GIBSON CHARLES ROBERT

THE AUTOBIOGRAPHY OF AN ELECTRON

Charles Gibson
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The Autobiography of an Electron / Wherein the Scientific Ideas of the Present Time Are Explained in an Interesting and Novel Fashion:

Содержание

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PREFACE

Although text-books of science may appear to the general reader to be "very dry" material, there is no doubt that, when scientific facts and theories are put into everyday language, the general reader is genuinely interested. The reception accorded to the present author's *Scientific Ideas of To-day* bears out this fact. While that volume explains, in non-technical language, the latest scientific theories, it aims at giving a fairly full account, which, of course, necessitates going into a great deal of detail. That the book has been appreciated by very varied classes of readers is evident from the large numbers of appreciative letters received from different quarters. But the author believes that if the story

of modern science were told in a still more popular style, it would serve a further useful purpose. For there are readers who do not care to go into details, and yet would like to take an intelligent interest in the scientific progress of the present day. Some of those readers do not wish to trouble about names and dates, while the mere mention of rates of vibration and such-like is a worry to them. They wish a book which they may read with the same ease as an interesting novel. Hence the form of the present volume.

The author is indebted to Professor James Muir, M.A., D.Sc., of the Glasgow and West of Scotland Technical College, and to H. Stanley Allen, M.A., D.Sc., Senior Lecturer in Physics at King's College, University of London, for very kindly reading the proof-sheets. The author is indebted further to Professor Muir in connection with some of the illustrations, and for others to Dixon and Corbitt and R. S. Newall, Ltd., Glasgow; Siemens Schuckert Werke, Berlin.

CHAPTER I
WHAT THE STORY IS ABOUT

The reason for writing this story is given in the Preface, but the title is so strange that the reader will wish naturally to know what the story is about. What is an electron? Is it an imaginary thing, or is it a reality?

One of the reasons for writing this story in its present form is to help the reader to realise that electrons are not mythical, but real existing things, and by far the most interesting things we know anything about. The discovery of electrons has shed a new light upon the meaning of very many things which have been puzzles until now. They give us a reasonable explanation of the cause of light and colour. They provide a new idea of the constitution of matter. They enable us to picture an electric current, and they give us definite, though by no means final, answers to the why and wherefore of magnetism, chemical union, and radio-activity.

The story is imaginary only in so far that one of the electrons itself is supposed to tell the tale. But in the endeavour to make the story interesting, there has been no sacrifice of accuracy in the statements of fact.

While all names and dates, and many other details, have been kept out rigidly from the story, a note of the more important

of these has been added in an Appendix for the sake of those readers who may wish to refer to them.

It will be well to introduce the electron to the reader before leaving it to speak for itself. We have definite experimental proof of the existence of electrons, and yet it is very difficult to realise their existence, for two reasons. In the first place, they are so infinitesimally small. We count a microbe a small thing; we can see it only with the aid of a very powerful microscope. Yet that little speck of matter contains myriads of particles or *atoms*. An atom of matter is therefore an inconceivably little thing, but even that is a great giant compared to an electron. Our second difficulty in realising the existence of an electron is that it is not any form of what we call *matter*; it is a particle of *electricity*, whatever that may be.

From the earliest experiments it became evident that there were two distinct kinds of electricity. These were described by the pioneer workers as *positive* and *negative* electricities. To-day we have definite experimental proof that negative electricity is composed of separate particles or units. Just as matter is composed of invisible atoms, so also is negative electricity of an atomic nature. These particles of negative electricity have been christened electrons, *electron* being the Greek word for *amber*, from which man first obtained electricity. Of course no one can ever hope to see an electron, but physicists have been able to determine its size and *mass*, its electric charge, and the speeds at which it moves.

While it has been known for more than a century that *light* is merely waves in the all-pervading æther of space, set up by incandescent bodies, it has been a puzzle always how matter could cause waves in the æther, as it offers no resistance to the movement of matter through it. Here we are on the back of a great planet, flying through space at the enormous rate of one thousand miles per minute, and yet our flimsy atmospheric blanket is in no way disturbed by the æther through which we are flying. In the following story we shall see that these electrons help us towards a solution of this and many other problems; they provide the missing link between matter and the æther.

