

Variable Star T Cassiopeiæ.

FROM long-continued observations of the above star, irregularities in the ascending light curve may be expected about October or November next. I shall be happy to supply a diagram of the field to any one interested in the question.

CUTHBERT E. PEEK.

Rousdon Observatory, Lyme, September 5.

THE OPPOSITION OF MARS.

THE *Times* of Saturday contains a most important telegram, giving the results of Prof. Pickering's observations in Peru during the present opposition of Mars, which is one of the most favourable which has occurred during the last half of the present century. The work done at Arequipa in one respect contradicts, and in others goes far beyond, the results recently announced from the Lick Observatory. There can be no doubt that a considerable advance has been made by this year's results; many prior observations which have been considered doubtful have been confirmed, and an additional interest lent to the observation of the planet.

The time, therefore, seems opportune for considering several questions connected with Mars, and it will be convenient to begin with the conditions of this year's observations, especially since the least astronomical among us has certainly noted with surprise the bright red star which now nightly rises low down in the south-east. Nor will he or she be less inclined to regard it when it is recognized as the planet about which during the last month so much has been written of human rather than of astronomical interest. If everything that one sees in print be true, the inhabitants of Mars are signalling to us, and it only remains for us to choose our manner of reply. Of course from signals the imagination of the ready writer has passed at once to words, and having got so far, each planet is about to become acquainted with the history and present conditionings of the other by means of a language understood of our neighbours as well as ourselves.

But first as to the cause of its excessive brilliancy during the last month or so, for this doubtless has had something to do with the present general interest taken in the planet. Mars was as bright in 1877, but on that occasion nothing like the present amount of interest was taken in its movements and possible structure. For this there are two obvious causes—one the increasing interest taken by people in science generally; the other, popular glosses on several recent discoveries made regarding Mars itself.

The popular idea that the changes which have been recently observed on the planet are changes due to the work of its inhabitants—an idea based upon a mistranslation of a word—has, of course, generated the other one—namely, that vast operations have been undertaken for signalling purposes; and from this idea the step to Mr. Galton's or Mr. Haweis's method of signalling back is a small one. Small though it be, however, the public interest has thereby been greatly enhanced.

One of the most serious suggestions in modern times regarding signalling to bodies outside the earth we owe to a German astronomer, who some while ago enriched the world with the idea that the inhabitants of the Moon might possibly be communicated with by establishing on the vast plains of Siberia geometrical figures, such as circles, &c., built up of fire-signals, to which signal, if seen, the Lunarians would reply by reproducing them.

Then the popular mind was content to bridge the chasm of 240,000 miles which separates us from the moon. But now Mars is the objective—Mars, which at its nearest approach is 35,000,000 of miles removed!

But Mars when in opposition may be very much further away than that; so far, indeed, that it is then observed

to be 1-5th of its maximum brightness, and naturally with very reduced angular diameter. The two preceding oppositions at which its brightness has been at all comparable to its present one, took place in 1860 and 1877, so that we find the most favourable oppositions about sixteen years apart. The reason of this will easily be gathered from Fig. 1, which shows with sufficient accuracy the very elliptic orbit of Mars in relation to that of the earth. The lines joining the two orbits are those connecting the two planets during some oppositions from 1830 onwards to 1871. The outer planet, Mars, is represented nearly at the *perihelion* part of its orbit, that is the point at which it is nearest the sun (and therefore the earth, if we treat the earth's orbit as a circle), and the reason that the 1830 and 1862 observing conditions were so much better than those of 1869 and 1871 is at once clear. The opposition of 1877 and the present are not shown on the diagram, but they occurred at a time when Mars was not far from its perihelion.

The diagram also allows us to see that at the perihelion point of Mars' orbit the planet is very nearly at the

