With Mr. Landor's illustrations, two of which accompany this notice, we have no fault to find. The photographs are excellent, and his own drawings are powerfully descriptive of the impressions which remained in his mind after his adventures were over. The Kumaon hill track where he climbs round the face of the cliff is indeed a perilous path; but anything is possible in a region where the habitations of the natives can cling to the face of a wall in apparent defiance of all laws of gravity, as they do in the illustration which faces p. 159 of vol. ii. But with Mr. Landor's system of spelling we cannot agree. It is *not* the "geographical" system, and it is at first a little difficult to recognise well-known Hindustani words in the guise in which Mr. Landor clothes them. The words "Acha giao" (achcha jao) would not in the mouth of a Pahari gypsy mean "Go well" so much as "All right, clear out."

And there is one other subject which we think requires further investigation. The habits and manners of Tibetans have often been described, sometimes by themselves, sometimes by scientific observers. But Tibetans have never so far been classed amongst cannibals. The revolting details which Mr. Landor gives of the practices of the Lamas in connection with the last rites of a dead Tibetan are too horrible to be admitted without question. It should be remembered that Mr. Landor deals with a section of the Tibetan community which is directly connected with the great religious centres at Lhassa. It happens that it is about these centres that we possess the fullest information. No Lama in the neighbourhood of Darjiling would admit for an instant that such practices were common; nor will the reports of educated native travellers to Lhassa support the accusation. Mr. Landor carries his search for sensation just a little too far when he accepts in all good faith accusations such as this without an appeal to the best authorities.

With reference to the appendix to Mr. Landor's book, and the report of Mr. Larkin, the Deputy Commissioner of Almorah, the following extract from the *Pioneer Mail* of October 14 will be interesting.

"We have the best authority for stating, as we did the other day, that Mr. Landor was told that this report was confidential, that no copy was given him, and that he was not authorised to publish any Government report." The certified copies of depositions made in Mr. Larkin's Court should not be mistaken for Mr. Larkin's report.

T. H. H.

BODE'S LAW AND WITT'S PLANET DQ.

IN comparing the distances of the planets from the sun, it was early thought that there might be some law which would connect these distances together and allow us to calculate them correctly or even approximately. Kepler, as long ago as the beginning of the seventeenth century, thought that he had discovered such a law; but as he could not account for the anomalous space between the orbits of Jupiter and Mars, he abandoned the idea "of reconciling the *actual* state of the planetary system with any theory he could form respecting it, and hazarded the assertion that a planet really existed between the orbits of Mars and Jupiter, and that its smallness alone prevented it from being visible to astronomers." In the year 1772 Prof. Bode announced a law which gave a curious approximate relation between these distances, although it seems certain that Titius of Wittenberg discovered and formulated it some years previously, pointing out "the existence of a remarkable symmetry in the disposition of the bodies constituting the solar system." This law was very simple, and amounted to this: If to each of the planets, beginning with the one nearest the sun, the number 4 be given, and to the second, third, fourth, &c., the numbers 3, 6, 12, &c., respectively, be added, then the resulting numbers, divided by ten, approximately give the values for the mean distances of each planet from the sun in terms of the radius of the earth's orbit.

The first six numbers calculated by this law gave with fair accuracy the relative distances of the planets; but there was one exception, namely the number 2·8, which represented the distance of a planet when there was no body known: this exception was the same that puzzled Kepler in the formation of his law. Prof. Bode supposed, however, a hypothetical planet to fill up this gap, which probably was absent simply because it had not then been discovered. We may mention that at that time Uranus and Neptune had not been found, so that the discrepancy with regard to the latter planet, in which this law utterly breaks down, could not then have been noticed. As this one feature in the law could not otherwise be explained, namely the number which accounted for the distance of a planet between Mars and Jupiter, a planet which had never been observed, it was decided to make a thorough search and try to pick up this missing member. The discovery of Uranus in 1781, and its distance agreeing with the value as given by Bode's law, set many astronomers thinking, with the result that it was decided to make a systematic search in the heavens for this unknown planet. Although all those who undertook this search worked diligently to pick up this supposed body, it was left for Piazzi, the Sicilian astronomer at the observatory of the University of Palermo, to make the discovery of the first (Ceres) of those now numerous small bodies known as planetoids, asteroids, or minor planets, which make their journey round the sun between Mars and Jupiter.

