clusters — that the Lick photographic telescope will find its chief application and demonstrate its immense superiority. One of the first works to be done is to photograph the vicinity of all the brighter stars, for the discovery of fainter companions, and for the permanent record of their surroundings. A certain number of stars will be selected and photographed at regular intervals throughout the year. Measures made upon these plates will give the data by which the distances of these stars from the earth can be determined. Similar measures upon photographs of star clusters may serve to give us a clue to the laws which govern the internal structure of these wonderful objects. A continuous series of photographs of the brighter parts of one of the brighter comets will certainly throw a flood of much needed light upon the process of their development."

THE additions to the Zoological Society's Gardens during the past week include a White-thighed Colobus (*Colobus vellerosus* ♂), a Campbell's Monkey (*Cercopithecus campbelli* ♀), a White-Collared Mangabey (*Cercocebus collarii*), a Bosman's Potto (*Perodicticus potto*), a Marabou Stork (*Leptoptilus crumeniferus*), a Black Sternothere (*Sternothærus niger*) from West Africa, presented by Mr. H. H. Johnston, F.Z.S.; two Black-Bellied Sand Grouse (*Pterocles arenarius*) from North Africa, presented by Sir Kirby Green, R.C.M.G.; an Eyed Lizard (*Lacerta ocellata*), European, presented by Mr. J. Hopson; a Patas Monkey (*Cercopithecus patas* ♀), two West African Love Birds (*Agapornis pullaria*) from West Africa, a Cormorant (*Phalacrocorax carbo*), British, three Scarlet Ibises (*Eudocimus ruber*) from South America, five Common Chameleons (*Chamæle n vulgaris*) from North Africa, deposited; a Chipping Squirrel (*Tamias striatus*) from North America, five Lesser Pintailed Sand Grouse (*Pterocles exustus* 1 ♂, 3 ♀) from Abyssinia, two Modest Grass Finches (*Amadina modesta*) from Australia, purchased; a Moor Monkey (*Semnopithecus maurus* ♂) from Java, received in exchange; a Spotted Tinamon (*Nothura maculosa*), two Cambayan Turtle Doves (*Turtur senegalensis*), three Chiloe Widgeon (*Mareca chilœnsis*), three Slender Ducks (*Anas gibberifrons*), two Australian Wild Ducks (*Anas superciliosa*), three Mandarin Ducks (*Æx galericulata*), eleven Chilian Pintails (*Dafila spinicanda*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE MARKINGS ON MARS.—M. Perrotin, in a more recent communication to the Paris Academy of Sciences, states that the district of *Libya*, the disappearance of which he had recorded a week or two earlier (NATURE, vol. xxxviii. p. 185), has undergone a further change, the "sea" which had so recently covered it having retreated again for the most part, so that the present appearance of the district is intermediate between that which it recently presented and that under which it was seen in 1886. Of the canals 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. No other observer as yet seems to have traced these canals for such a distance, and across "seas" as well as continents. This observation renders their true character more puzzling than ever, and seems effectually to dispose both of M. Fizeau's just published theory, which explains them by the analogy of the rifts in terrestrial glaciers, Mars being assumed to be in a glacial condition, and of that of Mr. Proctor, who ascribes them to the varying appearances of the Martial rivers when clearly seen or partly veiled by local mists. More detailed observations of these strange markings are needed, and it is to be much desired that as many as possible of actual drawings made at the telescope should be published. It is possible that the comparison of sketches made with different observers and with different apertures, would throw much light on the subject; if, for instance, the appearances were partly optical and due to some effect of diffraction, it would soon become apparent.

