XCIII. *A Letter from the Rev.* Nevil Maſkelyne, *M. A. F. R. S. to the Rev.* Thomas Birch, *D. D. Secretary to the Royal Society: containing the Reſults of Obſervations of the Diſtance of the Moon from the Sun and fixed Stars, made in a Voyage from* England *to the Iſland of* St. Helena, *in order to determine the Longitude of the Ship, from Time to Time; together with the whole Proceſs of Computation uſed on this Occaſion.*

SIR, St. Helena, Sept. 9, 1761.

Read June 24, and July 1, 1762.

DUring the courſe of my voyage from England to this place, I made frequent obſervations of the diſtance of the Moon from the Sun and fixed ſtars, in order to determine our longitude: and, as from their agreement with each other, I humbly conceive it will be allowed, that the longitude may in general be aſcertained by this method to ſufficient exactneſs for nautical purpoſes, I flatter myſelf it may not be diſagreeable to the Royal Society, if I communicate to them, through your hands, the reſults of my obſervations. I ſhall likewiſe deliver the whole proceſs of computation, which I uſe in deducing the longitude from an obſervation, wherein I include ſeveral uſeful rules of my own inveſtigation, which, I apprehend, render the calculation not only much ſhorter, but alſo much leſs intricate than it was before.

I am, SIR,

Your moſt obedient,

humble ſervant,

Nevil Maſkelyne.

MY Hadley's quadrant, which was made by Mr. Bird, the radius of which is 20 inches, appears, from all the trials I have made with it, to be very exact; this, indeed, the obſervations of the Moon alone ſufficiently prove, ſince I have often taken the diſtance of the Moon from two ſtars, on different ſides, on the ſame night, and found the ſame longitude to reſult from theſe ſeparate obſervations, with as little difference as from two obſervations of the ſame ſtar; whereas, if there was the leaſt error in the diviſion of the quadrant, or the leaſt refraction in the glaſſes of it, the error ariſing from hence affecting the computation of the longitude from the two ſeparate obſervations contrary ways, muſt be ſenſible in the reſult. I was ſecured from any errors in the conſtruction of the quadrant, by the known ſkill of the artiſt; and the ſpeculums, as well as dark glaſſes, were ground by Mr. Dollond, by a particular method of his own, by which he is certain of making the two ſurfaces of a glaſs truly parallel to each other.

The arch and the index were both of braſs, and the frame of well ſeaſoned mahogany; the Vernier's ſcale on the index carried the ſubdiviſions to ſingle minutes; and the eye might ſubdivide ſtill nearer to the fraction of a minute. When the index was brought near the proper diſtance for obſervation, in order to give it a more ſteady motion than the hand alone could, a plate was ſcrewed down to the arch, containing the head of a ſcrew, by turning of which, the index was carried backwards or forwards at pleaſure. This contrivance was extremely neceſſary for taking the diſtance of a ſtar from the Moon's limb in

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an exact manner; for the quadrant being often to be held in a very inclined plane, it was impoſſible, on account of the motion of the ſhip, to make the obſervation at once; therefore, by means of the ſcrew, the index was moved by gentle degrees, and each time after altering the ſcrew, the quadrant was turned by the hand round the viſual ray, going to the ſtar as an axis, ſo as to make the ſtar ſeem to paſs by the Moon's limb, and the index was gradually moved, till at laſt the ſtar, in paſſing by, exactly ſwept the Moon's limb. Beſides the ſcrew moving the index, there was another addition no leſs neceſſary, which was a dark glaſs, much brighter than any of thoſe commonly uſed, to take off the exceſſive brightneſs of the Moon, and that glare upon the horizon-glaſs, which always attends it. Without the uſe of this glaſs, it was not eaſy to obſerve accurately the diſtance of a ſtar from the Moon's limb, except when the Moon's light was weakened by a thin cloud.