Piazzi, it may be remarked, was at the time constructing a star catalogue, and discovered this small body in his usual course of work, thinking at first it was a new kind of comet.

This was the first of a series of discoveries which now followed one another, and, up to the beginning of this year, no less than 425 of these planetoids have been discovered. The question then was asked, Did Bode's law still hold good? Were these small bodies, which vary in size from 100 to 10 miles in diameter, remnants of one large planet which originally revolved between Jupiter and Mars at a distance approximately the same as that represented by Bode's number 2·8?

Taking the distance of the mean minor planet, namely 2·650, and comparing it with the computed value from Bode's law, namely 2·8, the agreement was found to be sufficiently satisfactory for such an approximate law. In the case of Saturn, the difference between the mean distance and that given by Bode's law is nearly three times that for the minor planet above mentioned, so that the law may be said to approximately hold good.

In the case of Neptune, which was discovered in 1846, the value of the mean distance, according to Bode's law, is far from the true one, so that the law in this case may be said to completely break down.

Quite recently another planet, not a member of the minor planet family, as far as we know, but one revolving by itself, in an orbit between Mars and the Earth, has been added to the members of the solar system. Does Bode's law account for this? Before answering this question, let us, first of all, confine our attention for a moment to the manner in which this body was discovered, and what we as yet know about it.

In the early days of minor planet discovery, the task of finding one of these heavenly wanderers was by no means a light one; for the watcher had not only to be provided with an excellent star map of the region of the sky he was studying at the time (he nearly always constructed one himself), but to make measurements of each of the bright points in his field of view, night after night, to see if he could detect any relative motion between them. Considering the number of stars in the region under investigation, and the improbability of there being a minor planet in that region at that time, it can be quite well understood that such discoveries were the result of an immense amount of labour. By the use of the photographic method, all these difficulties are at once swept on one side; for, since the presence of one of these bodies can only be detected by its own motion relative to the stars around it, the photographic plate can at once indicate this. Further, by using a fairly wide angle lens, a far greater portion of the sky can be examined at one time than was previously the case, and therefore the chance of finding these bodies is considerably increased.

We have only to expose a photographic plate in an equatorially mounted telescope driven by clockwork at sidereal rate, then all stars will appear as circular discs, and any minor planet, which, of course, has its own proper motion, will be represented by a small trail, the length of this depending on the duration of the exposure and the amount of movement of the minor planet during that interval.

plate searched for are by no means easily seen. The plates, further, must always be carefully washed for some hours, in order to get rid of all trace of the hyposulphate of soda. It is an exceedingly easy matter to quickly dry photographic plates; but most methods, even that of the use of alcohol, are inclined to create disturbances in the film, such as unequal contraction, which render it unfit for accurate measurements afterwards.

Herr Witt therefore waited until the following day before the negative was examined. Not only did he find on it the record of the long-lost minor planet he was seeking after, but another one, Althaea (119), which had been previously discovered. With the help of a lens a further trail was noticed, but on account of its unusual length, which was an indication of a quick moving body, he thought at first it must be a comet. To verify this conclusion, the following evening he turned the 12-inch refractor towards the same region, and found in that position a stellar- not cometary-like body of magnitude 10 to 11. Without any further delay the dis-