COMET 1888*a*, SAWERTHAL.—The remarkable change in brightness which this object displayed about May 20 (NATURE, vol. xxxviii. p. 114) seems to have been well observed, and there is a general agreement that the increase in brightness amounted to 2½ or 3 magnitudes. At Dorpat Herr Blumbach estimated the comet as 9-10 on May 19, and as 7-8 on May 22. Dr. Franz, at Konigsberg, considered the increase as amounting to 3½ magnitudes, estimating the brightness as 5 8 on May 21, whilst Dr. Kammermann, at Geneva, on May 25, reckoned the comet as between the 5th and 6th mags., and the increase as having been between 2 and 3. Father Fenyi, of the Kalocsa Observatory, finds the change of magnitude about the same, but estimates the absolute brightness differently; the recorded magnitudes being: May 20, 9·3; May 21, 7·8; May 22, 6·8; and May 23, 6·8. Father Fenyi also supplies (*Astr. Nach.*, No. 2844) a series of sketches of the comet, showing the changes of shape which have accompanied the changes of brightness, and especially the development about May 28 of a sort of wing on either side of the head. These wings appear, however, to have been seen earlier at other observatories, thus Herr Kortazzi, at Nicolaiew, observed them on May 24, and Herr Wutschichowski gives a beautiful drawing of them under date May 25 (*Astr. Nach.*, No. 2845). The comet does not appear to have been satisfactorily observed with the spectroscope during this period of unusual brilliancy. The outburst was soon over, and the comet speedily returned to its former faintness.

The following ephemeris (*Astr. Nach.*, No. 2838) is in continuation of that given in NATURE, vol. xxxviii. p. 186.

1888.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
July 13 ..	1 7 18 ...	50 32 8 N.	... 0·3352	... 0·3306	... 0·029
15...	1 7 42 ...	50 55·4			
17...	1 7 56 ...	51 17·2	... 0·3459	... 0·3331	... 0·028
19...	1 8 2 ...	51 38·4			
21...	1 7 57 ...	51 58·8	... 0·3563	... 0·3353	... 0·026
23...	1 7 43 ...	52 18·5			
25...	1 7 19 ...	52 37·4	... 0·3664	... 0·3372	... 0·025
27...	1 6 45 ...	52 55·4			
29...	1 6 0 ...	53 12·6	... 0·3762	... 0·3389	... 0·023
31...	1 5 6 ...	53 28·9			
Aug. 2...	1 4 1 ...	53 44·2 N.	... 0·3857	... 0·3405	... 0·022

The brightness on February 18 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 JULY 15–21.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 15

Sun rises, 4h. 3m.; souths, 12h. 5m. 44·2s.; sets, 20h. 8m.; right asc. on meridian, 7h. 40·8m.; decl. 21° 26′ N. Sidereal Time at Sunset, 15h. 44m.

Moon (at First Quarter July 16, 12h.) rises, 11h. 7m.; souths, 17h. 21m.; sets, 23h. 22m.: right asc. on meridian, 12h. 56·6m.; decl. 0° 35′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	3 44 ...	11 24 ..	19 4 ...	6 58·6 ...	18 0 N.
Venus ...	4 4 ...	12 11 ...	20 18 ...	7 45·9 ...	22 9 N.
Mars ...	12 56 ..	18 2 ...	23 8 ...	13 38·3 ...	11 15 S.
Jupiter ...	15 38 ...	20 2 ...	0 26* ...	15 38·0 ...	18 36 S.
Saturn ...	5 19 ...	13 6 ...	20 53 ...	8 41·8 ...	18 56 N.
Uranus...	11 34 ...	17 14 ...	22 54 ...	12 50·3 ...	4 42 S.
Neptune..	0 39 ...	8 25 ...	16 11 ...	3 59·5 ...	18 53 N.

* Indicates that the setting is that of the following morning.

Comet Sawerthal.

July.	h.	Right Ascension. h. m.	Declination. ° ′
15 ...	0 ...	1 7·5 ...	50 45 N.
19 ...	0 ...	1 8·0 ...	51 28

Occultations of Stars by the Moon (visible at Greenwich).