But what is this *æther* of which one hears so much in these days? The truth is we know nothing of its nature. We cannot say whether it is lighter than the lightest gas or denser than the densest solid. The æther, whatever it may be, is as real as the air we breathe. It is the medium which brings us light and heat from the sun, and which carries our wireless telegraph and telephone messages. The whole universe is moving in this great æther ocean.

In order to make the electron's story perfectly intelligible to every reader, I have added a short explanatory note at the beginning of each chapter. These notes merely state the facts about which the electron is speaking.

To make the electron's story as realistic as possible, it has been necessary to give the imaginary electron perfect freedom of knowledge concerning itself and its surroundings. In our

schooldays we had to write the autobiographies of steel pens, and such-like, but these inanimate things had to be endowed with powers of thought, feeling, and desire. It is very important, however, to remember that an electron is a particle of negative electricity —*a real existing thing*.

CHAPTER II
THE ELECTRON'S PREFACE

While many scientific men now understand our place in the universe, we electrons are anxious that every person should know the very important part which we play in the workaday world. It was for this reason that my fellow-electrons urged me to write my own biography. My difficulty has been to find a scribe who would put down my story in the way I desired. The first man with whom I opened negotiations wished me to give him dates and names of which I knew nothing. And he asked such stupid questions about where I was born and who my parents were, as if I were flesh and blood.

I am pleased to say that my relationship with the scribe who has put down my story in the following pages has been of the most friendly description. Apart from a little tiff which we had at the outset, there has been no difference of opinion. He complained that I related things in too abstract a form. However, we got over the difficulty by a compromise; I have allowed him to place what he calls "The Scribe's Note" at the beginning of each chapter, but it will be understood clearly that these are merely convenient embellishments, and that I am responsible for the story of my own experiences.

CHAPTER III
THE NEW ARRIVAL

THE SCRIBE'S NOTE ON CHAPTER THREE

It will be well to keep clearly in mind that an electron is a real particle of negative electricity.

Electrons have been discovered only within recent years.

No matter from what substances we take them, they are always identical in every respect.

Some electrons are attached to the atoms of matter in such a way that they may be removed easily from one object to another.

When a surplus of these detachable electrons is crowded on to any object, we say that it is charged with negative electricity.

We speak of the other object, which has lost these same electrons, as being charged with positive electricity.

In this chapter the electron refers to the old-world experiment in which a piece of amber when rubbed attracts any light object to it.

For many ages man believed this to be a special property belonging to amber alone.

One of Queen Elizabeth's physicians discovered that this property was common to all substances.

It is most amusing to me and my fellow-electrons to hear intelligent people speak of us as though we were new arrivals on this planet. Dear me! We were here for countless ages before man put in an appearance. I wonder if any man can realise that we have been on the move ever since the foundations of this world were laid. It is man himself who is the new arrival.

It does seem strange to us that men should be so distinctly different from one another. We electrons are at a decided disadvantage, for we are all identical in every respect. I have no individual name – it would serve no purpose. Even if you could see me, you could not distinguish me from any other electron. I wonder sometimes if men appreciate the great advantage they have in possessing individual names. I was impressed with this thought one fine summer morning. While I was riding on the back of a particle of gas in the atmosphere, I was carried through the open window of a nursery just as the under-nurse was putting the room in order. A little later there was some commotion in the nursery, for the young mother and her mother had come to see the twin daughters being bathed by the nurses. The grandmother happened to remark how very much alike the two little infants were. She said laughingly to the head nurse that she must be careful not to get the children mixed. But the big brother, aged five years, remarked that it would not matter really how much they were mixed until they got their names. Sometimes I wish we electrons did differ from one another, so that we might each possess an individual name, but no doubt it is necessary for us

all to be exactly alike.

