OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL :—

April 1. 14h. Saturn in conjunction with moon. Saturn 2° 16′ North.
5. Pallas in opposition to the sun.
7. 16h. 30m. Transit (ingress) of Jupiter's Sat. III.
13. Perihelion passage of Swift's comet (1899 *a*).
15. Venus. Illuminated portion of disc = 0·750. Apparent diameter = 14″·6.
Mars. Illuminated portion of disc = 0·900. Apparent diameter = 7″·5.
15. 11h. 26m. to 12h. 8m. Occultation of μ Geminorum (mag. 3·2) by the moon.
15. 12h. 35m. Minimum of Algol (β Persei).
17. 10h. 44m. to 11h. 8m. Occultation of 3 Cancri (mag. 6·0) by the moon
18. 9h. 24m. Minimum of Algol (β Persei).
19. 9h. 10m. to 10h. 14m. Occultation of *h* Leonis (mag. 5·4) by the moon.
20. Epoch of Lyrid meteoric shower (radiant 271° + 33°).
22. 11h. 12m. to 12h. 20m. Occultation of B.A.C. 4006 (mag. 5·7) by the moon.
24. Ceres in opposition to the sun.
25. 7h. Jupiter in opposition to the sun. At this time the planet will be about 1° from λ Virginis (mag. 4·6).
Polar diameter of Jupiter = 41″·2.
26. Ceres about ½° N. of ϕ Virginis (mag. 5).
26. 9h. 53m. to 11h. 1m. Occultation of B.A.C. 5023 (mag. 5·8) by the moon.
27. Predicted date of perihelion passage of Holmes's periodical comet (1892 III.).
28. 11h. 56m. to 13h. 6m. Occultation of θ Ophiuchi (mag. 3·4) by the moon.

The planet Jupiter will be well visible during the month, though his position is about 12 degrees south of the equator. The remarkable hollow in his great southern equatorial belt, and the remains of the famous red spot of 1878–81, may be observed on or very near the central meridian of the planet at the following times :—

	h.	m.		h.	m.
April 7	11	31	April 19	11	23
12	10	38	24	10	30
17	9	45	29	9	38

Saturn will be conspicuously displayed in the morning sky, and rises before midnight after the middle of the month. Considered as a telescopic object, however, his low position, nearly 22 degrees south of the equator, is a disadvantage, and will seldom allow the details of his surface to appear well defined.

ORBIT OF COMET 1896 III. (SWIFT).—Prof. R. G. Aitken, of the Lick Observatory, has collected all the observations of this comet that were available, and, after a thorough discussion, has made a definite determination of the orbit (*Ast. Nach.*, Bd. 148, Nos. 3550–51). The elements prove to be hyperbolic, and are as follows :—

T = 1896, April 17·6473143, G.M.T. ± 0·00057326d.

$$\left.\begin{aligned} \pi &= 179^\circ\ 59'\ 15''\!\cdot\!40 \pm 3''\!\cdot\!95 \\ \Omega &= 178\ \ 14\ \ 51\cdot48 \pm 6\cdot74 \\ i &= 55\ \ 34\ \ 24\cdot69 \pm 8\cdot88 \end{aligned}\right\} \text{M. Eq. } 1896\cdot0$$

$$q = 0\cdot5662857 \pm 0\cdot00001347.$$
$$e = 1\cdot0004757 \pm 0\cdot00009985.$$

SATURN'S NINTH SATELLITE.—A few further particulars respecting Prof. W. H. Pickering's important discovery are now to hand. The instrument used was the new photographic doublet, 24 inches aperture and about 160 inches focus, which was presented to the Harvard College Observatory by Miss Catherine Bruce. Attempts have been made in previous years to find satellites by photography, but these turned out unsuccessful in consequence of the relatively low rapidity of the lens. Last summer, however, the attempt was again made at the Harvard Observatory at Arequipa, Peru, with this new extremely rapid lens. The four successful photographs were taken on the nights of August 16, 17 and 18, 1898, each plate being exposed for about two hours. The number of stars shown on a plate is estimated as 100,000.

