Marignac and called by him originally Y*β*, gives absorption bands in the visible part and in the ultra-violet (Soret, *C.R.,* xc. p. 212). It frequently occurs with didymium, and most of the maps of the didymium spectrum contain the samarium bands. When pre­cipitated with another metal it shows a brilliant phosphorescent spectrum (Crookes), which, however, is slightly different accord­ing to the metal. The peculiar yttrium spectrum is very weak even when it is mixed in considerable quantities with samarium. But when the quantity of yttrium is increased to about 60 per cent. a very rapid change takes place, and afterwards it is the samarium spectrum which is very weak. A band in the orange peculiar to the mixture, weak in pure samarium and absent in yttrium, is strongest in a mixture containing about 80 per cent. of samarium aud 20 per cent. of yttrium.—*Holmium,* identified as a separate element by Soret (*C.R*., xci. p. 378), has absorption bands in the visible part of the spectrum (6405, 5363, 4855 on Lecoq’s map of chloride of erbium), and also a strongly marked ultra-violet absorption spectrum.—*Thulium,* likewise first recognized by Soret, is band 6840 on Lecoq’s drawing of chloride of erbium, and also possesses a band at 4645. Thalén has measured the bright line spectrum (*C.R*., xci. p. 376, 1880).—*Scandium* is characterized by a bright line spectrum (Thalén, *C.R.,* xci. p. 48, 1880).—*Gadolinium* (Marignac’s Yα) has a weak absorption spectrum in the ultra­violet and a characteristic phosphorescent spectrum (*Proc.* *Roy. Soc.,* February 1886); but the latest researches of Crookes have rendered it probable that it is a mixture of several new elements *(Proc. Roy. Soc.,* 10th June 1886).—The *mοsandrium* of Lawrence Smith seems a mixture of gadolinium and terbium. *The philippium* of De la Fontaine was a mixture of yttrium and terbium ; and the latest *decipium* of the same chemist is probably holmium.

*Aluminium Group.—*The spectra of the metals belonging to this group can be obtained in the ordinary way by means of the electric spark. The chloride of indium shows the two strongest metallic lines, one in the indigo and one in the violet, when intro­duced into the Bunsen flame. According to Claydon and Heycock, a number of other lines appear when the spark is taken from the metal electrodes. When a weak spark is taken from aluminium electrodes in air a band spectrum is often seen belonging apparently to the oxide, for it disappears when the spark is taken in hydrogen. Gallium, another metal belonging to this group, was first discovered by means of its spectroscopic reaction. The chloride shows two violet lines feebly in the Bunsen flame, but strongly if a spark is taken from the liquid solution. The ultra-violet lines of indium and of aluminium have been photographed by Hartley and Adeney, as well as by Liveing and Dewar. Some of the lines had been pre­viously mapped by Cornu, whose researches extend furthest into the ultra-violet. According to Stokes, aluminium shows lines more refrangible than those of any other metal, and the wave-lengths of their lines as measured by Cornu are for one double line 1934, 1929, and for another 1860, 1852.

*Metals of the Iron Group.—*The spectroscopic phenomena of this group are somewhat complicated. The line spectra can be obtained either by taking sparks from the metal or from the solution of a salt, and also by placing the metal in the voltaic arc. The lines are very numerous and very liable to alter in relative intensity under different circumstances. The great difference shown, for instance, between the arc and spark spectra of iron in the ultra­violet region is shown in the map by Liveing and Dewar in *Phil. Trans.,* 1885, pt. i. The visible part has also been investigated by the same authors and by Lockyer, and much information has thus been added to the knowledge previously obtained by Kirchhoff, Angstrom, and Thalén. That part of the iron spectrum lying between a wave-length of 4071 and 2947 has been mapped by Cornu ; Liveing and Dewar’s observations refer chiefly to the more re­frangible region. Considering the very important part which the iron spectrum plays in solar observations, a full investigation of its changes by a variation of temperature would at the present time be of great value. If observations with the method adopted by Lecoq de Boisbaudran were repeated with higher resolving powers they would add much to our knowledge. Some of the manganese salts, such as the chloride or carbonate, seem to be the only salts belonging to this group which show a characteristic spectrum when heated in the Bunsen burner or the oxyhydrogen flame. The spectrum observed in these cases is, according to Watts, the characteristic spectrum of the Bessemer flame, which disappears at the right moment for stopping the blast ; it is probably due to an oxide of manganese. When a spark spectrum is taken from a solution of the chloride the same spectrum is seen, but the relative intensity of the lines depends on the length and the strength of the spark. The green-coloured manganates show a continuous absorption at the two ends of the spectrum, transmitting in con­centrated solutions almost exclusively the green part of the spec­trum. The absorption bands of permanganate of potassium are well known and seem to be due to the permanganic acid, as they appear also with other permanganates. The green salts of nickel show a continuous absorption at the two ends of the spectrum. The cobalt salts show well-defined absorption bands. Their careful

investigation by Dr W. J. Russell deserves special notice *(Proc. Roy. Soc.,* xxxii. p. 258, 1881).

