

Certaine  
ERRORS IN  
NAVIGATION,

Arising either of the or-  
*dinarie erroneous making*  
or vsing of the sea Chart, Com-  
passe, Crosse staffe, and Tables of  
declination of the Sunne, and  
*fixed Starres detected and*  
*corrected.*

By E. Wright



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## *A correction of Errors*

lar and difference of latitude are proportionable. Whereof it followeth that so oft as one of these equal parts of the difference of latitude is contained in the segment of the rumb betwixt the two places (which before wee shewed to bee so oft as a degree of the meridian in the globe, is contained in the segment of the rumb betwixt the same places in the globe) so oft is one of the said equal parts of the perpendicular aforesaide (that is a degree of the æquinoctiall) contained in the segment of the same rumb betweene the foresayde crossing or ende of the perpendicular, and the æquinoctiall. Therefore looke how many degrees of the æquinoctiall there are found in the segment of the rumb of the two places, so many score legues is the distance of those two places, which was to be demonstrated.

Thus haue you a way infallible to find out the distance betweene any twoo places measured in their rumb: which because it is then onely their true distance (that is the shortest space betwixt the vpon the superficies of the terrestriall globe) when both places lie north and south each from other, or east and west, hauing no latitude: whereas otherwise the segment of the rumb betweene the two places is alwaies greater (yea sometimes greater by halfe and more, in places farre northwardes or southwardes) then the true distance: I thought good also here to sette downe the way to finde out the true distance of any two places, wherein I haue beene, and yet am publikely charged with my promise, and meane at this time to discharge my selfe thereof.

## *in the sea Chart.*

The true distance betwixt twoo places is the arch of a great circle intercepted betwixt them, which is thus to be found out.

If both places haue no latitude (as when they are both vnder the æquinoctiall) and one of them also no longitude, the longitude of the other being lesse, or not more then 180. degrees: the longitude is the distance.

But if the longitude be greater then 180 degrees, subtra& it out of 360. the remainder is the distance.

If both places haue either none or the same longitude (as when they are in the same semicircle of the meridian betweene the poles) and one of them onely haue latitude, that latitude is the distance. But if both places agreeing in longitude haue latitudes also of like denomination (as both northerly, or both southerly) subtra& the lesser latitude out of the greater, the distance remaineth. If one place haue northerly latitude, and the other southerly, adde them together, the summe is the distance.

If one or both places haue latitude, and differ also in longitude: in a great circle diuided exactly into degrees (with figures set to euerie fifth or tenth degree) note the longitudes of both places.

## A correction of Errors

foote in H (where the degrees beginne) the other stretched forwardes in the circle, will poynte you out the distaunce of Saint *Thomas* Ilande and *London*, 52 degrees of a great circle, and about one halfe, that is, 1050 leagues, or 3150 english miles.

If both places haue latitude, do the like for both places as before you did for the one place hauing latitude, till you haue crossed both diameters with perpendiculars: then take with your compasses the distance of those crossings. Now if both their latitudes bee of one denomination (that is, both northerly or both southerly) and equall, sette one foote of the compasses where the degrees begin to be numbred in the circle, and the other foote extended therein, that way which the numbers succede will shew you the distance.

As for example, *London* and *Cape Blanco* (neare the coast of new found land) haue both northerly and almost equal latitude of 51 degrees, 32 minutes. Hauing therefore drawne as well the diameters *BC* and *DL* from *B*, determining the longitude of *London* (viz. 22 degrees) and from the poynt of the longitude of *Cape Blanco* (which admitte to be 331 degrees, as also the perpendiculars or sines of both their latitudes, *EF*, and *KL*, (as before was shewed) crossing the diameters in *F* and *L*. The distance *FL* taken with the compasses, and translated into the circle (as the former example) wil shew you the distance of *cape Blanco* from *London*, to bee almost 31 degrees, of a great circle that is 620 leagues, or 1860 miles.

