three Grass Snakes (*Cyclophis vernalis*), a Hog-nosed Snake (*Heterodon platyrhinos*) from Montreal, received in exchange; two Patagonian Cavies (*Dolichotis patachonica*), two Ypecaha Rails (*Aramides ypecaha*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NOVEMBER METEORS.—With the July number of *Monthly Notices R.A.S.* a circular is issued by G. Johnstone Stoney, calling the attention of astronomers to the approach of the great secular maximum of the Leonids, which is due about 1899 or 1900. It is probable that this swarm was drawn into the solar system by the planet Uranus about February or March A.D. 126, and careful observations during the next few years may furnish materials for confirming or rejecting this hypothesis. Photography should be employed as widely as possible, and wherever practicable the time of appearance of each meteor recorded. Accurate simultaneous observations from different stations will be of exceptional use. The radiant-points and times of apparition of all meteors should be exactly noted, commencing a few nights before, and continuing some nights after, November 14 and 15.

PLUMB-LINE DEVIATIONS.—M. Messerschmitt, who has been for some time engaged in the determination of latitude and azimuths of a series of points in the Swiss Triangulation, has communicated (*Ast. Nach.*, No. 3365) the results of his most recent investigations. It may be recalled that M. Messerschmitt's first determinations were made in West Switzerland, and these were followed by further researches in the north of the country, which corroborated his previous results. The present paper is concerned with observations made on a line drawn approximately north and south through the centre. Collecting his results into a table showing the difference between geodetic and astronomical latitude, and arranged in order of increasing distance from the equator, a systematic deviation from the vertical is clearly shown. In the midst of the mountains (around Andermatt for example) these deviations are quite small. Going south they increase rapidly, and attain a negative maximum of 20″ (astronomical—geodetic) towards Lugano. A positive maximum occurs about Goschenen, the entrance to the Gotthard Tunnel; and still further north, the difference diminishes again, and changes sign about the latitude of Zürich. Schaffhausen shows again the position of negative maximum. The position of the mountain chains generally explains these variations.

An investigation, founded on these deviations of the plumb-line, of the form of the surface of the earth for a meridian length of about 200 km. through the Gotthard district, discloses the fact that the ellipsoid sinks everywhere below the geoid. Selecting as a zero point that position where no deviation from the vertical exists (47°·1 15′ lat.), the greatest difference between the two surfaces occurs near Airolo (the southern exit of the tunnel), where it amounts to nearly five metres. Going southwards from this point the surface sinks gradually, and approaches the ellipsoid before the valley of the Po is reached.

THE HAMBURG OBSERVATORY.—Prof. Rumker's report of the observatory work during the year 1895, shows that the activity of the various departments is fully maintained. The observations with the equatorial have mainly consisted in deriving the positions of small planets and comets, and of the fainter stars with which the nebulæ, whose places have been published in a communication from the observatory, have been compared. With smaller instruments attention has been given by Dr. Hänig to variable stars and occultations by the moon. With the meridian instrument, in addition to observations required for the accurate distribution of time signals, arrangements have been made for observing stars in the degree 80–81 N. Decln. down to 9·3 mag. In addition to this varied work, the attention of the staff has been called by Dr. Auwers and others to discrepancies between the places of stars in the Hamburg catalogue, and those recently obtained in the "Astronomischen Gesellschaft" zone catalogue. This has necessitated much searching of old records, and in some cases the detection of errors, which will be published in a communication from the observatory.

THE DUNSINK OBSERVATORY.—The seventh part of the astronomical observations and researches made at Dunsink, and published under the direction of Prof. Rambaut, contains the meridian places of 717 stars, of which upwards of 2000 observations have been made. These stars have been selected on account of suspected large proper motions, and the observations, interrupted as they have been from several causes, have been spread over eleven years. But, nevertheless, the accuracy maintained throughout is of a very high degree. From an examination of the separate results, the probable errors in R.A. and Declination are, respectively, $\pm$ 0″·037, and $\pm$ 0″·505. This error is probably increased by the uncertainty of the proper motion in many cases, and does not fully express the accuracy of the work. The Pistor and Martin's meridian circle, with which the observations have been made, has been frequently reversed in the course of the work, and the determination of latitude, on which great care has been bestowed, is slightly different in the two positions. With Clamp West the resulting latitude is 53° 23′ 13″·05, and with Clamp East three tenths of a second less. The value used in the final reduction is 53° 23′ 13″·00, and the results, it is believed, coincide very closely with Auwers' fundamental system. The cause of this systematic difference in the latitude, however, has not been satisfactorily explained.

