THE PLANET MERCURY.—The length of the period of rotation and the physical features of the inferior planet Mercury have formed the subject of a recent investigation by Mr. Percival Lowell, the results of which are contributed to the *Astr. Nach.* (No. 3417). The conclusion he has arrived at, from a considerable amount of research, is that this planet rotates once on his axis in the course of its circuit round the sun. As regards the markings on the planet's disc, he describes them as being perfectly distinct, absolutely defined, and always visible. They are narrow dark lines, but not so fine as they appear to be. Their relative positions are permanent. Their positions from hour to hour do not change, thus eliminating any question of a short period of rotation. The permanency of the markings indicates the absence of clouds and other obscurations over the surface of the planet. With regard to an atmosphere, we are informed that there are no positive signs, either direct or indirect. There is, however, negative evidence against the presence of any perceptible atmosphere—namely, the low albedo of the planet, and the great contrast of the surface markings. Unlike Mars, the planet's surface is colourless, and there seems, further, to be no change in the markings, which might indicate presence of seasonal effects. The observations made at the Lowell Observatory are thus in accord with what would be expected, considering the isochronism of the orbital and axial rotations, and the small inclination of the axis to the plane of the orbit. Without an atmosphere, and therefore waterless, the visible surface of the planet may be looked upon, as Mr. Lowell remarks, as "one vast desert."

It may be remarked that M. Leo Brenner, who has also made some recent observations of this planet's surface markings, has, in a recent number of the *Astr. Nach.*, come to a somewhat different conclusion. The spots, he says, are remarkably clear, and a comparison of drawings has indicated that the period of rotation of the planet is comprised between thirty-three and thirty-five hours, or in the mean thirty-four hours. It does not appear to be possible to admit a duration of eighty-eight days for the rotation period.

NOVA AURIGÆ.—Prof. W. W. Campbell publishes some spectroscopic notes in the *Astrophysical Journal* (No. 4, vol. v.), among which are some relative to the new star that appeared in 1892 in Auriga. The observed intensities of six of the principal bright lines up to October 6, 1896, were as follows:—

	Hγ	λ4360	Hβ	λ4960	λ5010	λ5750
1892 Aug. and Sept.	0·1	0·8	1	3	10	1
1894 May 8	0·1	0·3	1	3	10	0·4
1894 Sept. 7	0·1	0·2	1	3	10	0·4
1894 Nov. 28	0·1	0·1	1	3	10	0·3
1896 Aug. 15	—	—	1	3	10	0·1
1896 Oct. 6	—	—	1	3	10	0·1

It will be noticed that the bright lines 4360 and 5750 have gradually diminished in intensity, the latter being scarcely visible at the last observation. These lines, it may be remarked, were strong in the Nova, but faint in the old nebulæ. Their gradual disappearance indicates that the return of this Nova to the nebula stage has been reached, "it is now of the ordinary type of nebular spectrum, save that the lines remain broad, as they have always been described." When the question as to the actual visibility of the nebula after the spectroscopic evidence of its truly nebular character came to be inquired into, several observers found that its appearance was not like that of a star of the same magnitude; while Prof. Barnard announced that the object was "really a bright nebula with a 10th magnitude nucleus." Prof. Campbell, estimating the magnitude of the Nova by comparing the length of its spectrum with that of a star of equal magnitude, came to the conclusion that "the focal image of Nova Aurigæ is stellar."

THE SIMPLON TUNNEL.

THE project of a tunnel through the Simplon has been so much discussed and so frequently abandoned, that one might almost doubt whether the scheme last suggested will ultimately prove effective. But the present plan has been brought to a more forward stage than on any previous occasion; the requirements of interested Governments have been met, the pecuniary difficulties seem to have been overcome, and, finally, contracts have been signed with an eminent firm of engineers, whose name is a guarantee that what is undertaken will be performed. We may, therefore, confidently expect in a short time to hear that this arduous work has been commenced; and it is scarcely premature to glance at the various problems, physical, mechanical and economical, that have had to be solved, or to express a hope that the solutions which have been offered, based as they are on varied experience, will prove adequate to cope with the many difficulties that will arise.

The economical problem can be easily dismissed. The advantages of the Simplon route are so patent, that the perforation of the mountain was suggested in the early days of railway enterprise, at a time when the difficulties that the Alps presented to continuous traffic were more fully apprehended than were the means by which those difficulties were to be surmounted. It is a very easy thing to put down on paper the number of miles that separate, say, London from Brindisi, and show that the train mileage is less by way of Simplon than either by Mont Cenis or Saint Gothard; and yet both these routes have been opened to traffic before the most advantageous line has been begun. If we select some station, as Plaisance, on the eastern side of the Alps, and directly on the Brindisi route, we have the following distances, according to the course followed:—

From London, Calais, Paris, *Cenis* to Plaisance,
1438 km. = 894 miles.
From London, Calais, Bâle, *Gothard* to Plaisance,
1375 km. = 854 miles.
From London, Calais, Reims, *Simplon* to Plaisance,
1253 km. = 779 miles.

