Oliver Lodge: The Subliminal Influence

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Sir Oliver Lodge as 'media' star

Sir Oliver Lodge had 1143 items in his published bibliography

Apart from papers, he wrote many articles for magazines, newspapers, etc.

He published a large number of books, some of a semi-popular nature

He gave many public lectures – Royal Society, Royal Institution, Physical Society, IEE, Royal Society of Arts, various universities, etc.

Sir Oliver Lodge as 'media' star

He was a regular broadcaster in the early days of radio

Clearly he had a significant public ('media') presence

One of his most significant outlets was at the British Association meetings, which he attended almost witheout break between 1873 and 1936. The discussions at these, at which he was often prominent, would frequently be reported in *Nature*, etc.

Sir Oliver Lodge as 'media' star

He was quoted even by literary authors, e.g.

F. Scott Fitzgerald, novel *This Side of Paradise* 1920: 'All my own, too – the Sir Oliver Lodge of the new world.'

Thomas Thorneley poem *The Atom* 1939, epigraph'We do not in the least know how to harness the energy locked in the atoms of matter. If it could be liberated at will, we should experience a violence beside which the suddenness of high explosive is gentle and leisurely.'

Sir Oliver Lodge as 'media' star

Lodge was, by the standards of his day, a 'media' star, ready to pronounce on new developments, etc.

But, unlike many media stars, he was also a deeply original thinker.

He had a capacity to synthesize and produce genuinely new twists on the most recent findings, sometimes spontaneously, sometimes when he was working through a public presentation.

Many of his comments are recorded in a large variety of places. His views would be picked up by other working scientists and often commented on.

Lodge's 'subliminal' influences

They weren't presented as intellectual property to which he could attach discovery rights.

However, many of them are actually original with him, or present variations on original ideas by colleagues or collaborators.

Sometimes the ideas would subsequently re-emerge as part of a fully worked out concept in a scientific paper by some other author.

This is what I mean by the 'subliminal influence'. Lodge was almost like a background to many hot discussions during his time. Consciously or unconsciously, his ideas formed part of an emerging consensus.

Lodge's 'subliminal' influences

This doesn't quite fit the conventional picture of scientific development, which sees it as a series of discrete breakthrough discoveries published in key-note papers.

But it is a more widespread phenomenon than is usually recognised, especially in this period, where scientific competition between rival individuals and rival institutions hadn't yet reached the level that we see today.

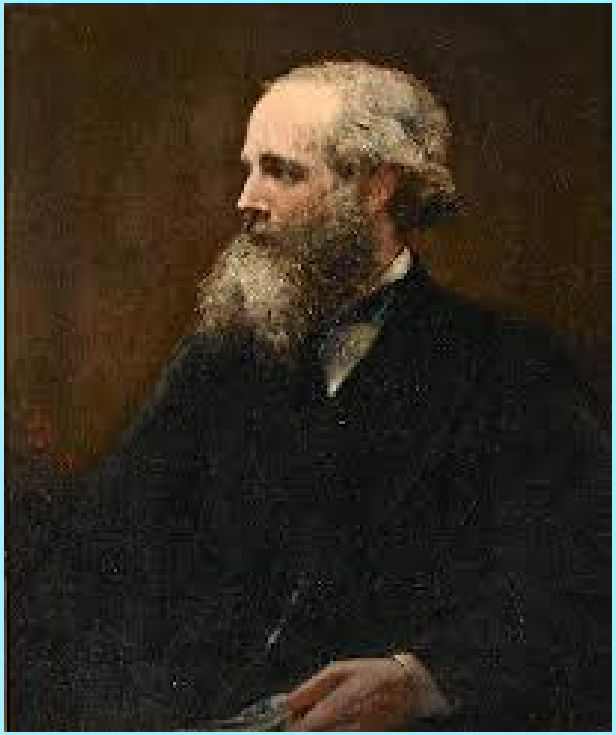
The question is: can we recognise instances of this 'subliminal influence' and what effect does this have on our portrayal of the history of physical concepts developed during Lodge's lifetime?

Lodge's 'subliminal' influences

This project is only at an early stage. I can identify a number of cases where I think subliminal influence might have taken place, but the full details need to be worked out.

Sometimes, the influence is on an individual, sometimes it is more general.

