OUR ASTRONOMICAL COLUMN.

A COMET ON THE ECLIPSE PHOTOGRAPHS OF 1893.—A year ago Prof. Schaeberle announced that the eclipse photographs taken by him at Chile in April 1893, showed a comet-like structure in the corona near the sun's south pole. The photographs taken by the British observers in Brazil and Africa were examined in order to see if they showed the cometary object, but nothing could then be made out. It is well known, however, that faint objects can be easily found when the observer knows what can be seen, and where to look for it. Prof. Schaeberle and Prof. Holden were confident that a comet was photographed upon the corona of the 1893 eclipse, and, with the idea of obtaining confirmation of the discovery, the latter sent Mr. W. H. Wesley copies from negatives obtained at Chile and Brazil, having marks upon them showing the exact position of the object in question. These guides have fulfilled their purpose, for Mr. Wesley says, in the *Observatory*, that they clearly point out a cometary structure in the corona. The object is extremely faint, and, unless particular attention is drawn to it, appears like a forked coronal ray. Evidently the only way to prove that the object was really a comet was to measure its angular distance from the moon's limb on the photographs taken at the different eclipse stations. Mr. Wesley has done this, and he finds that the distances are: Chile, 29′; Brazil, 36′; Africa, ± 47′. Therefore, it is concluded "the evidence of motion relatively to the sun, given by the comparison of the plates taken at the three stations, seems to place the nature of Prof. Schaeberle's interesting discovery beyond a doubt."

THE TRANSIT OF MERCURY.—The transit of Mercury across the sun on Saturday, November 10, is a matter of more interest to American than to European astronomers. The planet will enter upon the sun's disc at 98° from the North point, counting towards the East, and will leave at a point 50° from the North, counting towards the West. It will reach the sun's limb at five minutes to four in the afternoon; but as the sun sets at Greenwich about twenty minutes later, there will not be much opportunity for observation in London. In America, however, if the weather is favourable, the planet will be observed during the whole of the five hours it will take in transiting. The following are the Greenwich Mean Times of the phases of the transit:—

		h.	m.	s.
Ingress, exterior contact	Nov. 10	3	55	31·2
Ingress, interior contact	,,	3	57	15·4
Least distances of centres (4′ 26″·8) ...	,,	6	33	48·5
Egress, interior contact	,,	9	10	26·4
Egress, exterior contact	,,	9	12	10·4

MIRA CETI.—Mr. Fowler writes from South Kensington to draw attention to the fact that this remarkable variable will be suitably placed for observations during its progress to the next maximum. According to the *Companion to the Observatory*, the date of minimum was September 24, and the maximum may be expected about February next. It will be of great interest to obtain a spectroscopic record during the rise to maximum, with special reference to the time of appearance of the bright lines of hydrogen, which have been seen near the time of maximum.

Mr. Fowler observed the spectrum on October 24, with the three-foot reflector, and it did not then differ from the spectrum of such a star as α Herculis, in which the hydrogen lines are not known to appear bright. The bright part of the spectrum which is coincident with the carbon band near λ 5165 was relatively less bright, however, than when it was observed near the last maximum.

RETURN OF ENCKE'S COMET.—It is reported that Encke's comet was observed at Rome by Prof. Cerulli, near the predicted place, on November 1. According to a search ephemeris given in the *Astronomische Nachrichten*, No. 3260, for Berlin midnight, the comet's place for November 8 is R.A. 22h. 59m. 30s. Decl. + 12° 32′ 18″. The comet passes perihelion next February.

TWO VARIABLE STARS.—In a *Wolsingham Observatory Circular*, No. 40, dated October 30, the Rev. T. E. Espin says: "The variability of two red stars, R.A. 0h. 49·0m. Decl. + 58° 1′ and R.A. 1h. 49·8m. Decl. + 58° 46′ has been definitely ascertained."

OBSERVATIONS OF MARS.