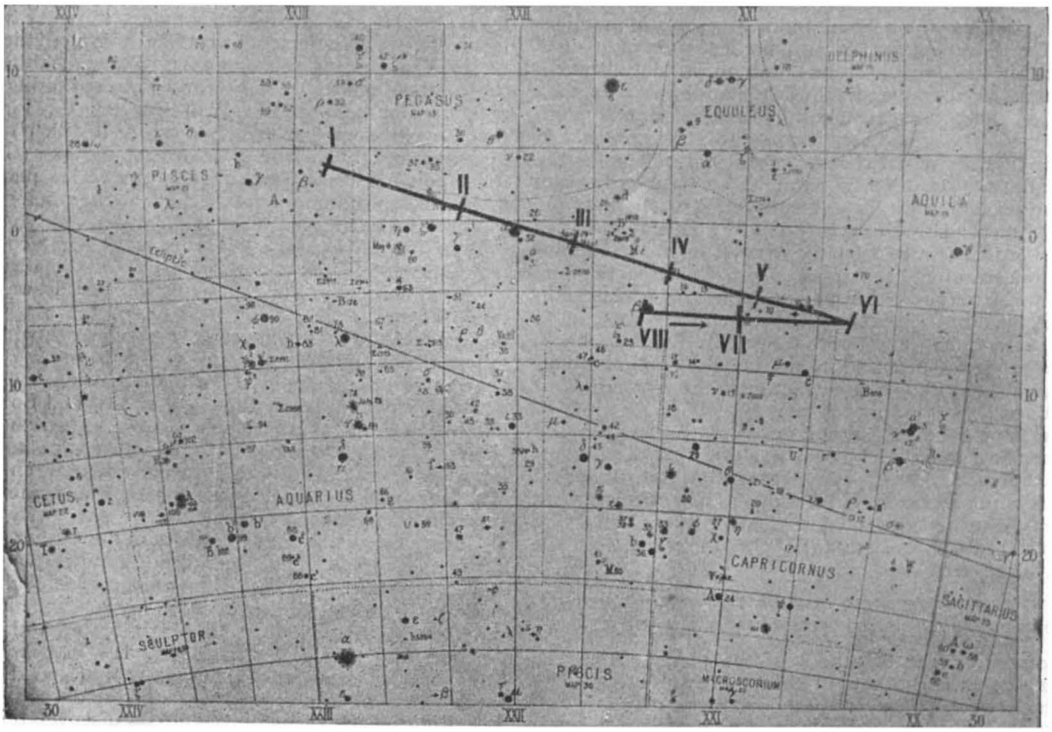

FIG. 1.—Showing path of new planet in sky between August 14 and December 31, 1898.

At the present day numbers of workers are exposing plates on clear nights to detect both new and old members of this family, and it was during such a search that Herr Witt, of the Urania Observatory in Berlin, made the important discovery of this new planet.

Since the year 1889 a certain minor planet named Eunike (185) has never been observed, and it was with the intention of photographing this object that Herr Witt turned his telescope, on the night of August 13, towards the region of β Aquarii, previous calculation having told him that the planet should be in or near that region. After a two hours' exposure the plate was developed and washed, and left to dry until the next day, when it was carefully examined. It may be asked, why the plate, after development, was not immediately examined? Any one who is familiar with such work will know that not only is the film very soft, and therefore easily liable to be damaged, but that the trails on the

covery was at once communicated to the "Centralstelle" for astronomical telegrams, and by this means the news was immediately sent to a great number of observatories.

Curiously enough, on the same evening (August 13) that Herr Witt was fortunate enough to photograph the trail of this planet, Herr Charlois, at the Nice Observatory, was photographing the same region (probably with the same intention as Herr Witt). He also secured a record of the presence of this new body. Prof. Perrottin, the director of the observatory, did not, however, make the discovery known until after Herr Witt's announcement; nevertheless, although the latter is entitled to declare himself the real discoverer, both names should be handed down to posterity, as is the case with the discovery of Neptune by Leverrier and Adams.