Electromagnetic waves 1879-80



An early (nontypical) example.

Maxwell showed that light came in the form of electromagnetic waves, but he had no concept that they could be *generated*, from, say, electric circuits.

Lodge, when he was at UCL in 1879-80, for the first time, came up with a number of suggestions for doing this. He thought that the waves, like Maxwell's, will be visible.

If they could be detected it would be the great proof of Maxwell's theory.

Electromagnetic waves 1880

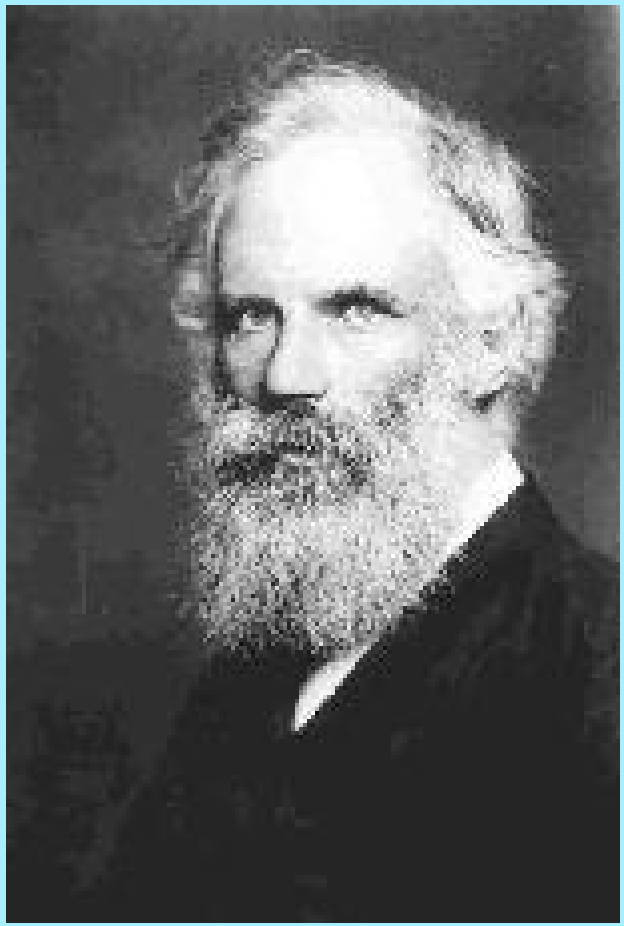
In Lodge's notebooks for 19 and 22 February 1880, for example, we read: 'To get emission of light electromagnetically suppose a set of coils were arranged so as to give induced currents of a high order.'Here, he imagines that a cascade of coils might multiply the frequency, and he calculates that 120 such coils would be necessary. Then: 'Perhaps the current would be better to be a discharge from a jar. This itself is oscillatory ... . Connect a thin mica condenser with the last coil it ought to emit light. Or have a jar – charge with a condenser. A jar being discharged does emit light. This must be the very thing ... .'

Electromagnetic waves 1880

In a section entitled 'Effect of distance and medium on Electromagnetic disturbances', he proposes to test Maxwell's theory that their velocity equals $1/\sqrt{(k\mu)}$ by interposing materials of high dielectric constant k, and magnetic permeability μ, and also to put a prism between the coils to see if the waves may be deflected: if EM disturbances travel with the vel(ocity) of light in all media (i.e. if $k = \mu$) they ought to be refracted like light'

Later, he had second thoughts, for a footnote, dated April, states that – 'This is all a misunderstanding', and another, dated August, that – 'It acts as a proof that ordinary EM disturbance is not of a wave nature.'

Lodge and FitzGerald 1880



The person Lodge influences is his friend, the Dublin professor, G. F. FitzGerald. At the Swansea meeting of the British Association in 1880, FitzGerald discussed the possibility of generating electromagnetic waves experimentally, in a note reported in title only.

However, FitzGerald thought that Lodge was wrong, and it was only later, after reading work on acoustics by Lord Rayleigh, that he changed his mind.

Lodge and FitzGerald 1882

On 5 May 1882, FitzGerald proposed before the Royal Dublin Society that: 'It might ... be possible to obtain sufficiently rapidly alternating currents by discharging condensers through circuits of small resistance.'