Long before man had discovered us, he caused us deliberately to do certain things. He was mystified by the results of his experiments, for he was not aware of our presence. A few of my fellow-electrons have rather hazy recollections of being disturbed while clinging to a piece of amber. They had been disturbed often before in a similar way, by being rubbed against a piece of woollen cloth, and the result had been always that a number of electrons let go their hold upon the cloth and crowded on to the amber. The overcrowding was uncomfortable, but it happened usually that the surplus electrons found some means of escape to the earth, where there is no need of excessive crowding.

On the occasion to which I refer, it so happened that the rubbing had been unusually vigorous and prolonged, so that the electrons were crowded on to the amber in great numbers. In their endeavour to escape they produced a strain or stress in the surrounding æther, and this caused a small piece of straw, which was lying within the disturbed area, to be forced towards the amber.

What attracted the attention of the electrons was that the man who was holding the piece of amber removed the clinging straw and replaced it exactly where it had been lying. In the meantime he had been handling the amber, and many of the crowded electrons had managed to make a bolt for the earth by way of the man's body. They did this so very quietly that the man did not feel any sensation. However, as soon as the amber was rubbed

again, a similar crowd provided the same attractive property. We electrons became impatient to hear what man would say of our work, for it was apparent that he had noticed the movements of the straw. You will hardly believe me when I tell you to what decision these wise men of the East came. They declared that, in rubbing the amber, it had received heat and life. As if life could be originated in any such simple manner!

You can picture our disappointment when we found that man was going to ignore our presence. Occasionally we were given opportunities of displaying our abilities in drawing light objects towards pieces of rubbed amber. But the funny thing was that man got hold of the stupid idea that this attractive property belonged to the amber instead of to us. If he had only tried pieces of sulphur, resin, or glass, he would have found that these substances would have acted just as well. You see it was not really the substance, but we electrons who were the active agents.

We had given up all hope of being discovered, when news came along that a learned man was on the hunt for us. He was crowding us on to all sorts of substances. He rubbed a piece of glass with some silk, and at first he was surprised greatly to see light objects jump towards the excited glass. Of course, we were not surprised in the very least. The only thing that amused us was to find that he was making out a list of the different substances which showed attractive properties when rubbed. He could not, evidently, get away from the idea that it was the substances themselves that became attractive.

We were sorry that the poor experimenter wasted so much time and energy in trying to crowd us on to a piece of metal rod. He rubbed and he rubbed that metal, but it would attract nothing, and I shall tell you the reason. You know that we electrons hate overcrowding; indeed we always separate from one another as far as possible when there is no force pulling us together. We only crowded on to the amber because we could not help ourselves; we had no way of escape, for amber is a substance we cannot pass through. But we have no difficulty whatever in making our way along a piece of metal, and as soon as the rubbing began, some electrons moved off the metal by way of the man's arm and body to make room for those being crowded on to the metal from the rubber. And so there never was any overcrowding, and consequently no straining of the æther. But it was not long before we found that man had succeeded in cutting off our way of escape. He had attached a glass handle to the metal rod, and we were compelled to overcrowd upon the metal as we could not pass through the glass handle. Neighbouring light objects were attracted by the excited or "electrified" metal. Even this demonstration did not put man upon our track.

Perhaps I should explain in passing, that when a glass rod is rubbed with a silk handkerchief we crowd on to the silk, and not on to the glass. This leaves the glass rod short of electrons, and the æther is strained so that light objects are attracted. Man did notice that there was some difference between a piece of amber and a piece of glass when these were excited. What the

difference was he could not imagine, but to distinguish the two different conditions he said that the amber was charged with *negative* electricity and the glass with *positive* electricity.

From that time forward man became of special interest to us. We felt sure that sooner or later he was bound to recognise that we were at work behind the scenes. It seemed to us, however, that man was desperately slow in turning his attention towards us, and we tried to waken him up in a rather alarming fashion, as I shall relate in the succeeding chapter.

CHAPTER IV
SOME GOOD SPORT

THE SCRIBE'S NOTE ON CHAPTER FOUR

Men began to make glass plate machines for producing electrification on a larger scale.

The electric spark is produced.

The electron tells the story of the first attempt to store electricity in a glass jar.

This is what we do now by means of a Leyden jar.

A sudden expulsion of electrons from one object to another is called a discharge of electricity.