A LARGE proportion of the October number of *Astronomy and Astro-Physics* is devoted to articles on Mars, illustrated by several coloured plates. Schiaparelli's map of Mars forms the frontispiece; Prof. Schaeberle contributes nine drawings of the planet; and there are three plates containing drawings made at the Lowell Observatory, Flagstaff, Arizona, by Mr. Percival Lowell, Prof. W. H. Pickering, and Mr. A. E. Douglass. The following statement, from an article by Prof. Pickering, is a chronological summary of the more important facts and discoveries relating to Mars. It is chiefly compiled from Flammarion's monograph on Mars, and should be of special interest at the present time:—

272 B.C. The first known observation of Mars is recorded in Ptolemy's Almagest.

1610. The phases of Mars were discovered by Galileo.

1659. The first sketch showing surface detail was made by Huyghens. He also suggested a rotation in 24 hours.

1666. Cassini determined the rotation of Mars to take place in 24 hours 40 minutes. He also observed the polar caps, and "he distinguished on the disc of Mars, near the terminator, a white spot advancing into the dark portion, and representing without doubt, like those of the moon, a roughness or irregularity of the surface." This latter statement is curious, but the effect was undoubtedly due to irradiation, since his telescope was entirely inadequate to enable him to observe such a delicate phenomenon.

1777. With the exception of Huyghens, Hooke, and possibly Maraldi, no one succeeded in making recognisable sketches of the surface detail upon Mars for over a century, until Sir William Herschel took the matter up in this year.

1783. Sir William Herschel detected the variation of the size of the polar snow caps with the seasons, measured the polar compression, and determined the inclination of the axis of the planet to its orbit.

1785–1802. Schrœter made an extended study of the planet. His drawings are upon the whole rather better than those of Herschel. He discovered among other things the very dark spots to which Prof. Pickering has referred in his publications as the Northern and Equatorial Seas. He, however, supposed them to be clouds.

1840. Beer and Maedler published the first map of the planet, assigning latitudes and longitudes to the various markings. On this map are indicated the first canals, and the first of the small lakes, so many of which have been discovered during the last few years. The canals are Nectar and Agathodaemon and portions of Hades and Tartarus. The lake is Lacus Phoenicis. Their map is the first satisfactory representation of the entire surface of the planet. The only region which previous observers had clearly distinguished was that in the vicinity of the Syrtis Major.

1858. Secchi made a careful study of the colours exhibited by the planet.

1862. Lockyer made the first series of really good sketches of the planet, showing all the characteristic forms with which we are now so familiar. His drawings, and also those of some of the other observers, give the first indications of the appearance of the central branch in the Y, so called by Secchi.

1864. Dawes detected eight or ten of the canals.

1867. Huggins detected lines due to the presence of water vapour in the spectrum of Mars.

1867. Proctor determined the period of rotation of Mars within 0·1 second.

1877. Hall discovered the two satellites of Mars.

1877. Green made a very excellent series of drawings of the planet, superior to anything which had preceded them.

1877. Schiaparelli made the first extensive triangulation of the surface of the planet, and added very largely to the number of known canals.

1879. Schiaparelli detected the gemination of Nilus, the first known double canal.

1882. Schiaparelli discovered numerous double canals, and announced that the appearance formed one of the characteristic phenomena of the planet.

Mr. Percival Lowell reports the observations of Mars made at the Lowell Observatory, in continuation of those recorded in our issue of September 13. The subjoined abstract of the paper raises some interesting points. The suitability of the site of the observatory may be judged from the fact that the planet has been observed at Flagstaff every night, with but few exceptions, since the beginning of June. British astronomers would like to be blessed with similar favourable opportunities.

A noteworthy feature of Mr. Lowell's previous paper was the large area occupied by the dark regions on Mars, while those singular, tilted peninsulas that are so generally represented connecting the continents with the islands to the south were conspicuous by their absence. At that time one continuous belt of bluish-green stretched unbroken from the Hour-glass Sea to the columns of Hercules, or rather to where this pass should have been, for it was not visible. Now (September 10) the continuity is cut. Hesperia has reappeared, and it has done this in just the way we should expect it to show were it land drying off by a sinking of the general water level. Simultaneously, the region formerly occupied by the polar sea and the region to the north of it from having been blue, has now become for the most part reddish yellow. This reappearance of Hesperia and change of colour of the regions farther south is not due to increasing distinctness of vision consequent upon the nearer approach of the two planets. Had Hesperia been then of anything like the brightness it is now it could not have been invisible. Furthermore, Eridania is at present one of the brightest parts of the disc, not only as it comes round into view, but in mid-career across. Last, and not least in significance, the polar sea has shrunk to a thin line in keeping with the diminished size of the polar cap itself. All this water has gone somewhere.

