area, which, let us say, is a couple of hundred times greater, in that case we shall be bound to have bright lines from the exterior regions mixing with the dark lines coming from the interior regions. Hence we see that the spectra which we may get from stars will not depend upon the diameter of the stars at all, but may depend upon the difference of area simply which we should get by cutting a section at right angles to the line of sight from the earth through the star and its whole atmosphere.

It comes to this: Suppose some stars have very large coronal atmospheres; if the area of the coronal atmosphere is small compared with the area of the section of the true disk of the sun, of course we shall get an ordinary spectrum of the star; that is to say, we shall get the indications of absorption which make us class the stars apart; we shall get a continuous spectrum barred by dark lines. But suppose that the area of the coronal atmosphere is something very considerable indeed, let us assume that it has an area, say fifty times greater than the section of the kernel of the star itself; now, although each unit of surface of that coronal atmosphere may be much less luminous than an equal unit of surface of the true star at the centre, yet if the area be very large, the spectroscopic writing of that large area will become visible side by side with the dark lines due to the brilliant region in the centre where we can study absorption; other lines (bright ones) proceeding from the exterior portion of that star will be visible in the spectrum of the apparent *point* we call a star.[1]

Those things, then, being premised, we are now in a position to approach the subject of stellar spectra. Much work is now being done in this direction, but we must not forget the early workers. We must not forget that it was Fraunhofer at the beginning of this century who first saw and carefully observed several spectra of stars, and we must be all the more careful to remember that, since really more than half a century passed before anybody took the trouble either to repeat his observations or to extend them. Some twenty years ago, however, several observations had been brought together by the labours of Italian and American men of science (scarcely a stellar spectrum had been observed in England). This enabled a distinguished American, Mr. Rutherfurd, to begin to put a little order into the facts which had so far been acquired.

He pointed out that it was easy to arrange these stars into classes—that all the spectra were not alike. There was a wonderful family likeness among three groups of them, and he showed that you might divide these spectra into three very definite classes. After him came two countrymen of our own, Dr. Huggins and Dr. Miller, who, when they did begin their work, certainly put into it an amount of vigour and assiduity which had never been approached before their time. They not only gave us careful drawings of the spectra of the stars which they

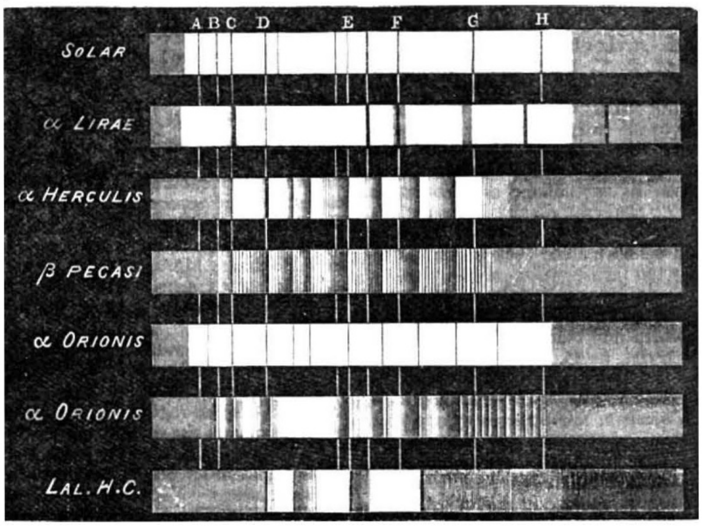

FIG. 21.—Various types of stellar spectra.

observed, but with infinite care and patience they made comparisons, as we may say, to determine the origin of the lines in exactly the same way as I have pointed out that Kirchhoff, Ångström, and Thalèn discovered the origin of the lines in the spectrum of the sun. Indeed, they did not rest here, or rather, one of them did not rest here, for Dr. Huggins subsequently introduced a system of photography, and now, thanks to his skill, we have several photographs, of priceless value, of some of the brighter stars. And while I am lecturing to you here in London there is one observer in Berlin, Dr. Vogel, and another in the north of Europe, Dr. Dunop, doing all they can to give us a complete and perfect spectroscopic catalogue of every star that shines in the northern heavens, so that you can see that the work is going on.

Now, before I say any more about it, I will refer to a diagram which gives an idea of the kind of thing that one sees when these observations are being made.