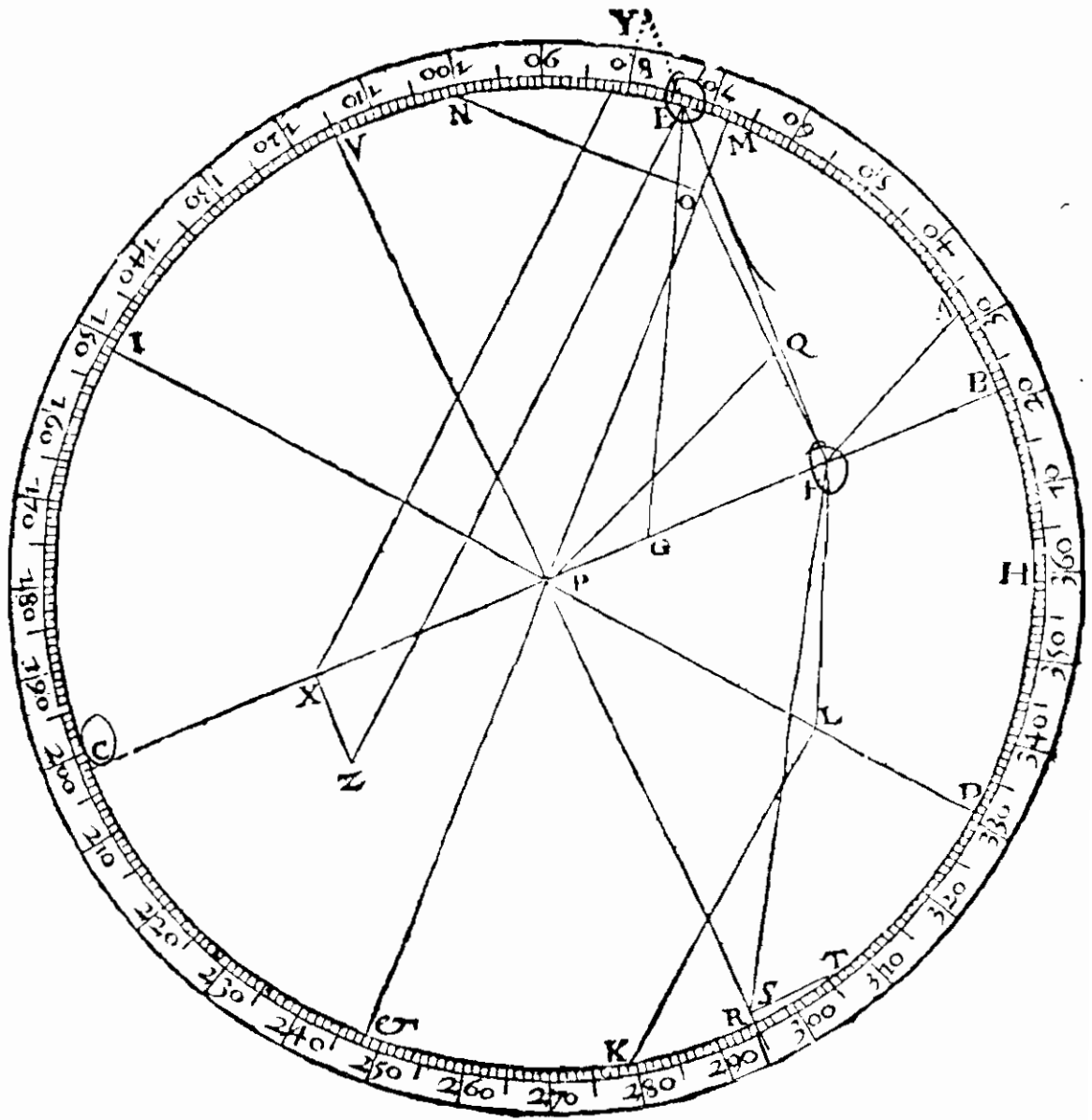
If the latitudes be not both equall, and also of  
one

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*in the sea Chart.*



one denomination, leaving one foote of the compasses in the crossing of the line or perpendicular descending from the poynt of the greater latitude, with thother foot make a prick in the same diameter, wherein that crossing is: Then if the latitudes  
be

## A correction of Errors

be both of one denomination, take with the compasses the length of the perpendicular or sine drawne from the poynt of the lesser latitude : and setting one foote in the poynt of the greater latitude, with the other make a pricke in the perpendicular descending from it, that is, in the sine thereof: Take the distance of this pricke from the former, made in the diameter : This distance transferred into the circle (as in the first example) wil giue you the distance of the places giuen.