In order to render the contact of a ſtar with the Moon's limb more diſcernible, I always uſed a ſmall teleſcope, magnifying about four times, except when the motion of the ſhip was very troubleſome, though I reckoned the obſervations were not quite ſo exact as thoſe made with the teleſcope. The teleſcope, by means of two ſwivels adapted to it, had a motion parallel to itſelf, by which it was carried nearer to or further from the plane of the quadrant; by means of which, the Moon, which was ſeen always by reflexion, was rendered more or leſs bright, according as more or leſs of her light was received by the teleſcope, from the quickſilvered part of the object ſpeculum; or by raiſing the teleſcope ſtill higher from the plane of the quadrant, the Moon was ſeen entirely by reflexion from the unſoiled part of the ſpeculum, which I generally found to be the moſt convenient: for my part, I ſhould always recommend the uſing of a ſmall teleſcope, magnifying about three times, as it would make the objects appear more diſtinct, and render the contact of the ſtar with the Moon's limb more evident.

My teleſcope, which was about 6 incles long, conſiſted of two convex glaſſes, ſo that it inverted objects; which is of no ſort of inconvenience to people, who have been uſed to inverting teleſcopes, the practiſe of which is ſoon acquired. But if any one would rather chuſe to have a teleſcope that ſhews objects in their natural poſition, he may uſe one conſiſting of a convex object-glaſs and a concave eye-glaſs; which kind of teleſcope anſwers better in ſhort lengths than the other.

Before I deliver the proceſs of the computation of the longitude, I ſhall firſt ſay ſomething with reſpect to the obſervations themſelves, and mention ſome cautions concerning them.

A moſt particular attention muſt be paid to the exact adjuſtment of the quadrant, as a thing of equal conſequence with the obſervation of the diſtance of the ſtar from the Moon. This is ſo much the more neceſſary, as the adjuſtment is ſubject to alter ſenſibly, even from one day to another. The beſt object of all for this purpoſe is the horizon of the ſea, when clear; and I found it moſt convenient, in this caſe, not to uſe the teleſcope, but applied a concave glaſs to my eye, which was fitted for giving

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me the moſt diſtinct view of diſtant objects, which alſo I always uſed in all obſervations where the teleſcope was not applied. The obſerver ſhould always be careful to examine the adjuſtment of his quadrant in the day-time, when the horizon is to be ſeen clearly, and particularly in the afternoon, when he expects to make an obſervation the enſuing night. Should he have failed of making this examination the afternoon before an obſervation, he may examine what the error was, if any, the next morning; or he may make this examination by means of the Moon itſelf, in which caſe, it will be beſt to uſe the teleſcope; though the horizon of the ſea is, in general, by far the beſt object for this purpoſe. As I found my quadrant would ſeldom continue exactly adjuſted for twenty-four hours together, inſtead of freſh adjuſting it every day, I choſe rather to examine what the error of the adjuſtment itſelf was. This is done by turning the index of the quadrant, till the horizon of the ſea, or the Moon, or any other proper object, appears as one, and then the number of minutes, by which o on the index differs from o on the arch, is the error of the adjuſtment. If o on the index ſtands advanced upon the quadrant, before or to the left hand of o on the arch, that number of minutes is to be ſubtracted from all obſervations; but if it ſtands off the arch behind, or to the right hand of o on the arch, it muſt be added to the obſervations. By examining the error of the adjuſtment in this manner, by at leaſt three trials, and taking a medium of the reſults, one can ſcarce err above half a minute in determining the exact error of the quadrant; whereas one may be miſtaken a minute, or more, by a ſingle trial.

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The obſerver would do well to write down in a book the error of adjuſtment thus found, and which way it is to be applied, whether it is additive or ſubtractive.

As it is neceſſary to know the exact time of the day, when the diſtance of the ſtar from the Moon is taken, which can only be found at ſea, by an altitude of the Sun, or a ſtar; and as the altitude of a proper ſtar cannot always be taken with ſufficient exactneſs in the night for this purpoſe, I would recommend it to the obſerver, when he expects to obſerve the Moon at night, to take an altitude of the Sun in the afternoon, two or three hours from noon, the more the better, provided the Sun be not too near the horizon; noting the exact time ſhewn by his watch, at the inſtant of obſervation; which will ſhew him, by computation, how much his watch is too faſt or ſlow for the meridian of the place; whence the time ſhewn by the watch being alſo noted, when the diſtance of the ſtar from the Moon was taken, he will know what the exact time of the day then was. Or if an altitude of the Sun was not taken the evening before, an altitude might be taken the next morning, after the obſervation of the Moon, provided the interval of time between the obſervation of the Moon, and the Sun's altitude did not exceed twelve hours; for a good common watch would hardly vary above a minute during that ſpace of time, which only makes an error of a quarter of a degree of longitude.

