

any dark bodies, but only imperfect eyes. All bodies, whatever, are a constant source of visible or invisible radiations, which, whether of one kind or the other, are always radiations of light."

These lengthy quotations give a fair idea of the range and character of the book. It is probable that very few people will agree with the author on all points; but that does not make the book any the less interesting. The author has discovered a number of important and unexpected facts, and he does make one think. Those two things are more than enough to make us overlook any looseness of argument which we may detect here and there. The translation is not a good one though one perhaps should not call it distinctly bad.

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**The New Physics and its Evolution.** By *Lucien Poincaré*. Being the authorized translation of "*La Physique Moderne, son évolution*." 12 × 19 cm; pp. vi + 344. New York: D. Appleton & Company, 1908.—The headings of the chapters are: principles; the various states of matter; solutions and electrolytic dissociation; the ether; wireless telegraphy; the conductivity of gases and the ions; cathode rays and radio-active bodies; the ether and matter; the future of physics.

The author begins by pointing out that the developments in physics during the first decade of the twentieth century have not been a bit more startling than those during the first decade of the nineteenth century. He next discusses the mechanical view of phenomena in which, p. 11, the idea of Descartes is treated as an ideal to be reached sooner or later.

"Certain scholars—particularly those of the English School—outrunning experiment, and pushing things to extremes, took pleasure in proposing very curious mechanical models which were often strange images of reality. The most illustrious of them, Lord Kelvin, may be considered as their representative type, and he has himself said: 'It seems certain to me that the true sense of the question, Do we or do we not understand a particular subject in physics? is—Can we make a mechanical model which corresponds to it? I am never satisfied so long as I have been unable to make a mechanical model of the object. If I am able to do so, I understand it. If I cannot make such a model, I do not understand it.' But it must be acknowledged that some of the models thus devised have become excessively complicated, and this complication has for a long time been discouraged by all but very bold minds. In addition, when it becomes a question of penetrating into the mechanism of molecules, and we were no longer satisfied to look at matter as a mass, the mechanical solutions seemed undetermined and the stability of the edifices thus constructed was insufficiently demonstrated."

On p. 19, in the chapter on measurements there is another interesting quotation from Lord Kelvin.

"I often say," Lord Kelvin has said, "that if you can measure that of which you are speaking and express it by a number you know something of your subject; but if you cannot measure it nor express it by a number, your knowledge is of a sorry kind and hardly satisfactory. It may be the beginning of the acquaintance, but you are hardly, in your thoughts, advanced towards science, whatever the subject may be."

On p. 63, in the chapter on the principles of physics, we find the following:

"By experiments which are now classic, it becomes established that the quantity of heat thus created independently of the nature of the bodies is always (provided no other phenomena intervene) proportional to the energy which has disappeared. Reciprocally, also, heat may disappear, and we always find a constant relation between the quantities of heat and work which mutually replace each other.

"It is quite clear that such experiments do not prove that heat is work. We might just as well say that work is heat. It is making a gratuitous hypothesis to admit this reduction of heat to mechanism; but this hypothesis was so seductive, and so much in conformity with the desire of nearly all physicists to arrive at some sort of unity in nature, that they made it with eagerness and became unreservedly convinced that heat was an active internal force.

"Their error was not in admitting this hypothesis, it was a legitimate one since it has proved very fruitful. But some of them committed the fault of forgetting that it was an hypothesis, and considered it a demonstrated truth. Moreover, they were thus brought to see in phenomena nothing but these two particular forms of energy which in their minds were easily identified with each other."

An interesting instance of pragmatism appears in the chapter on the ether, p. 179.

"Fresnel founded his theory of double refraction and reflexion by transparent surfaces, on the hypothesis that the vibration of a ray of polarized light is perpendicular to the plane of polarization. But Neumann has proposed, on the contrary, a theory in which he recognizes that the luminous vibration is in this very plane. He rather supposes, in opposition to Fresnel's idea, that the density of the ether remains the same in all media, while its coefficient of elasticity is variable.

"Very remarkable experiments on dispersion by M. Carvallo prove, indeed, that the idea of Fresnel was, if not necessary for us to adopt, at least the more probable of the two; but apart from this indication, and contrary to the hypothesis of Neumann, the two theories, from the point of view of the explanation of all known facts, really appear to be equivalent. Are we then in presence of two mechanical explanations different indeed, but nevertheless both adaptable to all the facts, and between which it will always be impossible to make a choice? Or, on the contrary, shall we succeed in realizing an *experimentum crucis*, an experiment at the point where the two theories cross, which will definitely settle the question?

