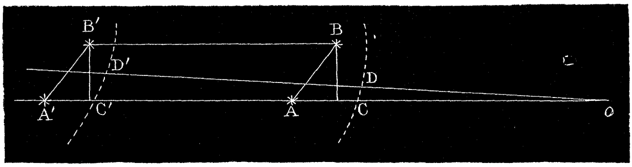
having become sufficiently enfeebled in comparison with the light of the intercepted area of the gaseous envelope. The continuousness of the gaseous envelope I contemplate is a physical, not a mere optical, continuity.



Let A and B be two of the stars of such a cluster, C D a section of the dispersed gaseous envelope enveloping the cluster.

Then the light falling within the solid angle at O may be considered to arise from the star A and the area C D of the gaseous envelope.

Suppose the system removed to a greater distance. The light from the star A is diminished in the proportion of the inverse square of the distances, while that from C D is sensibly equal to that from C′D′. The question, therefore, whether such a cluster would, according to my views, end in becoming a nebula or a mere optical cluster, would depend upon whether it would be possible, with any supposed distribution of stellar masses and vaporous envelopes, to diminish the brightness of the star A below that given by the intercepted area C D of the enveloping surface, before the star B has been brought to strengthen the beam of light which gives the continuous spectrum. In the one case we should have absolute irresolvability at that and all greater distances with any optical means at our disposal; in the other irresolvability, which might become resolvability with increase of optical power. The case of two stars is of course only taken for simplicity; it is the proportional increase in other cases which has to be considered. I have chiefly had in contemplation nebulæ like those of Orion and η Argûs, which extend over large angular distances; but at great distances such nebulæ might assume the character of planetary nebulæ. I see no difficulty in conceiving stellar clusters such as those I contemplate, which would give rise to bright-line spectra; and I believe that the more the matter is examined the larger will be the number of facts which will be found to group themselves around the hypothesis which I have suggested.

IV. "Experimental Researches on the Electric Discharge with the Chloride-of-Silver Battery.—Part I." By Warren De La Rue, M.A., D.C.L., F.R.S., and Hugo W. Müller, Ph.D., F.R.S. Received August 23, 1877.

(Abstract.)

In the Journal of the Chemical Society, November 1868, we first published an account of the "Chloride-of-Silver Battery." Since 1874 we

have commenced working with it systematically, and have gradually augmented the number of cells; we now possess 8040 in actual work, and have 2680 more completed, but not charged with fluid. Amongst the 8040 cells now in use are the first 1080 constructed in 1874, experiments with which we described on the 24th February, 1875*. Subsequently from time to time we have communicated to the Society some of the results we have arrived at, and in the detailed communication of which the present is a short abstract we have given the full particulars of our experiments. The paper in question deals mainly with the striking-distance between terminals of different forms in air and in other gases at ordinary atmospheric pressures, and in air at reduced pressures short of the partial vacua of the so-called vacuum tubes. Besides these experiments the paper describes the effects of currents of high tension in inducing secondary currents, and also their effects in inducing magnetism.

We have found that the discharge of the battery, with one or two poles in the form of a point, presents several interesting phenomena which precede the true jump of the spark, and which do not occur with other forms of terminals—for example, disks or spherical surfaces. With 8040 cells the striking-distance between a paraboloidal point, positive, and a disk is about 0·34 in. (8·64 millims.); but there is always a luminous discharge, very apparent, far beyond the distance measurable by our micrometer-discharger, namely 1·16 inch (29·5 millims.), as we have before stated †.

The current which passes during the luminous discharge which precedes the jump of the true spark is extremely feeble in comparison with that which takes place after the spark has passed and the voltaic arc has formed; even when the point and disk are not more distant than ·02 inch beyond the striking-distance (0·34 inch) for 8040 elements, it is only $\frac{1}{2564}$ part of it; moreover the current is diminished to $\frac{1}{45000}$ of that of the arc when the point and disk are 1·16 inch distant.

The appearance of the discharge is very different, according as the point is positive or negative; it is intermittent in both cases, but is much less discontinuous when the point is negative than when it is positive, as can be seen with a microscope having a rotating mirror placed in the bend of the body, between the objective and eyepiece. The appearances observed are shown in the wood engravings which illustrate the paper.

When a point and a disk 1·5 inch diameter are used as terminals, and a band of glazed writing-paper 1·5 inch wide, and say 0·00425 inch thick, is placed on the disk, a very strong adhesion of the paper to the disk takes place, and it requires a very strong pull, when 8040 cells are employed, to make the paper slide on the disk; the adhesion is strongest when the point is negative. The strain required to make the paper slide

* Proc. Roy. Soc. vol. xxiii. p. 356.

† Proc. Roy. Soc. vol. xxiv. p. 169.

on the disk was 30,000 grains with the point negative, and 18,000 grains when it was positive: to reproduce these strains the paper had to be loaded with 129,600 and 53,530 grains respectively after the current had been shut off.

When terminals with plane or spherical surfaces are used, the luminous phenomena preceding the jump of the spark do not take place, and there is scarcely an appreciable adherence between the band of paper and the terminals; it generally takes a diagonal position, forming a bridge between them.

Between a point and a disk the spark is longest with the point positive, when from 5000 to 8000 cells are used; but for a less number of elements, 1000 to 3000, it is longest when the point is negative.