It was not long, however, before numerous accurate observations of this new body were made, and they extended over a period of days (seventeen in number) sufficient to allow that well-known indefatigable minor planet-orbit calculator, Herr H. Berberich, to compute its orbit. The accompanying chart (Fig. 1) shows the path of the planet in the sky from August 14 to December 31. The Roman figures in the chart from VIII to I correspond to the dates August 14, September 1, October 1, November 1, 15, December 1, 15, 31, of the present year.

Now comes the astonishing result of Herr Berberich's computation. The planet was not one of those small bodies which revolve round the sun between Mars and Jupiter, but was an entirely new body, its path lying for the main part within that of Mars.

Here are the elements of the planet's orbit as given by the calculations. It must be mentioned, however, that these elements cannot be considered as final, since more observations, extending over a much longer period, are required to ultimately establish the true elements. These elements, however, will not deviate very much from those given below.

Epoch 1898, *August* 31·5, *Berlin Mean Time.*

	°	′	″	
Mean anomaly	220	14	3·7	
Perihelion distance from ascending node ...	178	28	26·2	1898·0
Longitude of ascending node	303	48	53·0	1898·0
Inclination of orbit to that of the earth ...	11	6	57·1	1898·0
Eccentricity	13	13	3·8	

Mean daily movement, 2010″·131
Period of revolution round the sun, 645 days.

Taking the mean distance of the earth from the sun as unity, the new planet at perihelion approaches the sun to within 1·12 of these units, and when furthest away is distant 1·79 of these units. These values in the case of Mars are 1·38 and 1·67 respectively. We thus see that we can now no longer look upon Mars as our nearest neighbour (excepting, of course, our moon), for the mean distance of Mars from the sun amounts to 1·52, while that of the new planet is 1·46.

The accompanying diagram (Fig. 2) shows the relation of the new planet's orbit relative to that of Mars.

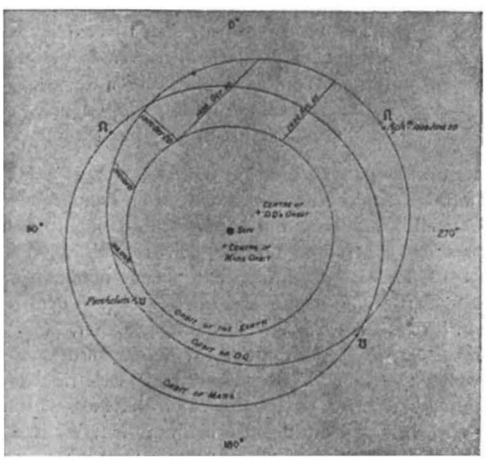

FIG. 2.—Comparison of orbits of Mars and the new planet D Q.

Assuming that Berberich's elements are correct, it is interesting to inquire into some of the relations which this orbit presents. Mr. Crommelin, to whom we are indebted for the above diagram, has considered such relations in his article in *The Observatory* (October, p. 372). A synodic period being two successive conjunctions with the sun as seen from the earth, this in the case of the new planet is 2·30692 years. We thus see that three synodic periods equal nearly seven years, so that after this period oppositions are repeated in nearly the same regions of the orbit. A closer approximation would be obtained if thirteen synodic periods, which extend over 29·99 years, were considered. As regards the time when the planet comes into opposition—a point of great importance, especially in the case of this planet—Mr. Crommelin tells us that, unfortunately, "an opposition under the most favourable circumstances took place in January 1894," and that we shall have to wait now until January 1924 until another equally favourable one occurs. In the years 1900 and 1917, only moderately favourable oppositions will occur, the planet in November of the former year then being of magnitude 8 or 9.

The close approach of this planet to the earth at times of favourable opposition will give us excellent opportunities of determining, more accurately than was possible before, the parallax of the sun—or, in other words, the distance of the sun from the earth.

The importance of a correct value of this quantity is very great, when it is considered that all measurements of distance in our solar system are based on it. Just as the foot is taken as a unit in measuring the side of a room, or a mile in measuring a strip of country, so astronomers adopt the mean distance of the earth from the sun as the unit in measuring the distance of Jupiter or Mars. A more accurate value of the standard of measurement for the solar system is, therefore, of the highest importance.