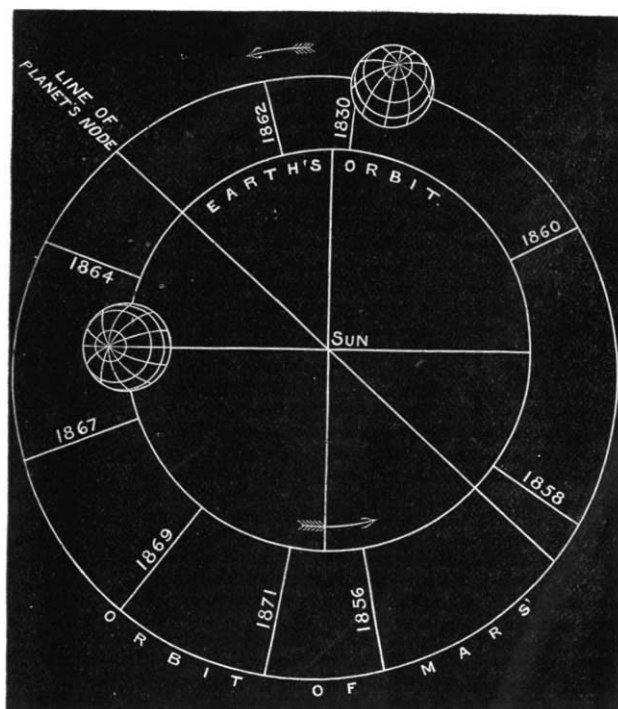


FIG. 1.—The orbits of the Earth and Mars.

time of the southern solstice, the N. pole being inclined away from the sun. Also that this must occur about four months before the southern solstice of the earth, the direction of the axis of which is also shown.

So that at an opposition which occurs in August, as the present one does, we observe what happens in the summer solstice of the northern, and winter solstice of the southern, hemisphere of the planet. In fact, generally we have:—

Time of opposition.	N. hemisphere.	S. hemisphere.
August ...	Winter ...	Summer
November ...	Spring ...	Autumn
February ...	Summer ...	Winter
May ...	Autumn ...	Spring

The perihelion point of a planet's orbit is astronomically expressed by its heliocentric longitude, and the apparent size of its disc (on which its apparent

brightness depends) by its semi-diameter in seconds of arc. Presuming that the longitude of the perihelion of Mars may be taken as about 334° , the following table will show how the great brilliancy of the planet in 1877 and the present year was caused: other less favourable oppositions are given for purposes of comparison:—

Date of opposition.	Semi-diameter.	Heliocentric longitude of planet.
1862, October 5	10.8	12
1869, February 13	8.2	145
1873, April 27	9.7	217
1877, September 5	14.7	343
1881, December 26	9.2	95
1884, January 31	8.3	132
1888, April 10	9.2	201
1892, August 13	14.7	312

So much, then, for the distance conditions. At its nearest approach the planet is 35,000,000 miles removed—let us say 150 times more distant than the moon.

We next come to the conditions of visibility. Mars is nearest to us (the degree of nearness depending upon its position in its orbit) when "in opposition," as we have said—that is, when it is in the south at midnight, and opposite the sun, the sun then being, of course, due north below the horizon. It will then appear to us "full," as the moon is said to be full when she occupies an analogous position. At this moment, then, the earth is invisible to the inhabitants of Mars unless she happens to transit the sun's disc.

The earth appears to Mars precisely as Venus does to us, and if inhabitants there be on Mars, and they study astronomy, a transit of earth to them will be what a transit of Venus is to us.

Further, as we see Venus as a half-moon, and when nearer to us as a fine large crescent, so the Martians, as the earth approaches them, will see her as a half-moon and then as a crescent, getting finer as the apparent diameter of the completed circle gets greater.

Mars, to see us best, must occupy a point near its perihelion. These things may be gathered from Fig. 2, in which an opposition at Mars' perihelion is shown, the orbits, but not the size of the bodies concerned, being to scale. Before the conjunction of the three bodies (in the line Mars, earth, sun) is approached, Mars will first have the earth as a half-moon at *a*; this will gradually melt into a crescent till the moment of conjunction. Afterwards the crescent will broaden, and its diameter will be reduced till the point *a'* is reached, when the earth will appear as a half-moon again.

It is clear, therefore, that the earth will be a morning and evening star to Mars at the time of their nearest approach. The earth's crescent must not be too fine, or no observation will be possible on a dark background of sky. In other words, although we can observe Mars best when he is nearest, the privilege of seeing the earth when nearest to Mars is denied to his inhabitants.

We are now, then, in a position to discuss, so far as the mere conditions of visibility are concerned, the two suggestions as to earth-signalling to which I have already referred.