The time being determined by an altitude of the Sun or a ſtar, and the diſtance of a proper ſtar from the Moon's limb, or the diſtance of the Sun and Moon's neareſt limbs in the firſt and laſt quarter, being

carefully

carefully obſerved, the longitude may be found from thence, without any other obſervations: and this is the method propoſed by the late Dr. Halley, which certainly deſerves to be highly eſteemed for its great ſimplicity, and the ſmall number of obſervations which it requires. Nevertheleſs, I muſt own myſelf of opinion with the learned Abbé De la Caille, that it will be more convenient at ſea to require the aid of more obſervations, which is the method I conſtantly practiſed myſelf, during my voyage, having always two obſervers, who were ready, one to take the altitude of the ſtar, and the other of the Moon's upper or lower limb, at the inſtant I ſpoke when I had made the obſervation of the diſtance of the ſtar from the Moon.

I can therefore anſwer, from my own experience, both that the method is practicable at ſea, and alſo, that ſo far from being leſs ſimple, it is more ſo than the other method; for the additional obſervations that it requires are very eaſily made, and even the error of a degree in the altitudes would ſeldom be of more conſequence than an error of a minute, in taking the diſtance of the ſtar from the Moon; ſo that an error of 10′ or 15′ in the altitudes would be of no great prejudice: but with reſpect to the facility of the calculations, there is no compariſon between the methods, the latter being much leſs intricate, and much more conciſe. The Abbé De la Caille requires the altitude of that part of the Moon's limb from which the diſtance of the ſtar is taken; but as at ſea we can only take the altitude of the Moon's upper or lower limb, an allowance might be made near enough, by eſtimation of the eye, for the difference of altitude

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between the Moon's upper or lower limb, and that part of the limb from which the diſtance of the ſtar is taken, I generally added the ſemidiameter of the Moon to, or ſubtracted it from, the obſerved altitude of the lower or upper limb, in order to have the apparent altitude of the center, and I found the apparent diſtance of the ſtar from the Moon's center, by adding or ſubtracting the Moon's horizontal ſemidiameter, augmented according to her height, to or from the obſerved diſtance of the ſtar from the Moon's neareſt or remoteſt limb.

This method will be exact enough, if the altitude of the Moon or ſtar be not leſs than 5°. Having thus got three ſides of the ſpherical triangle formed by the Moon, the ſtar, and the zenith; namely, the apparent zenith diſtance of the Moon, the apparent zenith diſtance of the ſtar, and the diſtance of the ſtar from the Moon, I find the effect of refraction and parallax, in altering the apparent diſtance of the ſtar from the Moon, by the two following rules:

RULE I.

To find the effect of refraction in contracting the apparent diſtance of two ſtars, or of the Moon and a ſtar.

Add together the logarithm-tangents of half the ſum, and half the difference of the two zenith diſtances, the ſum abating 10 from the index is the tangent of arc the firſt. To the logarithm-tangent juſt found, add the logarithm-cotangent of half the diſtance of the two ſtars, the ſum abating 10 from the index is the tangent of arc the ſecond. Then add

add together into one ſum the logarithm-tangent of double the firſt arc, the co-ſecant of double the ſecond arc, and the conſtant logarithm 2.0569; the ſum abating 20 from the index is the logarithm of the number of ſeconds required; by which the diſtance of the ſtars, or of the Moon and ſtars, is contracted by refraction: which therefore, added to the obſerved diſtance, gives the true diſtance, cleared from refraction.

N. B. This rule may be made univerſal, ſo as to ſerve with equal exactneſs almoſt down to the horizon, if the apparent zenith diſtances be diminiſhed by three times the refraction belonging to them, found from any common table of refraction, and the computation be made with the zenith diſtances thus corrected. But if the altitudes of the Moon and ſtar be not leſs than 10°, this correction will not be neceſſary. It will not be proper to make the obſervations, if the altitudes of the ſtar and Moon are either of of them leſs than 4° or 5°, on account of the variableneſs of refraction near the horizon.

Rule II.

To find how much the diſtance of the Moon and a ſtar is increaſed or diminiſhed, on account of the Moon's parallax.