"Professor Wiener thought he could draw from his experiment, a firm conclusion on the point in dispute. He produced stationary waves with light polarized at an angle of  $45^\circ$ , and established that, when light is polarized in the plane of incidence, the fringes persist; but that, on the other hand, they disappear when the light is polarized perpendicularly to this plane. If it be admitted that a photographic impression results from the active force of the vibratory movement of the ether, the question is, in fact, completely elucidated, and the discrepancy is abolished in Fresnel's favor.

"M. H. Poincaré has pointed, however, that we know nothing as to the mechanism of the photographic impression. We cannot consider it evident

that it is the kinetic energy of the ether which produces the decomposition of the sensitive salt; and if, on the contrary, we suppose it to be due to the potential energy, all the conclusions are reversed, and Neumann's idea triumphs.

"Recently a very clever physicist, M. Cotton, especially known for his skilful researches in the domain of optics, has taken up anew the study of stationary waves. He has made very precise quantitative experiments, and has demonstrated, in his turn, that it is impossible, even with the spherical waves, to succeed in determining on which of the two vectors which have to be regarded in all theories of light on the subject of polarization phenomena the luminous intensity and the chemical action really depend. This question, therefore, no longer exists for these physicists who admit that luminous vibrations are electrical oscillations. Whatever, then, the hypothesis formed, whether it be electric force or, on the contrary, magnetic force which we place in the plane of polarization, the mode of propagation foreseen will always be in accord with the facts observed."

In the chapter on radio-active bodies we find the following passages, p. 287.

"The most prudent physicists and those most respectful to established principles may, without any scruples, admit the explanation of the radio-activity of radium by a dislocation of its molecular edifice. The matter of which it is constituted evolves from an admittedly unstable initial state to another stable one. It is, in a way, a slow allotropic transformation which takes place by means of a mechanism regarding which, in short, we have no more information than we have regarding other analogous transformations. The only astonishment we can legitimately feel is derived from the thought that we are suddenly and deeply penetrating to the very heart of things.

"But those persons who have a little more hardihood do not easily resist the temptation of forming daring generalizations. Thus, it will occur to some that this property, already discovered in many substances where it exists in more or less striking degree, is with differences of intensity, common to all bodies, and that we are thus confronted by a phenomenon derived from an essential quality of matter. Quite recently, Professor Rutherford has demonstrated in a fine series of experiments that the  $\alpha$  particles of radium cease to ionize gases when they are made to lose their velocity, but that they do not on that account cease to exist. It may follow that many bodies emit similar particles without being easily perceived to do so; since the electric action, by which this phenomenon of radioactivity is generally manifested, would, in this case, be but very weak.

"If we thus believe radioactivity to be an absolutely general phenomenon, we find ourselves face to face with a new problem. The transformation of radioactive bodies can no longer be assimilated to allotropic transformations, since, thus, no final form could ever be attained, and the disaggregation would continue indefinitely up to the complete dislocation of the atom. The phenomenon might, it is true, have a duration of perhaps thousands of millions of centuries, but this duration is but a minute in the infinity of time, and matters little. Our habits of mind, if we adopt such a conception, will be none the less very deeply disturbed. We shall have to abandon the idea so instinctively dear to us that matter is the most stable thing in the universe, and to admit,

on the contrary, that all bodies whatever, are a kind of explosive decomposing with extreme slowness. There is in this, whatever may have been said, nothing contrary to any of the principles on which the science of energetics rests; but an hypothesis of this nature carries with it consequences which ought in the highest degree to interest the philosopher, and we all know with what alluring boldness M. Gustave Le Bon has developed all these consequences in his work on the evolution of matter."

In the chapter on the ether and matter, the following paragraphs, p. 296, are of especial interest.

"Unfortunately, if a gas is not absolutely incapable of emitting some sort of rays by simple heat, the radiation thus produced, no doubt by reason of the slightness of the mass in play, always remains of moderate intensity. In nearly all the experiments, new energies of chemical or electrical origin come into force. On incandescence, luminescence is superposed; and the advantage which might have been expected from the simplicity of the medium vanishes through the complication of the circumstances in which the phenomenon is produced.