Mr Galton's proposal depends upon the observation that a "reflected beam of sunlight sent through a hole in a plate in front of the mirror was just distinctly visible as a faint glint at a distance of ten miles when the hole was a square of one-tenth of an inch in the side." He then adds: "The amount of fog and haze that a beam of light would traverse between us and Mars when the planet was high above our horizon could not exceed that along a terrestrial base of ten miles; consequently the same proportion between the size of mirror and the distance would still hold true. It follows that the flash from many mirrors simultaneously, whose aggregate width was fifteen yards, and whose aggregate length (to allow for slope)

was, say, twenty-five yards, would be visible in Mars if seen through a telescope such as that at the Lick Observatory. With funds and good will, there seems no insuperable difficulty in flashing from a very much larger surface than the above, and sending signals that the inhabitants of Mars, if they have eyes, wits, and fairly good telescopes, would speculate on and wish to answer. One, two, three, might be slowly flashed over and over again from us to them, and possibly in some years, to allow time for speculation in Mars to bear practical fruit, one, two, three, might come back in response. Dr. Whewell, if I recollect right, wrote a paper on the possibility of coming to an understanding with lunar inhabitants, if there were any. He would begin from the mathematical side. The practical difficulty is by no means insuperable of enabling many independent observers (who need not be near together) to direct their flashes aright. If mirrors could be mounted without much cost as heliostats (and perhaps they can be) it would be easy enough to do this. My own method is not practicable, at least without considerable addition and

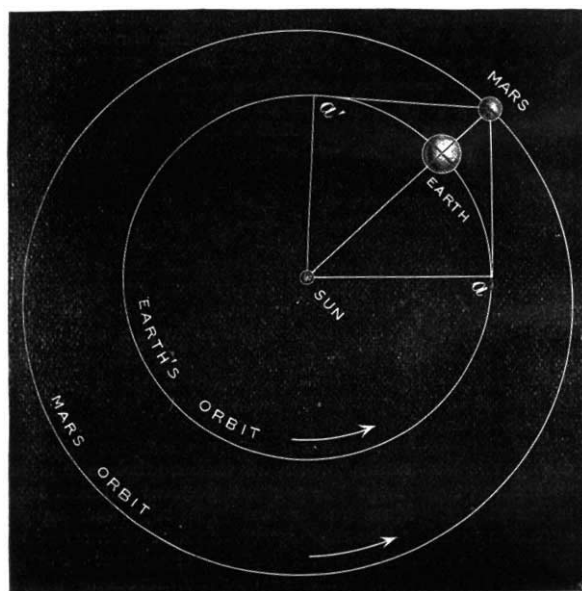


FIG. 2.—The Conditions of Visibility of the Earth from Mars.

modifications, as it requires the object to be visible towards which the flash is directed, but Mars is not visible to the naked eye at day."¹

Mr. Galton then uses sunlight and works in the day; Mr. Haweis, on the other hand, suggests electricity and night-time:—

"I infer from the astronomers that a signal on our earth about six miles in size of the nature of a bright light could be seen by the inhabitants of Mars, who by all accounts seem to be making the most systematic and herculean efforts to communicate with us by flashing triangular signals of presumably electric light. Why cannot we answer those signals by something which would resemble the lighthouse intermittent signal? Here is the method. London every night presents an area of at least twelve miles square brilliantly illuminated. That illuminating power might be enormously increased with only a few additional centres of powerful electric light. But without any additional expense, a little co-operation on the part of the gas companies would suffice to alternate darkness and light at intervals of five

¹ *Times*, August 6, 1892.

minutes over the whole of London between certain hours when traffic is more or less suspended. If only tried for an hour each night some results might be obtained. . . . We have actually the mechanism for interplanetary communication every night—why not use it?"¹

Mr. Galton is careful to point out that his method of signalling requires sunlight, and that the signals are to be flashed to Mars in the Earth's daytime; the moment of opposition therefore is at once out of the question. Even with the Earth at either α or α' in our Fig. 2, the Sun and Mars would be 90° apart, and in any case the signals would be visible to the Martians (if visible at all) on the part of the earth lit up by the Sun. This does not seem a favourable condition, or at all events the most favourable one.

Mr. Haweis' plan secures a much stronger contrast. If it or something like it could be carried out, we can imagine the inhabitants of Mars studying the delicate earth crescent (with telescopes as powerful or more powerful than our own *bien entendu*), whether as a morning or evening star, and then seeing rhythmic flashes, reproducing the star included in the crescent of the Ottoman flag well within the horns of the crescent. Here we certainly get light on dark instead of light on light.

But there are other conditions of visibility besides those we have so far discussed. Supposing the whole electric energy of London turned on Mars would the volume of light be sufficient to produce a valid signal?

It is worth while, quite independently of the popular expectations of the present moment, to inquire into the actual conditions of the problem, telescopes on Mars as powerful as our own being always assumed.

If we are armed with a powerful telescope, under the best seeing conditions, first among which is its location at a considerable elevation, we may perhaps reckon upon using a power of 1000, that is, the object is magnified a thousand diameters; in other words, it is brought a thousand times nearer. In the case of the moon, under these conditions any part of her we might choose to study could be examined, as if from London we were viewing it over Yorkshire with the naked eye.

