Mr. F. E. Baxandall (Proc. Roy. Soc., vol. lxxiv., pp. 548–550, 1905), when many lines in the emission spectrum of μ Centauri (also an Orion star with bright hydrogen lines) were found to agree in wave-length with enhanced iron lines.

WHAT BECOMES OF THE LIGHT OF THE STARS?—This question Prof. Very, of the Westwood Observatory, Mass., U.S.A., places before the readers of *The Popular Science Monthly,* and proceeds to give an interesting answer in an essay, highly speculative in character, developed in eighteen pages of the March number. The author ably marshals a useful body of evidence tending to establish that there is a general absorption of light by the ether. In this transformation of energy he sees the genesis of matter, and in meteorites he finds the "appointed instruments" whereby the nascent dust is collected "into the germs of future worlds." By atomic disintegration like that accompanying the degradation of radio-active elements the cosmogonic process is made reversible.

It may be mentioned that in reference to the "transient nebulosity," which appeared around Nova Persei, the author states: "It was an electric phenomenon, an exhibition of canal rays, or positive ions, on a grand scale," and that to explain the high temperature of the helium stars, he makes the hypothesis that they "contain an exceptional amount of peculiarly unstable elements."

PUBLICATIONS OF THE STRASSBURG UNIVERSITY OBSERVATORY.—The second part of vol. iv. of the *Annalen der Kaiserlichen Universitäts-Sternwarte in Strassburg,* published under the direction of Dr. Bauschinger, contains a large number of observations of double stars, planets, satellites, and nebulæ. The double stars were observed with a 49-cm. refractor by Dr. Wirtz between 1902 and 1910, and the results are compared with those obtained by other observers and with the ephemerides. The same observer is also responsible for the measures of the major planets and their discussion, in which are given the diameters and other measures, such as the dimensions of the Martian snowcaps, and the positions of the *streifen* on Jupiter; for the polar and equatorial diameters of the latter planet he finds the values $35{\cdot}986'' \pm 0{\cdot}028''$ and $38{\cdot}254'' \pm 0{\cdot}030''$ respectively.

TIDE TABLES.—From the Government Astronomer of New Zealand, Mr. C. E. Adams, we have received a report of the tide observations made at Auckland since December 1, 1908. These have now been harmonically analysed, and the results are given. There is also an interesting description of a new tide gauge designed by Mr. W. Ferguson, in which the recording pencil is moved by a clock and the paper on which the record is made is moved by the tide. The gauge has been running some months, and has given great satisfaction.

From the Government Printing Bureau at Ottawa we have received copies of the tide tables for the Canadian coast for 1913. The accompanying letterpress contains many interesting facts concerning the tides on the Pacific coast.

STARS WITH VARIABLE RADIAL VELOCITIES.—Mr. J. H. Moore, of the D. C. Mills Expedition's Observatory, Santiago, Chile, gives a list (L.O. Bulletin 224) of nine stars of about 5·0 magnitude, having variable radial velocities. In the same bulletin Prof. W. W. Campbell gives observations showing that the radial velocities of δ Andromedæ and μ Cephei respectively vary between $-1{\cdot}8$ km. and $-10{\cdot}8$ km., and $+15{\cdot}6$ and $+29{\cdot}4$. The latter also makes a correction regarding the radial velocity of i Capricorni. In L.O. Bulletin 97 this was stated to be variable. The removal of some errors of reduction leaves the velocity apparently constant at $+12$ km. per second.

THE TEACHING OF MATHEMATICS.[1]

THE papers enumerated below complete those written for the recent International Congress of Mathematicians. They deal with secondary schools, girls' school, preparatory schools, the training of teachers, technical institutes, and universities. Earlier papers in the same series were described in NATURE of March 14, 1912 (p. 44), and of May 23 (p. 305).

Secondary Schools.

No. 20 is a judicial discussion of "The Calculus as a School Subject." Mr. Jackson states impartially the questions involved, some of which can only be settled by greater experience than we now possess. Some questions are already settled, *e.g.* that if the calculus is to be introduced time must be found by a reduction in the drill which now prevails in algebra and trigonometry, by a frank recognition that tangents to curves and varying velocities involve the ideas of the calculus with some knowledge of the concrete ment that follows from this recognition. It is also desirable that the pupil should come to the study of the calculus, and by giving these subjects the treat-matters to which its methods are applicable. Mr. Jackson appears to be unaware that it is useless to point out an imperfection of proof to pupils who cannot discover the imperfection for themselves; but his pedagogy is in general so good that we feel sure he does himself injustice in this apparent ignorance.

