

does not seem open to doubt. I do not see how hydrodynamic laws enter into the question."

Dr. Chessin writes: "With regard to Prof. Newcomb's remark, I beg to observe that I did not raise the question as to whether the law which Dr. See calls *his* (and which, more correctly, should be called Ritter's, who expressed it in 1881, as Dr. See states himself), was at all plausible or not. I simply objected to Dr. See's *derivation*, in the course of which, as I have stated before, he assumes that which he wants to prove.

"As to neglecting the principles of hydrodynamics, it suffices to point out, for example, the inadmissible assumption of uniform density throughout a gaseous body in dynamical condition (v.l. contraction and radiation)."

SOURCES OF IMPORTANT MINERALS.

A VALUABLE Blue Book by Prof. C. Le Neve Foster, F.R.S., containing statistics relating to persons employed in mining, the output of minerals, and the number of accidents occurring in mines and quarries in the British Colonies and in

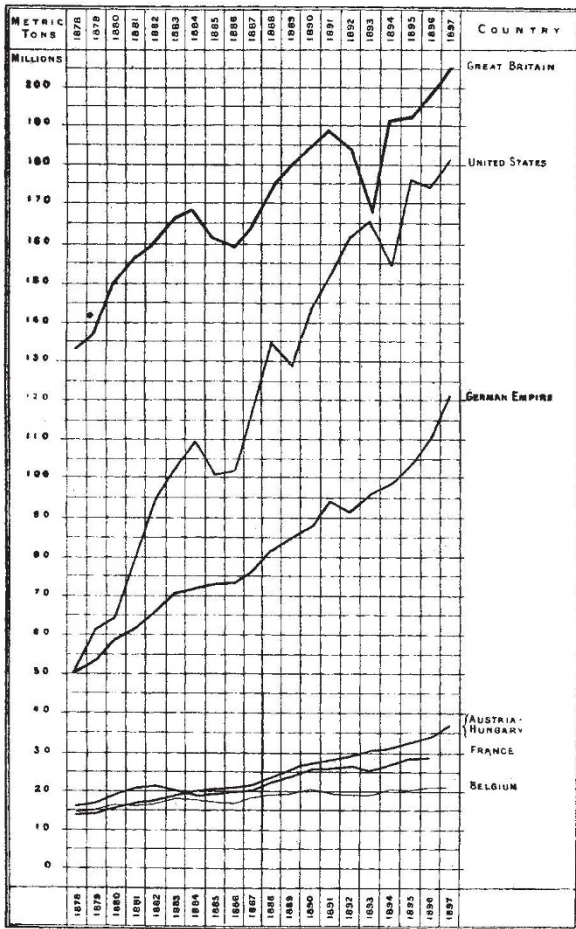


FIG. 1.—Diagram showing the output of coal in six of the principal coal-producing countries during the past twenty years.

foreign countries, has just been published by the Home Office. The tables are not complete, but the information given in them presents many points of interest. The part of the introduction referring to output is printed below, and the two accompanying diagrams, reproduced from plates in Prof. Foster's report, illustrate graphically the variations in the production of coal and iron ore in several countries during the past twenty years.

Coal.—The United Kingdom is at present the most important producer of coal, but the rapid growth of coal mining in various parts of the United States, as apparent from the curve in diagram (Fig. 1), and the knowledge of its enormous resources, lead to the belief that the mother country will eventually have

to yield its position to the younger branch of the Anglo-Saxon race. The British Empire, as a whole, produces more than two-fifths of all the coal raised in the world.

Copper.—Figures do not furnish a proper basis for comparison of output, because some countries state their output as ore, and others as metallic copper. The United States, with the enormous output of 223,000 tons of metal, produce more than half the copper of the world, and Spain and Portugal together about one-eighth.

Gold.—In the race of the gold-producing countries the South African Republic has been rapidly gaining upon the United States, and, though a little behind in 1897, will take the first place for the current year. In 1897 it may be said approximately that these two countries and Australasia each produced more than one-fifth of the world's supply. The only other country needing mention is Russia, with nearly one-tenth of the total.