What may be the condition of these seemingly amphibious lands, whether they be marsh chiefly water at one time and dry land at another; or whether their dark colour be due to vegetation which sprouted under the action of the water, and then died when it withdrew, is a moot point. Mr. Lowell's opinion is that it is half and half; that the transference of the water is chiefly a surface one, and that the layer of water is almost everywhere so shallow as to be soon drained off. His reasons for believing the aqueous circulation to be a surface one are many. In the first place, with the exception of certain peculiar appearances near the south pole, there is no evidence of anything like clouds or mist observable upon the planet, nor has there been since the observations began. On the contrary, all parts of the surface seem to be revealed unveiled. For an aerial circulation the only supposition at all feasible is thought to be that of a heavy, nightly dew, advanced by Prof. Pickering. There are strong reasons in the probable constitution of the Martian atmosphere for believing this possible. But in view of certain facts connected with the canals, and referred to later, the dew theory seems to be improbable.

As to how much of the dark areas are water, and how much vegetation, there is as yet no evidence to decide. Prof. Pickering has made some ingenious polariscopic observations to this end, but the difficulties inherent in the process are such as to preclude definite answer as yet. At first the polar sea seemed to show evidence of polarisation, confirming what we knew before of its watery character. Later the lakes, polar sea, and dark areas alike revealed no trace of it. Inasmuch, then, as there is every reason to suspect the polar sea, at least, to be water, we are left in doubt as to the adequacy of the instrumental means to detect at present such minute phenomena.

Since Mr. Lowell's last paper, irregularities have been detected at Flagstaff in the Martian terminator. These fall for the most part under two heads, of which one is practically new. It consists of certain polygonal flattenings first observed on June 30 by Mr. Douglass. Since then these irregularities have become so conspicuous that it is now difficult not to see one of them in the course of an hour's observation. Sometimes they show as simple slices shaved off the terminator, a paring of the planet's surface; sometimes they appear bordered by enclosing projections. They range from twenty to forty degrees wide. But the suggestive thing about them is that they show almost invariably upon that part of the terminator where the darker of the dark regions is then passing out of sight.

At first sight it might seem as if the observed appearance were directly due to the darker areas lying at a lower level than the rest of the surface. But the connection is not so simply direct. For Mr. Lowell points out that were it due to a zone of low-level lying between zones of higher altitude, it could be observed only as a limb effect in this case still further diminished by the cosine of the phase angle, a quantity far too small to be observable.

Nor will variations in slope explain the phenomenon. For to have an area show as a depression on account of its slope, either the areas on both sides of it must be rising in altitude, or the area itself must be falling in height, and this state of affairs could not go on for ever unless the surface were an impossible spiral. So that the persistency of this flattening is thus unaccounted for.

Prof. Story has suggested that these dark areas have smooth surfaces such as water would have. In this case, remarks Mr. Lowell, the reflection from them, by which alone they would be perceptible, would diminish much more rapidly from the centre to the side than would be the case with regions having rough surfaces, such as deserts. It may be added that though a rough surface, properly constructed, might obliterate itself by its own shadows, this could not happen to either a desert or a forest or a grass-grown plain.

The second kind of irregularities are projections, or small notches, such as are visible upon the lunar terminator; only that the Martian ones are much less pronounced. They are probably due to mountains which seem to be of no great height. The first of these was observed by Mr. Douglass on June 30. An especially prominent one he noted on August 19. It consisted of a projection flanked by a long shadow cutting into the planet obliquely. He measured the shadow's length at 35″. Taking the obliquity into account, this seems to imply a range the length of whose projection would be about 2″. It is difficult to say how much of this is due to irradiation; especially as each observer differs. The best tests Mr. Lowell has been able to make give a probable average of about five-sevenths of a tenth of a second of arc with the power then applied, about 640. Calling the terminal projection of this range therefore ·13″, its height appears to be about 3700 feet. But the smallness of the quantity measured and the uncertainty of the factor of irradiation renders the result largely indefinite.

A consequence of the slope on the effect of these mountains is interesting. For an elevation need not appear as such. What would show as a projection on the nether side of the terminator would appear as a depression on the hither one.

Interesting plateaus were observed on two occasions by Prof. Pickering. One of these lies in Phætontis not far from the columns of Hercules, which thus seem to have been most appositely named. Both plateaus rise abruptly, are surprisingly level on top, and stand at about the same height, a height which from the reduced measurements does not probably exceed 2600 feet.

On Mars the second kind of irregularity is less common than the first, and the elevations indicated are apparently never what we should call high. We may therefore conclude that the Martian surface is, as compared with our terrestrial one, relatively flat.

