prove disastrous to the district if the matter is continually neglected." The district is at present remarkably deficient in opportunities for higher education. With a population approaching half a million within easy reach of the centre, there is no institution where young people who have left the secondary school can obtain higher instruction nearer than Manchester (thirty-seven miles) or Birmingham (forty-five miles). Evidently there is room for further provision of educational facilities by the establishment of an institution of the rank of a University College; and it is satisfactory to know that another locality is being aroused to a sense of its educational deficiencies.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, April, 1901.—Prof. F. N. Cole opens with an account of the proceedings at the February meeting of the Society in New York City, and, in addition to the titles of the nineteen papers communicated, gives an abstract of several of them. Three of the papers are printed. Their titles are: (1) Green's functions in space of one dimension, by Prof. M. Bôcher. The results arrived at are given, but the proofs and further developments are reserved; (2) Possible triply asymptotic systems of surfaces, by Dr. L. P. Eisenhart. This supplements a note by the author, in the January *Bulletin*, entitled, "A demonstration of the impossibility of a triply asymptotic system of surfaces." Instead of the general negation previously given, the author now gives the qualified one: The only triple systems of surfaces cutting mutually in the real asymptotic lines of these surfaces are composed of properly associated families of hyperboloids of one sheet and hyperbolic paraboloids; (3) Note on Hamilton's determination of irrational numbers, by Dr. H. E. Hawkes. The purpose of the note is to call attention to Hamilton's use of the partition (Schnitt) in his definition of certain irrational numbers (*Trans.* of the R. Irish Academy, vol. xvii. 1837, p. 293).—On a system of plane curves having factorable parallels, by Dr. V. Snyder, was read before the December meeting of the Society. The type of scrolls contained in a linear congruence, and having factorable asymptotic lines, gives rise to a class of plane curves whose parallels have a similar property (cf. a paper by the author, in the *American Journal of Mathematics*, vol. xxiii., on a special form of annular surface). Mr. Bromwich gives a very useful analysis of Dr. P. Muth's "Theorie und Anwendung der Elementartheiler" (1899, xvi. and 236 pp.), and hopes that the book may induce its readers to take up the special part of invariant theory treated in it. Mr. Bromwich has done good work in this direction (see *Proc.* of London Math. Soc. vol. xxxii. 1900, p. 98), where he gives a list of papers on the subject.—Short notices follow of Dr. R. Fricke's "Kurzgefasste Vorlesungen über Verschiedene Gebiete der höheren Mathematik, mit Berüchsichtigung der Anwendungen" (1900), and Dr. R. Böger's "Ebene Geometrie der Lage" (1900), both by Prof. H. S. White.—The notes are very copious and interesting, giving account of the courses of lectures in the Continental and home Universities, and the usual new publications close the number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 28.—"A Preliminary Account of the Development of the Free-swimming Nauplius of *Leptodora hyalina* (Lillj.)." By Ernest Warren, D.Sc. Communicated by Prof. Weldon, F.R.S.

March 14.—"On the Preparation of Large Quantities of Tellurium." By Edward Matthey, A.R.S.M. Communicated by Sir George Stokes, Bart., F.R.S.

March 28.—"On the Enhanced Lines in the Spectrum of the Chromosphere." By Sir Norman Lockyer, K.C.B., F.R.S., and F. E. Baxandall, A.R.C.S.

In the recently published account (*Ast. Phys. Journ.* vol. xii. p. 307, 1900) of the spectroscopic results obtained by members of the expedition from the Yerkes Observatory during the solar eclipse of May 28, 1900, Prof. Frost claims to have established a close relationship between the bright lines in his eclipse spectra and the stronger lines of the Fraunhofer spectrum, and states that "61 per cent. of the latter were measured as bright on the plates."