Lightning is a discharge of electrons from a cloud to the earth or from cloud to cloud.

In repeating Franklin's experiment of drawing electricity from thunder-clouds, a Russian professor received a fatal shock.

Now I must tell you of a surprise in which I took an active part. Some man thought he would separate a great crowd of us from our friends. Of course, he did not think really of *us*, but whatever he may have supposed he was doing, he succeeded in accumulating greater crowds of us together than he had done previously. He managed this by making simple machines to do

the rubbing for him on a larger scale. The result was really too much for us; we were kept crowding on to a sort of brass comb arrangement from which we could not escape, as the metal was attached to a glass support. Talk about overcrowding! I had never experienced the like before, and I felt sure some catastrophe would happen. Suddenly there was a stampede, during which a great crowd of electrons forced their way across to a neighbouring object and thence to the earth. I can assure you it was no joke getting through the air. We all tried to leap together, but some of the crowd were forced back upon us; then bang forward we went again, back once more, and so on till we settled down to our normal condition. Of course all this surging to and fro occupied far less time than it takes to tell. Indeed, I could not tell you what a very small fraction of a second it took.

I wish you had seen the experimenter's surprise as we made this jump. We caused such a bombardment in the air that there was a bright spark accompanied by a regular explosion. Some men ran away with the idea that electricity was a mysterious fire, which only showed itself when it mixed with the atmosphere. Nothing delighted us more, after our own surprise was over, than to have a chance of repeating these explosions, to the alarm of the experimenters. But the best sport of all was to come, and when I heard of it I was so disappointed that I had not been one of the sporting party. It came about in the following way.

When a myriad of electrons is discharged suddenly from a cloud to the earth, it happens sometimes that considerable

damage is done. The above photograph is of a church steeple damaged by lightning in 1875. No lightning-conductor was provided, so the electrons had to get to earth by way of the steeple itself, with the disastrous result as shown.

One learned man thought he had hit upon a good idea. He tried to crowd a tremendous number of us into some water contained in a glass jar. Without condescending to think of us, he crowded an enormous number of electrons from one of his rubbing machines along a piece of chain which led them into water. The overcrowding was appalling, for it was impossible to escape through the glass vessel. Things had reached a terrible state, when the experimenter stopped the machine and put forward his hand to lift the chain out of the water. Now was the chance of escape, so the whole excited crowd made one wild rush to earth by way of the experimenter's body. The rapid surging to and fro of the crowd racked the man's muscles. I wish I had been there to see him jump; they say it was something grand. You can imagine how the little sinners enjoyed the joke; they knew they were safe, as man had no idea of their existence at that time.

Another man was foolhardy enough to try a similar experiment, and they say that his alarm was even greater; indeed, he swore he would not take another shock even for the crown of France. We were all eager to get opportunities of alarming man, not that we wished him any harm, but we thought he might pay us a little more attention.

I remember one occasion upon which some of us were

boasting of what we had done in the way of alarming men, whereupon one fellow-electron rather belittled our doings. He maintained that he had jumped all the way from a cloud to the earth, along with a crowd of other electrons. In doing so they had scared the inhabitants of a whole village, for they alighted upon the steeple of a church, and in their wild rush they played such havoc among the atoms composing the steeple that they did considerable outward damage to the great structure.

I may as well confess that we are not free agents in performing these gigantic jumps; we are compelled to go with the crowd when things are in such a state of stress. We simply cannot hold on to the atoms of matter upon which we happen to be located. It is only under very considerable pressure that we can perform this class of jump, and I beg to assure you that we are perfectly helpless in those cases where we have been dashed upon some poor creature with a message of death.

Alas! on one occasion I was one of a party who killed a very learned man. It was most distasteful to us; we could not possibly prevent it. He had erected a long rod which extended up into the air, and terminated at the lower end in his laboratory. Some of us who were in the upper atmosphere were forced on to this iron rod, and from past experience we quite expected that we should be subjected to a sudden expulsion to earth. Indeed we were waiting for the experimenter to provide us with a means of escape, when suddenly he brought his head too near to the end of the rod, and in a moment we were dashed to earth through his

body. We learned with deep regret that the poor man had been robbed of his life.