Add together into one ſum the logarithm-tangents of half the ſum, and half the difference of the zenith diſtances, and the cotangent of half the diſtance of the Moon and ſtar, all corrected for refraction; the ſum, abating 20 from the index, is the tangent of arc the

the third, for which arc the ſecond, found by the firſt rule, may be taken, without any ſenſible error.

Then, if the zenith diſtance of the Moon is greater than that of the ſtar, take the ſum of this arc, and half the diſtance of the Moon and ſtar; but if the zenith diſtance of the Moon is leſs than that of the ſtar, take the difference of the ſaid arcs; the tangent of the ſum or difference, which may be called the parallactic arch, added to the coſine of the Moon's zenith diſtance, and the logarithm of the Moon's horizontal parallax in minutes, abating 20 from the index, is the logarithm of the number of minutes required, by which the apparent diſtance of the Moon from the ſtar is always augmented by parallax, unleſs the zenith diſtance of the ſtar be greater than that of the Moon, and, at the ſame time, arc the third be greater than half the diſtance of the Moon and ſtar; in which caſe, the apparent diſtance of the Moon and ſtar is diminiſhed by the parallax:

Therefore, the number of minutes found by this rule is always to be ſubtracted from the obſerved diſtance of the Moon and ſtar, firſt corrected for refraction, in order to find the true diſtance, cleared from the effect of parallax likewiſe; except in the caſe ſpecified, when the zenith diſtance of the ſtar is greater than that of the Moon, and arc the third is at the ſame time greater than half the diſtance of the Moon and ſtar, when the correction is to be added. In computing theſe corrections, four places of figures, beſides the index, will be ſufficient.

It remains to be found, by calculation, at what hour under a known meridian, the diſtance of the Moon from the ſtar will be the ſame as reſults from the obſervation, cleared of refraction and parallax. For this purpoſe, it is neceſſary to compute the Moon's longitude and latitude, and horary motion both in longitude and latitude, from the moſt exact tables for the time under the known meridian, which is judged to correſpond nearly to the given time of obſervation under the unknown meridian. The mean motions of the Sun and Moon I took from very exact tables, which I received as a preſent from the ingenious Mr. Gael Morris, compoſed by himſelf, from the compariſon of a great number of Dr. Bradley's obſervations; to which I applied the lunar equations, as they ſtand in the learned Mr. Mayer's printed tables. After finding the mean longitude of the ſtar at the preſent time, I always allowed for its aberration in longitude, which will ſometimes amount to 20″, without conſidering the aberration in latitude, which can be of no conſequence in a zodiacal ſtar, ſuch as thoſe are which are always to be uſed in theſe obſervations. The diſtance of the ſtar from the Moon I computed from their longitudes and latitude, by the two following rules:

RULE I.

Add together the logarithmic coſine of the difference of the computed longitudes of the Moon and ſtar, and logarithmic coſine of the difference of their latitudes, if they are of the ſame denomination; or ſum, if they are of different denominations; the ſum, abating 10 from the index, is the coſine of the approximate diſtance.

N. B. This gives the abſolute diſtance of the Moon from the Sun, without any further calculation.

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But in caſe of a ſtar, it is neceſſary to apply another rule alſo. Seven places of logarithms, beſides the index, muſt be uſed, in computing from this rule, and the calculation muſt be carried to ſeconds.

RULE II.

To the conſtant logarithm 3.5363, add the ſines of the Moon's and ſtar's latitudes, the verſed-ſine of the difference of longitude, and the co-ſecant of the approximate diſtance juſt found; the ſum, abating 40 from the index, is the logarithm of a number of minutes, to be ſubtracted from the approximate diſtance, to find the true diſtance, if the latitudes of the Moon and ſtar are of the ſame denomination; but to be added, if they are of contrary denominations. The ſecond of theſe two rules, though only an approximation, is ſo exact, that if the latitude of the Moon was 5°, and that of the ſtar 15°, the error reſulting would be only 10″ in the diſtance. Four places of figures will be ſufficient in computing from this rule.

If the diſtance of the Moon from the ſtar thus computed, at the aſſumed time under a known meridian, ſuppoſe Greenwich, agrees with the diſtance obſerved, corrected for refraction and parallax, the time at Greenwich was aſſumed right, and the difference between this time and the time of the obſervation under the unknown meridian, is the difference of longitude in time between the ſaid meridian and Greenwich; which is turned into degrees and minutes of the equator, by allowing 15° for every hour, and 1° for every four minutes of time.