The length of the spark is greatly influenced by the form of the point: thus with a point in the form of a cone of 20 degrees the striking-distance is 0·184 inch with 5640 cells and 0·267 inch with 8040; while with a point approaching a paraboloid in form, and with the same base and of the same height as the cone, it is 0·237 inch with 5640 cells and 0·343 inch with 8040. The ratios $\frac{184}{237}=0{\cdot}776$ and $\frac{267}{343}=0{\cdot}778$, almost identical, represent the proportion which exists between the length of spark obtained with a conical point and one paraboloidal in form.

The striking-distance between a point and a plate is in accordance, very nearly, with the hypothesis of this distance increasing in the direct ratio of the square of the number of elements, at all events up to 8040 cells, thus*:—

Number of cells ...	1000	2000	3000	4000	5000	6000	7000	8000
	in.	in.	in.	in.	in.	in.	in.	in.
Distance observed...	0·0051	0·0221	0·0554	0·103	0·159	0·222	0·286	0·352
Distance calculated	0·0055	0·0220	0·0495	0·088	0·1375	0·198	0·2695	0·352

Between plane, spherical, or cylindrical surfaces the striking-distance does not follow this law; on the contrary, the increase is nearly, but not quite, in the ratio of the number of cells. We have given the striking-distance from 1000 to 8000 volts, between spherical surfaces 1·5 inch diameter and 3 inches radius, in the Proceedings, No. 182, so that it is only necessary here to state the striking-distance for

	1000 cells.	8000 cells.
	in.	in.
Between spherical surfaces	0·0050	0·0810
„ plane surfaces	0·0104	0·0852
„ two concentric cylinders .	0·0071	0·0991

It must, however, be stated that very probably the striking-distance for 1000 cells between plane surfaces is too great, on account of the diffi-

* Proc. Roy. Soc. 1876, vol. xxiv. p. 167.

culty of keeping them absolutely parallel when the micrometer is adjusted from time to time.

The striking-distance between two paraboloidal points was found to be with :—

1080 cells.	8040 cells.
in.	in.
0·005	0·401

The nature of the metal used for terminals has, in almost all cases, no influence on the length of the spark; but there is one striking exception, namely, in the case of aluminium. When an aluminium point is used the spark is longer than with points of all other metals tried in the ratio of 1·242 to 1.

The length of the spark is different in various gases—for example, air, oxygen, nitrogen, hydrogen, and carbonic acid; and the ratio between the lengths of spark in various gases varies with the forms of the terminals. The length of the spark bears no simple relation either to the density of the gas or its viscosity*.

The paper contains an account of a few experiments on the length of spark in air at different pressures, from 141·5 millims. to 760 millims. Between a point and a disk the length of the spark increases nearly, but not quite, in the ratio of the dilatation; but between two spherical surfaces it increases far more rapidly, and it is possible that at a certain degree of rarefaction the striking-distance may be coincident for spherical surfaces and points.

The appearance of the voltaic arc at ordinary pressures differs in different gases.

In air (possibly also in other gases) the arc, when examined with the microscope, presents a stratified appearance, especially in the barrel-shaped surrounding of the central brilliant spindle. The striæ are very close, and can be seen with difficulty even when the microscope, with a rotating minor, is employed for the examination of the arc.

In hydrogen, with the point positive, the central spindle of the arc is surrounded with a beautiful blue halo resembling a glass shade illuminated with fluorescent light. With the point negative the arc moves about rapidly and forms a sort of star on the positive disk. Before the jump of the spark, when the point is negative, the luminous discharge has the appearance of a pale olive halo, in form like a glass shade, extending from the point to the periphery of the disk.

In nitrogen the arc is reddish violet; in oxygen it presents the same appearance as in air.

When a strong resistance is interposed in the circuit, 4,000,000 ohms for example, the discharge is completely changed in character; instead of the ordinary spark and production of the voltaic arc, very brilliant snap-

* Proc. Roy. Soc. vol. xxvi. p. 227.

ping sparks pass between the terminals at more or less rapid intervals, exactly like the sparks of a small Leyden jar. They pierce writing-paper with minute holes. It is usually necessary to approach the terminals to a distance of 0·3 inch, when the striking-distance of 8040 cells is 0·34 inch, in order to produce this static discharge.

It has been found that an accumulated charge of a condenser of 42·8 microfarads capacity, charged with the potential of 3240 cells, produced neither an elongation nor a contraction of a metallic rod 0·2 inch when suddenly discharged through. This charge deflagrates 10·5 inches of platinum wire 0·0125 inch in diameter.

More dense sparks were obtained with one of Apps's coils for producing 6-inch sparks when the primary was connected with 1080, 2280, 3480 chloride-of-silver cells, than when it was used with a zinc-carbon bichromate-of-potash battery of 6 cells, producing a current 300 times as great, thus showing the influence of high potentials in inducing secondary currents.

These currents of high potentials have also a marked effect in inducing magnetism, when the actual current is taken into account.

The second part of the paper, which is in course of preparation, will deal with the discharge in rarefied gases, in the so-called vacuum tubes.

December 20, 1877.

Dr. ALLEN THOMSON, Vice-President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read :—

I. "Notes on Supersaturated Saline Solutions." By CHARLES TOMLINSON, F.R.S. Received September 14, 1877.

There is probably no subject in science that is more involved in contradiction than that of supersaturation. All the phenomena connected with it seem to behave differently in the hands of different inquirers, so that the facts affirmed by one writer are simply denied by another; and the same theory which seems to have been disproved by one is again and again brought forward by another.

Take one point by way of example, namely, the nuclear action of bodies in producing the sudden crystallization of a supersaturated saline solution. Ziz, in 1809, stated that not only air, but solids, act best as nuclei when dry: if wet, or boiled with the solution, or thrown into it