

OUR ASTRONOMICAL COLUMN.

DRAWINGS OF MERCURY.—Mr. Percival Lowell, writing (*Astr. Nach.*, No. 3407) of the planet Mercury, says that the markings of the planet are distinct and dark. They are generally of the nature of lines. Both poles, he says, are shaded, and there is a conspicuous dark band cutting off the southern one from the rest of the planet. This band is stated to be continuous for several degrees of longitude, and may possibly girdle the zone completely. The period of rotation of the planet was found to be synchronous with the orbital revolution, thus endorsing Schiaparelli's previously determined period of eighty-eight days. Even from the drawings, several of which are reproduced, a slow period of rotation seems the more probable, while observations made since they were completed confirm this still more.

PROMINENCE PHOTOGRAPHY.—During the last twelve months many attempts have been made to obtain impressions on a photographic plate, showing various solar phenomena, and all of them have had for their basis the well-known action of electrical radiation on a sensitive film. The method consists in wrapping a plate in some opaque material, velvet, tinfoil, paper, &c., and then exposing it to the sun, using either the general diffused light, or the image formed by an object-glass or in a pin-hole camera. In several cases results have been obtained more or less consistent, but in general the impressions have been dissimilar at each trial, thus suggesting accidental causes for the effect. In the *Photogram* for July 1896, Mr. D. Packer gave several photographs of impressions he had obtained on plates exposed in this way, which were supposed to show the details of the solar corona. Results exactly similar to those given have been obtained by the writer, but in every case the effect could be traced to imperfections in the wrapping of the plate, and the consequent spreading of the light thus admitted direct to the film.

Now in the current *Comptes rendus* (p. 459), M. P. de Heen describes the appearance he gets on exposing a covered plate at the focus of a small object-glass. He finds that a ring is produced on the plate, corresponding to the solar atmosphere in size, and thinks that the chromosphere is the seat of electric radiations, while the photosphere is simply the source of luminous radiation, thus suggesting that, if true, this may furnish a method of examining the spots and prominences.

OXYGEN IN THE SUN.—Some time ago (*NATURE*, vol. iv. p. 303) we pointed out in this column that Herren Runge and Paschen had reason to believe that the three lines of oxygen—7772.26, 7774.30, and 7775.97—in the solar spectrum were probably not atmospheric, and we further mentioned that a crucial test could be made by examining the solar spectrum for motion in the line of sight. Mr. Lewis Jewell has taken up this problem, and contributes the result of his inquiry to the *Astrophysical Journal* (February 1897, p. 99). He found that using a grating, 15,000 lines to the inch, the spectrum was so exceedingly weak to the eye when the slit of the spectroscope was placed near the edge of the sun's disc, that no satisfactory observations of the three lines mentioned above could be made.

Mr. Jewell then turned his attention to investigating whether a high or low sun caused any appreciable difference in intensity of these lines. In this he was more fortunate, and is now able to state that his observations "prove conclusively that the three lines supposed to be due to oxygen in the sun are produced by water vapour in the earth's atmosphere."

THE TOTAL SOLAR ECLIPSE OF AUGUST 8, 1896.—In the January number of the *Bulletin* of the St. Petersburg Imperial Academy of Sciences (5th series, vol. vi. No. 1) appear three accounts of the observations made at Novaya Zemlya. The first is the report of Prof. O. Backlund, whose station was situated at Malya Karmakouly, and whose programme consisted in observing the contacts and sketching the corona. The weather seemed to have been all that could be desired, and all four contacts were obtained. The second report is made by M. S. Kostinsky and A. Hansky, who observed from the same station. This is accompanied by some excellent reproductions taken direct from the enlarged negatives, showing an amount of detail in the streamers that is seldom obtained. One photograph was taken about third contact, and shows that interesting phenomenon known as "Baily's beads," which interferes so much with the estimation of the exact observed time of contact. There is also a plate showing the corona and a large region of

the sky around it: conspicuous on this are Jupiter and several stars. An excellent drawing of the details, as gathered from a minute examination of all the photographs taken, is further added. Lieut. Bouchteeff, who was carrying on some hydrographic operations at Novaya Zemlya, observed the eclipse from the Bay of Belougia Gouba. He noted the times of all four contacts, and made a rough sketch of the corona, which are all given in his report published in this *Bulletin*.

THE CHEMISTRY OF THE STARS.—The rapid strides that have been made in the development of spectrum analysis since the time of Wollaston, and the important step taken by Prof. Pickering in the adoption of the prismatic-camera form of instrument, have led many to investigate the spectra of the stars in our universe. Such a survey, although slow to accomplish, is of great importance, since we are able to pass at a bound from terrestrial temperatures, and observe the behaviour of our elements at temperatures far beyond our ken. The chemist is thus left far behind, and is restricted to a very limited range of temperature, while the astronomer has at his disposal temperatures the magnitude of which cannot be even conceived. That the celestial bodies about us vary enormously in their degrees of temperature is now admitted by every one, and some idea of the different kinds of spectra emitted by these bodies may be gathered from Mr. Fowler's interesting article in *Knowledge* (March), which deals in the main with the important work that is being carried on at Kensington under the direction of Mr. Norman Lockyer. That the stars are now being successfully classified in a closed curve—*i.e.* some are increasing and some decreasing their temperatures—is only one of many important advances of the last few years. The recent discovery of the new form of hydrogen, by Prof. Pickering, is another rundle in the ladder of temperature, which seems to indicate that even in those stars within our sphere of the cosmos we may not have examples of the *highest* attainable temperature.