The late Mr. Lassell, I believe, claimed as the highest achievement possible with his 4-foot telescope in the pure air of Malta, that if the lunarians were shaking a carpet as large as Lincoln's Inn Fields he could see whether it was round or square. This then would be the *ne plus ultra* in the case of a body 240,000 miles away.

Now, if we take the nearest distance to Mars as 35,000,000 miles, as I have stated,

			Miles.
1,000,000	magnifying power would give us the power of studying Mars as if it were		35
100,000	ditto ditto		350
10,000	ditto ditto		3500
1000	ditto ditto		35,000
			away from us.

We can put this differently. To the naked eye at the distance of Mars $1'' = 160$ miles. Were Mars 1000 times nearer $1''$ would become $\cdot 16$ mile. Now this at first seems very hopeful, for the exterior satellite of Mars has been seen in various telescopes.

We have already learned that the power employed last month at the Lick Observatory has not been so much as 1000, but such that the planet has been brought within a distance of 50,000 miles. Under these conditions a line on Mars a quarter of a mile long will subtend an angle of $1''$, or two lines a quarter of a mile apart should be separated and appear as doubles.

The second satellite to which reference has been made is only some 10 miles in diameter. We are justified by the visibility of the satellite, then, in saying that

if a space 10 miles in diameter could be lighted up, as brilliantly as by sunlight, on the dark hemisphere of the Earth when Mars is above the horizon and at perihelion, it could be seen from Mars by telescopes equal to our own.

London, of course, is more than 10 miles in diameter, and we can imagine all the navies of the world with their search lights to flash simultaneously towards the planet, or to light up the clouds in a space as large as London, but there then will remain the question of the intensity of the light. What do electricians say is possible in this direction?

Whatever the answer to this question may be, it seems that signalling on Mr. Haweis' lines, light on dark, is a more hopeful proceeding than that suggested by Mr. Galton, and that on this system our conditions for reading signals are far better than those on Mars, as our dark hemisphere is much more exposed to our sister planet than is hers to us.

It is time now that we turn to those recent observations of our neighbour which have given rise to the ideas we have been discussing—ideas based upon the supposition that there is evidence which goes to show that the Martians are signalling to us by digging "canals" 1000 miles long and 200 miles wide, and then doubling them, and in addition lighting numerous signal fires or flashing electric lights!

Here we approach a region of astronomical inquiry which requires no enhancement of its interest by the intrusion of popular delusions or imaginings, which, moreover, for the next few months as details come to hand, will have all eyes directed to it.

It is not necessary to go further back than the year 1830 to appreciate the importance of the later inquiries. In 1830 Beer and Mädler made an admirable series of drawings of the planet which enabled them to affirm the existence of fixed markings, and having fixed markings, not a long series of observations was necessary to determine the period of the planet's rotation on its axis.

In 1862 I (and many others) had no difficulty in recognizing the features on the planet which Beer and Mädler had observed with smaller optical power thirty years before. The instrument employed was a 6-inch Cooke achromatic, which I still hold to be one of the finest telescopes ever made. It enabled me to add details to those before noted, and the observations left no doubt on my mind that Mars had an atmosphere like our own; that its temperature did not vary many degrees from our own; that there were land surfaces and water surfaces; clouds and very obvious cloud drift; polar snows which melted with marvellous rapidity as the perihelion sun made its full strength felt. Further, that the changes in the appearances observed, especially in the lighter or darker shading, depended upon clouds and the smoothness or roughness of the water surfaces.

This latter conclusion I arrived at from the fact that the darkest markings, assuming them to be water surfaces, were more or less land-locked, and that changes in some of these surfaces were always most obvious close to the land. It was clear also that the rapid melting of the polar snow must be accompanied by tremendous inundations.

I append, as an example of the kind of work done on the planet with the small refractors generally available thirty years ago, some extracts from a memoir I communicated to the Astronomical Society at that time.¹ The large refractors employed added so far as I know very little.

"Although the complete fixity of the main features of the planet has been thus placed beyond all doubt, daily—nay, hourly—changes in the detail and in the tones of the different parts of the planet, both light and dark, occur. These changes are, I doubt not, caused by the transit of clouds over the different

¹ *Pall Mall Gazette*, August 13.