"Professor Pringsheim has succeeded in certain cases, in finding the dividing line between the phenomena of luminescence and that of incandescence. Thus, the former takes a predominating importance when the gas is rendered luminous by electrical discharges and chemical transformations, especially, play a preponderant rôle in the emission of the spectrum of flames which contain a saline vapor. In all the ordinary experiments of spectrum analysis the laws of Kirchhoff cannot, therefore, be considered as established, and yet the relation between emission and absorption is generally tolerably well verified. No doubt we are here in presence of a kind of resonance phenomenon, the gaseous atoms entering into vibration when solicited by the ether by a motion identical with the one they are capable of communicating to it."

From the final chapter on the future of physics, the following paragraphs, p. 324, are worth quoting.

"The electron has conquered physics, and many adore the new idol rather blindly. Certainly we can only bow before an hypothesis which enables us to group in the same synthesis all the discoveries on electric discharges and on radioactive substances, and which leads to a satisfactory theory of optics and of electricity; while by the intermediary of radiating heat, it seems likely to embrace shortly the principles of thermodynamics also. Certainly one must admire the power of creed which penetrates also into the domain of mechanics and furnishes a simple representation of the essential properties of matter; but it is right not to lose sight of the fact that an image may be a well-founded appearance, but may not be capable of being exactly superposed on the objective reality.

"The conception of the atom of electricity, the foundation of the material atoms, evidently enables us to penetrate further into nature's secrets than our predecessors; but we must not be satisfied with words and the mystery is not solved when, by a legitimate artifice, the difficulty has simply been thrust further back. We have transferred to an element ever smaller and smaller, those physical qualities which in antiquity were attributed to the whole of a substance; and then we shifted them later to those chemical atoms which, united together, constitute this whole. To-day we pass them on to the electrons which

compose these atoms. The indivisible is thus rendered, in a way, smaller and smaller, but we are still unacquainted with what its substance may be. The notion of an electric charge which we substitute for that of a material mass will permit phenomena to be united which we thought separate, but it cannot be considered a definite explanation or as the term at which science must stop. It is probable, however, that for a few years still physics will not travel beyond it. The present hypothesis suffices for grouping known facts, and it will doubtless enable many more to be foreseen, while new successes will further increase its possessions.

"Then the day will arrive when, like all those which have shone before it, this seductive hypothesis will lead to more errors than discoveries. It will, however, have been improved, and it will have become a very vast and very complete edifice which some will not willingly abandon; for those who have made to themselves a comfortable dwelling-place on the ruins of ancient monuments are often too loth to leave it."

This is a good book. The author has selected his material well and has presented it in a satisfactory form. Unfortunately, the unknown translator has done his work very badly. Such foot-notes as the one on p. 25 make one wonder how much the nameless editor has understood of the book he was supposed to edit.

Wilder D. Bancroft.

**Qualitative Analyse vom Standpunkte der Ionenlehre.** By Wilhelm Böttger. Zweite, umgearbeitete und stark erweiterte Auflage. 16 × 24 cm; pp. xvi + 524. Leipzig: Wilhelm Engelmann, 1908. Price: paper, 10 marks; bound, 20 marks.—The first edition was reviewed (6, 267) in 1902. The arrangement of the second edition differs to a certain extent from that of the first, the special and the general parts now being kept separate. The book is divided into the following sections; general principles; manipulation; characteristic reactions of the cations and their salts; scheme of qualitative analysis for cations; scheme of qualitative analysis for anions; preliminary tests in qualitative analysis; dissolving and leaching of solids for qualitative analysis; rare elements.

It is perhaps a question whether this book is suitable for an introductory course in qualitative analysis; but it would unquestionably be useful for a more advanced course and it is a book which every one interested in chemistry should look through at some time or other. Some of the experiments in the section on general principles are admirable. As instances of this, I cite the action of cobalt salts on hypochlorites, p. 109; the filtration of silver chlorides, p. 116; the testing of a potassium chrome oxalate solution for potassium, chromium and oxalate ions, p. 89.

Wilder D. Bancroft

**Kurzes Lehrbuch der organischen Chemie.** By William A. Noyes. Mit Genehmigung des Verfassers ins Deutsche übertragen von Walter Ostwald und mit einer Vorrede von Wilhelm Ostwald. 14 × 21 cm; pp. xxiv + 722. Leipzig: Akademische Verlagsgesellschaft m. b. H., 1907.—The interesting feature of this book is that the author has dropped the usual distinction between aliphatic and aromatic compounds. He treats all the hydrocarbons together, then all the alcohols and phenols, and so on. This is unquestionably a logical arrangement; but so was the old arrangement. It seems to the reviewer that the treatment adopted in this book is not a good one for elementary students. Take toluene