But if the diſtance computed differs from the diſtance inferred from the obſervation, it muſt be found by proportion from the Moon's horary motion to or from the ſtar, how long time ſhe will take to run over that difference; whence the time will be found at Greenwich, when the true diſtance of the Moon from the ſtar was the ſame with that reſulting from the obſervation; which, compared with the time of the obſervation by the meridian of the ſhip, gives the difference of longitude from Greenwich, as before. If the diſtance of the Moon from the ſtar computed agrees with that reſulting from obſervation within 10′ or 12′, and the diſtance of the Moon from the ſtar be not leſs than 20° or 30°, the horary motion of the Moon in the ecliptic may be taken for the horary motion of the Moon to or from the ſtar; but otherwiſe, the Moon's longitude and latitude muſt be found at an hour's interval after the time aſſumed at Greenwich, by adding the horary motions to the longitude and latitude computed; and by the application of the rules, the diſtance of the ſtar from the Moon muſt be found again at the end of that hour; which gives the horary motion to or from the ſtar, as required.

It is to be obſerved, that the longitude thus found, is that of the ſhip, at the inſtant when the altitude of the Sun or ſtar was taken, by which the watch was regulated, and not at the time of the obſervation of the diſtance of the ſtar from the Moon; for the watch being ſuppoſed not to vary conſiderably during that interval of time, muſt continue, to indicate the time according to the meridian, by which it was corrected; and the obſervation of the diſtance of the Moon from the ſtar ſhewing the time at Greenwich, the difference

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muſt ſhew the difference of longitude between that meridian and Greenwich.

Perhaps the following method of deducing the longitude from the obſervations may be leaſt liable to miſtake:

Find what the longitude by account was, at the inſtant of taking the Sun's or ſtar's altitude, for the regulation of the watch; which being turned into time, at the rate of one hour for every 15°, and four minutes for every degree, add to the correct time from noon, when the diſtance of the ſtar from the Moon was taken, if the ſhip is to the weſt of Greenwich, or ſubtract from it, if it be to the eaſt: this gives the apparent time at Greenwich by account; and the mean time is found, by applying the equation of time; to which time, compute the Moon's longitude and latitude from the tables, and the diſtance of the ſtar from the Moon, by the rules, and find, by proportion, as before, what time the Moon will take to run over the difference between the diſtance computed, and that reſulting from the obſervation; this turned into degrees and minutes of the equator, will ſhew the error of the ſhip's account; and the following rules will ſhow, whether the ſhip is to the eaſt or weſt of its account:

If the diſtance of the Moon obſerved eaſt of a ſtar (or the Sun in the firſt quarter) is greater than that computed, the ſhip is weſt of the longitude by account; but if the diſtance obſerved is leſs than that computed, it is eaſt of account.

If the diſtance of the Moon obſerved weſt of a ſtar (or the Sun in the laſt quarter) is greater than computed, the ſhip is eaſt of account; but if the diſtance

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observed is less than computed, it is west of account.

The horary motion of the Moon in the ecliptic may be thus made out very expeditiously from Mayer's equations, by the help of the principal arguments used in the computation of the Moon's place. Call A, B, C, and D, the differences of the equations of the center, evection, and variation, and reduction to the ecliptic, for 1° addition to their arguments; where it must be noted, that they must have the same sign as the equation, if it is increasing; but a contrary sign, if it is decreasing. Compute the value of $32' \, 56'' + A \times \frac{11}{20} \times \frac{99}{100} + B \times \frac{1}{2} \times \frac{16}{17}$, which put $= H$; and the true horary motion of the Moon in her orbit $= H + C \times \frac{H - 2' \, 28''}{60'}$, which put $= K'$; and the horary motion of the Moon in the ecliptic is $K + \frac{D \times K'}{60'}$.

The horary motion of the Moon in latitude, calling the difference, answering to 1° increase of the argument of latitude E, is $\frac{E \times K'}{60'}$.

The most difficult part in the above computations, and in which a person is most liable to make mistakes, is the computation of the Moon's place; but if this be done at land for every twelve hours at least, and the distance of a proper star, or of two stars, one to the east, and the other to the west, from the Moon's enlightened limb, be computed for every six hours at least, according to Monf. De la Caille's proposal, the rest of the computation, which will remain to be done at sea, will be very plain and concise.

