while the sun is not eclipsed, the observation of the helium (D_3) line in the chromosphere by Lockyer, twenty-five years before the element was discovered terrestrially, and even the very recent work of Dr. Nicholson in the theoretical construction of such spectra as those of the unknown cosmical elements nebulium and coronium. This brief enumeration will serve to show that Dr. Wolf's paper is not only comprehensive, but also up to date, and should be read by all interested in astrophysics.

ELEMENTS OF RECENTLY DISCOVERED MINOR PLANETS.—In No. 4607 of the *Astronomische Nachrichten*, Dr. Cohn gives the elements and permanent numbers of eighteen minor planets discovered during 1911–12. Four of these have been identified with older discoveries to which no numbers had been allotted, and eleven of the "discoveries" made during 1911 have since been identified with planets previously included in the official records. The total number thus included, as shown by the present list, is 732.

THE PHYSICAL SOCIETY'S EXHIBITION.

THE eighth annual exhibition of physical apparatus under the auspices of the Physical Society of London was held on Tuesday, December 17, at the Imperial College of Science, and attracted the usual large attendance. At both the afternoon and evening sessions a short discourse was given by Mr. S. G. Brown on "Some Methods of Magnifying Feeble Signalling Currents." The lecturer described several instruments designed by himself for magnifying the currents received through Atlantic cables, by the use of which largely increased speed of signalling had been made possible. The most interesting of these was one in which the original signalling current moves a thermo-electric junction into and out of a small flame, the thermo-electric current thus produced being twenty-seven times that of the signalling current. The magnifying power is approximately constant for all currents, an advantage over the ordinary form of relay in which the current of the local circuit is constant and is merely made or broken by the signalling current. Other mechanical methods of achieving the same result were also described.

Exhibits of apparatus were shown by some thirty firms of manufacturers. The principal exhibit of the Cambridge Scientific Instrument Co. was a complete cardiograph outfit, composed of an Einthoven string galvanometer, projection apparatus, camera with moving plate or continuous paper for cases where long records are necessary, and a switchboard by which the standardisation of the galvanometer, compensation for skin currents, and measurements of body resistance could be quickly made. By an auxiliary apparatus, records of the heart sounds could also be obtained. Another of their exhibits was a Wilson cloud apparatus for showing the path of α particles or X rays by the condensation of water upon the ions. Messrs. J. J. Griffin and Sons had an interesting exhibition of motor-gyrostats with models for illustrating the Schlick method of steadying ships, and the gyrostatic mono-rail car. Mr. C. V. Boys's rainbow cup for showing the colours of thin films was also exhibited in action. In addition to the usual laboratory instruments, Messrs. Gambrell Bros. exhibited a new convection radiometer by Mr. F. W. Jordon for measuring small, steady rates of evolution or absorption of heat. The convection current of gas produced by the source of heat deflects two very light suspended mica vanes the deflection being shown in the usual way by a mirror. The Marconi Co. exhibited instruments for use in wireless telegraphy, including a portable knapsack receiving and transmitting set for communicating across distances of fifteen miles. The Helsby Wireless Telegraph Co. showed a vibration-proof detector and a rotary quenched spark discharger.

Microscopes for ultra-microscopic and for metallurgical work were exhibited by Messrs. R. and J. Beck, Messrs. E. Leitz, and Messrs. Carl Zeiss. The last firm also had an example of its projection apparatus at work. The principal exhibits of Messrs. Alexander Wright and Co. consisted of various forms of Dr. Leonard Levy's apparatus for the examination of mine air according to the provisions of the Coal Mines Act of 1911. They also exhibited some good examples of palladium and platinum plating on metals and gold plating on glass.

Messrs. Kelvin and James White, Ltd., exhibited a compass for use on aeroplanes. It was of the floating type, and said to be entirely unaffected by the vibrations of the engines. A Fullarton vibrometer for obtaining the frequency and intensity of vibrations produced by any form of machinery was also shown. It consists of a vibrating reed which can be adjusted to the frequency of the vibration to be measured, the intensity being shown by the amplitude of the vibration of the reed. An Aitken portable dust counter for quickly estimating the number of dust particles in the air, based on the method of condensation of moisture on them, was exhibited by the same firm. Mr. R. W. Paul had a large exhibit of electrical measuring instruments, including several new types. Among them was a string galvanometer somewhat similar to the Einthoven, but with the string in a horizontal position. The Irwin optiphone was shown in use. This is an instrument for magnifying the motion of a vibrating body, such as the diaphragm of a telephone, the wave-form of the motion being obtained by the revolving mirror method.

