

cyclone to the south; and no doubt that theory is attractive and has much evidence in its favour. But the gales which burst from the E.S.E. or S.E. were invariably accompanied by a sudden and great rise of temperature, which in eleven cases cited ranged from nearly 14 to more than 44 Fahrenheit degrees. This wind beat against Cape Adare from the level surface of the frozen sea, and does not suggest a Föhn effect or an origin in the icy heart of a South-Polar anticyclone. Does it not rather indicate the passage of a cyclone centre to the north and the sweeping in of air from the warm surface of the sea south of Australia? An anticyclone brooding over the southern land would probably tend to turn wandering cyclones eastward along its margin, and the two explanations are thus to some extent compatible.

The magnetic observations are being worked up by Dr. Chree; from the preliminary figures quoted here we note that the greatest dip observed was $88^{\circ} 2' 37''$ at the base of the Mount Melbourne, but it is pointed out that the magnetic dip all along the coast of Victoria land was less than at the time of Ross's expedition. The zoological chapter contains no information; it merely quotes a few descriptive remarks of the vertebrates noticed, all of them of known species. The invertebrates are not referred to, but the whole of the zoology of the expedition is being worked up at the British Museum.

There was no geologist on board the *Southern Cross*, but the non-technical descriptions of rocks in the narrative and the reference to the determination of specimens by Mr. J. T. Prior show that the geologist on the *Discovery* will have a splendid field in which to win his spurs, though the alternation of volcanic and metamorphic rocks does not suggest the probability of sensational fossil finds.

The difficulty of making astronomical observations in high southern latitudes is feelingly dealt with. The determination of longitude was particularly difficult, the only really satisfactory attempt to fix Cape Adare being by an occultation of Saturn by the moon. Refraction was a never-ceasing trouble, for the horizon was frequently very far from being a straight line. Thus on one occasion Mr. Bernacchi says (p. 156):—

"Huge icebergs to the north which must have been quite thirty miles away, and which, under ordinary circumstances, were invisible even from the huts, were elevated by refraction to a height on a level with the top of Cape Adare, the height of which is nearly 900 feet. The display, it can almost be called so, was ever changing in appearance; sometimes one part of the horizon was elevated, then this would subside and another part rise up. At this time of the year the coast line in the direction of Yule Bay and Cape North, nearly 100 miles away, was frequently seen on clear days in consequence of the great rarity of the atmosphere."

A comparison of Mr. Borchgrevink's and Mr. Bernacchi's narratives yields several minor points of interest to which it is unnecessary to refer; but we find the resultant of reading both books is an increase of our opinion of the commander's power of overcoming difficulties and of the physicist's scientific zeal and loyal cooperation.

THE SPECTRA OF BRIGHT SOUTHERN STARS.¹

THE well-known researches on stellar spectra which have been carried on for many years at the Harvard College Observatory under the direction of Prof. E. C. Pickering have now reached another very definite stage. The publication of the Draper Catalogue in 1890 put us

¹ "Spectra of Bright Southern Stars, Photographed with the 13-inch Boyden Telescope as a Part of the Henry Draper Memorial, and Discussed by Annie J. Cannon under the Direction of Edward C. Pickering." (*Annals of the Astronomical Observatory of Harvard College*, vol. xxviii. part ii.)

in possession of the general characteristics of the spectra of more than 10,000 stars, and this work will long remain a monument to the skill of Prof. Pickering, besides fulfilling its original purpose as a lasting memorial of Dr. Henry Draper (*NATURE*, vol. xlv. p. 427). Following this, a detailed description and classification of the spectra of 681 of the brighter stars north of -30° , based upon photographs taken with relatively large dispersion, was published in 1897 (*NATURE*, vol. lvi. p. 206). The establishment of a branch observatory in the southern hemisphere, at Arequipa, Peru, has enabled Prof. Pickering to extend the inquiry to the southern stars, with results described in the volume under notice.