This was the 'magnetic oscillator' method for generating electromagnetic radiation, in which a condenser or Leyden jar, of capacitance C, discharged in a circuit of inductance L, would generate waves of frequency $1/2\pi\sqrt{(LC)}$.

It was the one that Lodge himself used in 1888.

FitzGerald 1883

At Southport, in 1883, FitzGerald gave two papers, the first of which, ‘The Energy lost by Radiation from Alternating Currents’, showed that short waves would be more effective than long, because the radiation intensity is proportional to the fourth power of the frequency;

and the second of which, ‘A Method of Producing Electromagnetic Disturbances of Comparatively Short Wave-Lengths’, indicated in only three lines the method by which all such waves were subsequently generated: ‘This is by utilising the alternating currents produced when an accumulator is discharged through a small resistance. It would be possible to produce waves of as little as ten metres wave-length, or even less.’

FitzGerald 1883

Effectively, FitzGerald, the superior mathematician, has taken over the work. Also FitzGerald has shifted the emphasis from visible light waves to long-wavelength invisible ones.

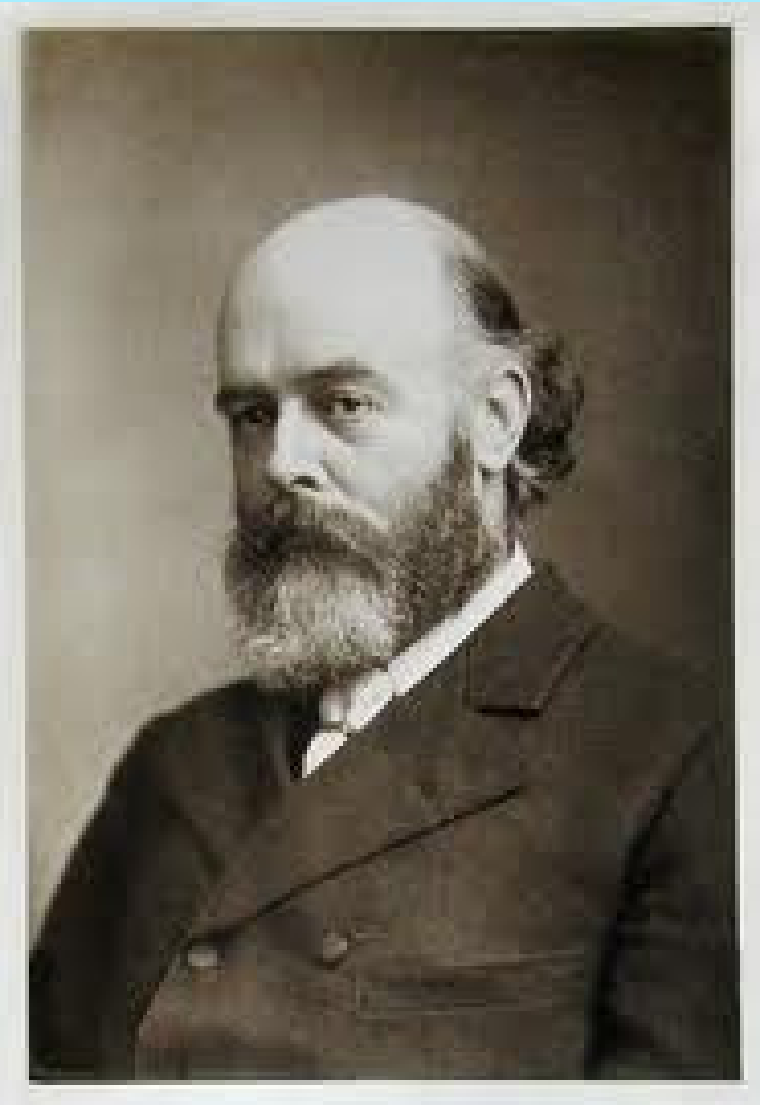
Now, FitzGerald has published the concept of their generation in a BA note, not in a journal paper, not because he has any desire to seek credit for it, but because he thinks if it could be done it would be worth doing.

The concept of ‘intellectual property’ doesn’t come into it. He has taken a half-formulated concept from his friend which didn’t convince him, applied the work of a recognised superior physicist, and put it out in a form where something useful might come out of it. We know of Lodge’s part because of his autobiography and his notebooks.