OBSERVATORY OF MOSCOW.—The last issue of the *Annals* of this Observatory (series 2, vol. iii. part 2, 1896) contains several papers of general interest. The director, W. Ceraski, contributes the following articles: (1) "Photometry of the star cluster χ Persei," in which he gives the measures of the magnitude of seventy stars of the group, determined with a Zollner photometer on a 10-inch refractor. One star he finds to be variable, and recommends its further study. (2) "Observations of eclipses of Jupiter's satellites without photometric appliances," using eye estimates of relative magnitude compared with some neighbouring star of known brightness. (3) "On the temperature of the sun," in which he gives the inferior limit to be about 3500° C. (4) "A new method for the electrical comparison of pendulums."—P. Sternberg discusses the photographs he obtained during the transit of Mercury on May 9, 1891, and also contributes an important description of his determination of the variation of latitude at Moscow.—B. Modeston gives a full description of the calculation of double-star orbits by the methods of Kowalski and Encke respectively.—S. Blajko, as the result of thirteen photometric measures of the magnitude of Mira Ceti during the winter of 1894–5, finds evidence of a secondary maximum in its light curve, occurring about a month previous to the highest maximum, the magnitudes at the secondary and principal maxima being about 3·5 and 3·16 respectively.

THE SOLAR ECLIPSE OF APRIL 16, 1893.

M. DESLANDRES has now issued his report on the work accomplished by the French expedition to Fundium, Senegambia, for observations of the total solar eclipse of April 16, 1893. Some of the results obtained have already been made known, and these are now brought into connected order and discussed. A full account is also given of the general objects and organisation of the expedition. The programme decided upon included the photography of the corona, a photographic study of the coronal spectrum, especially in the ultra-violet, and a spectroscopic study of the movements of the corona.

The report is of special importance in view of the approaching eclipse, for the reason that reference is made to several points which may serve as a guide in future operations. For example, M. Deslandres' experience indicates that for the corona pictures plates of moderate sensitiveness give better results than the plates of greater rapidity. Another practical suggestion is that at least two cameras should always be employed in the search for an intra-mercurial planet; M. Deslandres found it impossible to determine whether certain spots on the single plate which he obtained represented stars or photographic defects.

The general results relating to the coronal spectrum are thus stated: (1) The continuous spectrum of the corona, which forms the greater part of its light, is most intense on the red side, relatively to the spectrum of the disc, and the difference appears to become greater as the point considered is further removed from the photosphere. (2) The spectrum of dark lines, under very favourable conditions, did not appear at 5′ from the sun's limb; at this height the light diffused by the coronal particles is still too feeble with respect to their own light. (3) The luminous gases of the corona, indicated by the fine lines, have not the same intensity or composition in different parts of the corona, or at different heights; further, they most frequently do not correspond to elements known upon the earth.

Special interest attaches to the investigation of the rotation of the corona by observing or photographing the displacement of lines in the spectrum at some distance from the limb on each side of the equator. No photographic impression was secured with the fourth order spectrum of a diffraction grating, adjusted for H and K, and, although the eclipse occurred at a maximum of sun-spots, 1474 K was too feeble in the second order spectrum to permit any trustworthy measures to be made visually. A successful photograph of the H and K lines was obtained, however, with a 3-prism spectroscope attached to a 6-inch refractor, one half of the slit being exposed on the west and the other on the east side of the corona. The measured velocity of 6·8 km. per sec. has led M. Deslandres to conclude that the equatorial part of the corona moves very nearly with the same angular velocity as the photosphere. This result must be received with caution until confirmed by further researches, as the photographs taken at the same moment by Mr. Fowler give no indications of the presence of H and K in the true coronal spectrum. It is pointed out that this research may be simplified in future by making only one exposure, placing the slit radially, so that the velocities may be determined from the inclination of the lines, as in the recent researches on Saturn's rings.

In the last chapter of the report, various hypotheses as to the nature of the solar atmosphere are reviewed, and an electrical theory is propounded. It is pointed out that, notwithstanding the diversity of appearances, there is really a great similarity between the solar and terrestrial atmospheres, and the report ends as follows: "Terrestrial meteorology and solar physics, which are separated by the necessity for the division of work, are in reality connected sciences, which, by the nature of things, ought to be studied together."

THE RÖNTGEN RAYS.[1]

PROF. RÖNTGEN, of Wurzburg, at the end of last year published an account of a discovery which has excited an interest unparalleled in the history of physical science. In his paper read before the Wurzburg Physical Society, he announced the existence of an agent which is able to affect a photographic plate placed behind substances, such as wood or aluminium, which are opaque to ordinary light. This agent, though able to pass with considerable freedom through light substances, such as wood or flesh, is stopped to a much greater extent by heavy ones, such as the heavy metals and the bones; hence, if the hand, or a wooden box containing metal objects, is placed between the source of the Röntgen rays and a photographic plate, photographs such as those now thrown on the screen are obtained. This discovery, as you see, appeals strongly to one of the most powerful passions of human nature, curiosity, and it is not surprising that it attracted an amount of attention quite disproportionate to that usually given to questions of physical science. Though appearing at a time of great political excitement, the accounts of it occupied the most prominent parts of the newspapers, and within a few weeks of its discovery it received a practical application in the pages of *Punch*. The interest this discovery aroused in men of science was equal to that shown by the general public. Reports of experiments on the Röntgen rays have poured in from almost every country in the world, and quite a voluminous literature on the subject has already sprung up.