To turn to something of a happier nature, I shall proceed to tell you of some of my earliest recollections. Remember I shall be speaking of a time long before man existed – even before this great planet was a solid ball.

CHAPTER V
MY EARLIEST RECOLLECTIONS

THE SCRIBE'S NOTE ON CHAPTER FIVE

This great globe upon which we live was once a glowing mass of flaming gas.

It is possible that the whole solar system was once one great mass.

In any case, we have no doubt that the moon is simply the result of a part of our glowing mass having become detached.

In the hottest stars we find only the lightest atoms of matter, such as hydrogen gas, the atoms of heavier substances being found in stars which have begun to cool down.

The electrons have been present from the very beginning, and it is they who go to make up the atoms of matter.

We picture an atom of matter as a miniature solar system of revolving electrons.

There is doubtless a corresponding amount of positive electricity, but so far we have no evidence of its nature.

Before giving an account of the everyday duties which we

perform, it may interest you to hear something of our early history.

Not only have we been on the move ever since the beginning of this world, but some of us have clear recollections of this planet long before it was a solid body. The whole world was a great ball of flaming gas. I have heard some fellow-electrons say that we were attached to a greater mass of incandescent gas before the beginning of this world, but I have no personal recollections of it. But one thing I do remember is a great upheaval which caused a large mass of gas to become detached from our habitation. Without any warning a great myriad of our fellow-electrons were carried away on this smaller mass. At first this detached mass circled around our greater mass at very close quarters, but we soon found that our friends were being carried farther and farther away, until they are now circling around this solid planet at a comparatively great distance. Man calls this detached mass *the moon*, and when I have heard children say in fun that they wish they could visit the man in the moon, I have longed to go and see how it fares with those fellow-electrons who seem to be separated from us in such a permanent manner.

After this exciting event, which I have heard described as "the birth of the moon," our great ball of flaming gas began to cool gradually. But you will be interested in what happened before the moon's birth. I saw a crowd of electrons suddenly congregate together along with *something* else which man has not discovered. Never mind the other part, but picture a number of electrons

forming a little world of their own. There they went whirling around in a giddy dance. I saw these little worlds or "atoms" being formed all around, and I feel truly thankful now that I was not caught in the mad whirl, for these fellow-electrons have been kept hard at it ever since, imprisoned within a single atom. I have met a very few electrons who have escaped from within an atom, but I shall tell you about them later on.

The first thing I noticed was that each of the atoms had practically the same number of electrons in it. At that time I thought only in an abstract way, but since then I have learned that these were *hydrogen* atoms; hydrogen being the lightest substance known to man. Exactly what happened next I cannot recollect, but my attention was attracted later to larger congregations of electrons forming other little worlds of their own. These atoms were, of course, heavier than the hydrogen atoms. I saw quite a variety of different systems, of which I thought then in an abstract fashion, but which I know now to be atoms of *oxygen*, *nitrogen*, *carbon*, *iron*, *copper*, and so on. While man has given the atoms these distinguishing names, you will understand that the incidents which I am relating took place long before there was any appearance of solidity about our planet; these substances were all in a gaseous state.

After this, I recollect that there was a great envelope of water-vapour condensed around the planet. Some condensed into liquid water upon the surface of the globe, while part was suspended in the form of clouds. Some of my fellow-electrons acted as *nuclei*

or foundations for the formation of the cloud particles. The water which condensed upon the earth settled down in the hollows, which had been produced previously by the immense pressure of the water-vapour envelope. We can hardly believe it is the same world.

You cannot imagine how strange it was to see the great oceans boiling and steaming; of course, they were fresh water then. I need hardly tell you that they have become salt only because the rivers have brought down sodium into them, and when these sodium atoms unite with chlorine atoms they form particles of common salt. I know all about this because we electrons play a very important part in all such combinations.

One very memorable recollection is that of life originating in the oceans. I wish I could let you into the secret of *the origin of life*, but, according to the Creator's plan, man must find out for himself. Your guesses are all wide of the mark.