The coherer 1888

Lodge discovers the coherer principle in 1888, ‘whereby a couple of little knobs in ordinary light contact, not sufficient to transmit a current, become cohered or united at their junction whenever even a minute spark passed, and thus enabled the passage of a current from a weak E.M.F. through a galvanometer, until they were broken asunder again, which a tap sufficed to do.’

The coherer 1894



When he takes up the research again in 1893-4, he finds two very efficient coherer devices for detecting radio waves – the filings tube and the point contact coherer. The first is based on a device investigated by Branly and examined by several investigators, including W. B. Croft.

The coherer 1894

Lodge uses it to create what we might now describe as a radio signalling method, which he demonstrates in 1894 in lectures at the Royal Institution, Royal Society and British Association. The paper incorporating this is published in *Nature* and elsewhere.

Almost immediately, we have ‘simultaneous’ discovery of the coherer by Popov, Righi, Marconi and Bose.

Marconi later made a point of naming Branly as the ‘discoverer’ of the coherer, even though both the principle and the uses go back to Lodge, as a way of excluding Lodge from the story.

The electron 1897

Lodge did not originate the electron concept, but his writings played a major part in developing its meaning. The name ‘electron’ was introduced by Johnstone Stoney in 1891 to describe the fundamental unit of charge he had been proposing since 1874.

Even before this, Joseph Larmor had been developing a concept of free units of charge to overcome certain anomalies in Maxwell’s theory with regard to conductivity. He was persuaded by Stoney’s nephew, G. F. FitzGerald, to adopt Stoney’s term.

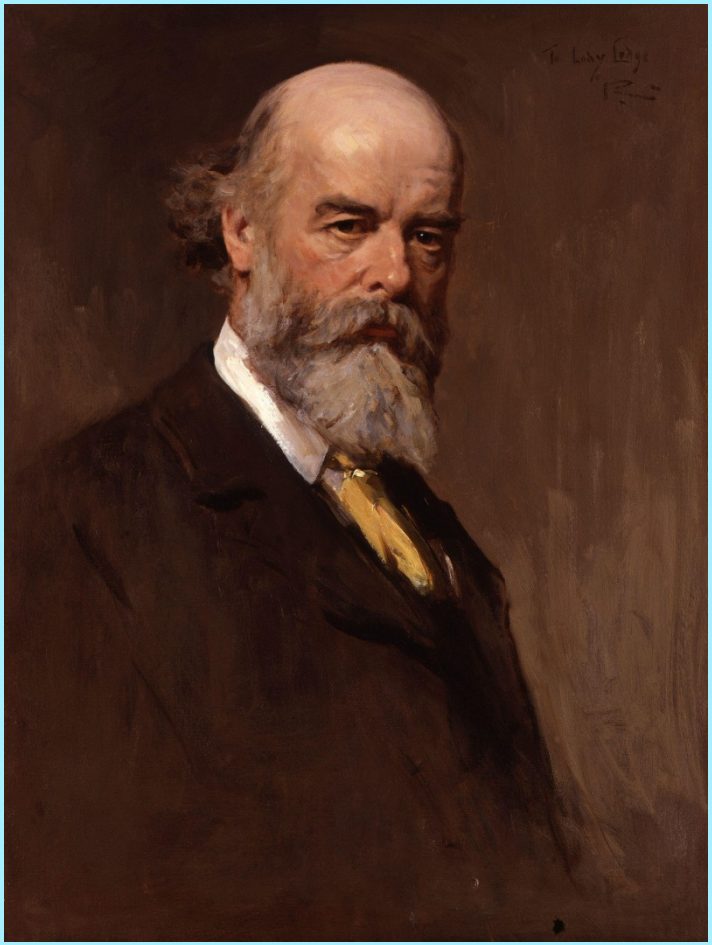
When J. J. Thomson announced the discovery of a ‘corpuscle’ fundamental to matter in April 1897, FitzGerald quickly saw to it that the name ‘electron’ became attached.

The electron 1897

Even before this, Lodge had been investigating the Zeeman effect, which had emerged from the 'ion' theory of H. A. Lorentz, which was in many ways parallel to the 'electron' theory of Larmor. Lodge and his assistant Benjamin Davies were able to experimentally extend Zeeman's discovery of spectral line broadening in a magnetic field to spectral line splitting.