But this saving of distance, amounting as it does to nearly 8 per cent., does not express the whole of the advantage that a route through the Simplon would offer. This last tunnel being at a much less elevation above the sea-level than either of the others, the speed of the trains would be greater, and no special precautions needed to ensure the safety in passing over inclines rather steeper than are usually experienced on friction railways.

The maximum height of the Simplon tunnel is 706 m.
,, ,, ,, Gothard ,, 1155 ,,
,, ,, ,, Mont Cenis ,, 1295 ,,
The Arlberg railway is the highest of all, being 1311 m.

To balance the economy of distance and small altitude, we have to consider the length of tunnelling necessary, and unfortunately the length required is in the inverse proportion to the conveniences of the route. The first-made tunnel, that of Mont Cenis, is 12,849 m. long, the Gothard 14,984 m., while that of the Simplon is computed at 19,731 m., so that the ratio of the first is to the third as 2 : 3.

The geological conditions have been well studied, and it will be interesting to compare the forecast framed from an examination of the external appearance of the mountain with the character and extent of the rocks actually encountered. On the south side, for a distance of about four miles, the principal rocks will be clay and mica slate with gneiss. In the central portion, extending over something like six miles, the boring tool will have to work its way through gneiss, alternating with mica schist, and limestone. On the northern side, towards the Rhone, slate and beds of gypsum will form the principal constituents; and here, though the rocks may not be so hard as in the centre of the mountain, greater difficulty is anticipated owing to the extreme precaution that will have to be taken in protecting the sides of the tunnel. The direction given to the perforation will make the axis of the tunnel practically perpendicular to the various seams.

If the extent and hardness of the rock were the only physical difficulties with which the engineers had to contend, doubtless the boring would have been attempted long since; but another, and a greater obstacle has to be overcome in the temperature of the rocks themselves. To excavate under a mountain is to some extent comparable with sinking a mine; and recalling the comparatively low altitude at which the tunnel is to be constructed, and the consequent height to which Monte Leone will tower above it (more than 2000 m.), it is evident that a pretty deep mine is contemplated. We are going to learn something of the internal heat of the earth at a considerable distance from the surface. One can make a pretty shrewd guess at what these temperatures will be, from previous experience in the Cenis and Gothard tunnels; and evidently the advantage of keeping the tunnel nearer to the sea-level, which will facilitate traffic, is accompanied with the disadvantage of having a greater mass overhead, and consequently greater heat. In the case of the Gothard, an increase of depth of 44 m. occasioned a rise in the temperature of 1° C. On this hypothesis, which is of course rough and approximate, in the middle of the work the thermometer will read about 40° C. In the Cenis the maximum temperature reached was 29° C.; but the workmen had to submit to this temperature for a short time only. In the Gothard the temperature of 31° C. had to be contended with for a long distance, and the sufferings were proportionately severe. Anæmia and kindred diseases played havoc with the workpeople. Some 60 per cent. of the workers, it is reckoned, were attacked; and to prevent a similar disaster in the present undertaking, another set of problems, dealing with ventilation and sanitation, had to be considered as part of the entire mechanical difficulties that present themselves.

The lines along which the main engineering problem has been solved are tolerably well known. The scheme contemplates the construction of two parallel tunnels, whose axes will be separated by 17 metres. These two parallel roads will be connected at regular intervals by transversal galleries leading from one to the other, capable of being closed at will by air-tight doors. Only one of the main tunnels will at present receive its final dimensions, and be fully finished for traffic. The breadth will be 5 m., and the height above the sleepers 5·5 m. These dimensions will permit only a single line of rails to be laid, and provision is made in the middle of the tunnel for a siding 400 m. long, so that two trains may pass in opposite directions. The object of the second tunnel, which will have a section of eight square metres, is mainly to ensure sufficient ventilation, and, indeed, to make the work in the main gallery possible. It was this ingenious thought, of carrying along simultaneously the two galleries, which has brought the perforation of the Simplon within the range of possibilities. This suggestion is due to Herr Brandt, of the firm with whom the contract has been placed. The distinguishing feature of this proposal is that it will ensure a current of air passing through the entire system of the tunnels. Evidently, if ventilating apparatus be placed at the entrance of either gallery, a current of air can be forced through one tunnel, through the transverse gallery at the end of the working (all the intermediate openings being closed), and out through the other tunnel. If it be objected that the construction of the second gallery is a very expensive method of supplying fresh air to the workpeople, the answer is that, without some such means, the perforation is found to be impracticable. But the expense is not so great as it seems, because the second gallery can at no very great additional cost be made available for traffic when this increases to such an extent as to make the single line first laid insufficient. It is proposed to supply through this supplementary tunnel 50 cb.m. of air per second, by means of a current moving with the velocity of 13 miles an hour. Such a supply is far in advance of the quantity available at the Saint Gothard workings, and is to some extent founded on the amount that is found necessary to ventilate the Mersey tunnel. In this latter case the supply of fresh air, which no one who has made the journey from Birkenhead to Liverpool would say is excessive, is, it is true, four times greater than the quantity that will be pumped into the Simplon passage; but the number of trains that pass in a day is considerably more, under the Mersey, than will be the case in the Simplon passage. Such a current may, therefore, be sufficient for the workmen, and will certainly tend to reduce the high temperature; but the engineers will not trust to this means alone, to make the interior of the cutting endurable. Recourse will be had to the distribution, throughout the workings, of fine water-dust under considerable pressure. If the water, as it is hoped, can be delivered at the rock face at a temperature of 12° C., it can be employed with the happiest effect. Experiments made at Winterthur, before a committee of experts, proved that an air temperature of 40°—50° C. could be lowered to 15° by employing a water-dust of 12° C. under a pressure of five and a half atmospheres. When higher pressures are available a still more marked result is produced, and the abundant supply of water at both ends of the tunnel will permit this method to be tried under very favourable circumstances.