July.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
17 ...	ξ′ Libræ	6 ...	19 22 ...	19 40 ...	145 176
18 ...	θ Libræ	4½ ...	21 2 ...	21 23 ...	8 339
19 ..	49 Libræ	5½ ...	0 20 near approach		202 —
19 ...	B.A.C. 5700 ...	6½ ...	22 26 ..	23 14 ...	142 232

July. h.
16 ... 13 ... Mars in conjunction with and 6° 40′ south of the Moon.
18 ... 17 ... Jupiter in conjunction with and 4° 5′ south of the Moon.
20 ... 0 ... Mercury stationary.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·4	81 16 N.	July	15, 21 31	*m*
			,,	20, 21 11	*m*
W Virginis	13 20·3	2 48 S.	,,	16, 22 0	*m*
δ Libræ	14 55·0	8 4 S.	,,	20, 0 44	*m*
U Coronæ	15 13·6	32 3 N.	,,	15, 21 43	*m*
W Herculis	16 31·3	37 34 N.	,,	20,	*m*
U Ophiuchi	17 10·9	1 20 N.	,,	19, 2 4	*m*
			,,	19, 22 12	*m*
W Sagittarii ...	17 57·9	29 35 S.	,,	16, 21 0	*m*
Z Sagittarii	18 14·8	18 55 S.	,,	16, 0 0	*m*
T Serpentis	18 23·4	6 14 N.	,,	20,	*M*
β Lyræ	18 46·0	33 14 N.	,,	15, 1 0	*M*
R Lyræ	18 51·9	43 48 N.	,,	18,	*m*
R Cygni	19 33·8	49 57 N.	,,	19,	*M*
S Aquilæ	20 6·5	15 17 N.	,,	21,	*m*
S Delphini	20 37·9	16 41 N.	,,	18,	*m*
X Cygni	20 39·0	35 11 N.	,,	21, 0 0	*m*

M signifies maximum ; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
The *Perseids*	2°	50° N.	Swift, streaks.
Near γ Draconis	269	51 N.	Swift.
,, α Lacertæ	336	49 N.	Swift, short.

GEOGRAPHICAL NOTES.

THE Geographical Society of Paris have decided to avail themselves of the Universal Exhibition at Paris, next year, by convening an International Congress of the Geographical Sciences, to meet in the month of August. There will be two classes of members, subscribing respectively 40 and 20 francs, and each member will be entitled to receive a copy of the publications of the Congress and have a vote in the questions discussed at the meetings. Each Society represented at the Congress will be invited to submit a report on the voyages, explorations, and publications which have most contributed, in the country to which it belongs, to the progress of geography during the past hundred years ; the combined reports will afterwards be published with the names of their authors.

DR. H. MEYER has made some important corrections in the preliminary account of his ascent of Kilimanjaro. After verifying and correcting his barometrical observations, he admits that the previously accepted height of 18,700 feet is more accurate than that given by himself, 19,850 feet. He then refers to the dense mist which prevented him from seeing beyond a wall of inaccessible ice, 130 feet high, which his first account indicated as being the terminal point of the peak. It results from these observations that Dr. Meyer did not reach to within 820 feet of the summit of Kilimanjaro, which therefore still remains unconquered.

M. JULES BORELLI, the French traveller, who accompanied M. Rimbaud last year in his interesting journey from Antotto to Harar, is engaged in exploring the country to the south-west of Shoa. The Paris Geographical Society has received some of the results accruing from his journey from Antotto to Jiren, which is situated in 7°42′ N. latitude, and 34°35′ E. longitude. Among these results is the discovery of the sources of the River Hawash, which lie at the foot of Mount Ilfata at the extremity of the Meca range, and not near Mount Dandi, as hitherto supposed. On the summit of the latter peak the traveller found a double lake resembling in shape the figure 8, which is of considerable extent and depth ; an affluent of the Gudar, and thus of the Abbay, issues from this lake. He also discovered a deep lake at the bottom of the immense crater mountain known as Mount Harro ; the surroundings of this sheet of water are described by the traveller as of incomparable beauty. From this lake, which is named by the natives Wancit, a stream issues and joins the Walga, the source of the latter river being in the summit of Mount Harro. Dr. Traversi, the Italian explorer, made in June, 1887, an excursion into the mountainous region of Urbanagh, lying to the east of the district now being explored by M. Borelli. The chief result of this journey of Dr. Traversi is to throw light on the problem of the hydrographical systems of the Somali and Galla countries. From the summit of Mount Gafat he was able to comfirm his previous observations made near the Suai Lake, with reference to the three lakes above-mentioned and their interconnection.