Reporting to the Royal Society on the Zeeman effect on 11 February 1897, Lodge promoted Larmor's free electron theory used the mass and charge values available from the Zeeman effect to calculate the approximate 'size' of electrons, at 0.25×10^{-14} cm. After Thomson published his results, FitzGerald reviewed his work, proclaiming that Thomson's corpuscles were free electrons, and the name stuck.

The electron 27 November 1902



27 November 1902 Lodge gave a major presentation on the electron to the Institution of Electrical Engineers.

Apart from giving a lengthy review of all the relevant experimental evidence, Lodge also gives himself opportunity for some more personal thoughts and speculations.

The electron 27 November 1902

Various astronomical analogies – electrons in comet-like orbits, and an atom which is mostly empty space, indicating a greater disproportion between the atom and the electron than between the Sun and the Earth in the Solar System.

Unanswered questions: why don't the 'quiet orbital revolution of electrons round the atom' produce perceptible radiation? And why are positive 'electrons' grouped together while negative electrons remained free.

All these ideas and questions become significant in the literature. In historical works, the prime references given seem to be later than to Lodge's.

The atom 5 February 1903

Bedford College, 5 February 1903: ‘the atom is becoming like a solar system, or like nebulae, or Saturn’s rings or something of that kind’.

He gives an estimate of the ‘size’ of an electron at 1/105 the size of an atom, calculated from the radius for a uniformly charged sphere ($3m_e^2 / 2m$). Essentially, this is the ‘classical radius’. Again the ‘standard’ reference is later than Lodge.

The atom 13 February 1903

13 February 1903, lecture on ‘Electrons’ to the Liverpool Physical Society. He sees the chemical atom as composed of ‘a very large number of electrons’, separated by very great distances, and revolving ‘rapidly round orbits in the atom in much the same way as the planets move in the solar system’.

Physicists could ‘expect phenomena due to perturbations analogous to those exhibited by the planets’. Such had been observed by Preston, Zeeman and others. ‘For example, one of the simplest perturbations, known as progression and recession of apses (the slow revolution of the orbit in its own plane) accounts for the doublet in the spectrum.’

The atom 13 February 1903

There is also the emission of electrons by radioactive materials, ‘some substances such as radium giving them off with tremendous energy’. He implies that radioactivity is the source of the Sun’s energy.

He ends with the speculation ‘that the material universe consists of an infinite series of systems, in which the solar system is next to the system of electrons which compose the atom’. This is not entirely a new idea. Lodge’s immediate source was probably the infinite series of ever more subtle aethers, leading back to God, in Stewart and Tait’s *Unseen Universe*, but Lodge applies the idea here to matter, maintaining that there could be only a single aether.

Atomic stability 5 June 1903

5 June 1903 ‘Note on the probable instability of all matter’, summarises remarks made at the Physical Society of London following a communication by Rutherford on 5 June. Larmor, in giving the nonrelativistic formula for radiation losses from orbiting electrons in 1897, had pointed out the implications that this process held for atomic stability. Lodge now calculates that electrons revolving about the ‘much more massive rest of the atom with its positive charge’ will radiate energy and be drawn in towards the centre; but although this means a loss of kinetic energy, the electrostatic force on the electrons will increase to a greater degree, with a net overall increase in speed, ‘until presently their speed approaches the velocity of light’.

Atomic stability 5 June 1903

Lodge hopes that this might explain radioactive decay.

In fact, its historical significance was rather different – it was the basis of the argument on which Bohr rejected the idea of continuous energy transitions for atomic electrons.

Radioactivity 12 June 1903

Romanes Lecture on ‘Modern Views of Matter’, the Sheldonian Theatre, Oxford, 12 June 1903

Fired up by Rutherford and Soddy’s recent announcement that radioactivity is a process of natural transmutation of the atoms of one kind of element into those of another, with the release of large amounts of energy.

Radioactivity 12 June 1903

Multitudes of positive and negative electrons are imagined ‘flying about inside the atom, as a few thousand specks like full stops might fly about inside this hall; forming a kind of cosmic system under their strong mutual forces, and occupying the otherwise empty region of space we call the atom ... .’

It is possible, but ‘very unlikely’, that the electron contains ‘a material nucleus in addition to its charge’, but the purely electrical origin must remain a hypothesis until the positive electron can be ‘isolated from the rest of an atom of matter’.