ON ELECTRIC EQUILIBRIUM BETWEEN URANIUM AND AN INSULATED METAL IN ITS NEIGHBOURHOOD.¹

THE wonderful fact that uranium held in the neighbourhood of an electrified body diselectrifies it, was first discovered by H. Becquerel. Through the kindness of M. Moissan we have had a disc of this metal, about five centimetres in diameter and a half-centimetre in thickness, placed at our disposal.

We made a few preliminary observations on its diselectrifying property. We observed first the rate of discharge when a body was charged to different potentials. We found that the quantity lost per half-minute was very far from increasing in simple proportion to the voltage, from 5 volts up to 2100 volts; the electrified body being at a distance of about 2 cms. from the uranium discs. [Added March 9.—We have to-day seen Prof. Becquerel's paper in *Comptes rendus* for March 1. It gives us great pleasure to find that the results we have obtained on discharge by uranium at different voltages have been obtained in another way by the discoverer of the effect. A very interesting account will be found in the paper above cited, which was read to the French Academy of Sciences on the same evening, curiously enough, as ours was read before the Royal Society of Edinburgh.]

These first experiments were made with no screen placed between the uranium and the charged body. We afterwards found that there was also a discharging effect, though much slower, when the uranium was wrapped in tinfoil. The effect was still observable when an aluminium screen was placed between the uranium, wrapped in tinfoil, and the charged body.

To make experiments on the electric equilibrium between uranium and a metal in its neighbourhood, we connected an insulated horizontal metal disc to the insulated pair of quadrants of an electrometer. We placed the uranium opposite this disc, and connected it and the other pair of quadrants of the electrometer to sheaths. The surface of the uranium was parallel to that of the insulated metal disc, and at a distance of about 1 cm. from it. It was so arranged as to allow of its easy removal.

With a polished aluminium disc as the insulated metal, and with a similar piece of aluminium placed opposite it, in place of the uranium, no deviation from the metallic zero was found when the pairs of quadrants were insulated from one another. With

¹ By Lord Kelvin, Dr. J. Carruthers Beattie, Dr. M. Smoluchowski de Smolan. Read before the Royal Society of Edinburgh, March 1.

the uranium opposite the insulated polished aluminium, a deviation of -84 sc. divs. from the metallic zero was found in about half a minute. After that the electrometer reading remained steady at this point, which we may call the uranium rays-zero for the two metals separated by air which was traversed by uranium rays. If, instead of having the uranium opposite to the aluminium, with only air between them, the uranium was wrapped in a piece taken from the same aluminium sheet, and then placed opposite to the insulated polished aluminium disc, no deviation was produced. Thus in this case the rays-zero agreed with the metallic zero.

With polished copper as the insulated metal, and the uranium separated only by air from this copper, there was a deviation of about $+10$ sc. divs. With the uranium wrapped in thin sheet aluminium and placed in position opposite the insulated copper disc, a deviation from the metallic zero of $+43$ sc. divs. was produced in two minutes, and at the end of that time a steady state had not been reached.

With oxidised copper as the insulated metal, opposed to the uranium with only air between them, a deviation from the metallic zero of about $+25$ sc. divs. was produced.

When the uranium, instead of being placed at a distance of one centimetre from the insulated metal disc, was placed at a distance of two or three millimetres, the deviation from the metallic zero was the same.

These experiments show that two polished metallic surfaces connected to the sheath and the insulated electrode of an electrometer, when the air between them is influenced by the uranium rays, give a deflection from the metallic zero, the same in direction, and of about the same amount, as when the two metals are connected by a drop of water.

THE EXTRACTION OF GOLD BY CHEMICAL METHODS.

EXCLUDING mechanical, smelting, and amalgamation processes, the methods of extracting gold from its ores may conveniently be grouped together under the heading of wet or chemical methods. In these, the gold is dissolved by some suitable solvent, and is then separated from the unaltered ore by washing, and recovered by precipitation. The processes owe their origin to the rapid advance in the science of chemistry which has been made during the present century, and, although they are now of vast importance, and give results which would astonish our grandfathers, it is, perhaps, somewhat surprising that chemistry has not done more for the gold-mining industry. At the present day, the wet methods produce little more than a tenth of the total output of gold, while mechanical improvements in the old processes, made during the last half-century, are probably answerable for four or five times as much.