He also states that "these plates give no evidence of any relationship between the bright lines and the 'enhanced' lines, or lines distinctly more intense in the spark than in the arc spectrum, although Sir Norman Lockyer has attached much significance to a supposed connection between them." He quotes specially the cases of titanium and iron lines, and of 48 enhanced lines of the former element acknowledges that 29—or 60 per cent.—correspond with lines in his eclipse spectra

The authors of the present paper show that if a difference of 0·3 tenth-metres be allowed between the wave-length of an eclipse line and that of the corresponding metallic line (and in some cases Prof. Frost accepts a difference of 0·35 or more between his adopted wave-length and Rowland's wave-length of the corresponding Fraunhofer line), there are 38 of the 48 enhanced titanium lines—or 80 per cent.—which have corresponding lines in the eclipse spectra, thus showing a closer relationship between the enhanced lines of titanium and the eclipse lines than that claimed by Prof. Frost between the latter and the stronger of the Fraunhofer lines.

To show the difference in behaviour in the eclipse spectra of the enhanced and unenhanced lines, several tables have been compiled. The first contains all the Fraunhofer lines in the region covered by Frost's eclipse spectra which have an intensity of 2 or greater, and which Rowland has ascribed to titanium only. These are 53 in number, 20 are enhanced lines and 33 are not. The comparison table indicates that 19 of the 20 enhanced lines have corresponding lines (nearly all prominent) in the eclipse spectra, the remaining one being probably masked by H7. Of the 33 unenhanced lines, 23—or 70 per cent.—do not correspond with eclipse lines. Of the nine eclipse lines which do agree in position with unenhanced titanium lines, three are nearly certainly due to other metals, and the remainder are lines of insignificant intensity.

The second table gives the enhanced lines of titanium which are recorded by Hasselberg in the arc spectrum, and a comparison is made with Frost's eclipse lines. This table shows that though the "arc" intensities of the enhanced lines vary from 2 to 7 (max. = 8), they have nearly all corresponding lines in the eclipse spectra, the majority of the latter being quite prominent.

The third table contains all the strongest lines (Int. 7 and 8) in Hasselberg's list of arc lines which are unenhanced. It is shown that only 7 out of 20 have corresponding eclipse lines. To three of these Frost gives no origin, to the others he gives compound origins, three of them involving titanium. In no case is the eclipse line as strong as the majority of those which are the representatives of the enhanced lines.

In the case of iron a similar analysis is given, but only over a limited region of the spectrum (λ 4500 to λ 4600) owing to the great number of lines in the iron spectrum. The same results are arrived at, viz., that the enhanced lines, though insignificant in the iron spectrum so far as intrinsic intensity is concerned, are, in the main, represented in the eclipse spectra by lines of abnormal intensity, whereas many of the stronger iron lines are either not represented at all, or only by weak lines.

"On the Arc Spectrum of Vanadium." By Sir Norman Lockyer, K.C.B., F.R.S., and F. E. Baxandall, A.R.C.S.

In this paper the authors give a list of lines in the arc spectrum of vanadium which have been measured from photographs taken at Kensington with a Rowland concave grating of 21½ feet focus and 14,438 lines to the inch. The region of the spectrum investigated extends from λ 3887 to λ 4932. The sources of the spectrum were (1) vanadium chloride, and (2) a pure sample of vanadium oxide supplied by Sir Henry Roscoe. These were volatilised in the arc between poles of the purest silver obtainable, and which were furnished by Sir W. C. Roberts-Austen.

The lines are compared with those published previously by Rowland (*Ast. Phys. Journ.* vol. vii. p. 273, 1898) and Hasselberg (*Svenska-Vetenskaps. Akad. Handl.* vol. xxxii. No. 2, 1899). The three records contain many lines in common, but there are also many differences between any two of them. The lines special to any one list have been analysed with the object of either properly establishing their claim to be accepted as true vanadium lines, or possibly tracing them to their true origin. Lines in the Kensington spectra which are due to impurities have been eliminated, as far as possible, by comparing the vanadium spectrum directly with those of forty-three other elements. They are twenty-nine in number, and are traces of the strongest lines only of Fe, Mn, Cr, Co, Ca, Al, Sr and Ag.