Certain whitish patches have been observed on the planet, first by Prof. Pickering on August 16, and subsequently several times by both Prof. Pickering, Mr. Douglass, and Mr. Lowell. Prof. Pickering calls them clouds. To Mr. Lowell, appearances thus designated are of two kinds. The one, certain whitish, flocular patches not far from the pole, may possibly be cloud; for they present a peculiar aspect, not like snow, nor yet like *terra firma*. No motion, however, has been seen in them. The others are merely certain bright spots on the general surface of the planet. These are not whitish, but yellowish, and will probably do very well for the more arid, dried-up tops of the land. They likewise do not move, and, furthermore, show always the same appearance day after day as regularly as their regions come round. Many of them were equally conspicuous at previous oppositions, and have been chronicled by various observers. Their contours are neither shifty nor indistinct, but as sharp-cut as those of any other region.

Most suggestive of all Martian phenomena are the canals. Were they more generally observable, the world would have been spared much scepticism and more theory. They may, of course, not be artificial, but observations made at the Lowell Observatory indicate that they are. For it is one thing to see two or three canals, and quite another to have the planet's surface mapped with them upon a most elaborate system of triangulation.

In the first place, they were, at the season of writing, bluish-green, of the same colour as the seas into which the longer ones all eventually debouch. In the next place, they are almost without exception geodetically straight, supernaturally so, and this in spite of their leading in every possible direction. Then they are of apparently nearly uniform width throughout their length. What they are is another matter. Mr. Lowell thinks, however, that the mere aspect is enough to cause all theories about glaciation fissures or surface cracks to die an instant and natural death.

But it is their singular arrangement that is most suggestively impressive. They have every appearance of having been laid out on a definite and highly economic plan. They cut up the surface of the planet into a network of triangles instantly suggestive of design. What is more, at each of the junctions there is apparently a dark spot. This feature seems to be invariable, as, on closer approach, junction after junction turns out to have one. The larger of these appear on Schiaparelli's chart as lakes. But there would seem to be a small infinity of smaller ones. A short half-hundred of them were seen at Arequipa in 1892, and others have recently been detected at Flagstaff. For example, an important new canal, which runs from the western end of the sea of the Sirens to Ceraunius, and which in view of its point of departure Mr. Lowell is induced to call the Ulysses, passes through three of these small dark spots on the way, one at each junction. One of these was seen at Arequipa and elsewhere in 1892; the other two are new discoveries. The region of the Lake of the Sun is especially fertile in canals. In one of the drawings which accompanies the paper here summarised, thirty-one canals are to be seen, counting each line between junctions as a separate canal. Of these seventeen are among those in Schiaparelli's chart, while fourteen are not. Of the twelve lakes in the figure, five are not down on his chart. This is thought not, in general, to be the result of change, though changes there apparently have been after proper discount has been made for difference of observations and of drawing. First and foremost, the Golden Chersonese has vanished; the land of Ophir now forms the continental coast-line. Secondly, Icaria has entirely altered in contour, resembling now an open fan about the Phœnix lake for pivot. Phætontis has shrunk to one-third of its former width—as represented in Schiaparelli's chart. Eosphoros no longer enters Phœnix lake at the point opposite Pyriphlegethon, but farther to the west. But the strangest transformation of all is that of the Phasis, which has apparently obligingly become two (not geminated in the technical sense) to suit both the old and the new state of things. There is now a canal running in the same direction as the old Phasis, but not to the southern end of Phætontis; and there is another one running to the southern end of Phætontis, but not in the same direction as heretofore. This attempt to carry out two apparently important ends by self-multiplication is not a common characteristic of inanimate nature—a point which Mr. Lowell holds is worth consideration.

Mr. A. Stanley Williams contributes to the November *Observatory* an account of his observations of Mars up to October 20. With regard to the canals Mr. Williams says:—"By taking advantage of every favourable opportunity, fifty-one canals have been observed up to the present time [October 20]. These include most of those shown in Prof. Schiaparelli's latest map that could be properly observed at present, and in addition three others not marked in the map. Generally speaking there is no difficulty in certainly identifying the canals, with the exception of a few which are situated far north, and consequently are too close to the limb to be distinctly observed. The general accuracy of the map is very striking, and I have often been strongly impressed by the very thorough manner in which Prof. Schiaparelli's work has been done. It is most rare to come across the trace of a canal not marked in his map, and the positions of objects are usually very reliable."