Messrs. A. Gallenkamp showed some cheap electric furnaces and various laboratory apparatus for heat experiments, including a student's optical bench for radiant heat experiments. They also exhibited a sensitive flame for working at the low pressure of an ordinary gas supply, designed by Prof. S. P. Thompson. The Westminster Engineering Co. exhibited a small useful projection arc lamp for photographic work and optical lanterns. Resistance testing sets were shown by Messrs. Crompton and Co., Evershed and Vignoles, and Nalder Bros., and a large range of switchboard instruments was exhibited by the Weston Co.

RIVERS, GLACIERS, AND THE ICE-AGE.

BRUNO DIETRICH, of Potsdam, has made a geographical study of the Moselle valley ("Morphologie des Moselgebietes zwischen Trier und Alf," *Verhandl. des naturhist. Vereins der preuss. Rheinlande*, 1911, for 1910, p. 83). Basing his description on the geological structure and history of the district, he shows how the valley has been cut in a pre-Miocene surface of denudation. The meanders that arose on this fairly even surface are now traced as winding ravines (p. 120), owing to the elevation of the country and the consequent lowering of the base-level of the Moselle. The tributaries of the left bank, however, are held to have been incapable of forming such large meanders as are now seen in the forms of their ravines. At present they wander somewhat aimlessly in the flat land of their floors, now cutting back one valley-wall, now the other. Their valley-flats (*Talauen*) are attributed to lateral erosion at a time when the land remained stationary for a time (p. 130), and we gather that these flats have become per-

petuated during the general lowering of the valley-floors. For those who do not know the details of the ground, the argument seems to require further development, since it may be urged that the large meanders arose when the tributaries received much more water from the drainage of the plateau, while the *Talauen* represent the natural consequence of the diminution in volume of the streams. The "misfit" of a small meandering streamlet in a widely meandering valley reminds us of the conditions of the Altmühl valley, near Eichstätt, which is believed at one time to have held the Danube. An interesting account is given (p. 164) of the changes that have taken place where the Moselle traverses the sunken area of Wittlich. This depression is attributed to Middle Cainozoic earth-movements, and its form has become moulded by the Moselle and its tributaries, which have removed an immense amount of the yielding Permian strata and have left courses illustrating dry loops and river-capture.

E. C. Andrews, in his "Corrasion by Gravity Streams" (Proc. Roy. Soc. N.S. Wales, vol. xliii., p. 204), has urged that running water may work out a hollow in a valley-floor wherever its velocity is increased, as occurs in a constriction of the valley. The greater the velocity, the steeper will be the heads of these hollows, and a series of steps may thus arise in the floor, comparable to those found in valleys that have been filled by ice. Andrews compares the receding heads of the waterfall-regions or torrent-regions with the cirques (p. 282) of glaciated lands; the only cirques considered by him, however, are those that lie at valley-heads. He urges that rivers in flood-time effect so abnormal an amount of denudation that their normal action may be left out of count in considering the formation of their valleys. Similarly, the glacial epoch gave rise to ice-floods, beside which anything that we see now is insignificant (p. 274). Glaciers are considered as a type of "gravity-stream," and the author's studies in Australasia, California, and Scotland, while they do not bring him to any very new conclusions, lead to a pronounced advocacy of the importance of glacial erosion. In vol xliv., p. 262, Andrews illustrates the formation of steps and *roches moutonnées* by plucking action in the Yosemite valley. We do not know why (p. 292) he writes the extraordinary words, "lee seites" and "stoss seites," when he has used the convenient adjectives "downstream" and "upstream" in his previous paper. Here, again, cirques are regarded, not as arising independently on an upland by the corroding action of frost, but merely as the faces of steps formed beneath an ice-flood (p. 305), which have retreated upstream to their present positions on divides. In vol. xlv., p. 116, the author discusses "Erosion and its Significance," and points out that where two peneplane surfaces in association are separated by youthful topography, tectonic movements must have produced the difference of level. The flood-question is again discussed.

P. Morin, of Montlucon, reviews "Le problème de l'érosion glaciaire" in the *Revue générale des Sciences* for 1911, p. 762. He shows how the rock-ridges in the centre of some glaciated valley-floors, which are quoted by Brunhes as evidence of the inefficiency of the ice, may arise from a union of glaciers along arêtes which they have not been able to remove. Others represent the central parts of rock-barriers that lay athwart the ice-flow, the more rapid erosion by frost action and plucking on the margins of the glacier having excavated their ends more rapidly. The paper is agreeably illustrated, and sections are given on a true scale of the floors of glaciers descending from Mt. Blanc.