Radioactivity 12 June 1903

Radioactivity, on this model, can be likened to the progressive stages in 'the condensation or contraction of a nebula', the particles falling together until the centrifugal force of the outer parts exceed the gravitational pull of the central mass; the outer parts will then be thrown off and the residue shrink even further until the process occurred again.

An appendix to the lecture describes a 'crude resemblance' between radioactive decay and 'the contraction and gradual collapsing of a nebula, with occasional shrinking off of peripheral material as an unstable stage is periodically reached, in accordance with the rough approximation known as Bode's law, together with a strong radio-activity of the central mass, and a conversion of constitutional potential energy into heat'.

Radioactivity 12 June 1903

Lodge supposes that the whole of matter might be a merely ‘transient phenomenon’.

However, radioactivity may well involve processes of regeneration as well as those of degeneration – for there are attractive as well as repulsive forces within atoms – and the idea that the conservation of energy is violated in radioactive decay is a ‘gratuitous absurdity’ with not the ‘slightest foundation’.

Radioactivity 10 September 1903

British Association, Southport, 10 September 1903, strong support for Rutherford's theory of radioactive decay. It is 'supported by Larmor's electrical theory of matter', according to which atoms are necessarily unstable.

Lodge's speculations on atomic energy are said to have influenced Rutherford into perceiving radioactive decay as a slow but inevitable process of transformation within matter.

Radioactivity and Astrophysics July 1903

'Radium and its lessons', *Nineteenth Century*, July 1903

An atom can be said 'to be composed of an aggregate of smaller bodies in a state of rapid interlocked motion, restrained and coerced into orbits by electrical forces'. A minute fraction of these break down, possibly due to 'an approach to the speed of light in some of their internal motions – perhaps the maximum speed which matter can ever attain'.

Matter, he said, is 'evanescent and transient', 'subject to gradual decay and decomposition' by internal forces. Perhaps atoms originate by 'some agglomeration of the separate electrons' comparable with the gravitational aggregation of cosmic material into 'nebulae, suns and planets'. An early inkling of fusion.

Radioactivity and Astrophysics 1907

Electrons, 1907, extended from 1902 lecture

The whole doctrine of solar emanations, and the repulsion of small particles from the Sun's light and 'probable electrification', a matter which has been familiar to him for many years, 'through conversation with FitzGerald and others'.

The 'Sun must be intensely radioactive' and that the discharge of its electrons 'into the approximate vacuum of its immediate neighbourhood' is probably responsible for the 'appearance known as the Corona'. also

Draws a cosmic analogy between radioactivity and novae. 'Both are outbursts of a kind of radio-activity, though they may be excited by different causes ... .' Again novel.

Radioactivity and Astrophysics 21 February 1908

'The Æther of Space', Royal Institution on 21 February 1908.

Speculates that, 'if the whole sensible universe' (10^9 suns, according to the estimate of Lord Kelvin) were 'concentrated into one body, the stress may be so great as to cause a disintegrating explosion and scatter the particles as an enormous nebula and fragments into the depth of space ... . I do not suppose that this can be the reason but one would think that there must be *some* reason for the scattered condition of gravitative matter.'

At 10^{33} dynes per square centimetre 'something would have to happen' – in modern terms this would be the result of the (radioactive) weak force acting through electron degeneracy pressure.

Positive and Negative Electricity November 1907

Modern Views of Electricity, third edition, published in November 1907

‘The hypothesis ultimately suggested is that excessively minute portions of ether have, by some unknown means, been dissociated here and there into electric charges, and that these immensely numerous mobile specks of electrified ether – through the forces they exert and the disturbances they originate – constitute the substratum of what appeals to our senses as matter.’

‘The two constituents are called positive and negative electricity respectively; and of these two electricities we imagine the ether to be composed.’

Positive and Negative Electricity November 1907

Many possible models for the atom

One mentioned, though not favoured, ‘a central ‘sun’ of extremely concentrated positive electricity, with a multitude of electrons revolving in astronomical orbits, like asteroids, within its range of attraction’;

another was the Kelvin-Thomson suggestion of a uniformly charged sphere of positive electricity with negative electrons embedded within it.