We will just run through them one by one. There is a very rough and general view of the spectrum of the sun. The actual spectrum of the sun has been thrown on the screen before you, and therefore it will be quite understood that there we have a very rough copy of it for diagrammatic purposes, indicating merely the most obvious among the Fraunhofer lines. When we pass from the sun to α Lyræ, we pass from a star having a relatively large number of lines to one having a small number; and this small number of lines is further remarkable from the fact that the lines are much thicker than those seen ordinarily in the solar spectrum. Keeping to the stars which give us spectra of lines, here in α Orionis we get another case in which the lines do not occupy the places occupied by lines in the spectrum of the sun, nor, at the same time, are they so thick as the lines in stars of the Lyra type. We can also learn from this diagram, by the examination of the spectra of α Herculis and β Pegasi, that we get flutings from stars as well as lined spectra. We also see that these flutings are not all exactly in the same place, by which we can infer that the flutings are not all probably of the same chemical origin. Of that further by and by. The use of the diagram is to give a general idea.

J. NORMAN LOCKYER

(*To be continued.*)

SCIENTIFIC SERIALS

The American Journal of Science, June.—The Biela meteors of November 27, 1885, by H. A. Newton. From a general survey of the observations made in various places, the author infers that the maximum of the shower was about 6h. 15m. Greenwich mean time; that the total hourly number of meteors visible at one place in a clear sky was at the utmost 75,000; that the densest part of the stream was not over 100,000 miles in thickness; that the meteors of November 27,

[1] *Proc.* Roy. Soc., No. 185, 1878.

1872 and 1885, did not leave the immediate neighbourhood of the Biela comet earlier than 1841–45, and may be treated as having at that time orbits osculating that of the comet.—The ultra-violet spectrum of cadmium, by Louis Bell. The ultra-violet spectrum of cadmium having long served as a standard of reference in the measuring of other spectra, an attempt is here made to determine its principal wave-lengths more accurately than is possible by Cornu's ingenious process. By taking photographs on Stanley instantaneous dry plates, Mr. Bell believes the wave-lengths here determined will be found correct to probably within 1/50,000 part of their respective values. The total number of lines accurately determined in the entire spectrum was thirty, of which the wave-lengths are tabulated with the corresponding figures obtained by Hartley and Cornu.—Communications from the United States Geological Survey, Rocky Mountains Division. The present communication (No. vii.) deals with the occurrence of topaz and garnet in lithophyses of rhyolites, and is contributed by Mr. Whitman Cross, who had already described the occurrence of minute crystals of topaz in the small drusy cavities of a coarsely crystalline rhyolite from Chalk Mountain, by Fremont's Pass, Colorado. The present specimens of topaz and small dark red garnets are from the trachyte on the Arkansas River, opposite Nathrop, Chaffee County, Colorado. The mode of formation of the topaz and garnet in the lithophysal cavities of the rhyolite in this district is not fully determinable, but they are evidently not secondary, but primary products, produced by sublimation or crystallisation from presumably heated solutions contemporaneous, or nearly so, with the final consolidation of the rocks.—On the strain-effect of sudden cooling exhibited by glass and by steel, by C. Barus and V. Strouhal. The experiments here described confirmed the views already announced by the authors, that the annealing of steel, considered physically, is at once referable to the category of viscous phenomena; also that the existence of the characteristic strain in glass-hard steel is the cause of electrical effects so enormous, that any additional effects caused by any change of carburation may be disregarded, and the electrical and magnetic results interpreted as due to variations in the intensity of the said strain. The chief results here arrived at have since been substantiated by polariscope evidence and by the investigation of the density of the consecutive shells of the "Prince Rupert drop." An account of these results will be given in their next paper.—Upon the origin of the mica-schists and black mica-slates of the Penokee-Gogebic iron-bearing series, by C. R. Van Hise. The iron-bearing formation of this region extends for over 80 miles from Lake Numakagon in Wisconsin to Lake Gogebic in Michigan; and at Penokee Gap, Wisconsin, the series is 13,000 feet thick, the upper 11,000 feet being mica-schists and black slates. The Muscovitic and biotitic greywacke, biotite-schists, and other formations here described furnish a graded series from the slightly altered greywackes to the crystalline mica-schists.—On two masses of meteoric iron of unusual interest, by Wm. Earl Hidden. One of these specimens, found on July 2, 1885, on a height to the east of Batesville, Independence County, Arkansas, weighs 94 lbs., and belongs to the class holosiderite of Brezina. It is specially remarkable for a hole piercing it near the edge, and cone-shaped from both sides. Analysis yielded: iron, 91·22; phosphorus, 0·16; nickel and cobalt, 8·62 by difference. The other, found in 1857 in Laurens County, South Carolina, weighs only 4 lbs. 11 oz., but is noted for the perfection of the Widmanstätter lines and unusual abundance of nickel and cobalt. Analysis: iron, 85·33; nickel, 13·34; cobalt, 0·87; phosphorus, 0·16, with trace of sulphur.—Notice of a new genus of Lower Silurian Brachiopoda, by S. W. Ford. This nearly perfect specimen of the ventral valve of the species described by E. Billings under the name of *Obolella desiderata*, and now preserved in the collection of Walter R. Billings, Ottawa, may be taken as the type of a new genus, probably including several described Lower Silurian species. It differs from *Obolella* in the form and arrangement of its muscular impressions, in the possession of a thinner shell and in other respects. The author, therefore, proposes for it the new generic name of Billingsia in honour of Mr. E. Billings, the late eminent palæontologist of the Canadian Geological Survey.