¹ *Mem. R.A.S.*, 1863, p. 179.

features. The effect of a cloudless and perfectly pure sky, both here and on Mars, appears to be that the dark portions of the planet become darkest and most distinctly visible; the coast-lines (if I may so call them) being at such times so hard and sharp, that (as has been mentioned by Mr. Lassell) it is quite impossible to represent the outlines faithfully; and this effect, be it observed, is completely distinct from the way in which the features grow upon one. MM. Beer and Mädler remark: 'Generally some time elapsed before the undefined mass of spots seen upon first looking into the telescope resolved itself into recognizable parts.' This observation will commend itself to all who have observed such a delicate object.

"The effect of clouds, on the contrary, will be, I think, to make the dark portions less dark in proportion to the density of the clouds, and the light portions lighter in the same proportion. *It can never make a light portion dark.* If this be so, when we see a dark spot well defined, we can be sure that no clouds are above it, and that we actually see the planet itself; we cannot be sure, however (unless we are acquainted with the locality from previous observation), that dark spots do not underlie any of the lighter portions. Some instances of cloud-transit were suspected by Father Secchi in 1858. Several unmistakable instances occurred during my observations. . . .

"But besides the cloud-masses, which, as we have seen, obliterate the dark portions either partly or wholly, giving rise to different contours and tones, and rendering the actual features of the planet undistinguishable, the dense atmosphere of Mars, with its fogs and mists, appears to go for very much. I mention this more especially to point out that—although its effect was evident in the southern hemisphere in mid-summer, upon the spots as they came on, and left the disc, as remarked by previous observers—it was much more evident in the northern hemisphere in mid-winter, blotting out, as before remarked, *even on the central meridian*, all features north of $+30^\circ$ latitude. This would appear to furnish another proof of extreme seasons on Mars, in addition to that supplied by the rapid melting and great extent of the polar snows, and to point out the desirability of taking advantage of all oppositions which happen, as did those last year and in 1830, in the full summer-time of the southern hemisphere, when the atmospheric conditions of the planet may be considered the best possible. With regard to this last point, it may be remarked that the southern hemisphere is the one which we shall ever be able to study best, in consequence of the great distance of the planet from us at those oppositions which occur when the northern one is turned to us.

"With regard to the green and red tints so often noticed on Mars, my observations have led me to hold the same opinions as to their nature as those arrived at by Father Secchi in his study of the planet in 1858. Nor do I think that it can any longer be doubted that—as he considered probable—the green and red portions do actually represent seas and continents, and are not the effect of contrast.

"The dark portions were noticed to be decidedly green in my instrument, both by myself and others who observed Mars from time to time with me, the colour being especially marked in Beer and Mädler's spot *p n* (Drawings Nos. 7 and 8). In spite of the over-correction of my object-glass, which should have 'reinforced' the red tinge, it was never sufficiently decided, I think, to suggest a contrast; and, indeed, the green was sometimes unmistakable when the red was not noticed, and when therefore there was no contrast to mislead the eye.

"Another point of agreement between the two series of drawings is not a little remarkable: the spots which were observed to be of a most decidedly dark tint in 1830 were darkest last year; and supposing the dark portions to be water, the darkest spots are those which are nearly, if not quite, land-locked. Passing on from the consideration of the general features of the planet, the snow-zone next demands our attention. . . . Last year the solstice occurred on August 30, on the 23rd of which month the snow-zone was estimated to be $\frac{1}{3}$ of the apparent diameter; by the 25th of the next month, September, this was reduced to about $\frac{1}{10}$, and again to $\frac{1}{15}$ by October 11, when it was at times scarcely discernible; after which it began apparently to increase again.

"To the great eccentricity of the orbit of Mars, and the fact that the summer of the southern hemisphere occurs when the planet is near perihelion, is doubtless to be ascribed this very rapid melting of the southern snow-zone, an observation confirmed by the much slighter variation in the dimensions of the

opposite one. It appears to follow from my drawings, and I think also from those of Messrs. Beer and Mädler, although they make no mention of the fact, that even at its minimum the centre of the snow-zone was not absolutely coincident with the planet's pole, being situated in somewhere about 20° of areocentric longitude (using Beer and Mädler's start-point), and in a latitude probably only a very few degrees from it. . . . The snow-zone was at times so bright that, like the crescent of the young moon, it appeared to project beyond the planet's limb. This effect of irradiation was frequently visible; on one occasion the snow-spot was observed to shine like a nebulous star when the planet itself was obscured by clouds, a phenomenon noticed by Messrs. Beer and Mädler, recorded in their valuable



FIG. 3. Mars September 25, 1863, showing the darker shading of a land-locked water surface and its projection into the open water beyond.