The late Prof. R. S. Tarr, who made a special province of Alaska, gave a general account of its glacial features in *Science* for February 16, 1912. The burden of sediment in the streams flowing from the glacier-margins led him naturally to ask (p. 250), "Can there be any doubt but that the glacier which protects the rock against the atmospheric agencies must attack it with equal or even greater vigour?" We may, perhaps, refer back to his excellently illustrated paper on "Some Phenomena of the Glacier Margins in the Yakutat Bay Region, Alaska" (*Zeitschrift für Gletscherkunde*, Bd. iii., p. 81), which has enabled many of us to compare outwash-features with those traceable in the British Isles. The results of glacial advance over old deposits are also clearly indicated (p. 102), and a warning is given against interpreting layers of vegetation interbedded with glacial detritus as evidence of an interglacial epoch. "A slight forward motion may well have pushed a broken ice-margin out into the fringing forest," as it did before the author's eyes in the Malaspina region in 1906.

O. D. von Engeln, of Cornell University (*ibid.*, Bd. vi., p. 104), records the results of observations made in Alaska on "Glacier Drainage and Wastage" during two expeditions led by Prof. Tarr. Much interest attaches to the forcing up of marginal streams against the valley-sides (p. 128) when a glacier increases in width; rock-gorges are then cut, parallel to the sides, which may easily again run dry. It is shown (p. 142) how denudation is rapid in an ice-filled valley, even if we neglect the erosive action of the ice, since the removal of the material copiously avalanched from the valley-walls leaves the surfaces continuously open to attack.

G. W. Lamplugh has published in the Proceedings of the Yorkshire Geological Society (Leeds, vol. xvii., p. 216) an important paper on the shelly moraine pushed up by the Sefström Glacier from the sea-floor in Spitsbergen in 1896. The illustrations selected are of exceptional beauty, apart from their geological value as Arctic landscapes.

W. von Lozinski usefully discusses "Die periglaziale Facies der mechanischen Verwitterung" (*Naturwissenschaftliche Wochenschrift*, October 8, 1911). The traces of widespread weathering by frost are destined to disappear as the conditions of the Ice age recede from us. The breaking up of rock-surfaces into block-detritus by frost must have occurred on an enormous scale as glacial conditions spread, and the material thus loosened provided the abundant erratics that were carried by the ice-invasion into the lowlands. Similar block-formations arose as the ice retreated, and also in unglaciated lands subject to its chilling influence; these detrital masses of local origin cumber the surface of large parts of Europe at the present day.

R. A. Daly (*Amer. Journ. Sci.*, vol. xxx., p. 297) publishes a characteristically speculative but suggestive paper on "Pleistocene Glaciation and the Coral-reef Problem," in which he represents the existing reefs as arising on a plateau of marine denudation, which was formed when the sea-level was lowered by the abstraction of its waters to form continental ice.

Those who wish to follow the course or courses of opinion on the origin of Ice ages will find a good review and a new cosmic suggestion in Fr. Nölke's paper, "Die Entstehung der Eiszeiten" (*Deutsche geographische Blätter*, Bd. xxxii., p. 1.). The passage of the sun through a heat-absorbing nebular aggregate is invoked. Ach. Grégoire (*Bull. Soc. Belge de Géologie*, tome xxiii., p. 154) believes that the elevation of a sea-floor to form a continent brings

up a mass of cold rock as against one that has long felt the influence of the sun; hence unusual precipitation follows on the new land-surface, and an Ice age sets in. Stanislas Meunier ("Les Theories Glaciaires," *Revue des Idées*, 1910, p. 207) affirms, as usual, that no general and contemporaneous refrigeration has been proved; but he also asserts that the scratches of stones in boulder-clay are produced by the infiltration of rain and consequent settling of the mass. M. Yokoyama ("Climatic Changes in Japan since the Pliocene Epoch," Journ. Coll. Sci., Tokyo, vol. xxxii., 1911, part v.) cannot accept the evolution of carbon dioxide as a cause of warmer climates, since in Japan the output must have been considerable during glacial times. He prefers, from local palæontological evidence, to account for the difficulties by a shifting of the poles. This is, of course, seriously opposed by the evidence of contemporaneous world-wide refrigeration. R. Speight ("The Post-glacial Climate of Canterbury," Trans. New Zealand Inst., vol. xliii., 1911, p. 408) finds no local cause in New Zealand to account for the succession of climates that he records, a moist climate following the glacial, and modified steppe conditions preceding those of the present day. The author points out that the sequence is so similar to that in Europe as to suggest some cause that affected the whole earth, though changes in the grouping of land and water in the southern hemisphere might account for the former conditions in New Zealand.

