tinent of India by a network of triangles is now an accomplished fact, Mr. More, District Surveyor, having in November last finished his series of observations with the large theodolite. Nothing now remains but to reduce the observations, a work which it is anticipated will take about six months. Mr. More had enormous difficulties to overcome in his survey. The north of the island is so much covered with forests that he was compelled to erect lofty stages for his theodolite, at a height of from 40 to 70 feet above the ground; and the observed signals were in many cases 140 feet from the earth. All these stages had to be made on the spot, the appliances at hand being of the poorest description, and it was with the greatest difficulty that the structures thus made were kept at the necessary rigidity. The climate is so uncertain that the surveyors often watched for days without seeing a flash from the heliostat, and at other times every member of the working parties was prostrated by fever. As the observers approached the coast, stone towers were put up instead of timber stages, and these towers will serve not only as permanent survey stations, but as landmarks for those navigating the neighbouring waters. In all, eleven stone towers were erected, and very many wooden stages. Ceylon, by the completion of this trigonometrical survey, is now free from the reproach which it has lain under since the Indian surveyors finished their portion of the work. There is now a complete chain of triangles from Asiatic Russia to the south of Ceylon. The *Observer* adds that it is curious to note that exactly one hundred years ago (1787) a complete triangular connection was formed between Great Britain and France across the Channel under the superintendence of General Roy, R.E.

THE additions to the Zoological Society's Gardens during the past week include a Burrowing Owl (*Speotybo cunicularia*) from South America, presented by the Rev. Basil Wilberforce; a Vulpine Phalanger (*Phalangista vulpina* ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

O'GYALLA SPECTROSCOPIC CATALOGUE.—The systematic survey with the spectroscope, undertaken for the northern heavens several years ago, by Prof. Vogel and Dr. Dunér, the former examining the region from Decl 1° S. to Decl. 40° N., and the latter that from Decl. 40° N. up to the Pole, has been now carried some considerable distance into the southern hemisphere by Dr. N. de Konkoly and his assistant, Dr. Kövesligethy; and the second part of the eighth volume of the O'Gyalla observations, which has recently appeared, contains a spectroscopic catalogue of the stars down to mag. 7·5, lying between Decl. 15° S. and the equator. The work was commenced in August 1883, and was completed in August 1886, 2797 spectra having been observed on ninety nights. A number of these were observed on more than one night, so that the resulting catalogue contains only 2022 stars. Vogel's arrangement of types was followed, so that the present catalogue is on the same lines as those of Vogel and Dunér. The annexed table gives the number of stars ranged under each type.

I.*a.*	I.*b.*	I.*b*?	I.*c*?	II *a.*	II.*b.*	III.*a*	III.*b.*
990	4	12	1	865	2	87	3

Continuous.	Monochromatic.	?
41	3	14

The three monochromatic spectra indicate the presence of minute planetary nebulæ. There was only one star spectrum suspected of showing a bright line, a star of mag. 6·5 about 50′ *n* of ζ Orionis. This latter star, together with β, δ, and ε of the same constellation, Dr. Konkoly finds to be variable as to its spectrum. It is to be hoped that the details of the observations upon which so important a statement is based will be published. And it is also to be desired that the work which has been carried so far may now be taken up by some southern observer, and the remaining portion of the heavens surveyed. It is to such works as the present, and the similar labours of Vogel and Dunér, that we must look for evidence of such physical changes amongst the stars as Dr. Konkoly would seem to predicate of the principal stars of Orion.

ASTRONOMICAL PRIZES OF THE PARIS ACADEMY OF SCIENCES.—The Lalande Prize of the Academy has been decreed to M. Dunér for his micrometric measures of double stars, and for his researches on spectra of the third type. M. Périgaud, of the Observatory of Paris, receives the Valz Prize for his important astronomical labours. Amongst those specially mentioned are his determinations of the division errors of four of the circles, and of the absolute flexure of the two principal meridian instruments of the Paris Observatory. The Janssen Prize for important progress in physical astronomy —in the recent sense of the term—awarded this year for the first time, was most appropriately assigned to the late Prof. Kirchhoff. Amongst the general prizes of the Academy should be noted the Arago Medal decreed to M. Bischoffsheim for his great and generous aid to science, and especially for his magnificent foundation of the Nice Observatory. This prize also is now given for the first time. The La Caze Physical Prize is given to MM. Paul and Prosper Henry, chiefly for their great achievements in astronomical photography.

The subject for the Damoiseau Prize for 1888 is proposed in the following question: To perfect the theory of inequalities of long period caused by the planets in the movement of the moon; to see if they exist sensibly beyond those already known.