Iron.—Tables which merely show tons of ore without stating the average percentages of metal must be read with caution; but, whether judged by the gross weight of the ore or by the actual amount of metal present, the United States take the lead among the iron-yielding countries. Great Britain comes next as a producer of iron, and is followed by Germany with its 10

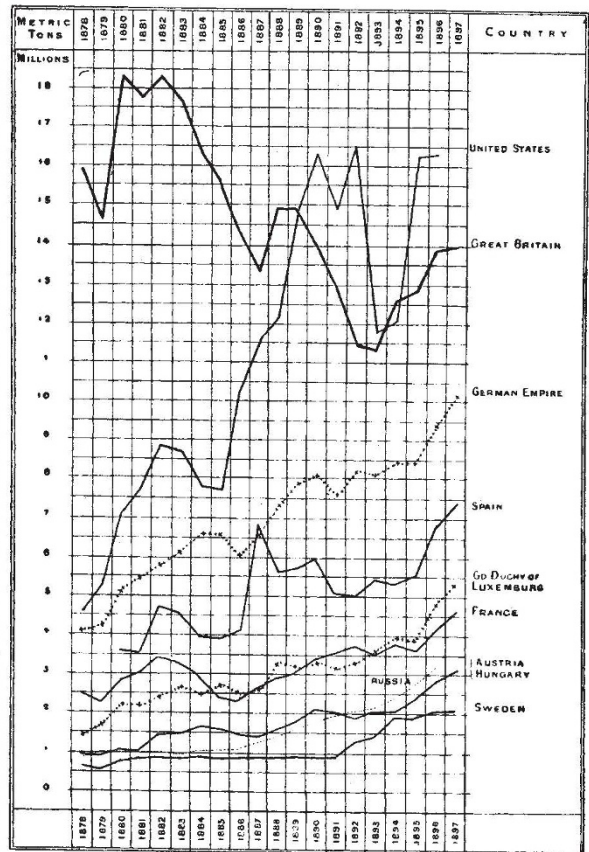


FIG. 2.—Diagram showing the output of iron ore in the principal iron-producing countries during the past twenty years.

million tons of ore derived mainly from the poorer but easily wrought deposits of Alsace-Lorraine. Spain ranks fourth with a production of 7 million tons of ore; but in comparing its position with that of Germany, the higher percentage of metal in the Spanish ores should be borne in mind. In the same way the low percentage of iron in the ore produced in Luxembourg must be considered in comparing its output of 5 million tons with that of France, Russia and Austria-Hungary.

The production of iron ores in the principal countries during the past twenty years is illustrated by a diagram (Fig. 2).

Lead.—Spain is the greatest lead-producing country in the world; it is followed at no great distance by the United States. Germany produces little more than half the total output of Spain.

Petroleum.—Russia and the United States are the two great petroleum producers. In the British Empire, Canada and Burma are the only oil regions deserving mention at the present time, though their output is, comparatively speaking, small.

Salt.—The United States and the United Kingdom produce about 2 million tons of salt each, Russia $1\frac{1}{2}$ million, Germany $1\frac{1}{2}$ million, India about 1 million.

Silver.—Here again the United States are the largest producers, followed closely by Mexico. Australasia furnishes an output nearly equal to one-third of that of the United States, and Bolivia and Germany approximately the same amount.

Tin.—The Malay Peninsula is *facile princeps* as regards the production of tin, probably yielding nearly two-thirds of the world's supply; and when aided by other British Possessions fully three-quarters.

Zinc.—The mines of Upper Silicia alone would suffice to make the German Empire *par excellence* the zinc-producing country of the whole world. The United States, after a long interval, take the second place in the list.

It must be carefully remembered that many valuable minerals are not mentioned: for instance, Cape Colony produces diamonds to the value of $4\frac{1}{2}$ millions yearly; Italy has no equal for its sulphur, Chili for its nitrate of soda, Germany for its potassium salts, Spain for its quicksilver, and the United States for their phosphates.

ON THE ORIGIN OF MAGNETO-OPTIC ROTATION.¹

IT is known (*Phil. Mag.*, December 1897) that when in a material molecule there exists an independently vibrating group of ions or electrons, for all of which the ratio e/m of electric charge to inertia is the same, then the influence of a magnetic field H on the motions of this group is precisely the same as that of a rotation with angular velocity ω , equal to $\frac{1}{2}eH/mc^2$, imposed on the group around the axis of the field, on the hypothesis that the extraneous forces acting on the ions are symmetrical with respect to this axis. This result involves the main features of the Zeeman effect; it requires that the separations of the doublets representing the spectral lines arising from such a group must all be equal when measured in differences of frequency, or be inversely as the square of the wave-length in vacuum when measured in differences of wave-length, a relation which Preston has recently found to obtain for the natural series of lines in ordinary spectra.