Gold exists in nature practically only in one form, the metallic state, and the differences in treatment of the ores are necessitated by the variations in the physical condition of the metal, and by changes in the other constituents of the rock. Where the particles of gold are large enough to be seen by unassisted vision, they can usually be collected by means of mercury, and, on the other hand, are not dissolved in a reasonable time by any of the solvents of gold yet applied in practice. In these cases, therefore, chemical methods are not advantageous. Nevertheless, it usually happens that some, if not all, of the gold in an ore is in an extremely fine state of division. It has recently been shown by Edman that a great proportion of the gold in American ores consists of particles less than $\frac{1}{1000}$ inch in diameter, and that some of these are less than $\frac{1}{12700}$ inch. Sometimes, gold in an ore is not visible even under the microscope, though readily detected by chemical means. Metal in such a condition is far more readily dissolved by a mobile liquid than by a viscous one like mercury, which does not wet the grains of sand between which the gold is hidden. Moreover, mercury may be prevented from doing its work by the presence of substances on which it exerts chemical action, such as the sulphides of antimony, or arsenic, or which protect the gold from its action by coating the particles with insoluble films.

From such causes as these, it has long been recognised that the treatment of gold ores by mercury is very imperfect in a great many cases. The method is, speaking generally, unsatisfactory in extracting gold contained in pyrites or other sulphides, and it is in the treatment of these substances that the chlorination process, now nearly fifty years old, has its main value.

Chlorine is a somewhat slow solvent for gold, but the time occupied by it in dissolving the fine flakes existing in pyrites is not excessive. Unfortunately, chlorine has a strongly preferential action on sulphides, and, to avoid the enormous waste of the gas which is entailed in the oxidation of a small percentage of these substances, it is necessary to precede chlorination by careful and complete roasting. Even in the rare cases, such as that of the Mount Morgan ore, in which the use of chlorine on completely oxidised ores is found to be desirable, the preliminary roasting is not omitted, as the percolation of liquids through the roasted mass is far easier than through the raw ore.

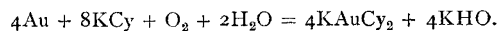
After roasting, there is little difficulty in the process. Oxides of the metals, except the alkaline earths, are very slowly attacked by chlorine; and when the alkaline earths are present salt is added in the roasting furnace. Here one of the sources of loss in the process is encountered, chloride of gold being formed and volatilised at all temperatures above 200° , when common salt is mixed with the ore. In long-bedded furnaces, however, this loss is reduced to a minimum; chloride of gold is prevented from formation by the presence of large quantities of unoxidised pyrites, and when formed, in the oxidised product in the hottest part of the furnace, it is in great part decomposed and re-absorbed during its passage over the bed of comparatively cool ore, which has just been charged into the furnace.

It was formerly the universal practice to apply the chlorine to the slightly-damped roasted ore in the form of gas, and this method has never been entirely abandoned. Subsequently, after Dr. Mears had discovered that compressed chlorine was more rapid in its action than the same agent under ordinary atmospheric pressure, strong aqueous solutions were used, the ore being agitated with the solvent in revolving barrels. This practice is still adhered to in several works in the United States. Elsewhere, however, it has been completely set aside. For example, at Mount Morgan, in Queensland, the largest chlorination mill in the world, stationary vats have been reverted to, aqueous solutions of chlorine being, however, still used. At this mill about 1,500 tons of ore are treated every week at a cost of about 18s. per ton, or little more than one-sixth of the value of the yield in gold.

After the ore has been treated with chlorine for a period varying in different mills from an hour to one or two days, the liquid is filtered off and the gold precipitated by ferrous sulphate, sulphuretted hydrogen, or charcoal. As regards the relative advantages of these methods, it may be noted that charcoal only acts well with boiling solutions, and that sulphuretted hydrogen is now recommended by its advocates even when copper is present in the ore, Rothwell having recently pointed out that in acid solutions there is partial precipitation, all the gold being removed from solution before the copper begins to come down.

The chlorination process, though perhaps unrivalled in the percentage of extraction which can usually be attained, labours under two serious disadvantages. Roasting the ore is often so expensive as to be impracticable, and the silver is, in any case, all lost. Both of these disadvantages are avoided by the use of the cyanide process. This was introduced by MacArthur and the Forrests after prolonged researches, having for their object the discovery of some chemical process which would not require a preliminary roasting of the ore.

The action of cyanide solutions on the precious metals had long been known. Elsner had stated, in 1846, that the presence of air was necessary for the dissolution of gold or silver by potassium cyanide, and, subsequently, it was suggested that the action was represented by the equation



This equation has recently been established by MacLaurin (*Jour. Chem. Soc.* vol. lxiii. (1893) p. 724; vol. lxvii. (1895) p. 199), who also showed that the dissolution of gold and silver becomes slower in proportion as free oxygen is more and more carefully excluded from the system. Thus, when a plate of gold was treated with a solution containing 1 per cent. of cyanide of potassium in a stoppered bottle filled with oxygen, the loss of weight was 0.24 gramme in 96 hours; in a shallow vessel exposed to the air, the loss was 0.00835 gramme in 24 hours, and in a flask, freed from air as completely as possible, the loss was only 0.0002 gramme in the same time. In addition, MacLaurin prepared the curves of solubility of gold and silver in cyanide solutions, and showed that the maximum rate of dissolution of both metals is reached at 0.25 per cent. of KCy, and