OUR ASTRONOMICAL COLUMN.

A NEW STAR IN GEMINI.—A communication received from Prof. H. H. Turner on March 25 announced that the image of a Nova, or a variable, had been discovered on a photograph taken at the University Observatory, Oxford, on March 16. The position of the object was given as

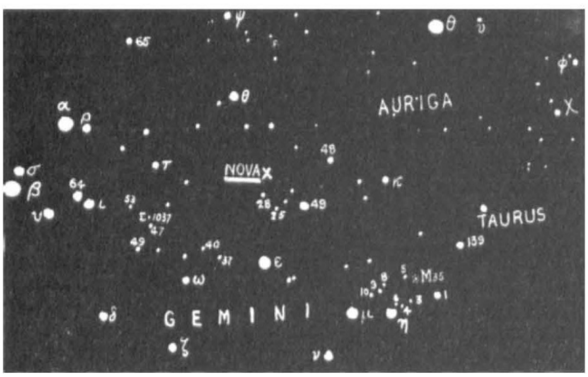
R.A. = 6h. 37m. 48·9s., Dec. = $+30° 2' 39''$ (1900),

which is situated in the constellation Gemini near to the border of Auriga, and about half-way between θ and ϵ Geminorum, a little preceding the straight line joining them. This position was confirmed by an observation made at Oxford on the evening of March 24. A telegram from the Kiel Centralstelle confirmed the discovery.

In a second communication from Oxford it was announced that Mr. Newall had observed the spectrum with a direct vision spectroscope attached to the Sheepshanks equatorial at Cambridge, and had little doubt that the object was a Nova. He found that bright lines—both numerous and strong—were present, those in the green part of the spectrum being especially bright.

In a letter to the *Times* of Saturday, March 28, Prof. Turner stated that the object was not bright enough for its image to appear on plates taken on February 24 and earlier, and as no apparent movement had taken place between March 16 and 24, it was certainly not a planet.

The magnitude of the new star is about 7, and, as it is at present near to the zenith during a greater part of the evening, it should be easy to observe, given favourable meteorological conditions. The accompanying chart shows the approximate position of the Nova in regard to the surrounding stars.



A *Circular* (No. 58) from the Kiel Centralstelle announces that Prof. Hartmann, at Potsdam, examined the visual spectrum on March 27. He found the hydrogen lines $H\beta$ and $H\alpha$ to be present, the latter appearing especially bright; the yellow part of the spectrum is extremely faint as compared with the blue, which contains many bright lines superimposed on a continuous spectrum. The spectrum leads to the conclusion that the star is either a Nova or a variable of the Mira type.

Prof. Hale, at Yerkes Observatory, observed the Nova on March 27·75 (G.M.T.), and found its position to be α = 6h. 37m. 49s., $\delta = +30° 2' 38''$, and its magnitude 8·5. The spectrum contains bright lines (or bands), and the colour of the Nova is red.

THE SOLAR CONSTANT.—In a paper read before the American Association for the Advancement of Science on December 30, Prof. S. P. Langley discussed the values which have hitherto been obtained for the constant of solar radiation, and gave an outline of the course of study of this constant that it is proposed to carry out in the immediate future at the Smithsonian Astrophysical Observatory.

The author, in his opening remarks, drew attention to the vital importance to humanity of obtaining definite knowledge of the magnitude, nature and possible variations of this radiation, and stated that whilst many other astronomical problems are of great interest from a purely scientific point of view, this one problem is of intensely practical importance; he then summarised this view in the following statement:—"I recognise that every nebula might be wiped out of the sky to-night without affecting the price of a labourer's dinner, while a small change in the solar radiation may conceivably cause the deaths of numberless men in an Indian famine."

Thus recognising the grave importance of a minute study of solar physics, Prof. Langley devoted a great deal of attention to its problems whilst connected with the Allegheny Observatory and the Mount Whitney expedition, and with his bolometer made a long series of observations which led to the conclusion that the values obtained by Pouillet and other observers were far too small. By measuring the solar radiations wave-length by wave-length, he obtained values varying from 3·0 to 3·5, thus nearly doubling the classical value, 1·76 calories, obtained by Pouillet.