The prismatic camera has been employed throughout the whole investigation, and the accumulation of so much valuable material in so short a time must be attributed in great measure to the many advantages which this instrument possesses over the slit spectroscope when radial velocities are not in question. At Arequipa the 13-inch Boyden telescope has been employed in conjunction with one, two or three prisms, giving spectra of lengths 2.24, 4.86 and 7.43 centimetres respectively from H_{ϵ} to H_{β} . The number of photographs taken from November 29, 1891, to December 6, 1899, was no less than 5961, with an average exposure of one hour; but as many of the spectra were photographed several times the number of individual stars investigated is smaller, namely 1122. In these are included all stars south of declination -30° which have a photometric magnitude of 5.0 or brighter, numerous fainter stars in the same region, many stars between the equator and -30° , and a few northern stars.

Dr. McClean's magnificent series of photographs of the spectra of southern stars had prepared us to find that the spectra are not less diverse than in the northern hemisphere, and it became a point of much interest to see if the greater number of stars now studied necessitated any revision of the classification proposed for the northern stars alone. This question of classification, it will be understood, is one of the greatest importance, since the ultimate aim is not merely to enable the astronomer to place his photographs in their proper pigeon-holes, but to indicate the various stages of star life. It is an unfortunate circumstance, however, that not one of the classifications hitherto suggested has met with general acceptance, but the reason for this may perhaps be traced to a want of confidence due to the frequent revisions which have been necessary as the more delicate features of the spectra have been brought to light by the use of better instruments. However that may be, it is sufficiently remarkable that the old classification which we owe to Rutherford and Secchi is almost the only approach to a universal language of stellar spectra, in spite of the fact that it is hopelessly inadequate to deal with modern data.

For the present discussion Miss Cannon has found it convenient to revert to the nomenclature of the Draper Catalogue, but with modifications to suit the intermediate classes revealed by the use of greater dispersion. It is pointed out that in most cases the symbols can be readily translated into the numbers previously applied to the groups of northern stars, but it would surely have been more convenient to have two such closely associated investigations expressed in the same language. However, the classification is fairly adequate, but as the nomenclature is too cumbersome to be likely to come into common use it is unnecessary to describe it in detail.

The great majority of the 1122 stars discussed in this publication can be arranged in a sequence, agreeing in the main with that arrived at in the case of the northern stars, but permitting its extension towards the beginning of the series. The investigation of the northern stars led Prof. Pickering and Miss Maury to commence the

series with stars of the "Orion" type, which by transitional stages were succeeded by the Sirian and solar stars, and then by stars with fluted spectra. An important advance has now been made in establishing the place of the bright-line stars of the Wolf-Rayet class as immediately preceding the stars of the Orion type. The spectra themselves do not indicate whether the series begins or ends with the bright-line stars, but that it begins with them is probable from their general spectroscopic resemblance to nebulae. One piece of evidence on this point does not seem to have been followed up as closely as its importance calls for; on p. 141 it is stated that the green line λ 5007, which has hitherto been regarded as specially characteristic of nebulae, is sometimes present in the Wolf-Rayet stars. If this be the case there would seem to be no possible doubt that the bright-line stars are the first results of nebular condensation; but we find no further reference to this interesting point in the detailed description of spectra.

A considerable part of the volume is occupied with detailed accounts of typical spectra which are exceedingly valuable, and the descriptions of the various classes of bright-line stars will be especially welcomed by other investigators. The discussion apparently indicates that the forms most closely resembling the planetary nebulae are those in which there are no dark lines in the spectra, while succeeding stages are represented by stars in which dark lines are gradually introduced, until finally the Orion type of spectra, usually consisting wholly of dark lines, is reached.

Three catalogues are given. One of them brings together the stars belonging to each of the spectroscopic groups; another is a general catalogue with the stars in order of right ascension; and still another is an index to the stars, both northern and southern, which have letters assigned to them. In the last named, the nomenclature previously employed for the spectra of the northern stars has been converted into the new system adopted for the present volume. It will thus be seen that no pains have been spared to provide every convenience for those who may have occasion to use the catalogues for purposes of reference.