Mr. Barnard (No. 22) frankly disapproves of the methods of teaching which have resulted from Prof. Perry's movement. He is all for thoroughness, and most of his article is taken up with a list of the blunders of text-books. We gather that he attributes these blunders to the new methods, a surprising view when we consider how few men educated in the new methods are old enough to write books.

Our conclusion is different. Writers of text-books are on the whole picked men, such as university professors and the ablest schoolmasters, and they are at present men trained on the old "thorough" methods; and if such blunders are possible for these picked men, it is indeed few of the schoolboys who are fit to profit by that training.

[1] The Teaching of Mathematics in the United Kingdom. Special Reports on Education Subjects.
No. 18. "Mathematics in the Education of Girls and Women." By Miss E. R. Gwatkin, Miss Sara A. Burstall and Mrs. Henry Sidgwick. Price 2½d.
No. 19. "Mathematics in Scotch Schools." By Prof. G. A. Gibson. Price 3d.
No. 20. "The Calculus as a School Subject." By Mr. C. S. Jackson. Price 1½d.
No. 21. "The Relation of Mathematics to Engineering at Cambridge." By Prof. B. Hopkinson. Price 1½d.
No. 22. "The Teaching of Algebra in Schools." By Mr. S. Barnard. Price 1½d.
No. 23. "Research and Advance Study as a Training for Mathematical Teachers." By Prof. G. H. Bryan. Price 1½d.
No. 24. "The Teaching of Mathematics in Evening Technical Institutions." By Dr. W. E. Sumpner. Price 1d.
No. 25. "The Undergraduate Course in Pass Mathematics, generally, and in relation to Economics and Statistics." By Prof. A. L. Bowley. Price 1½d.
No. 26. "The Preliminary Mathematical Training of Technical Students." By Mr. P. Abbott. Price 1½d.
No. 27. "The Training of Teachers of Mathematics." By Dr. T. P. Nunn. Price 1½d.
No. 28. "Recent Changes in the Mathematical Tripos at Cambridge." By Mr. A. Berry. Price 1½d.
No. 29. "Mathematics in the Preparatory School." By Mr. E. Kitchener. Price 1½d.
No. 30. "Course in Mathematics for Municipal Secondary Schools." By Mr. L. M. Jones. Price 1½d.
No. 31. "Examinations for Mathematical Scholarships at Oxford and Cambridge." By Mr. A. E. Jolliffe and Mr. G. H. Hardy. Price 2d.
No. 32. "Parallel Straight Lines and the Method of Direction." By Mr. T. James Garstang. Price 1d.
No. 33. "Practical Mathematics at Public Schools." By Prof. H. H. Turner, Mr. R. C. Fawdry, Mr. A. W. Siddons, Mr. F. W. Sanderson, and Mr. G. M. Bell. Price 1d.
No. 34. "Mathematical Examinations at Oxford." By Mr. A. L. Dixon. Price 6d.
(London: Wyman and Sons, Lt Edinburgh: Oliver and Boyd; Dublin; E. Ponsonby, Ltd.)

Even Chrystal blundered; he is the only blunderer whose name is given by Mr. Barnard. Chrystal's was the last and greatest attempt to do for algebra what Euclid attempted for geometry, to build up the whole structure on a few axioms the truth of which was obvious. As the result of his attempt Chrystal learned (and was always ready to admit) how impossible of attainment this ideal is, a conclusion which is to-day becoming generally accepted. In the future, instead of trying to build mathematics up on axioms which are absolutely fundamental and by reasoning which only a genius is fit to grasp, we shall use as the foundation properties which are intelligible to every boy, we shall assume the truth of these whether obvious or not, and upon these we shall build the superstructure. The question of the soundness of the foundation is not a question for schoolboys, it is not even a question for the average university student, it is a question of metaphysics to be dealt with by the mathematical philosopher.

No. 30 is an account by Mr. L. M. Jones of the work in a municipal secondary school. The course is good, and ends with the calculus. It includes here and there an item on the value of which all would not agree, *e.g.* stocks and present value, solution of a quadratic by guessing factors, and the use of the straight line graph as introduction to graphs and the calculus. A sound opinion of Mr. Jones's, which one would like to see more widely adopted, is that the time spent in arithmetic on contracted methods is out of proportion to its value to the pupil, it being quicker and surer in most natural questions to use all the figures given than to contract.

In No. 32 Mr. Garstang attempts to pile up a load of wickedness on the Board of Education. He charges Circular 711 with loose reasoning in the matter of parallels, and quotes many authorities to show that a rigorous development cannot be based on the method of direction. But the withers of the Board are unwrung. It is the second and third stages of the Circular which deal with the systematic development of geometry; the first stage, containing the passage which displeases Mr. Garstang, is not concerned with rigorous development, but with the preliminary acquisition of the concepts of the subject.