In view of the general interest taken in this subject, I thought that the Röntgen rays might not be an unsuitable subject for the Rede Lecture.

Before discussing these rays themselves, I think it may perhaps make matters clearer if I call your attention to one or two of the phenomena which accompany the discharge of electricity through gas at a low pressure. I have here a bulb from which the air has been taken until the pressure has been reduced to about 1/10000 part of the atmospheric pressure. When the electric discharge passes through this bulb you see that there is considerable luminosity in the gas in the bulb, except in a region round this terminal—the negative one; this region, where the luminosity is so deficient, is called the negative dark space. In this bulb there is no phosphorescence on the glass, and I may say no emission of Röntgen rays. If I were still further to reduce the pressure of the gas in this bulb, this dark space would expand and encroach on the luminous part of the discharge, and would, when the pressure got very low, reach the walls of the tube; the expansion of the dark space diminishes the luminosity in the gas, but we find that where the dark space reaches the glass of the tube the glass itself becomes luminous, until finally at very low pressures we get to the state of things shown by this tube, where the luminosity is all on the glass, and little or none is to be observed in the gas. Röntgen rays are produced by this bulb, though not by the other.

There is one feature in this tube to which I must call your attention: you see that there is a shadow on part of the tube; this shadow is thrown by a mica cross fixed between the negative electrode and the wall of the tube, and if we observe the shape of the shadow we see that any point of the tube is in shadow if the line joining that point to the negative electrode passes through the mica cross. We thus conclude that we have something starting from the negative electrode, travelling in straight lines, and producing phosphorescence when it reaches the glass, and, further, that this something is stopped by the mica cross. This something which travels in straight lines from the kathode is called the kathode rays: these rays are of great interest in relation to the subject of this lecture, for the kathode rays seem to be the parents of the Röntgen rays. Let me call your attention to the effect produced by a magnet on these rays: you see that when the magnet is brought near, the shadow of the cross is displaced; this shows that the direction of the rays casting the shadow have been deflected by the magnet, thus the kathode rays are deflected by a magnet. We shall see later on that the Röntgen rays, on the other hand, are not so affected. This is one of the most striking differences between the parent—the kathode rays—and the child, the Röntgen rays. The effects of the kathode rays inside the tube were discovered more than twenty years ago by Crookes and Goldstein; it is only quite recently, however, that any effects produced by these rays outside the tube have been observed. In 1894 Lenard, using a tube of the kind shown in the diagram (Fig. 1), where the kathode

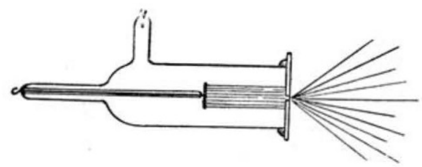

FIG. 1.

rays struck against a window made of very thin aluminium, found that if he placed outside the tube in front of the window a screen covered with a phosphorescent substance, pentadecaparatolyketon, it became phosphorescent; he found, further, that a photographic plate placed behind the window was affected—nay, that this plate was affected even though he placed in front of it a plate of aluminium or a thin quartz plate—in fact, he took a photograph through aluminium and quartz; he thus obtained two of the most prominent phenomena shown by the Röntgen rays. In fact, we know from the researches of Röntgen that the Röntgen rays must have been present and played a part in these experiments. Lenard himself ascribed the effects he observed to kathode rays which had penetrated the aluminium window, and indeed it would seem that something in addition to the Röntgen rays must have been present, as Lenard found that the position of the phosphorescent patch was affected by a magnet, while the Röntgen rays themselves are, as we shall see, not influenced by such an agent.

I now come to the consideration of the Röntgen rays themselves, and shall endeavour to repeat some of the experiments by which Röntgen established their existence. The apparatus consists of a tube exhausted to such a low pressure, that when the electric discharge passes through it there is an abundant supply of kathode rays; these rays strike against a metal plate in the bulb. This metal plate is not essential for the production of the rays, and was not present in the bulbs used by Röntgen; it, however, considerably increases the efficiency of the bulb.

When the electric discharge passes through this bulb, the region round it is the seat of some very remarkable phenomena. I have here a screen coated with a phosphorescent substance,

[1] The Rede Lecture, given at the University of Cambridge, on June 10, by Prof. J. J. Thomson, F.R.S.