In the October number of our contemporary, Mr. Williams stated that Phison was probably double. Later observations, however, have shown it to be only single, the apparent gemination being probably caused by the existence of a feeble, unrecorded canal running parallel to it, and about midway between it and the coast bordering the Kaiser Sea. Agathodæmon and Araxes were seen intensely double on three or four nights in September. Chrysorrhoas was also seen double, but this canal appeared as an inconspicuous object compared with Agathodæmon and Araxes. In September Mr. Williams saw Amenthes as a narrow inconspicuous and apparently single canal. At the beginning of October, however, the object appeared as a very broad, dusky, double canal. Ganges is another broad, conspicuous double canal, the duplicity of which, according to Mr. Williams, is so obvious as to be apparent on almost any night on which observations are possible.

Referring to the small dark spots designated lakes, Mr. Williams says:—"Several more of these curious dark spots have been seen. Lacus Phoenicis on a good night appears as a small, nearly round, almost black spot, resembling the shadow of a satellite of Jupiter when in transit. On one night a feebler companion spot was seen just preceding it. Lacus Tithonius is a similar definite and nearly black spot, with a feebler companion following it. In a fine drawing of Mars, dated September 5, Mr. Cammell shows Lacus Moeris as a minute dark spot, with Nepenthes as a narrow definite line, and so I have seen them on several nights lately. Lacus Tritonis is a similar spot. At the junction of the canals Amenthes (following component), Thoth, and Astapus, there is also a little dark spot. The dark spot at the north end of the Ganges, known as Lacus Lunæ, has been rather perplexing. On several nights there was an evident appearance of duplicity about it, though it was impossible to say with certainty in which direction it was double. At length, however, the mystery was cleared up, the lake having been seen distinctly double on September 29 at right angles to the direction of the Hydraotes. The streak or bridge dividing the lake into two was bright yellow."

The varying appearances presented during October by the Mare Cimmerium, and the extensive region lying to the north of it, leads Mr. Williams to think that a great development of cloud or mist has lately taken place on Mars. His observations suggest "that cloud and mist formations are much more extensive and common on Mars than is generally considered to be the case."

THE ELECTRIC CONDUCTIVITY OF PURE WATER.

THE difficulties besetting the preparation of water free from the last traces of dissolved impurity cannot be better illustrated than by the attempts which have been made to ascertain the electric conductivity of the pure liquid. At the outset it has to be remembered that the conductivity of water is exceedingly small. As the result of the most recent observations it has been found that one millimetre of water has at 0° almost the same resistance as 40,000,000 kilometres of copper of the same cross-section; consequently a copper wire having the same resistance and sectional area as one millimetre of water would be long enough to encircle the earth one thousand times. From the difficulty of preventing the introduction of small quantities of dissolved material into the water, and from the large diminution which such impurities exercise upon the resistance, there is probably no physical constant for which such widely varying values have been given as for the electric conductivity of water.

If the conductivity of mercury be taken as 10^{10}, prior to 1875, the following values had been ascribed to water by the observers named:—80, Pouillet; 70, Becquerel; 15, Oberbeck; 4·5, Rosetti; 2·16, Quincke; and 1·33, Magnus. In 1875, Kohlrausch succeeded in reducing the observed conductivity to 0·71, or a value only 1/120th of that given by Pouillet. The large diminution thus brought about was no doubt due, for the most part, to the improved methods employed in obtaining purer samples of water. In Kohlrausch's experiments pains were taken not only to remove organic matter and any volatile alkaline or acid impurities from the water, but also to ensure that in its subsequent treatment contact with glass was avoided, the purified water being distilled through a platinum condenser into a platinum resistance-cell. The next important modification in the treatment of the water was again introduced by Kohlrausch in 1884. The whole of the above measurements had been made upon water distilled under ordinary conditions, and thus in presence of air; he therefore proceeded to ascertain what alteration in conductivity took place when the water was rendered air-free. For this end he employed a glass apparatus resembling in construction the so-called "water-hammer." A glass bulb of some 150 c.c. capacity, which served as a retort, was connected by a glass tube with a small glass receiver fitted with platinum electrodes. In this receiver the resistance of the water was measured by the use of a galvanometer and a continuous current, as the latter was so feeble that no appreciable effect was produced by polarisation. The glass connecting-tube was provided with a vertical branch, through which water, or liquids to clean the apparatus, could be introduced. Having admitted a quantity of purified water into the bulb, the vertical tube was then connected with a mercury air-pump, the pump