At Oundle (paper No. 33) the data for practical mathematics are supplied from "the school shops, testing-rooms, and fields." This is admirable, and the boys show a keenness about the results because of their contact with reality, a keenness much greater than is aroused by questions which are only of academic interest to the pupils, however practical and important they may be for men or for other boys. A difficult problem for schools less fortunately situated than Oundle is the invention of laboratory questions which have real interest and importance for the boys to whom they are set.

No. 19 is a clear exposition by Prof. Gibson of mathematics in Scotch schools, which must have been of great value to members of the congress who were investigating such matters.

Preparatory Schools.

Paper No. 29 contains a pleasing sign of the times in the cooperation of public and preparatory schoolmasters. In former years a preparatory school had to prepare boys for a great variety of scholarship examinations, and a public school to continue the education of boys taught on a great variety of plans. To obviate the consequent difficulties, representatives of the Headmasters' Conference and the Association of Preparatory Schools have drawn up a syllabus for a boy's education in mathematics from nine to sixteen. This syllabus is now pretty widely used; it also bears witness to the advance made in recent years in the teaching of the subject.

Training of Teachers.

In No. 27 Dr. Nunn discusses the training of teachers of mathematics. Perhaps the most interesting part of his paper is his excellent syllabus of mathematical studies. The first part of the syllabus is compulsory, and includes numerical trigonometry and the ideas of the calculus. It is arranged with the object of giving a clear consciousness of mathematical conceptions. The logical proofs of these conceptions belongs to the second part, which is optional. The introduction to the calculus is made on historical lines, on which lines it is interesting to note that integration preceded differentiation.

One would like to see logarithms also follow the historical order, and introduced in Napier's way, without any consideration of indices. Dr. Nunn's method compels the treatment of negative and practical indices in part i., for which they are too difficult. But it is perhaps ungenerous to criticise a detail in a scheme drawn on such broad and statesmanlike lines.

Technical Institutions.

Nos. 24 and 26.—Most teachers of mathematics have their pupils at their mercy. In evening technical institutions we meet a new type, the youth who must be persuaded to come in. It is interesting and important that while mathematics treated in an abstract way deters him, the subject treated in connection with (and arising out of) concrete problems related to the boy's work not only persuades him to come in, but often gives him such an interest that he goes on with the abstract study.

Mr. Abbott also contributes the valuable suggestion that each locality should have an advisory committee composed of teachers of elementary schools, evening continuation schools, secondary schools, and technical schools, for the coordination of the work of these schools in regard to the preliminary training of technical students.

Dr. Sumpner and Mr. Abbott agree in the statement that students who come from elementary schools require much training in accuracy. There is clearly still room for reform in the mathematical teaching of these schools, when it is still necessary to recommend the abandonment of "discount, stocks and shares, H.C.F. and L.C.M., &c."

Universities.

In Nos. 21, 23, 25, 28, 31, 34, we have the views of the universities. Various changes are advocated, a reduction of the degree of analytical skill now required, an extension of the range of mathematical studies, closer connection with other subjects, more regard for after-careers, encouragement of original research. Recent reforms in school mathematics sometimes meet with approval, sometimes with disapproval. Oxford and Cambridge are working, in their examination regulations, towards a greater range and less analytical skill; Cambridge also towards meeting the needs of students of physics and engineering.

Prof. Bryan deplores the indifference of the practical man to the value of mathematics. Of this indifference there is no doubt, or of the fact that the practical man frequently meets a problem in which the mathematician could help him. The engineer has an outfit of mathematical tools sufficient for his ordinary needs, but at times he meets a problem for which his tools are useless. He may then spend thousands of pounds on the determination of some point which the mathematician could have settled for a five-pound note. Instead of collaborating, the practical man and the mathematician scorn one another with an equal scorn, and indulge in pin-pricks when they happen to meet. It seems to us that it is for the mathematicians, who are seeking admission into the practical man's sphere, to hold out the olive branch, to go to him and say:—"Yes, we have often given you reason for thinking us fools. But we think we can really help you this time. Only let us try; if we fail, you are no worse off than before."

Education of Girls and Women.

No. 18 contains three papers by Miss Gwatkin, Miss Burstall, and Mrs. Sidgwick. Miss Gwatkin gives an effective statement of the advantages to be gained by a girl from the study of mathematics. We fear, however, that these advantages can only be attained by exceptional girls, and that for the average girl it is an attempt to turn a good girl into an inferior boy, to implant masculine virtues in place of developing the feminine ones. We could wish that Miss Gwatkin had supplemented her statement by an estimate of the relative advantages to the girl of mathematics and of possible alternative studies.