As *London* and *Hierusalem* haue both northerly and vnequall latitudes, *Hierusalems* latitude being onely 32 degrees. First therefore note in the circle both their longitudes : the longitude of *London* (*viz.* 22 degrees) as before with B : The longitude of *Hierusalem* (68 degrees) note with M. Let the perpendicular or the sines of the latitudes of *London* and *Hierusalem*, E F, and N O be drawne as in the former examples. Make F P equal to O F, and P Q equal to N O. The space betwixt P and Q taken with the compasses, and then both feet set in the circle (in such sort as the first example was shewed) shall containe betweene them the desired distance of *Hierusalem* from *London*, 38 degrees, and about  $\frac{1}{2}$  that is 775 leagues, which are 2325 miles.

But if the latitudes be of diuers denominations, (that is, one northerly and the other southerly) continue forth the perpendicular (that crosseth the diameter, wherein the foresayd prick was made) till it be equal to both perpendiculars, that is, to the sines of both latitudes. The distance of the  
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## *A correction of Errors*

many degrees of a great circle are contained between both places.

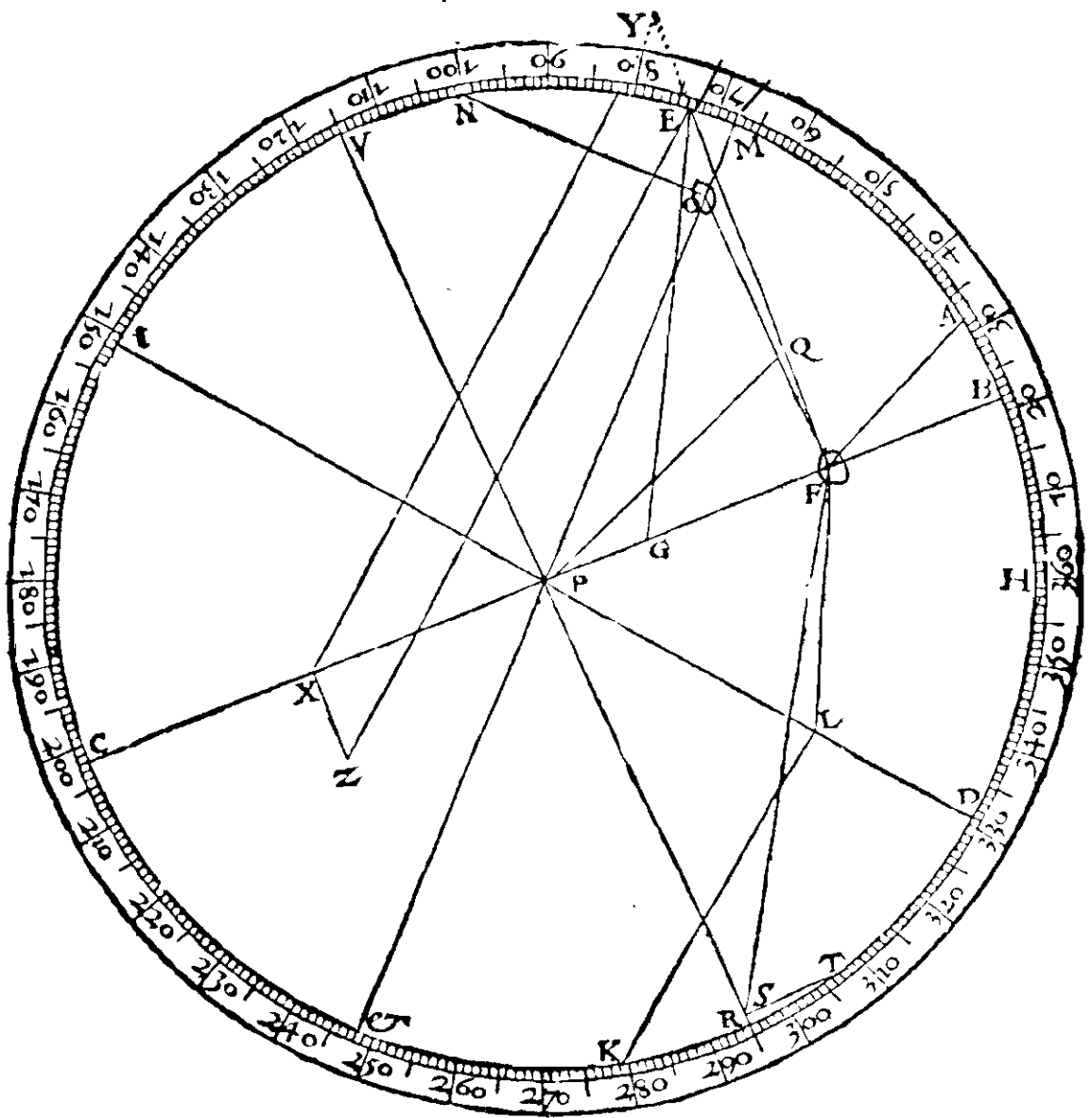
To shut vp this matter with one example, suppose you would know how farre *Cusco* in *Peru* is from *London*. Let the longitude of *Cusco* be 295 degrees, the latitude 11 degrees southerly : The longitude of *London*, as before, 22 degrees, the latitude 51 degrees, 32 minutes. From both these longitudes noted in the circle with B and R, draw the diameters, as before, B C, and R V : as also the perpendiculars or sines of their latitudes E F, and T S. Make F X equall to F S, the distance of those sines, and E Y equall to S T the sine of *Cuscoes* latitude. Take the distance Y X betweene the feete of the compasses, and set them both in the circumference of the circle, as in the first exampl, so shall you finde that there are betwixt *London* and *Cusco* almost 97 degrees, of a great circle that is 1940 leagues or 5820 miles.