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Here follows the ſeries of my determinations of the longitude, during my voyage, delivered in an extract of my ſea journal. The firſt column contains the day of the month; the ſecond, the latitude; the third, the longitude, which I deduced from my obſervations of the Moon, reduced to the neareſt noon; the fourth ſhews the longitude per account, kept in the uſual manner; the fifth gives the difference between the third and fourth columns, and expreſſes how much the longitude deduced from the obſervation of the Moon is weſt of the longitude per account; the laſt column ſhews, whether the diſtance of the Sun from the Moon, or diſtance of what ſtar from the Moon, was obſerved.

1761.
♂ Jan. 20. At noon, took our departure from the Lizard, which bore full north, diſtance 21 miles, allowing its longitude from London to be 5° 14′ weſt, and latitude 49° 57′ north.

	Latitude.	Longitude W. by obſervation of Moon.	Longitude per reckoning.	Longitude by Moon W. of account.	The Sun or ſtars whoſe diſtance from the Moon's enlightened limb was taken.
	° ′	° ′	° ′	° ′	
♂ Feb. 10.	16 49 N.	30 22 W.	27 33 W.	2 49 W.	Sun's E. limb from Moon's W. limb.
11.	14 3 N.	29 22 W.	26 47	2 35 W.	Sun's E. limb from Moon's W. limb.
15.	5 10 N.	23 39 W.	22 44	0 55 W.	Cor Leonis from Moon's W. limb.
19.	1 42 N.	23 35	22 44	0 51 W.	Pollux from Moon's E. limb.
28.	9 6 S.	29 44	26 2	3 42 W.	Sun's W. limb from Moon's E. limb.
March 9.	24 9 S.	30 7	25 55	4 12	Aldebaran from Moon's W. limb.
10.	25 51 S.	29 32	24 32	5 0	Aldebaran from Moon's W. limb.
13.	29 49	27 55	22 19	5 36	Sun's E. limb from Moon's W. limb.
		27 44		5 25	Cor Leonis from Moon's W. limb.
15.	30 8	26 52	22 8	4 44	Cor Leonis from Moon's W. limb.
17.	30 39	24 50	18 58	5 52	Pollux from Moon's W. limb.
		25 5		6 7	Spica Virginis from Moon's W. limb.
18.	31 1	24 0	18 47	5 13	Pollux from Moon's W. limb.
		24 33		5 46	Spica Virginis from Moon's W. limb.
19.	31 37	21 41	17 7	4 34	Pollux from Moon's W. limb.
20.	32 4	20 19	15 27	4 52	Pollux from Moon's E. limb.
		22 4		6 37	Antares from Moon's E. limb.
25.	31 23	12 4	5 57	6 7	Spica Virginis from Moon's E. limb.
26.	30 51	9 55	4 17	5 38	Spica Virginis from Moon's E. limb.
29.	30 32 S.	6 49 W.	1 13 W.	5 36	Sun's W. limb from Moon's E. limb.

April 6. $7\frac{1}{2}$ A. M. came to an anchor in the harbour before James's fort at St. Helena; making the latitude per account 15° 55′ S. longitude per common reckoning 1° 28′ E. longitude corrected by obſervations of the Moon 4° 16′ W.

By

By the comparifon of the longitude determined by the Moon, with the longitude by the common reckoning, we feem to have been fet by a current to the eaftward about 20 miles per day, between February 10th and 15th, while we were paffing from 17° to 5° north latitude, at the diftance of about 11° weftward of the coaft of Guinea; and I am told that fhips paffing near the coaft of Guinea always meet currents, which fet them in upon the land, which are fo much the ftronger the nearer they approach the coaft; as on the contrary, if they approach the oppofite coaft of the Brafils, they will be fet by a current to the weftward, which appears to have been our cafe; for between February 19th and 28th, during which time we paffed by the moft eaftern part of the coaft of Brafils, leaving cape St. Auguftin only 6° to the weft of us, we appear to have been fet by a current at the rate of 20 miles per day to the weftward, and from this time to our arrival at St. Helena, we feem to have been continually fet to the weftward, though flower than before; which muft have been owing to our approaching fo much nearer, and continuing fo much longer near the eaftern coaft of South America, than the weftern coaft of Africa.