The object of this note is to point out that it is possible to deduce the Faraday effect from the Zeeman effect by general reasoning, as regards any medium in which the optical dispersion is mainly controlled by a series of absorption bands for which the Zeeman effect obeys the above law, without its being necessary to introduce any special dynamical hypothesis. For this law ensures that the effect of the magnetic field on the periods of the corresponding free vibrations of the molecules is the same as that of a bodily rotation, say with angular velocity ω , round its axis;² while the complete circular polarisations of the Zeeman doublets, viewed in the direction of the axis, show that their states of vibration are symmetrical with respect to that axis. Thus, Ω being the angular velocity of the displacement vector in a train of circularly polarised waves traversing the medium along the axis, the state of synchronous vibration which it excites in the molecules will have exactly the same formal relation to this train when the magnetic field is off as it would have to a train with very slightly different angular velocity $\Omega \pm \omega$ when the magnetic field is on, the sign being different according as the train is right-handed or left-handed. Now, change of this angular velocity Ω means change of period of the light: thus the propagation of a circularly polarised wave-train when the field is on is identical with that of the same wave-train when the period is altered by its being carried round with angular velocity $\pm \omega$ and there is no influencing magnetic field.

This last result has been employed by H. Becquerel as a single hypothesis (suggested by Maxwell's notion of a magnetic field in this connection as a vortex in the medium) from which

¹ Communication to the Cambridge Philosophical Society, March 6, by J. Larmor, F.R.S.

² The circumstance that the mean of the two disturbed periods is equal to that of the undisturbed line shows that no effect of constitutive type is involved in addition.

to deduce quantitatively both the Zeeman effect and the Faraday effect, and thus correlate them ("Sur une interprétation applicable au phénomène de Faraday et au phénomène de Zeeman" — *Comptes rendus*, November 8, 1897). He shows, employing chiefly the quantitative results of his own previous experimental investigations, that the hypothesis is capable of providing a satisfactory general view of the whole range of the phenomena, and in particular that it leads immediately to a simple law of dispersion for the Faraday effect, namely rotatory power proportional to $\lambda dn/d\lambda$ where n is the refractive index corresponding to wave-length λ measured in vacuum, a law which is in good agreement with Verdet's results for carbon disulphide and creosote.

The preceding argument provides a general dynamical justification of this hypothesis, for the case of all media in which the ordinary gradient of dispersion is mainly controlled by one or more powerful absorption bands beyond the visible spectrum, for all of which the Zeeman constants are the same: it also shows that Becquerel's hypothesis has an approximate validity when these constants are nearly the same for all the effective bands. In the immediate neighbourhood of any single band the dispersion is anomalous, and is controlled practically by that band alone; the application will then be exact, and in Becquerel's hands it has given a complete account of the excessive and anomalous rotation first observed by Macaluso and Corbino in sodium vapour for light adjacent to the D lines. As was to be anticipated, these simple general conclusions are consistent with the results of the more special dynamical investigations of FitzGerald and Voigt.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR ROBERT MUIR, at present professor of pathology in the University of St. Andrews, has been appointed to the chair of Pathology in the University of Glasgow.

By the will of the late Miss Elizabeth Brown, who died on March 5, the British Astronomical Association will receive her observatory at Further Burton, with the astronomical instruments in it, and the sum of 1000*l*.

Science states that Mr. John D. Rockefeller has offered 100,000 dollars to Denison University, Granville, O., if the friends of the institution will, within the next year, raise the sum of 150,000 dollars.

THE British Child-Study Association has issued the first number of a magazine entitled *The Paidologist*, which is to be published three times a year, and will be concerned with the physical and psychological aspects of child-life. The aims of the Association are both scientific and educational; and the new magazine is intended as a medium in which the results of research on child psychology shall be recorded, and practical suggestions which will assist in the evolutionary progress of the race shall be described.

WITH reference to the Board of Education Bill, the Council of the Association of Technical Institutions has unanimously adopted the following resolutions: (1) In reference to Section 2 of Clause 3, "That, inasmuch as in some counties and in most county boroughs the funds available are already fully appropriated for the purposes of technical education it is not, in the opinion of this Council, desirable that these funds should be applied to the payment of the expenses of inspecting schools under this Section." (2) "That, in the opinion of this Council, having regard to the fact that the funds assigned under the provisions of the Technical Instruction Acts are not more than adequate for the maintenance and development of technical education, it is essential that for the further purposes of secondary education additional funds be provided." It has also decided to take steps to endeavour to secure that the interests of technical education shall be adequately represented on the consultative committee named in Clause 4 of the Bill.

THE Commissioners appointed under the University of London Act, 1898, have given notice that they are now prepared to consider applications from duly qualified teachers and lecturers giving instruction of the University type in public educational institutions situate within a radius of thirty miles from the University buildings, who desire to be recognised as teachers of the University. By a "public educational institu-