*Metals of Chromium Group.—*The metallic spectra of this group have been measured principally by Thalén in the usual way. Lockyer and Roberts have obtained a channelled spectrum of chromium by absorption. As regards the spectra of compounds of chromium, the absorption of the vapour of chloro - chromic anhydride has been measured by Emerson and Reynolds *(Phil. Mag.,* xlii. p. 41, 1871), and consists of a series of regularly dis­tributed bands. The chromium salts all possess a decided colour and show interesting absorption phenomena. The chromates ab­sorb the violet and blue completely, also the extreme red, and transmit only the orange, yellow, and in dilute solutions part of the green. The most complete investigation of the salts in which chromium plays the part of a base is due to Erhard in a dissertation published at Freiburg. Potassium chrom-alum, am­monia chrom-alum, sulphate of chromium, when in solution, give an identical absorption for the same amount of chromium. The extreme red is freely transmitted by the violet solution, but the absorption grows rapidly towards the yellow. An indistinct absorption band (λ = 6790 to λ=6740) is seen when the layer is thick or the solution concentrated. The strongest absorption takes place for a wave-length of 5800. The green is transmitted again more freely, the minimum absorption taking place for a wave-length 4880 ; the absorption then grows rapidly towards the violet. When the solutions are heated the colour changes to green, the absorp­tion is increased throughout the spectrum, except in the green, where it remains nearly unchanged, and the minimum of absorption shifts to a wave-length of 5090. The solution, which remains green on cooling, has, when compared with its original state, an increased absorption in the red and blue and a slightly diminished absorption in the green. When light is sent through plates cut out of crystals of potassium chrom-alum or ammonia chrom-alum, three absorption bands (6860, 6700, 6620) are seen in the red. The green and blue show the same absorption as the solution. The chloride in solution gives the same absorption as the chrorn-alums,—transmitting, how­ever, slightly more light for the same quantity of chromium. The hot solution also shows the same changes, but with this difference that colour and absorption phenomena are almost entirely recovered on cooling. The nitrate (solution of chromic hydroxide in nitric acid) agrees with chrom-alum, but transmits more light. Red crystals of potassic chromic oxalate only transmit the red with an absorption band slightly less refrangible than B (λ=6867). The blue salt has the absorption band at a wave-length of 7040 and transmits part of the light in the green and blue. The solutions of the salts show the same absorption as the crystals, with the position of the absorption band apparently unchanged. The warm solutions absorb more than the cold ones. The oxalate of chromium gives an absorption band of 6910 to 6860 and transmits the green and blue more freely than the double salt. The tartrate only shows the absorp­tion band in the red very weakly aud absorbs more red than the previously mentioned solutions. The acetate transmits more yellow than the other salts and has some broad absorption bands near a wave-length of 7170. When the solution is heated it becomes green, absorbing the red more than when cold, but leaving the green and blue absorption unchanged. The absorption phenomena shown by uranium salts are more complicated than those of the chromium salts, but they are at the same time more characteristic, as the spectra are more definitely broken up into bands. According to Vogel, the uranic and uranous salts behave differently *(Praktische Spectral-Analyse,* p. 247), but a more careful investigation is de­sirable. Sorby finds that a mixture of zirconium and uranium dissolved in a borax bead shows characteristic bands, which are visible neither with uranium nor with zirconium alone.

There is little to be said as regards the remaining groups of metals (tin, antimony, gold). Their spectra are best obtained by taking the spark from metallic electrodes or by volatilization in the voltaic arc.

*Influence of Temperature and Pressure on Spectra of Gases.*

If the spectrum of an element is examined under different con­ditions of temperature or pressure, it is often found to differ con­siderably. The change may be small—that is to say, the lines or bauds may only show a different distribution of relative intensity— or it may be so large that no relationship at all can be discovered between the spectra. It has been pointed out by Kirchhoff that a change in the thickness of the luminous layer may produce a change in the appearance of the spectrum, and Zöllner and Wöllner have endeavoured to explain in this way a number of important varia­tions of spectra. But their explanation does not stand the test of close examination. The thickness of layer cannot be neglected in the discussion of solar and stellar spectra, or in the comparison of absorption spectra of liquids ; but none of the phenomena which we shall notice here are affected by it.

*Widening of Lines.—*The lines of a spectrum are found to widen under certain conditions, and, although probably all spectra are subject to this change, some are much more affected by it than