Besides the catalogues there are several tables of the wave-lengths and intensities of the lines in the various sub-groups of the bright-line stars and stars of the Orion type, and in some cases the wave-lengths extend into the visible spectrum as far as D_{β} . It is only in the more obvious cases, however, that an attempt has been made to assign origins to the lines, but the determination of origins is perhaps wisely avoided unless the work of a laboratory goes hand in hand with that of an observatory. Still, one cannot help regretting that the tables of enhanced lines published by Sir Norman Lockyer have not been utilised in this connection, especially as there are distinct indications that some apparent difficulties might thus have been removed. Thus, on p. 186 it is stated that in the spectrum of α Cygni there are two lines of greater wave-length than H_{β} , which are "well marked and agree in position and intensity with the helium lines 4922 \cdot 1 and 5015 \cdot 7 as present in the spectra of the Orion stars. It appears far more probable, however, that these are solar lines." The probability is that these lines, like so many others in α Cygni, according to Sir Norman Lockyer, are enhanced lines of iron, their wave-lengths being 4924 \cdot 1 and 5018 \cdot 6, which are curiously near to two prominent lines of helium. It seems very likely also that a reference to enhanced lines would throw much light upon such spectra as that of η Carinae (Argus) and possibly upon other "peculiar" spectra.

Again, the descriptions of typical spectra clearly show that among the first additional lines introduced in passing from the Orion to the Sirian stars are 4233 \cdot 6, 4173 \cdot 6, 4179 \cdot 5 and 4385 \cdot 2, which are doubtless enhanced lines of iron at corresponding wave-lengths; these lines, how-

ever, are simply regarded as "characteristic solar lines" (p. 154), although as the true solar stage is approached they cease to be conspicuous.

Among many interesting results, it may be mentioned that a few stars have been found to have spectra resembling that of α Cygni, which hitherto had been practically the only representative of its type. The detailed description of the spectrum of γ Velorum (Argus), the brightest star of the Wolf-Rayet type, is also worthy of special mention.

The volume is enriched by three fine plates, one of which illustrates six typical spectra; another shows six examples of "peculiar" spectra, including ζ Puppis and γ Argus; while the third exhibits, by direct enlargements of portions of three spectra, the vast amount of fine detail portrayed by the prismatic camera.

Great praise is due to all who have taken part in this magnificent piece of work.

A. FOWLER.

FOREIGN INDUSTRIAL COMPETITION AND TECHNICAL EDUCATION.

ON the occasion of the prize distribution to the students of the Goldsmiths' Institute at New Cross, on December 12, Mr. Balfour made some remarks on technical education and its bearing upon foreign competition which are worthy of comment. With the optimism which characterises this statesman's utterances, he expressed the opinion that although

"unquestionably there was a time when we ignored the great need for a thorough scientific and artistic training in connection with our great industries," yet he was "not sure whether we are not now verging upon the opposite danger to that which we ran a few years ago," for there was a tendency, in some quarters at all events, to "talk as if the only thing which had to be done to restore British manufactures to their pristine condition in the world's industries was a manipulation of our methods of education."

Mr. Balfour then went on to say that he placed no faith whatever in the arguments which he constantly heard indicating the relative decay of British manufactures, and deprecated the tendency, which he characterised as a "dangerous fallacy," of supposing

"that every successful and prosperous manufacture started by any other nation but our own was a kind of robbery committed on British trade," for we ought to be satisfied with the reflection that, "broadly speaking, the prosperity of one nation conduces to the prosperity of all nations, and we are not poorer, but richer, because other nations are rich."

As was to be expected, these self-satisfying sentiments met with full approval; but the distinguished speaker proceeded to introduce a little rift into his lute when he said,

"I look with perfect serenity upon the general increase of the world's wealth as long as I can be assured that in this country we organise our labour in such a manner that the best workman gets the greatest remuneration; . . . that there is no lack of well-trained and skilled persons in all branches of manufacture; and last, but not least, that those who lead industry in this country, the capitalists, the manufacturers and the managers, show that flexibility, that power of adaptation to the ever-changing needs of the world which is, of course, an absolute necessity if we are to make the best of the great advantages by which we have been enabled to meet the demands of the world in the matter of manufacture."

Mr. Balfour is apparently already assured on these points, but can this attitude be accepted by those who view the future of their country from a higher standpoint than that of an armchair political economy? Are we to stand calmly by and see the supremacy in industry after industry transferred to foreign shores until at last, like the inhabitants of a Gilbertian island, we are re-