NEW OBSERVATORY IN VIENNA.—The observatory of Herr M. von Kuffner, the erection of which was commenced in the summer of 1884, has been practically completed. The building is cruciform in shape, and is 82 feet from east to west, and 61 from north to south. The meridian instrument is by Repsold, and has an aperture of 4·9 inches, and a focal length of 5 feet; the eye-piece and object-glass are interchangeable; the circle is 21·6 inches in diameter, and is divided to 2′ and read by four microscopes. The principal equatorial is by the same maker, and has an aperture of 10·6 inches, and focal length of 12 feet 6 inches, with a finder of 2·6 inches aperture, and 26 inches focal length. The co-ordinates of the observatory are provisionally given as long. = 1h. 5m. 11·1s. east of Greenwich, and lat. = 48° 12′ 47″·2 N.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 JANUARY 15-21.

(FOR the reckoning of time, the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 15

Sun rises, 8h. 2m.; souths, 12h. 9m. 34·3s.; sets, 16h. 17m.: right asc. on meridian, 19h. 47·1m.; decl. 21° 10′ S. Sidereal Time at Sunset, 23h. 55m.

Moon (at First Quarter on January 21, 5h.) rises, 9h. 18m.; souths, 14h. 1m.; sets, 18h. 51m.: right a c. on meridian, 21h. 39·3m.; decl. 15° 14′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	8 9	12 2	15 55	19 39·4	23 26 S.
Venus ...	4 52	9 7	13 22	16 44·5	20 0 S.
Mars ...	0 0	5 36	11 12	13 12·8	5 17 S.
Jupiter ...	3 56	8 16	12 36	15 52·5	19 19 S.
Saturn ...	16 58*	0 49	8 40	8 24·9	19 47 N.
Uranus ...	23 56*	5 28	11 0	13 4·5	6 9 S.
Neptune..	12 23	20 3	3 43*	3 42·1	17 55 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Jan	h.	
18	20	Mercury in superior conjunction with the Sun.

Meteor-Showers.

	R.A. °	Decl. °	
Near π_1 Orionis...	72	5 N.	January 15–20.
From Canes Venatici.	180	35 N.	Swift; streaks.
Near θ Aurigæ...	295	53 N.	January 14–17.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
T Cassiopeiæ ...	0 17·2	... 55 10 N. ...	Jan.	19,		*M*
U Cephei	0 52·4	... 81 16 N. ...	,,	15,	22 1	*m*
			,,	20,	21 41	*m*
Algol	3 0·9	... 40 31 N. ...	,,	18,	2 59	*m*
			,,	20,	23 48	*m*
V Tauri	4 45·6	... 17 21 N. ...	,,	15,		*M*
ζ Geminorum ...	6 57·5	... 20 44 N. ...	,,	19,	7 0	*m*
R Canis Majoris...	7 14·5	... 16 12 S. ...	,,	19,	21 45	*m*
			,,	21,	1 1	*m*
T Canis Minoris...	7 27·8	... 11 59 N. ...	,,	19,		*M*
W Virginis	13 20·3	... 2 48 S. ...	,,	17,	3 0	*M*
δ Libræ	14 55·0	... 8 4 S. .	,,	18,	4 8	*m*
W Scorpii	16 5·2	... 19 51 S. ...	,,	17,		*M*
U Ophiuchi... ...	17 10·9	... 1 20 N. ...	,,	15,	17 47	*m*
		and at intervals of			20 8	
β Lyræ...	18 46·0	... 33 14 N. ...	Jan.	16,	6 0	*M*
R Lyræ	18 51·9	... 43 48 N. ...	,,	16,		*M*
T Vulpeculæ ...	20 46·7	... 27 50 N. ...	,,	19,	21 0	*M*
Y Cygni	20 47·6	... 34 14 N. ...	,,	16,	20 54	*m*
			,,	19,	20 47	*m*
δ Cephei	22 25·1	... 57 51 N. ...	,,	17,	6 0	*m*
			,,	18,	21 0	*M*

M signifies maximum ; *m* minimum.

DUNÉR ON STARS WITH SPECTRA OF CLASS III.[1]

II.

A SERIES of observations such as ours ought to add at least a little to our knowledge of the development by which the spectra of stars pass from the second class to one of the two sections of the third, especially if these observations are combined with those made of the stars of the two first classes generally, and of our sun in particular; we might even draw conclusions as to the successive development of stars after they have already reached this class. He who sees trees in a forest in different stages of development, some old, some young, some decaying, can at once form an idea of the different stages undergone by each : it is just the same with the observer of the different classes of stellar spectra.

The spectra of the first class are characterized by the almost total absence of all metallic lines excepting those of hydrogen. In spite of that, we cannot doubt for a moment the presence of metallic gases in their atmospheres, for even in the spectrum of Vega we can faintly distinguish the principal rays of sodium, magnesium, and iron. But these gases are probably at such a high temperature that their power of absorption is very slight. But as the star cools and the spectrum approaches the second class, the metallic lines become stronger and more numerous, whilst, strange to say, the lines of hydrogen diminish. Thus the spectrum becomes more and more like that of our sun in its actual state, and at length, as the metallic lines increase, it resembles that of Arcturus.

Up to this stage of development it is unnecessary to consider the two divisions of the third class separately, but after this it becomes indispensable.