By the way, perhaps I should explain why I have been selected to write this biography. The first reason is that I am a free or detachable electron, and the second point in my favour is that I have had exceptional opportunities of seeing about me. I have heard men say that lookers-on see most of the game, and as I have witnessed the gradual evolution of things, you will understand that I have views of my own. A casual observer might think that things had deteriorated, for long ago there were immense monsters upon this planet, and these would put all modern creatures in the shade as far as size and strength are

concerned. But one of the most interesting things to me has been to watch the evolution of man, and more especially the gradual development of his brain. Indeed, sometimes I have wished that I had happened to be an electron in the brain of a man; but, on the other hand, my career would not have been of the varied kind which it has been.

CHAPTER VI
MAN PAYS US SOME ATTENTION

THE SCRIBE'S NOTE ON CHAPTER SIX

Men found that by exhausting the air from glass globes or tubes it was possible to pass electric discharges through them, and in so doing some very beautiful luminous effects were produced within the vacuum tubes.

It was when experimenting with one of these tubes that a scientist suggested that radiant particles were being shot across the tube.

These particles were really electrons, but it was thought at that time that they were atoms of matter.

Another scientist declared, from certain mathematical calculations, that there existed extremely small particles of something around the atoms of matter, and that it was the motion of these in the æther which produced *light*.

People were not willing to accept this theory.

Some time later another scientist was able to prove by experiment that these particles did exist.

This was done by means of the spectroscope, as will be related by the electron in a later chapter.

From the little I have told you already of our experiences,

you will see that men had been making many experiments in which we electrons took a very active part. It was disappointing that even although we had surprised man in so many different ways, he had never become suspicious of our presence. One day, however, we did begin to hope for recognition. I was present, with a great crowd of electrons, imprisoned within a glass globe from which the air had been extracted. We were very pleased to find that the surrounding space had been cleared of air, for it was apparent that the experimenter was going to make us jump across from one end of the glass tube to the other.

A crowd of us had collected on the extremity of a wire, or "electrode," at the one end of the tube, while another similar crowd was present on the other electrode at the opposite end of the tube. While I speak of a crowd, meaning that there were millions of us, I do not suggest that we were overcrowded, for we had plenty of elbow-room to move about on the atoms to which we were attached. All in a moment the scene was changed. We felt a crowd of electrons pressing us forward and forcing us right up to the very end of the electrode. We found that the crowd was approaching by a wire leading into the tube. Soon the crowding had reached such a condition that we became alarmed; we could see no way of escape. We were imprisoned by the glass walls, but we soon discovered that many of the electrons who had been stationed on the other electrode had deserted their posts and fled along a wire leading out of the tube. If we could only follow them. It would be a tremendous jump to get over to the other

wire, but the way was fairly clear of air. When the overcrowding reached a certain point we were literally shot across from the one electrode to the other. This was the first time I had ever experienced anything of the kind, but many fellow-electrons had gone through similar performances for years at the hands of other experimenters.

However, it was somewhat alarming to be fired off like a rocket across the tube. What happened after that I cannot recollect, but some time later I was present in that or a similar tube when I heard the experimenter say to a friend that he believed there were particles flying across his tube. We sent news all along the line stating that at last we had been discovered, and I can assure you that we felt proud. But our joy was not long-lived, for it turned out that we were considered to be particles or atoms of matter; the experimenter spoke of us as "radiant matter." This was a real disappointment.

It took us some time to recover from our disappointment at being mistaken for clumsy atoms of matter. We are of a higher order of things altogether. No atom of matter can travel at speeds such as we can. We cross these vacuum tubes with speeds equal to millions of miles per minute.

A great many of us were kept busy within vacuum tubes by other experimenters, but nothing very exciting happened. Indeed, we had lost all hope of attracting man's attention to ourselves as long as we were imprisoned within these tubes. In the meantime our hopes were revived by news which reached us

from another quarter.

We heard that a very learned man had declared boldly that there did exist little particles which revolved around the atoms of matter, and that it was the motion of these tiny particles in the æther which produced the well-known waves of *light*

Конец ознакомительного фрагмента.