Since the new planet when nearest to and furthest from us will vary from the sixth to the twelfth magnitude, several useful photometric problems may be attacked. Thus, as Prof. Pickering suggests, the approximate diameter may be determined by comparing it with those of the brighter minor planets and satellites, on the assumption that the reflecting power is the same.

Again, the well-known law that light varies inversely as the square of the distance might be tested, as the planet's distance from the earth varies very considerably. At the same time, it could be determined whether there exists in the solar system any medium capable of absorbing light.

Let us now consider whether the law of Bode holds good for the presence of this new planet.

We give below a table showing a comparison between the true mean distances and those calculated by Bode's law.

Planet.	Distance.	Bode.	Diff.	Syn. period. Days.
Mercury	0·387	0·4	−0·013	116
Venus	0·723	0·7	+0·023	584
Earth	1·000	1·0	0·000	—
Witt DQ	1·461	?	—	644·7
Mars	1·523	1·6	−0·077	780
Mean asteroid	2·650	2·8	−0·150	Various
Jupiter	5·202	5·2	+0·002	399
Saturn	9·539	10·0	−0·461	378
Uranus	19·183	19·6	−0·417	370
Neptune	30·054	38·8	−8·746 !	367·5

In the above table the column headed "Bode" gives the distance according to the law of Bode, while the following column, that headed "Diff.," represents the difference between the true mean distance, as given in the second column, and that calculated after Bode's law.

A glance at this will show that the distance of the new planet does not fall into line at all, but, like Neptune, is an exception to the law.

Indeed, for the new planet, Bode's law does not even suggest a number, as there is no break between the distance accorded to our Earth and that of Mars. If we assume the law of Bode as mainly correct, then we must look upon the new planet as one of the minor planets gone somewhat astray.

There is, however, one outlet which believers in this law can take advantage of, namely, that perhaps the new body was originally part of the planet which, when broken up, gave rise to the group of minor planets. As opinion is still divided as to the true origin of asteroids, namely, whether they are the result of a large series of explosions of an original planet which revolved between Mars and Jupiter; whether they are the condensation of matter which originally was distributed in rings like Saturn, but which was disturbed by the action of Jupiter; or, lastly, whether they are the result of tidal action on the tenuous primitive masses, the presence of the new planet in this exceptional orbit might be accounted for on any of these hypotheses. Perhaps, for all we know, this planet may be one of several similar bodies which were so thrown off or perturbated from the original mass, that they were able to get into more favourable positions for being disturbed by the attraction of Mars when nearest them, and that their orbits were changed.

Mr. Rees, in a lecture before the New York Academy in 1897, suggested that "the very rapid augmentation in the number of minor planets indicates that there may be thousands or even millions in the zone: with more powerful telescopes and more sensitive plates we may hope to find many of these thousands. And perhaps the same agencies will discover asteroids between the orbits of all the planets." There is, however, no doubt that the orbits of some of the minor planets are not very dissimilar from those of Mars and Jupiter, and must be subjected at times to large disturbing forces by both these planets. That one, or even several, of these bodies may have been violently disturbed by Mars when in a very favourable position, and thus made to revolve in orbits more eccentric and inside that of Mars, does not seem at all improbable.

Jupiter also would be responsible for a great disturbing force, and it is as likely as not that beyond his orbit many of these small bodies pursue their paths; these, however, would probably be invisible to us on account of the greater distance. In fact, it seems more natural and in harmony with the solar system in general to consider this newly-discovered small planet as an unusually situated member of the minor planet group, than as a single condensed body which has from the beginning of its career been up till now an unseen major planet.

If future research on the movement of this new body should indicate the probability that we are dealing with a member of the minor planet group that has suffered considerable perturbations, then the law of Bode will, with the usual exception (Neptune), still afford us the simple approximate means of quickly calculating the distances of the members of the solar system.