This large supply of water, from the Rhone on the north side, and from Italian streams on the south, very fortunately permits the use of hydraulic machinery as a means of economically working the boring apparatus. In other works of similar character, compressed air has been the agent employed, against the use of which some objections have been urged. We have here, therefore, the means of comparing the efficiency of the two methods, both in the operation of cutting through the hard gneiss rock, and the effect on the health of the operators, on whom the escape of the compressed air is said to work disadvantageously. On the Arlberg, the natural surroundings of which are comparable with those to be met on the Simplon, the Brandt hydraulic perforating machine has given great satisfaction. It is contended by its supporters that, in a work of such magnitude, where the power has to be supplied from a great distance, that hydraulic transmission is to be preferred to all other, because with it the loss of force is the least. From actual experiment on gneiss rock, it has been shown that a perforation 1 m. deep and 70 mm. diameter can be bored in 12 to 25 minutes, and that consequently a daily advance of 5·85 m. can be reckoned upon. That M. Brandt has the greatest confidence in his invention and in his methods is shown by the fact that, in the contract which he has signed, he is willing to submit to a fine of 5000 francs a day in case the work is not completed in the five and a half years he allows himself. The total cost of the entire construction is computed at less than 3,000,000*l*. It is interesting to compare the rate of progress and cost of construction of the three tunnels which will compete for the Trans-Alpine traffic. In the case of the Mont Cenis tunnel, which represents the state of mechanical science some thirty years since, a year, approximately, was required to complete each kilometre at a cost of six millions of francs. The Saint Gothard, about ten years later in date, proceeded twice as rapidly, while the cost of construction dropped to four million francs per kilometre. Herr Brandt, however, proposes to complete four kilometres per annum, at the same time reducing the expense per kilometre to one half that of the earliest tunnel. One may well wish that this sanguine estimate will be justified.

ON THE COLOUR AND COLOUR-PATTERNS OF MOTHS AND BUTTERFLIES.

A PAPER by Mr. Alfred Goldsborough Mayer, on "The Colour and Colour-Patterns of Moths and Butterflies" (*Proceedings* of the Boston Society of Natural History, vol. xxvii. No. 14, pp. 243-330, March 1897), is a rather elaborate discussion of a subject which has lately attracted much attention; but though Mr. Mayer has made some interesting experiments and observations, his results are neither so novel nor so important as he claims them to be. One of the most interesting parts of the paper is the account of the development of wing-colours during the pupal state, a summary being given of previous researches, supplemented by a series of new observations on common species of American moths and butterflies. The result arrived at is, that the wings are at first transparent, then white, then drab or dusky yellow, while all the purer and brighter colours arise later on. This is what might be expected from the general distribution of colour in lepidopterous insects, and has been indicated by Dr. Dixie and other writers as probable.

Some ingenious experiments were made for the purpose of ascertaining whether the wing-scales were of any use in giving a greater hold on the air. The wings, with and without scales, were attached to a delicate pendulum, but no measurable difference in air-friction was found. Neither do the scales perceptibly strengthen the wings, hence it was concluded that they have been developed solely as colour-producing organs of use to the various species.

A considerable space is devoted to the development of the colour-patterns of the Danaoid and Arcræoid Heliconidæ and the phenomena of mimicry. These are illustrated by four coloured plates intended to show the markings of a large number of species. These plates do not represent the insects themselves, but are "projected by Keeler's method" on rectangles of uniform size, which are supposed to afford more accurate means of comparison. This will seem to most naturalists to be a great mistake. It not only renders the patterns of the most familiar species almost unrecognisable, but it introduces many possibilities of error in the process of projection which even a comparison with the species represented may not enable us to detect. In the case of mimicking species it has the further disadvantage of obscuring differences of outline, and by irregular distortion giving undue prominence to what may be very slight differences in the actual species. In many mimicking species there is a wonderful similarity of