G. A. J. C.

THE WORK OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT, CHARLOTTENBURG, IN 1911.

THE following notes describe some of the more important researches, &c., undertaken at the above institution during 1911. They are compiled from the annual report of the Reichsanstalt, appearing in *Zeitschrift für Instrumentenkunde*, April, May, and June, 1912.

The comparison of platinum resistance thermometers with various gas thermometers has been completed between 0° and 450° C. It was found that the hydrogen thermometer and the helium thermometer of constant volume with an initial pressure of 620 mm. mercury indicated about 0·1° higher at 450° C. than the nitrogen thermometer under the same conditions. With the accuracy attained, the hydrogen scale may be at once identified with the ideal scale, since, according to Berthelot, these only differ by about 0·01° at 450° C. in the present case. The data for the following fixed points, which were determined afresh, refer to the ideal gas scale :—

Freezing points		Boiling points	
Tin	231·8$_3$°	Naphthalin ...	217·9°
Cadmium ...	320·9$_2$°	Benzophenon...	305·8$_9$°
Zinc	419·4$_0$°	Sulphur ...	444·5$_1$°

In connection with an investigation of the mean specific heat of gases at high pressures, the specific heat of air between 20° and 100° C. at 1 and 11 atmospheres was measured with a new calorimeter. It was found that when the pressure was increased from 1 to 11 atmospheres the specific heat increased by about 2·1 per cent. This result must not, however, be considered as final at present.

The investigation into the specific heat at constant pressure of air by the Callendar and Barnes continuous-flow method was concluded. The values found for the specific heat at constant pressure of carbonic-acid-free air under atmospheric pressure are given below. The method gives the results direct in electrical measure (watt-seconds); and the values converted into heat units (Cal.$_{15°}$) are also given.

Temperature °C.	c_p In electrical measure	c_p In calories
+ 20	1·009 ...	0·240$_8$
− 78	1·019 ...	0·243$_2$
-183	1·058 ...	0·252$_5$

The experiments were extended to carbonic acid gas, oxygen, and nitrogen. For the pure, dry gases, at atmospheric pressure and 20° C., the following results were found in electrical and in heat units respectively :—

Carbonic acid gas	c_p=0·846 and 0·202	respectively.
Oxygen	c_p=0·917 „ 0·219	„
Nitrogen	c_p=1·041 „ 0·249	„

For carbonic acid gas at −78° C. and atmospheric pressure the respective results were, c_p=0·76$_8$ and 0·183. The decrease in specific heat of CO_2 between +20° C. and −78° C. is, when calculated per degree, only slightly less than that between +100° C. and +20° C. determined by Swan.

Specific Heat of Water between 0° and 100° C.—A precise determination of the calorie in electrical units on a trustworthy basis appears very desirable. The bases of the measurement, viz. the unit of resistance, the e.m.f. of the standard cell and the temperature scale, have now been fixed internationally to such a degree of certainty as to appear to render possible a determination of the calorie in international watt-seconds to within 1 part in 10,000. This research was commenced at room temperature, and a description of the various apparatus and of the experimental arrangements is given in the report. No results are, however, recorded.

Weston Normal Cells.—A number of these were constructed, using new mercurous sulphate preparations, with the view of seeing whether all freshly precipitated samples yielded the same e.m.f. as the older preparations, and for the purpose of discovering whether the method of washing the precipitated mercurous sulphate had any influence on the e.m.f. of the cell. The results show that the method of washing has no appreciable influence on the e.m.f. Other extensive investigations were undertaken on Weston cells, and the general results arrived at indicate that both the reproducibility and constancy of the cell can be guaranteed internationally to within a few parts in 100,000.

In connection with some experiments on resistance thermometers, it was found that the differences shown between fused silica platinum resistance thermometers and the ordinary type may be ascribed to a reaction of the quartz glass on the platinum—probably of a chemical nature. Experiments were also made with the view of comparing the behaviour of the quartz glass resistance thermometer at the highest temperatures at which it can be used with the ordinary resistance thermometer. Full details of these experiments are given.

Electrolysis of Glass.—The investigation of the badly conducting layers discovered by Warburg in the electrolysis at 300°–350° C. gave the following result :—

Platinum or graphite anodes are not soluble in glass. On electrolysis, a layer of high resistance occurs at these anodes, sodium migrating from the glass to the kathode and oxygen to the anode. With mercury as anode, quantitative migration takes place. The metals lead, bismuth, antimony, tin, iron, and copper, when oxide-free, appear to migrate quantita-