In searching for the satellite two plates were placed film to film, so that each star was indicated by two dots. On the first two plates examined an isolated point was found near the planet. A similar isolated point was found on each of the other plates but in different positions with respect to the stars. The plates having been taken at an interval of two days, Saturn had moved in its orbit, and the images on the plates being found to have moved in the same direction, this furnishes strong evidence of the reality of their being due to a satellite and not to accidental defects of the plates. The new satellite is so faint that there is little possibility of its observation with any but the largest instruments.

MEASURING EXTREME TEMPERATURES.[1]

II.

Extension of the Range of the Gas-Thermometer.

THE methods of measurement so far considered are in a certain sense *arbitrary* in so far as they depend on extrapolation of empirical formulæ. If all these methods could be reduced by direct comparison to perfect agreement with each other, a definite scale of temperature would be attained to which all measurements could be referred, and which would leave nothing to be desired from a purely practical point of view. It is probable that this scale would not differ much from the theoretical or absolute scale of temperature. For theoretical investigations, however, without which no true scientific advance can be made, it is a matter of such fundamental importance to refer every measurement to the absolute scale, that no opportunity should be neglected of extending the possible range of accurate observation with the gas-thermometer, because this instrument affords at present the closest approximation to the absolute or theoretical scale. A consideration of the difficulties of the methods of gas-thermometry at present in use will lead naturally to the best methods of extending the range and accuracy of the instrument.

Defects of Bulb-Methods.

In the ordinary method of gas-thermometry a *bulb* containing the gas is exposed to the temperature to be measured, and the observation consists in determining either the expansion of volume or the increase of pressure of the gas. The principle is very similar to that of the ordinary liquid in glass thermometer, but the apparatus is more cumbrous and difficult to use on account of the necessity of observing both the volume and the pressure of the gas. This method is very accurate at moderate temperatures, but the difficulties increase very rapidly above 1000° C. Above 1200° C. it is doubtful whether such measurements are of any greater value than those obtained by extrapolation. Apart from the difficulty, which is common to nearly all methods at high temperatures, of maintaining a uniform and steady temperature, the bulb-method of gas thermometry is liable to the following special sources of error.

(1) Changes in volume of the bulb.
(2) Leakage and porosity.
(3) Occlusion or dissociation.

In order to investigate these sources of error a special form of porcelain air-thermometer (Fig. 3) was designed by the writer, and was constructed in Paris in December 1886, under the supervision of W. N. Shaw, F.R.S., of Emmanuel College, Cambridge. A figure and description of this instrument were published in the *Phil. Trans.* A., 1887. The same form has since been adopted by MM. Holborn and Wien in their experiments on the measurement of high temperatures at the Reichsanstalt. Thick tubes of 3 sq. mm. cross section, marked AC, BD in Fig. 3, were connected at each end of the cylindrical bulb BA. The length CD could be directly observed at any time with reading microscopes, and the linear expansion of the bulb could be deduced. The volume of the bulb could also be gauged at any time with air, and the mean temperatures of the separate portions AB, AC, BD, could be determined by means of platinum wires extending along the axis of the instrument. This was a most essential part of the apparatus, as the wires afforded a means of accurately reproducing any given set of conditions, and of testing the performance of the gas-thermometer at high temperatures in respect of all the various sources of error above mentioned. (1) It was observed that the volume of the bulb underwent continuous changes, chiefly in the direction of contraction, and that the shrinkage was not symmetrical, being apparently greater in the circumference than in the length of the cylinder. (2) To prevent leakage, and to close the pores of the material, it is

[1] Discourse delivered at the Royal Institution, on March 10, by Prof. H. L. Callendar, F.R.S. (Continued from p. 497.)