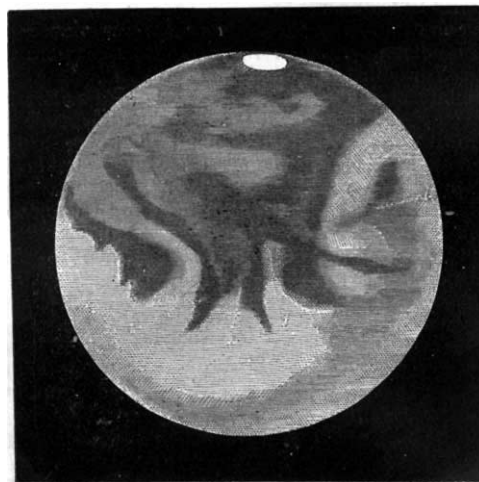


FIG. 4. Mars September 23, 1862, showing bright appearance of snow cap, and the details of one of the chief coast lines.

work, *Fragments sur les Corps Célestes*. The brightness, however, seemed to vary very considerably, and at times, especially when the snow-zone was near its minimum, it was by no means the prominent object it generally is upon the planet's disc."

We owe it to the illustrious Italian astronomer Schiaparelli that a world of wonders undreamt of thirty years ago now forms the chief subject of inquiry. His work was begun at the opposition of 1877, which, as we have seen, was as favourable as the present one, and continued during that of 1879-80. He showed that those

parts of the planet which had been regarded by myself and others as the land surfaces, instead of being wanting in detail, as they had been seen, were really riddled by streaks, many of them very long and very straight, but in every case running towards a water surface, and in many cases connecting two water surfaces. These streaks he called *canali*, which in Italian, as *canalis* in Latin, means either a channel, a canal, or a pipe. Unfortunately, however, whenever it has been translated into English the word *canal* has been used, which of course with us suggests human labour. We have already seen what this has led to.

As a result of this minute inquiry rendered possible by his fine instrument (8 $\frac{3}{4}$ in. Merz) and perfect observing weather, a complete map of the planet with these channels was made.¹ But this was but the beginning of marvels. During the opposition of 1881-82 the work was continued, and now Schiaparelli, besides endorsing all the discoveries of 1880-81, found that in at least twenty cases the channels were doubled and consisted of two streaks 200 or 400 miles apart, instead of one. I append

Not only was this wonderful change noted, but here and there bright spots (previously noted by Green in 1877, and recalling Dawes' "snow island," seen in 1865), were recorded.

In the doubling of these water channels then, and in these snow-tipped hills, we have the origin of the "canal digging" and "fire signals" of which we have lately heard so much.

It will thus be seen that the widespread notions of the signals from Mars rest only on a mistranslation and upon the popular imagination running riot among the startling revelations of modern observers, among whom in this special line of work Schiaparelli must be acknowledged as *facile princeps*.

The observations which engendered invention in one class of minds engendered doubts in others, but the work of Perrotin and Thollon at Nice in 1886 with the 15-inch refractor has completely endorsed the main points advanced by Schiaparelli with regard to the existence of the channels or straits. Two or three references to their published papers will show clearly what their view