Using the bolometric method it is now possible to obtain results in fifteen minutes which it previously took two days to obtain, and the Smithsonian Observatory proposes to commence, in the immediate future, a series of observations in order to determine (*a*) the coefficients of atmospheric transmission under all conditions, and (*b*) the coefficients of transmission of the various parts of the apparatus. In doing this the observers will become familiar with the experimental methods which, it is hoped, will be used later at more elevated stations where the atmospheric conditions are much more favourable, and they will also obtain values more nearly approximate to the true values than those hitherto obtained (*Astrophysical Journal*, vol. xvii. No. 2).

THE MAGNESIUM SPECTRUM LINE AT λ 4481.—Sir William and Lady Huggins communicate to the March number of the *Astrophysical Journal* the preliminary results obtained by them in a series of experiments made in order to determine under what laboratory conditions the line at λ 4481 in the magnesium spectrum assumes the sharp, narrow appearance it has in many stellar spectra.

The authors have arrived at the conclusion that the quantity and the electromotive force of the electricity which acts during the spark discharge between magnesium poles, have only a small influence on the character of this line, but that the suddenness of the blow of the discharge determines its character.

In a plate which accompanies the article is shown a reproduction of the spark spectrum where the discharge of the secondary took place directly between the magnesium poles, the jar having been removed from the circuit; in this case the blow of the discharge is less sudden, through the incoming of the full self-induction of the coil itself, and the line assumes the sharp appearance seen in stellar spectra.

Other spectra which are reproduced show the difference in the appearance of this line under various conditions of spark discharge.

THE EMANATIONS OF RADIUM.[1]

A SOLUTION of almost pure radium nitrate which had been used for spectrographic work was evaporated to dryness in a dish, and the crystalline residue examined in a dark room. It was feebly luminous.

A screen of platinocyanide of barium brought near the residue glowed with a green light, the intensity varying with the distance separating them. The phosphorescence disappeared as soon as the screen was removed from the influence of the radium.

A screen of Sidot's hexagonal blende (zinc sulphide), said to be useful for detecting polonium radiations, was almost as luminous as the platinocyanide screen in presence of radium, but there was more residual phosphorescence, lasting from a few minutes to half an hour or more according to the strength and duration of the initial excitement.

The persistence of radio-activity on glass vessels which

1 By Sir William Crookes, F.R.S. Read at the Royal Society on March 19.

have contained radium is remarkable. Filters, beakers, and dishes used in the laboratory for operations with radium, after having been washed in the usual way, remain radio-active; a piece of blende screen held inside the beaker or other vessel immediately glowing with the presence of radium.

The blende screen itself is sensitive to mechanical shocks. A tap with the tip of a penknife will produce a sudden spark of light, and a scratch with the blade will show itself as an evanescent luminous line.

A diamond crystal brought near the radium nitrate glowed with a pale bluish-green light, as it would in a "Radiant Matter" tube under the influence of kathodic bombardment. On removing the diamond from the radium it ceased to glow, but when laid on the sensitive screen, it produced phosphorescence beneath which lasted some minutes.

During these manipulations the diamond accidentally touched the radium nitrate in the dish, and thus a few imperceptible grains of the radium salt got on to the zinc sulphide screen. The surface was immediately dotted about with brilliant specks of green light, some being a millimetre or more across, although the inducing particles were too small to be detected on the white screen when examined by daylight.

In a dark room, under a microscope with a ⅔-inch objective, each luminous spot is seen to have a dull centre surrounded by a luminous halo extending for some distance around. The dark centre itself appears to shoot out light at intervals in different directions. Outside the halo, the dark surface of the screen scintillates with sparks of light. No two flashes succeed one another on the same spot, but are scattered over the surface, coming and going instantaneously, no movement of translation being seen.

The scintillations are somewhat better seen with a pocket lens magnifying about 20 diameters. They are less visible on the barium platinocyanide than on the zinc sulphide screen.