WILLIAM J. S. LOCKYER.

NOTES.

WE regret to see the announcement of the death of Mr. Latimer Clark, F.R.S., the well-known electrician, at the age of seventy-six.

PROF. JAMES A. CRAIG, of the University of Michigan, spent his summer vacation in London at work in the British Museum, on the astrological-astronomical tablets of the Kujundjik (Nineveh) collection known as the Illumination of Bêl. This is the most important series of unedited texts in the British Museum, and by far the most important in many respects to be found in any of the collections extant. Prof. Craig has worked upon it during the last three summer vacations, and has now completed all the texts of the series, which number about 130 tablets. His manuscript is already in the press with Die Hinrichssche Buchandlung, Leipzig, and will appear shortly in the "Assyriologische Bibliothek," in which the author has already published two volumes.

THE Paris correspondent of the *Chemist and Druggist* states that Dr. Calmette, Directeur of the Pasteur Institute at Lille, has endowed that body with a sum of 250,000 francs (10,000*l.*), representing the profits realised by the distilleries at Seclin by one of his inventions.

Natural Science, the impending decease of which was announced in the October number, has received a new lease of life. An editor has been found willing to take upon himself the burden of responsibility, so the journal will appear as heretofore during 1899, and, it is hoped, for many years to come.

THE Committee on endowment of the Franklin Institute, Philadelphia, is making an appeal for subscriptions to the endowment fund. It is of the utmost importance for the future prosperity and progress of the Institute, that a substantial addition to its annual revenues be acquired, not only to provide income sufficient to carry on its present work, but also to enable it to extend this in other directions.

PROF. ISRAEL C. RUSSELL, of the department of geology of the University of Michigan, has recently conducted a geological survey for the United States Government over the northern portion of the Cascade Mountains. The greater part of the work was in Washington State, and extended from the Northern Pacific railroad to the Canadian boundary, crossing the mountains several times. Among the places of interest visited was Glacial Peak, the height of which was verified.

AT the close of the last, and the beginning of the present week, the weather over these islands was of a very unsettled character. On Saturday, October 29, a cyclonic disturbance appeared off the south of Ireland, and subsequently passed to the Shetlands, causing gales, especially over the western and northern parts of the country, and rough weather in the Channel and Bay of Biscay, with very heavy rainfall generally, amounting in forty-eight hours to 1·26 inches at Greenwich and 2·48 inches at Pembroke, while thunder and lightning were observed at several places. At Camberwell Green (south-east London) a terrific squall, resembling a small tornado in its character, occurred at about 9h. 30m. on Saturday evening, overturning vehicles, uprooting trees, and causing much damage to buildings. The violence of the storm, the track of which was apparently from about E.S.E. to W.N.W., fortunately lasted only a few minutes, and was confined to a very small area, other places in the immediate locality experiencing nothing beyond strong wind accompanied by very heavy rainfall.

THE ordinary general meeting of the members of the Institution of Mechanical Engineers was held on October 26 and 27, Mr. Samuel W. Johnson, the president, being in the chair. The president announced that Sir W. H. White, Chief Constructor of the Royal Navy, had been nominated as his successor, Mr. T. Hurry Riches as a vice-president, and Sir William Arrol, M.P., Sir Benjamin Baker, Mr. Henry Chapman, Mr. W. J. Pirrie, and Sir T. Richardson, M.P., as members of the Council. In a paper on "Electric installations for lighting and power on the Midland Railway, with notes on power absorbed by shafting and belting," Mr. W. E. Langdon showed that an extensive loss of power takes place in shafting and belting, but this may be reduced by driving each tool or machine direct from an electric motor. With large tools or machines absorbing over one horse-power, there seems to be no question of the advantage derived from driving them direct by electricity. Mr. W. M. Smith described some recent practical experience with express locomotive engines. The train resistance was found to be considerably increased by side winds. On one trip it was found that the side wind increased the mean train resistance by about 3·558 lbs. per ton of load. The