ON CERTAIN INEQUALITIES RELATING TO PRIME NUMBERS.

I SHALL begin with a method of proving that the number of prime numbers is infinite which is not new, but which it is worth while to recall as an introduction to a similar method, by series, which will subsequently be employed in order to prove that the number of primes of the form $4n + 3$, as also of the form $6n + 5$, is infinite.

It is obvious that the reciprocal of the product

$$\left(1 - \frac{1}{p_1}\right)\left(1 - \frac{1}{p_2}\right)\left(1 - \frac{1}{p_3}\right) \cdot \ldots \left(1 - \frac{1}{p_{N.p}}\right)$$

(where p_i means the ith in the natural succession of primes, and $p_{N.p}$ means the highest prime number not exceeding N)[1] will be equal to

$$\tfrac{1}{1} + \tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} + \tfrac{1}{5} + \tfrac{1}{6} + \ldots + \frac{1}{N} + R,$$

and therefore greater than log N (R consisting exclusively of positive terms).

Hence

$$\left(1 + \frac{1}{p_1}\right)\left(1 + \frac{1}{p_2}\right) \cdot \ldots \left(1 + \frac{1}{p_{N.p}}\right) > M \log N,$$

where

$$M = \left(1 - \frac{1}{p_1^2}\right)\left(1 - \frac{1}{p_2^2}\right) \cdot \ldots \left(1 - \frac{1}{p_{N.p}^2}\right),$$

and is therefore greater than $\frac{2}{\pi}$.

Hence the number of terms in the product must increase indefinitely with N.

By taking the logarithms of both sides we obtain the inequality

$$S_1 - \tfrac{1}{2}S_2 + \tfrac{1}{3}S_3 - \tfrac{1}{4}S_4 + \ldots > \log \log N,$$

where in general S_i means the sum of inverse ith powers of all the primes not exceeding N ; and accordingly is finite, except when $i = 1$, for any value of N. We have therefore

$$S_1 > \log \log N + \text{Const.}$$

The actual value of S_1 is observed to differ only by a limited quantity from the second logarithm of N, but I am not aware whether this has ever been strictly proved.

Legendre has found that for large values of N

$$(1 - \tfrac{1}{3})(1 - \tfrac{1}{5}) \cdot \ldots \left(1 - \frac{1}{p_{N.p}}\right) = \frac{1{\cdot}104}{\log N}.$$

Consequently

$$\left(1 - \frac{1}{p_1}\right)\left(1 - \frac{1}{p_2}\right) \cdot \ldots \left(1 - \frac{1}{p_{N.p}}\right) = \frac{{\cdot}552}{\log N}.$$

This would show that the value of our R bears a finite ratio to log N ; calling it $\theta \log N$ we obtain, according to Legendre's formula,

$$\frac{1}{1 + \theta} = {\cdot}552, \text{ which gives } \theta = {\cdot}811,$$

so that the nebulous matter, so to say, in the expansion of the reciprocal of the product of the differences between unity and the reciprocals of all the primes not exceeding a given number, stands in the relation of about 4 to 5 to the condensed portion consisting of the reciprocals of the natural numbers.

I will now proceed to establish similar inequalities relating to prime numbers of the respective forms $4n + 3$ and $6n + 5$.

Beginning with the case $4n + 3$, I shall use q_j to signify the jth in the natural succession of primes of the form $4n + 3$, and $q_{N.q}$ to signify the highest q not exceeding N, $N.q$ itself signifying the number of q's not exceeding N.

[1] N p itself of course denotes in the above notation the number of primes (p) not exceeding N.