In those spectra which at length become III.*a*, the change seems to operate as follows. On account, probably, of the progressive cooling, the metallic lines, especially those of iron, magnesium, calcium, and sodium, become larger, and, besides these, numerous weak narrow lines are seen grouped together, generally in the neighbourhood of the stronger lines. At this stage it is often difficult, if not impossible, to decide, with spectroscopes of small dispersion, whether one sees broad lines or real bands (or flutings). This happens in the spectrum of Aldebaran. The faint lines go on accumulating, until they cannot be separated from one another and occupy broader spaces, and now the spectrum is easily seen to belong to Class III.*a*. At first the bands in the red and orange are the only ones distinctly visible; but later the bands in the green-blue and in the blue become very strong and broad.

While the development of the stars III.*a* was very well known before my researches, former observers have known no star with a spectrum intermediate between II.*a* and III.*b*. Thus, M. Pechüle declares the hypothesis of the co-ordination of the III.*a* and III.*b* classes to be inadmissible. On the other hand, he seems disposed to think that the spectra III.*b* represent a phase, perhaps the last before its total extinction, in the development of each star, and that the passage from type III.*a* to III.*b* takes place suddenly or by a catastrophe, during which the bright lines appear ("Expedition Danoise," pp. 22–25). M. Pechüle seems, however, to consider this hypothesis doubtful, and at length declares that the physical *rôle* of the stars III.*b* is still quite a mystery.

A very simple explanation clears up at least part of this mystery. If the hypothesis which I, in full agreement with M. Vogel, have suggested be correct, the stars intermediate between the second and third classes must necessarily be comparatively rare, considering that this is only a transitory phase of their existence. The general spectroscopic observations of M. Vogel affirm this fact, for amongst the numerous stars examined by him there are only forty-eight whose spectra are denoted by II.*a* !!! II.*a* !! or II.*a* ! But as the lines must be very distinctly visible in the spectra of the stars which are on the point of passing from the second class to Class III.*a*, we are obliged to acknowledge that almost all the stars of this category within the zone examined by M. Vogel are among these forty-eight objects. At first sight one might be disposed to seek these stars among those whose spectra are designated by M. Vogel by II.*a* (III.*a*), II.*a*? III.*a*, and III.*a* (II.*a*); but a closer examination shows that although it is not impossible that these spectra may be among these objects, they must be so rare that that is of no essential consequence as regards the question which occupies us.

Amongst these stars there are none which attain the magnitude 4·5, and only fourteen which surpass the magnitude 6·4. All the others are faint objects, and the ambiguous symbols show the difficulty M. Vogel found in recognizing with certainty the details in the spectra, and not that he could not decide with certainty to which of the two contiguous classes a spectrum of which he could easily perceive the details belongs. The correctness of this supposition is, however, proved by the circumstance that certain spectra are designated by III.*a*(III.*b*), or III.*a*? III.*b*. And none will believe that M. Vogel meant to imply that these spectra were in the act of passing from one section of the third class to the other. Besides, one of these stars is R Serpentis, whose spectrum when the star is at the maximum is one of the most strongly marked of III.*a*, according to M. Vogel's earlier researches, and according to mine. But in his general spectroscopic review M. Vogel examined it when its magnitude was only 9·0, and therefore it was easy to doubt, on account of the excessive width of the bands, whether the spectrum might not be III.*b* instead of III.*a*.

Consequently, although I think I am right in admitting that most of these stars belong to the pure type II.*a* or III.*a*, I will nevertheless suppose that a third of them really have spectra intermediate between II.*a* and III.*a*. Their number in M. Vogel's catalogue is 120, and the third is 40, so we should have therefore between the Pole and $-25°$ declination 160 spectra intermediate between II.*a* and III.*a*. I found also by special observations that among the spectra designated by II.*a* !!! II.*a* !! and II.*a* ! a fourth part really belong to the intermediate type. Thus there would be in all 200 such spectra, a number evidently much too great. Then, the spectra III.*b* being about fifty times rarer, we should have at most four spectra intermediate between II.*a* and III.*b*, and if only stars of a higher magnitude than 6·0 are reckoned, there would scarcely be one.

But, if we consider the differences between the spectra III.*a* and III.*b*, we shall find that in reality we can scarcely expect to find any spectrum intermediate between II.*a* and III.*b*. As we have seen above, the spectra III.*a* are formed by the exaggeration of the essential characteristics of the spectra II.*a*. There must then be a phase, especially if the star is not very bright, in which one cannot decide to which of the two classes the spectrum belongs. Thus in the spectra III.*b* there are undoubtedly well-marked Fraunhöfer lines—for instance, D, and the narrow band 8, which is probably nothing but the collection of strong lines in the neighbourhood of E, and the very narrow band 5 ($\lambda = 576\mu$) which is almost like a broad line ; but all these details are only secondary. The essential characteristics are the three nebulous, very broad flutings, which owe their origin to some carbon compound. If these bands are visible, the spectrum is called III.*b* ; if they are not, it is called II.*a*. The only forms intermediate between the spectra of the type of Aldebaran and the normal

[1] Continued from p. 23?.