A powerful electromagnet has no apparent effect on the scintillations, which appear quite unaffected when the current is made or broken, the screen being close to the poles and arranged axially or equatorially.

A solid piece of radium nitrate is slowly brought near the screen. The general phosphorescence of the screen as visible to the naked eye varies according to the distance of the radium from it. On now examining the surface with the pocket lens, the radium being far off and the screen faintly luminous, the scintillating spots are sparsely scattered over the surface. On bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow each other so quickly that the surface looks like a turbulent luminous sea. When the scintillating points are few there is no residual phosphorescence to be seen, and the sparks succeeding each other appear like stars on a black sky. When, however, the bombardment exceeds a certain intensity, the residual phosphorescent glow spreads over the screen, without, however, interfering with the scintillations.

If the end of a platinum wire which has been dipped in a solution of radium nitrate and dried is brought near the screen, the scintillations become very numerous and energetic, and cease immediately the wire is removed. If, however, the end of the wire touches the screen, a luminous spot is produced which then becomes a centre of activity, and the screen remains alive with scintillations in the neighbourhood of the spot for many weeks afterwards.

"Polonium" basic nitrate produces a similar effect on the screen, but the scintillations are not so numerous.

Microscopic glass, very thin aluminum foil, and thin mica do not stop the general luminosity of the screen from the X-rays, but arrest the scintillations.

I could detect no variation in the scintillations when a rapid blast of air was blown between the screen and the radium salt.

A beam of X-rays from an active tube was passed through a hole in a lead plate on to a blende screen. A luminous spot was produced on the screen, but I could detect no scintillations, only a smooth uniform phosphorescence. A piece of radium salt brought near gave the scintillations as usual, superposed on the fainter phosphorescence caused by the X-rays, and they were not interfered with in any degree by the presence of X-rays falling on the same spot.

During these experiments the fingers soon become soiled with radium, and produce phosphorescence when brought near the screen. On turning the lens to the, apparently, uniformly lighted edge of the screen close to the finger, the scintillations are seen to be closer and more numerous; what to the naked eye appears like a uniform "milky way," under the lens is a multitude of stellar points, flashing over the whole surface. A clean finger does not show any effect, but a touch with a soiled finger is sufficient to confer on it the property. Washing the fingers stops their action.

It was of interest to see if rarefying the air would have any effect on the scintillations. A blende screen was fixed near a flat glass window in a vacuum tube, and a piece of radium salt was attached to an iron rocker, so that the movement of an outside magnet would either bring the radium opposite the screen or draw it away altogether. A microscope gave a good image of the surface of the screen, and in a dark room the scintillations were well seen. No particular difference was observed in a high vacuum; indeed, if anything the sparks appeared a trifle brighter and sharper in air than in vacuo. A duplicate apparatus in air was put close to the one in the vacuum tube, so that the eye could pass rapidly from one to the other, and it was so adjusted that the scintillations were about equal when each was in air. The vacuum apparatus was now exhausted to a very high point, and the appearance on each screen was noticed. Here again I thought the sparks in the vacuum were not quite so bright as in air, and on breaking the capillary tube of the pump, and observing as the air entered, the same impression was left on my mind; but the differences, if any, are very minute, and are scarcely greater than might arise from errors of observation.

It is difficult to form an estimate of the number of flashes of light per second. But with the radium at about 5 cm. off the screen they are barely detectable, not being more than one or two per second. As the distance of the radium diminishes the flashes become more frequent, until at 1 or 2 cm. they are too numerous to count.

[*Added March* 18.—On bringing alternately a Sidot's blende screen and one of barium platinocyanide, face downwards, near a dish of "polonium" sub-nitrate, each became luminous, the blende screen being very little brighter of the two. On testing the two screens over a crucible containing dry radium nitrate, both glowed; in this case the blende screen being much the brighter. Examined with a lens, the light of the blende screen was seen to consist of a mass of scintillations, while that of the platinocyanide screen was a uniform glow, on which the scintillations were much less apparent.