Bulletin de l'Académie Royale de Belgique, April 3.—Determination of the remainder in Gauss's quadrature formula, by M. Mansion. By a definite integral the author completes this formula, which thus becomes applicable to non-parabolic curves.—On some remains of cetaceans from the foot of the Caucasus, by M. P. J. Van Beneden. These remains, comprising portion of a skull with some vertebræ from the district east of Vladikavkas, and an almost perfect vertebral column, with ribs, radius, and humerus from the bed of the Kuban River, all belong to the same species, the *Cetotherium rathkei*, Brandt. By their means the author is enabled to determine the true characteristics of the Cetotherium, which shows some affinity to the Pachyacanthæ of the basin of the Danube, but was quite distinct from the extinct species of the Antwerp basin.—On some rocks dredged off the Ostend coast, by M. A. F. Renard. These include granites, porphyries, diorites, &c., such as occur along the French seaboard and in the Channel Islands; also Jurassic and Chalk formations identical with those of Boulogne and the cliffs of Dover. There is nothing to show that any of these rocks have been transported either from the south or from the Scandinavian regions during the Glacial epoch.

Bulletin de la Société des Naturalistes de Moscou, 1885, No. 1.—Revision of the numerical values of the repulsive force, by Prof. Th. Bredichin. In his preceding researches the author had determined it approximately by means of the rough formula of Bessel. Now, he corrects these results, either by direct evaluations by means of more exact formulæ, or indirectly by means of the isodynames constructed upon his rigorous formulæ. Taking 40 different comets (since 1472) M. Bredichin classifies them under three different types, and, on the former method, receives for the first type, $R = 14$, while the initial speed (due to the ejective force) varies between $g = 0·1$ and $g = 0·34$, the average being 0·22; for the second type, $R = 1·1$, and $g = 0·05$ (varies between 0·03 and 0·07); and for the third type, $R = 0·2$, and $g = 0·1$ to 0·2.—On the oscillation of the emissive of comets, by the same (with a plate). From a careful study of the comet 1862 III. the learned professor concludes that the oscillations of its emission ought to be considered beyond doubt, as they result not only from measurements, but also from all the *ensemble* of phenomena afforded by the head and tail of the comet.—Third report upon my herbarium, by Ed. Lindemann (in German).—Plantæ Raddeanæ Monopetalæ (continuation of Labiatæ), by Ferd. Herder.—Letters from Dr. A. Regel dated from Bokhara, Merv, &c., between May 1884 and April 1885.—Notice of a journey to Akhal-Tekke, by A. Becker, with a list of plants found at Kyzyl arvat.—On northern *Aucellæ*, by H. Trautschold.

No. 2.—Enumeration of the vascular plants of the Caucasus, by M. Smirnoff, continued from the preceding issue, and forming an introduction to the flora of the Caucasus.—Birds of the Transcaspian region, by M. Zaroudnoï.—Thirty-five years of observations on the earliest and latest times of blooming of wild and cultivated plants in the neighbourhood of Kishineff, by A. Dœngingk, followed by remarks on vegetable parasites and noxious insects. Four hundred plants are on the lists of the author.—Revision of the copulatric armatures of the males from the *Phileremide* tribe, by Gen. Radoszkowski (with two plates).—The appendix contains the third part of the systematic catalogue of the herbarium of Moscow University, published by Prof. Goroshankin.

SOCIETIES AND ACADEMIES

London

Royal Society, May 13.—"On the Structure of Mucous Salivary Glands." By J. N. Langley, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge.

The cells of mucous salivary glands I have previously described as consisting of a framework or network, containing in its spaces hyaline substance and granules. The granules of the mucous salivary glands are rendered very distinct by irrigating a mounted specimen of a fresh gland with moderately dilute solutions of neutral or alkaline salts. In these fluids the granules can scarcely be distinguished from small fat globules; those of the submaxillary gland of the dog have a diameter of 1 to 2 μ. In the resting gland the granules are fairly closely packed throughout the cell, in a line stretching from basement membrane to lumen; there are 8 to 12 granules. Both hyaline substance and granules give rise to mucin.

During secretion both the hyaline substance and the granules are turned out of the cells; after prolonged secretion the cells consist of an outer zone, chiefly of freshly-formed substance, and of an inner zone of network, hyaline substance, and granules, as in the resting state. When the saliva has a high percentage of