Lodge had discussed such models with J. H. Poynting, some years before; Lodge favoured the ‘diffuse globular charge’ of Thomson and Kelvin, Poynting preferred the ‘other or astronomical form of atom’.

Positive and Negative Electricity November 1907

Whatever the nature of the positive charge, the work of Thomson now suggests that the electrons were arranged in a series of rings, each with its own natural frequency of vibration corresponding to a definite line in the spectrum of the atom.

Detectable radiation will be emitted only when the centre of gravity of a ring of electrons is displaced from its natural position by some perturbing influence.

An electron revolving in an orbit 400 billion times per second would emit red light of the lowest visible frequency; faster orbits would emit higher frequencies. An electron which got nearer to the centre of force in the atom would have to revolve quicker.

Positive and Negative Electricity November 1907

Perturbations in the orbits similar in principle to astronomical ones would cause spectral doublets and triplets.

The size of the orbit of a radiating electron could be calculated by considering a single negative electron orbiting round the fixed positive charge attached to an atom. Using a formula equivalent in modern terms to $E^2/4\pi^2\nu^2e^2m$, where E is the electrostatic energy, would make the orbital radius r at which the frequency ν of visible light could be attained equal to 10^{-8} cm, the atomic distance: 'in other words, ... the electron is roaming over the surface of the atom'.

The calculation is in fact equivalent to finding the Bohr radius for the ground state of hydrogen, $h^2/4\pi^2e^2m$.

Fusion 1907

Radioactivity represented ‘the disintegration and collapse of some more massive atoms’ but the reverse process of growth of complex atoms by assimilation has not yet been observed.

Indirect evidence could be found from spectroscopic examination of nebulae, ‘the probable parents of solar systems’, which are composed only of the lightest and simplest elements, such as hydrogen and helium.

‘Hence it is natural to think that just as the cloud contracts into sun and planets, so its materials coalesce into heavier elements.’ This dates to 1907, but is usually assigned to a much later period.

Fusion

A year earlier he had written that if the ether were whirling at its constitutional velocity (technically called ‘the velocity of light’), it would have immense energy, and be capable of many things of which we are not yet aware. Hydrogen to helium fusion ‘must have been done some time and somewhere; perhaps in the interior of stars, certainly in ways at present unknown’. If so, some of the energy associated with matter could be accounted for. ‘This is believed to be why the stars are hot.’

The production of energy by nuclear fusion was now being invoked by astronomers and physicists to explain the extraordinary energy possessed by the sun and other stars, but Lodge had long associated the coalescence of fundamental particles to form atoms of matter with the formation of stars and nebular systems.

The Proton 1920

Royal Society in June 1920, and then at the British Association later in the same year, Rutherford suggests the nucleus of the hydrogen atom be considered a component particle within all nuclei, as in the old theory of Prout, and that it should be named the ‘proton’.

Lodge accepts the proton as a component of the nucleus, but continues to regard it as, in some sense, a composite particle, made up of positive and negative electrons.

It is just possible, he thinks, that ‘the progress of discovery’ will detach from the proton a positive charge more closely akin to the negative electron – in fact an image of it;.

The Proton 1922

‘Speculation concerning the Positive Electron’, *Nature*, 25 November 1922

Considered that, as a result of radioactivity: ‘The formation of strange substances and unusual combinations may be expected and the composite nature even of the proton may yet be demonstrated by the emission of something fractional of extreme instability.’

The Proton and the Positive Electron 1922

The proton has not totally replaced the positive electron, which is, in some way, more fundamental: ‘According to Larmor’s theory the positive and the negative electrons can only differ, or at least must chiefly differ, in one being the mirror-image of the other. One for example might be a concentrated locked right-handed screw twist in the Ether while the other would be a left-handed contortion of the same kind, simultaneously and inevitably produced, and contorted with its fellow by transferable lines of force.’

Conclusion

In a number of different ways, ideas first promoted by Lodge became standard components of the scientific literature.

There is no doubt that his ‘media presence’ and success at popularising had a significant effect.

At the same time, Lodge’s kind of speculative synthesizing, has rarely been given its due as a stimulator of scientific advancement, largely because of its semi-popular origin.

Lodge, however, was a deep thinker as well as ‘media’ personality and his profound influence on a number of developments deserves to be investigated.

The End