The screens were now turned face upwards so that emanations from the active bodies would have to pass through the thickness of card before reaching the sensitive surface. Placed over the "polonium" neither screen showed any light. Over the radium the platinocyanide screen showed a very luminous disc, corresponding with the opening of the crucible, but the blende disc remained quite dark.

It therefore appears that practically the whole of the luminosity on the blende screen, whether due to radium or "polonium," is occasioned by emanations which will not penetrate card. These are the emanations which cause the scintillations, and the reason why they are distinct on the blende and feeble on the platinocyanide screen is that with the latter the sparks are seen on a luminous ground of general phosphorescence which renders the eye less able to see the scintillations.

Considering how coarse-grained the structure of matter must be to particles forming the emanations from radium, I cannot imagine that their relative penetrative powers depend on difference of size. I attribute the arrest of the scintillating particles to their electrical character, and to the ready way in which they are attracted by the coarser atoms or molecules of matter. I have shown that radium emanations cohere to almost everything with which they come into contact. Bismuth,[1] lead, platinum, thorium uranium, elements of high atomic weight and density, possess this attraction in a high degree, and only lose the emanations very slowly, giving rise to what is known as "induced radio-activity." The emanations so absorbed from radium by bismuth, platinum, and probably other

[1] I have been quite unable to detect any lines but those of bismuth (and of known impurities) in the spectrum of the strongest and most active "polonium" salt I have been able to procure.

bodies, retain the property of producing scintillations on a blende screen, and are non-penetrating].

It seems probable that in these phenomena we are actually witnessing the bombardment of the screen by the electrons[1] hurled off by radium with a velocity of the order of that of light; each scintillation rendering visible the impact of an electron on the screen. Although, at present, I have not been able to form even a rough approximation to the number of electrons hitting the screen in a given time, it is evident that this is not of an order of magnitude inconceivably great. Each electron is rendered apparent only by the enormous extent of lateral disturbance produced by its impact on the sensitive surface, just as individual drops of rain falling on a still pool are not seen as such, but by reason of the splash they make on impact, and the ripples and waves they produce in ever-widening circles.

THE PSYCHOLOGY AND NATURAL DEVELOPMENT OF GEOMETRY.

IN connection with recent endeavours to place the teaching of geometry on the best possible basis, much interest attaches to Dr. Mach's attempt to trace the order in which geometrical facts first made themselves known in the natural order of evolution.

The earliest notions of space must have been suggested by the relations of physical bodies to the parts of the human body, the spacial behaviour of bodies towards one another subsequently acquiring a mediate and indirect interest far transcending that of the momentary sensations. While the senses of sight and touch only give rise to sensations of surface, crude physical experience soon impels us to conceive the notion of volume, and the *constancy of volume* of bodies would be one of the first attributes to manifest themselves to our senses. Geometry, although asserted to be concerned with ideal objects only, arose from the consideration of the space relations of physical bodies. The earliest units of measurement were derived from our hands and feet. But the material properties of bodies rather than their spacial properties possess the greatest interest for us, and Dr. Mach considers that the first ideas of measurement were those of volume, and arose from counting the number of equal identical immediately adjacent bodies which would fill a given space. The notion of *areas* would be derived from the number of food-bearing plants which a given field would contain or the labour required in planting them, *distance* would be estimated by hours of travel. The measurement of lines and areas by means of *solids* is a notion now completely estranged from our geometrical ideas, but in early times we should have measured lengths and areas by the number of solid bodies placed in line or distributed over a surface required to cover them, an idea which is borne out by the remarkably elegant methods of mensuration expounded in the seventeenth century by Cavalieri.

Although movable bodies present different spacial sensations to the visual sense dependent on the position and distance of the observer, the notion of spacial constancy becomes associated with them both by the sense of touch and by combined experience.