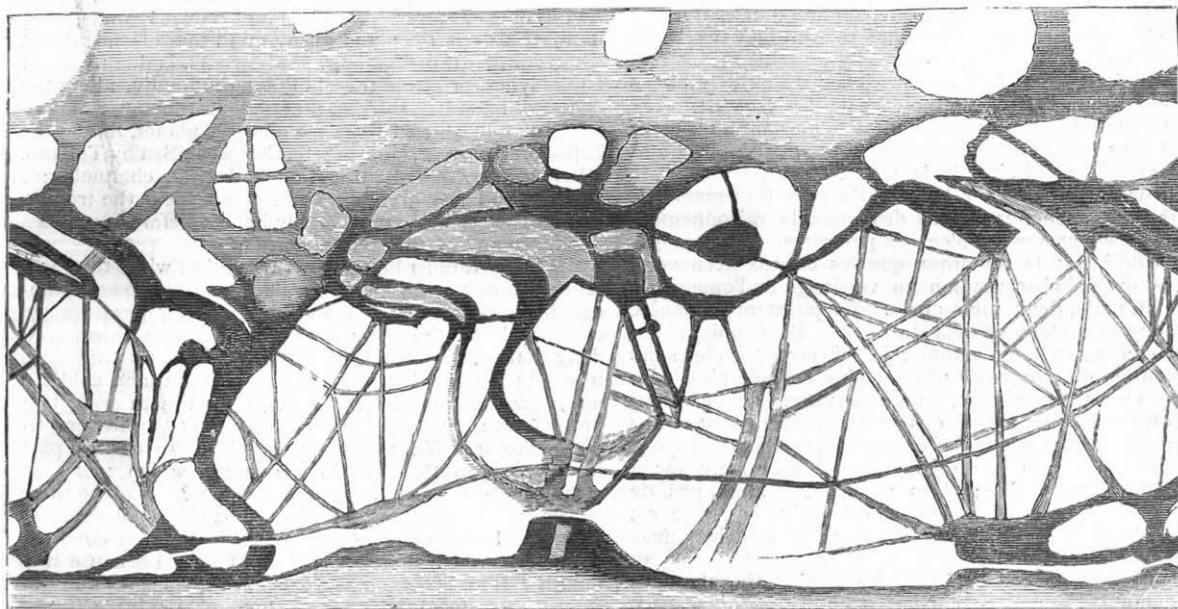


FIG. 5. Doubling of the channels, observed by Schiaparelli in 1882.

a copy of the sketch map he gave in his preliminary communication to the Academy of the Lincei.²

He distinctly stated that the doubling of these channels seemed to be connected with the time of the planet's year, and to occur simultaneously over the superficies of the planet which is supposed to represent land. When the opposition took place in August, that is in the full winter of the northern hemisphere, no trace of the doubling was visible which is precisely what we should expect if the doubling depended in any way upon inundations caused by the melting of the northern snows, the north pole being turned away from the sun. The vernal equinox took place on December 18, 1881, and the opposition took place in the same month. The doubling of 17 of these channels was observed between January 19 and February 19—that is, in the late spring of the northern hemisphere, which again is precisely what we should expect if they were connected with inundations.

¹ Osservazioni astronomiche e fisiche sull'asse di rotazione e sulla topografia del pianeta Marte. R. Accad. dei Lincei, 1880-81.

² Memorie della Soc. Spettroscopisti Italiani, vol. ix. Dis. 6, p. 25.

of the relation of them to the variously-tinted parts of the planet really is:—

"The triangular continent, somewhat larger than France (the Lybia of Schiaparelli's map), which at that time stretched along both sides of the equator, and which was bounded south and west by a sea, north and east by channels, has disappeared. The place where it stood, as indicated by the reddish-white tint of land, now shows the black, or rather deep-blue, colour of the seas of Mars. The Lake Moeris, situated on one of the channels, has also vanished, and a new channel, about 20° long and 1° or 1·5 broad, is now visible, running parallel with the equator to the north of the vanished continent. This channel forms a direct continuation of a previously existing double channel, which it now connects with the sea. Another change is the unexpected appearance about the north pole of another passage, which seems to connect two neighbouring seas through the polar ice."¹

A short time afterwards M. Perrotin stated that this same district of Libya, had undergone a further change, the "sea" which had so recently covered it having retreated

¹ Abstract in NATURE May 21, 1888.

again for the most part, so that the appearance of the district was intermediate between that which it recently presented and that under which it was seen in 1886. Of the channels M. Perrotin has noticed four, three of which are double, which, starting from the "seas" of the southern hemisphere near the equator, and following a nearly meridional course, extend right up to the north polar ice cap, being traceable across the "seas" which immediately surround the latter.

Although Schiaparelli, as it will have been seen, connects the changes in the channels with the seasons of Mars, and although Perrotin and Thollon show their relation to the seas in their vicinity, other explanations of the phenomena have been suggested. Among these we must first refer to the view of Fizeau,¹ that we were in presence of the results of glaciation on a tremendous scale, the parallel ridges being likened to crevasses or rectilinear fissures! It was imagined by him that relatively longer seasons and a lower temperature were capable of producing crevasses some thousands of miles long and hundreds broad.

But this was not the only physiographic explanation offered. Mayeul Lamey, a Benedictine monk, ascribed the channels to volcanic action; to him they were the remains of enormous crater walls, and he states that they are best seen when Mars reaches its most gibbous form and the angle of the incident light is greatest.

"Le plus souvent les astronomes se bornent à observer Mars vers l'époque de son opposition, c'est-à-dire de sa plus grande proximité de la terre; c'est, pensent-ils, le meilleur moyen de voir bien et de près les 'mers' de Mars. Si ces taches étaient des mers la raisonnement serait excellent, mais il n'en est pas ainsi. M. Schiaparelli a déjà fait la remarque que les canaux découverts par lui ont été observés non au voisinage de l'opposition mais un mois, deux mois après. Et pourtant la planète est alors bien éloignée déjà de nous. Pour moi, je constate également le même fait; je découvre tous les soirs un nombre de cirques de plus en plus considérable. La raison en est bien simple, du moment que les taches sont des ombres, ou du moins des parties réfléchissant moins la lumière. A l'époque de l'opposition, en effet, les rayons solaires tombent à peu près perpendiculairement sur la surface de la planète; Mars ne possède alors pas de phase, tandis qu'un mois avant ou après, la phase est très accentuée et les ombres deviennent possibles avec les élévations du sol."²

Another attempted explanation was that the channels were doubled in consequence of some play of diffraction. But enough has been said on this head; let us rather turn to the first fruits of last month's work.