Though I had no obfervation of the Moon within lefs than eight days of my arrival at St. Helena, I make the longitude of the ifland, by my account, to be only $1\frac{1}{2}$° eaft of its true fituation, which is $5\frac{3}{4}$° weft of London; whereas the account kept in the common manner made the ifland $1\frac{1}{2}$° eaft of London, or $7\frac{1}{4}$° eaft of its true fituation, and moft of the accounts on board the fhip made it 10° eaft of the true longitude. Having got twelve obfervations in the

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compaſs of eleven days, between March 9th and 20th, I had the curioſity to compare them together. Setting aſide any errors in the common method of keeping a ſhip's reckoning, and ſuppoſing us not to be affected by currents during this time, the ſame difference ought to have been found between all the longitudes by account, and the longitudes deduced from the Moon, or the ſame error of the common account ought to have reſulted from all the obſervations. The mean error of account from all the twelve obſervations is 5° 20′, by which we were really more to the weſt than our account made us. And comparing each particular error of account with this quantity, the difference between them, in any of the twelve obſervations, ſcarce exceeds a degree; whence we may ſuppoſe, that the longitude was deduced truly from every one of theſe twelve obſervations, within the compaſs of leſs than $1\frac{1}{2}$°.

I have ſet them down in the following table, the error of the common account, and the difference between 5° 2′, the mean quantity of it, and each particular error of account, which, except in the firſt and laſt obſervations, does not exceed $\frac{3}{4}$°. The laſt obſervation, which differs moſt from the medium, was taken in ſome haſte, on account of the poſition of the ſails of the ſhip, which did not allow a mean uninterrupted view of the ſtar; nevertheleſs, as I was tolerably ſatisfied with the obſervation at the time, and as it does not materially differ from the others, I did not think proper to reject it.

	Error of account.		Difference between 5° 20′, and each particular error of account.	
1761.	°	′	°	′
March 9.	4	12	— 1	8
10.	5	0	— 0	20
13.	5	36	+ 0	16
	5	25	+ 0	5
15.	4	44	— 0	36
17.	5	52	+ 0	32
	6	7	+ 0	47
18.	5	13	— 0	7
	5	46	+ 0	26
19.	4	34	— 0	46
20.	4	52	— 0	28
	6	37	+ 1	17
Mean error of account	5	20		

After finding ſo great an agreement in the reſult of all my different obſervations, whether made on the ſame or different ſtars, or on the ſame or different nights, I muſt own I find myſelf at a loſs to account for the great difference found by the Abbé De la Caille, in the reſult of ſeveral obſervations taken by himſelf, and a friend of his, at land, which ought to agree ſtill nearer with one another than thoſe made at ſea. I cannot conceive that ſuch able obſervers could be liable to an error of 5′ in meaſuring the diſtance of a ſtar from the Moon's limb, if their inſtruments were not faulty. The moſt likely and the moſt common cauſe of error lies in the ſpeculums and dark glaſſes;

glaſſes; for if theſe are not ground truly parallel, which I am afraid they very often are not, by the common methods, they may eaſily produce a refraction of ſome minutes.

As a proof how near different obſervations made in compaſs of an hour or two will agree in giving the ſame longitude, February 11th, by ten different obſervations of the diſtance of the Moon from the Sun, I made the longitude, reduced to noon as uſual, 28° 57′, 29° 50′, 29° 16′, 29° 22′, 29° 53′, 28° 59′, 29° 30′, 29° 48′, 29° 30′, 29° 30′: none of which differ above half a degree from 29° 22′, which is the medium of them all. March 18th, by four different obſervations of the diſtance of Pollux from the Moon, I found the longitude 23° 52′ twice, and 24° 8′ twice. I never found that a ſingle obſervation would give the longitude above a degree different from the medium reſulting from three or four obſervations, and ſeldom above half a degree; which argues, that the error of any ſingle obſervation never exceeded two minutes, and ſeldom one minute.

From the whole, I congratulate the curious aſtronomer and ingenious mariner, that the method of finding the longitude, propoſed by Sir Iſaac Newton, is by the improvement of the theory, of which he laid the foundation, and, by the great perfection to which our artiſts have carried the conſtruction of inſtruments, rendered practicable in our times, at ſea as well as at land, to a degree of exactneſs ſufficient to make it of great and valuable utility to the extenſive navigation and commerce of our native country.