In the same paper Miss Burstall shows, in a historical sketch, the chance wind by which mathematics was introduced as a necessary element in the secondary education of girls, and then proceeds to inquire how far it is appropriate there. She is in general agreement with the present tendency to give an occupational turn to school studies, and points out how little connection mathematics has with the life of the bulk of women.

Miss Burstall divides girls into three classes. At one end of the scale is the small number with a real taste for mathematics. For these the subject is an admirable training, provided the danger of "narrowness, hardness, ossification," is avoided by requiring a concurrent training in English literature or some other literary subject.

At the other end of the scale come a number of girls who cannot do mathematics at all, or only with an enormous expenditure of energy. The teaching of these she compares to the laboratory manufacture of diamonds, the cost of production being quite out of proportion to the value of the resulting article.

Between these two extremes lie the bulk of the girls. For them mathematical training has value, but the same attainment must not be expected of them as of boys. The importance of other subjects and the girl's total energy-supply have to be considered. They should study mathematics for two or three years and get what value they can from the study, but the assessment of results by examination should not be forced on every girl. In school-leaving and college-admission examinations the necessary guarantee of austere intellectual effort can be secured by making Latin or an appropriate treatment of Harmony alternative with mathematics.

In a short and eloquent paper on university mathematics for women, Mrs. Sidgwick maintains that "there is no need to consider the case of women separately from that of men," and that while "in planning a scheme of general education regard must be had to the probable future work of the learners, a subject which is studied not for its own sake, but because it is useful for something else, is almost always degraded in the process, and loses much of its educational value." DAVID BEVERIDGE MAIR.

THE RUSTING OF IRON.[1]

IN the October issue of the Chemical Society's Journal, Mr. Bertram Lambert describes a second series of experiments on the rusting of iron. In these experiments it is shown by spectroscopic examination that carbon dioxide was actually present under the conditions used previously. Elaborate care was therefore taken to remove this, by heating as much as possible of the apparatus, whilst maintaining a high vacuum, and (during some of the successive heatings) cooling an attached tube in liquid air. The spectroscopic indications of carbon dioxide disappeared after the first of eight successive heatings, but no change was noticed in the readiness with which commercial iron rusted in the apparatus when purified oxygen and purified water were admitted. The author maintains, therefore, that these substances are capable of bringing about rusting in the absence of any trace of carbonic or other acid. The contrast between these results and those observed by Moody and by Friend is attributed to "passivity" induced in the metal in the one case by treatment with chromic acid (as suggested by Tilden), and in the other case by treatment with caustic soda (as suggested recently by Dunstan and Hill). This passivity must evidently be supposed to be permanent during many months of contact with air and water, but to be destroyed immediately by the merest trace of carbonic acid or by contact with glass.

An interesting account is given of the properties of pure iron as prepared by the methods previously described by the author, in which ferric nitrate is obtained so perfectly free from manganese that it no longer shows the violet colour which usually characterises the salt, and is then decomposed in iridium vessels, so as to avoid all risk of contamination with platinum. The metal so prepared is permanently resistant to rusting, even in contact with common air and common water. It does not dissolve in cold dilute sulphuric and nitric acids, but dissolves readily when the acids are heated. Hydrochloric acid dissolves the metal even in the cold. A similar contrast is noticed in the behaviour of the salts; the metal does not rust when exposed to air in presence of sodium, potassium, or ammonium sulphate or nitrate, but undergoes corrosion in a few hours when transferred to a normal solution of one of the chlorides. Again, pure iron will withstand the action of a saturated solution of copper sulphate or copper nitrate at the ordinary temperature for an indefinite time, without losing any of its lustre and without any perceptible trace of copper being deposited; but if a concentrated solution of copper chloride is used, the iron becomes coated with copper immediately it is put into the solution, and, within a few minutes, the iron all disappears, and only finely divided copper remains. The behaviour of the pure metal is here very similar to that of commercial aluminium.

The resistance of the purified metal to corrosion and to dissolution is probably due to the homogeneity of its surface, since if this is destroyed by pressing the metal with an agate pestle in an agate mortar the metal begins to corrode in less than an hour, rust being deposited on the unpressed parts of the metal whilst the pressed parts remain bright. In the same way copper is deposited on the iron if it is pressed in an agate mortar before being put into a solution of copper sulphate, or if it is pressed with a quartz rod while under the copper sulphate solution.

As a rule iron which will not rust will not deposit copper from the sulphate, and conversely; but in one

[1] See NATURE, 1911, vol. lxxxvi., p. 25.