At the Lick Observatory the channels were seen, and one of them was considered by three observers to be doubled.

From Peru we learn that Prof. Pickering saw many of the channels observed by Schiaparelli, but all were found to be single. The telegram adds, "not double, as stated by him"; but here is an error. We are near the southern solstice, as in 1877, and they were *not* seen double at that epoch. But even this is comparatively uninteresting after the revelations as to the effects of the melting snows.

Prof. Pickering discovered two mountain ranges in Mars to the north of the green patch near the planet's south pole. Between these mountain ranges the melted snow has collected before flowing northward. In the equatorial mountain regions snow fell, covering two of the summits, on August 5. On August 7 the snow had melted. "I have seen eleven lakes," the professor writes, "varying in size. These lakes branched out in dark lines connecting them with two large dark areas like seas, but

not blue. There has been much local disturbance in the clouds round the planet since the snow melted, as is evident from the dense clouds which were concentrated within one area. These clouds were not white, but yellowish in colour, and partly transparent. They now seem to be breaking up, but are still hanging densely on the south side of the mountain range. The northern green spot has been photographed."

Surely we have here the connection between the work of 1862 and 1877. The channels are true water channels; at one time at low channel we may have an unimportant stream like the low Nile; at another an ancient river-bed, as it were, is filled to the utmost limit by the inundation. One requires to have seen an Indian river, or better still, the Nile valley to realize what an inundation may mean, and especially under the conditions which have now been established to exist on Mars. But we may go further. A comparison of Schiaparelli's sketch of 1882 with his map of 1879, helps us considerably, and shows that we must take the effect of clouds over warm water into consideration. Two among the most undoubted and continuous water-surfaces which I observed in 1862, which he has named Mare Cimmerium and Sabæus Sinus, were doubled also in 1882, and in my mind there is no doubt whatever that this doubling, at all events, is due to cloud banks lying, or rather travelling longitudinally, along the centre of the water-surface, precisely as the most magnificent cumuli which I have seen on this planet, follow the Equatorial current, entering the Caribbean Sea by Tobago. Obviously, by their lightness of shade, the channels are shallow, and they are only noticed in or near the tropics, so that the water must be highly heated before it empties itself into any of the southern seas.

Certainly it must be acknowledged that while the revelations show a remarkable similarity to our own atmosphere, so far as chemical structure and temperature are concerned, for the *onus probandi* lies with those who deny that we are dealing with the various forms of water, it would appear that the extremes of heat and cold are more generally operative in Mars than with us. The problem thus presented to us should prove interesting to the geologist. Was there any period in the earth's past history, or can there be in the future, which more resembles the present Martian conditions? Had we these enormous inundations, chiefly caused by polar snows melting? If not, were we sheltered from them by our more circular orbit and shorter year? Is Mars red because it is muddy? If so, what mud could give it the tinge we know?

J. NORMAN LOCKYER.

NOTES.

FOR some days much anxiety was felt as to the condition of Sir Richard Owen. We are glad to say that his health has greatly improved, and that he is now able to take more nourishment.

THE four hundredth anniversary of the discovery of America is being celebrated this week with great splendour at Genoa. The King and Queen of Italy are taking part in the celebration, and the maritime Powers are represented by a fine assemblage of warships.

A BOTANICAL CONGRESS, which is attended by some of the most eminent botanists of Berlin, Paris, Jena, and St. Petersburg, was opened at the University of Genoa on September 5.

AN interesting ceremony took place at the University of Genoa on Tuesday, when the Hanbury Institute was formally handed over to that body. The correspondent of the *Times* at Genoa says that Mr. Thomas Hanbury, an English gentleman, whose house at La Martola, near Ventimiglia, is well known to visitors to the Riviera, had already won the gratitude of Italians

¹ *Comptes Rendus*, June, 1888.

² "Note sur la Découverte du Système Géologique Éruptif de la planète Mars." Par Fr. Mayeul Lamey, O.S.B. Autua. (Dejussien, 1834.)