LETTERS TO THE EDITOR.

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X-Ray Spectra.

IT was shown by Barkla and Sadler (*Phil. Mag.*, February, 1907, and October, 1908) that many elements, when subject to a suitable beam of X-rays, emit a homogeneous beam of secondary X-rays of penetrating power characteristic of the radiating element. One of the writers (Barkla, Proc. Camb. Phil. Soc., May, 1909) showed that various groups of these characteristic radiations exist, and that each element most probably emits a line spectrum of X-rays, each line moving to the more penetrating end of the spectrum, with an increase in the atomic weight of the radiating element. For no single element, however, was the homogeneity of more than one radiation proved, or the penetrating power accurately determined. As all the principal phenomena accompanying the transmission of X-rays through matter are determined by the spectra of the constituent elements, it became a matter of considerable theoretical interest to confirm the theory by demonstrating the homogeneity of various radiations from some particular element. The writers therefore chose several of those elements the characteristic radiations of which were expected to be well within the range of penetrating power comparatively easy to experiment upon.

First, by using a penetrating primary beam, a mixture of the various secondary radiations characteristic of a particular element was obtained. After absorbing the softer constituents, a homogeneous beam of the penetrating secondary X-radiation belonging to Group B was left, its homogeneity was proved, and the coefficient of absorption in aluminium determined.

In order to isolate one of the more absorbable constituents, a very "soft" primary beam was used—too "soft" to excite the radiation of Group B just referred to. After the effect of the scattered radiation was determined by separate experiment and eliminated, this secondary X-radiation was also found to be homogeneous, and its absorption was determined. This radiation belonged to Group A.

Thus two of the lines of the spectra of antimony, iodine, and barium were determined. The following values of λ/ρ are the results of the most accurate measurements so far made (λ is defined by the equation $I = I_0 e^{-\lambda x}$ in transmission through aluminium of density ρ):—

Sb : (Group B) 1·21 ; (Group A) 435
I : (Group B) 0·92 ; (Group A) 306
Ba : (Group B) 0·8 ; (Group A) 224

A more absorbable radiation belonging to Group A has also been found to be emitted by silver in addition to the penetrating radiation of Group B, thus accounting for what appeared to Mr. Sadler (*Phil. Mag.*, March) to be an exception to the law connecting the emission of secondary corpuscular and secondary X-radiations emitted by an element.

There is indirect evidence of other spectral lines besides those of Groups A and B. Whether or not the radiation, more absorbable than that of Group A—in hypothetical Group X—has the properties of ordinary X-rays is a question to be decided experimentally.

C. G. BARKLA.
J. NICOL.

King's College, London, July 29.

Pwdre Ser.

IN case no other reader of NATURE should do so, may I direct Prof. McKenny Hughes's attention to a paper by M. Melsheimer on "Meteorgallerte," published in the *Jahresber. d. westfäl. Provinzialver. f. Wissensch. u. Kunst* (Bd. xxxvi., 1907–8, Münster, 1908, pp. 53–5), an abstract of which appeared in the *Centralblatt f. Bakteriologie* (Abt. ii., Bd. xxvii., Nos. 10–12, p. 237), published on June 22 of this year? The author appears to have paid attention to these masses of jelly, which are to be found in winter on meadows and other open places, for a period of years, and has come to the conclusion that they are the swollen oviducts of frogs. Herons eat female frogs in winter, and the oviducts become mixed in the crop with fish remains, which may become luminous. The contents are thrown up undigested, and become gelatinous when moistened. It is also possible that the heron may, during flight, discharge the gelatinous mass in a luminous condition, and hence the idea that the jelly is of meteoric origin.

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Royal College of Science, Dublin, July 4.

THE PRESSURE OF LIGHT.[1]

THE earliest attempts to detect the pressure of light were made in the eighteenth century. The corpuscular hypothesis was then almost universally accepted, and to the believers in that hypothesis the idea that light should exert a pressure upon a body against which it fell was perfectly natural. Regarding the atoms and molecules of a luminous surface as a battery of minute guns firing off a continuous stream of still more minute shot—the corpuscles—they inevitably supposed that any body bombarded by the shot would be pressed back. Many experiments were made to detect this bombardment by directing a powerful beam of light on to a delicately suspended disc, sometimes in air at ordinary pressures, sometimes in a vacuum, but with quite inconsistent and inconclusive results. They were met with the disturbances which still beset experiments on light forces—disturbances partly due to convection in the surrounding gas, and partly due to the radiometer action which Sir William Crookes discovered and investigated a hundred years later.

According to the corpuscular theory, the pressure sought should be equal to twice the kinetic energy of translation per unit volume in the beam used. If the earlier experimenters had known the principle of the conservation of energy and the mechanical equivalent of heat, they would no doubt have measured the energy of the beam, and would then have found that the pressure to be looked for was far too minute for detection by the apparatus which they employed.

With the abandonment of the corpuscular theory and its replacement by the wave theory, the idea of pressure of light disappeared, for the form which the wave theory took at first did not suggest a pressure, and it was not until 1874 that a definite and exact theory of light pressure was given by Clerk Maxwell. According to his theory of stresses in the medium, both electric and magnetic tubes of force press out laterally. If, then, light waves consist of electric and magnetic tubes of force transverse to the direction of propagation, these tubes should press on any surface against which they impinge, and the pressure should be equal to the energy in unit volume of the light. Maxwell calculated that the pressure which should be exerted by full sunlight amounted to about 1/23000 of a dyne per sq. cm.

Twenty-five years later Prof. Lebedew succeeded in detecting and measuring the pressure. He allowed the concentrated rays of an electric lamp to fall on a thin blackened platinum disc delicately suspended in a vacuum so high that there was probably no convection, and even the radiometer action was comparatively small. By the ingenious device of using discs of different thickness with radiometer action proportional to the thickness, he was able to calculate the force acting on an infinitely thin disc on which there would

1 Based upon the Bakerian lecture on "The Pressure of Light against the Source: the Recoil from Light," by Prof. J. H. Poynting, F.R.S., and Dr. Guy Barlow, delivered at the Royal Society on March 17.

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