The earliest conceptions of *purely spacial* properties naturally asserted themselves in the pursuit of trades and arts. The property that a number of equal and similar triangles of any shape can be fitted together in regular order to form a pavement or mosaic naturally leads to the property that the three angles of a triangle are together equal to a straight angle. A consideration of the way in which the triangles run in rows would lead to the notion of parallels, and the property that the adjacent angles made by the parallel lines with any transversal are together equal to two right angles. The theorem of the Pythagoreans, according to which superficial space can only be partitioned into regular polygons in three ways, namely, into equilateral triangles, squares, or hexagons, naturally finds its origin in the same source.

A stretched string furnishes the simplest visualisation of a straight line, and leads to the property that a straight line is the shortest distance between two points, but Dr. Mach reminds us that this property cannot be regarded as being established by mere visualisation. It is true that we have learnt instinctively to reproduce in our imagination some method of demonstrating that, for example, two sides of a triangle are greater than the third side, but the source of our knowledge here is *physical experience* derived from our knowledge of material bodies. Another property of straight lines, namely, that a straight line is self-congruent if made to slide or rotate upon itself, is also a result of experience with straight and bent wires.

The knowledge that the measures of geometry depend on one another was reached in divers ways. The division of a parallelogrammatic field into smaller fields gave rise to the area being measured by the product of the length and breadth, and the knowledge that the area of a rectangle is greater than that of a parallelogram having the same sides gave rise to the idea that the area also depended on the angles.

In regard to *angles*, Dr. Mach points out that the definition of an angle as the difference between two directions is a *physiological* definition, the notion of direction being a purely physiological conception. In *abstract space*, obtained by metrical experiences with physical objects, differences of direction do not exist. An angle is determined when the distance is assigned between two points on its arm at given distances from the vertex, but, as Dr. Mach points out, this measure, though closely resembling those adopted in trigonometry, was not used in geometry, because angles so measured would not possess *additive* properties. The simpler measure of an angle by the arc or area which it intercepts on a circle surrounding the vertex thus became generally adopted. In connection with Dr. Mach's views on this point, it may be maintained that even with our present experience of geometry an angle instinctively suggests the idea of *space*, extending, no doubt, indefinitely from the vertex, but possessing the remarkable property of being a definite fraction of the whole space surrounding that point.

The object of geometry is to answer questions that occur repeatedly in the same form, and with this object has arisen the study of deductive geometry, which takes theorems and proves them once for all. But it will be seen that Dr. Mach strongly emphasises the *physical* and *material origin* of geometry, and his studies will naturally support the view that geometry is likely to be best understood when taught in its early stages from the experimental side.

THE EUCALYPTS.[1]

THE economic importance of the genus Eucalyptus to our Australian Colonies accounts, no doubt, for the somewhat extensive official literature which has grown up there on this subject. This includes numerous publications by the Government botanists and forest officials of the Australian colonies, and especially the classic "Eucalyptographia," now, unfortunately, no longer obtainable, of the late Baron von Mueller, whose enthusiasm for the genus is mainly responsible for the large Eucalyptus plantations now existing in Italy, France, Algeria, California and other countries.

Messrs. Baker and Smith, in their contribution to Eucalyptus literature, give an account of the results they have secured in the course of a systematic study of the Eucalypts, both from the botanical and chemical points of view, and they conclude from the data so obtained that the trees belonging to this genus may be divided into a series of natural groups, in which there is a striking correlation between the structure of the leaves, and to a certain extent, also, of the barks, and the composition of the essential oils produced by the species; thus, in *Eucalyptus tesselaris*, which the authors regard as the primitive type, the leaves have a characteristic parallel lateral venation and furnish

[1] Radiant matter, satellites, corpuscles, nuclei; whatever they are, they act like material masses.

[2] Abstract of a paper by Dr. E. Mach in the *Monist*. Translated by T. J. McCormack.

[1] "A Research on the Eucalypts especially in regard to their Essential Oils." By R. T. Baker, F.L.S., and H. G. Smith, F.C.S. Pp. 295; with 9 plates. (Technological Museum: New South Wales.)

"Eucalypts Cultivated in the United States." By A. J. McClatchie, M.A. Pp. 101; with 91 plates. (Department of Agriculture, U.S.A.)