If you had rather keepe within the compasse of the circle, make the perpendicular X Z equall to S T, and proceede with E Z, as you did before with X Y.

He that desireth a demonstration of the former rules, must suppose the circle A B H D R & C to be the æquinoctial circle : let him also vnderstand the sines of latitude E F, K L, N O, T S, to stand perpendicularly erect from their diameters of longitude B C, D I, M &, V R, and from the plaine of the æquinoctiall, and consequently by the 3 e. 21. Ra, or 4. pr. 11 *Enc.* from the lines F A, F L, F O, F S, which lines are imagined to be in the plaine of the æquino-



in the sea Chart.



æquinoctiall, and are the distances of the lines of latitude. Therefore if  $FG$  be made æquall to  $FA$  (which is a line drawne in the plaine of the æquinoctiall from *Saint Thomas* Iland to the line of *Londons* latitude)  $EG$  must needs bee æquall to

## *A correction of Errors*

the line subtending the distance of London and S. Thomas Island by the 2. c 7. Ra. 4. 26. pr. 1. *Eucl.*

Also, because all the sines of latitude (being perpendicular to the same plaine of the equinoctial) are parallels, by the 5. c 21. Ram 6. pr. 11. *Eucl.* Therefore by the 11. c 2. Ram. or 35 d. 1. *Eucl.* FL is the line subtending the distance of London and Cape Blanco.

Again, because FP whereto EF is perpendicular is made equall to FO, (the distance of the sines of London and Hierusalem, to which (distance) EF is also perpendicular in the globe) and EQ also equall to NO: Therefore FQ being the difference of the sines of Londons and Hierusalems latitudes: there must needs be the same distance betwixt P and Q that there is betweene the toppes of the sines of Hierusalems and Londons latitudes in the globe.

Lastly, FX being equal to FS (the distance of the sines of latitude of London and Cusco in Peru) & XZ perpendicular to FX, and equall to ST the sine of Cuscoes latitude: as EF is the sine of Londons latitude and perpendicular to the same line XF: EZ (to which XY is equall by the 6. c 12. c 5 Ram. 33 pr. 1. *Eucl.* YE being equall and parallel to XZ must needs be equall to a streight line extended within the globe betweene the points of latitude of Cusco and London.

Now out of this demonstration it were an easie matter (if any list take the paines to be so curious) to find out the distance of any two places arithmetically by the doctrine of triangles, hauing alwaies

### *in the sea Chart.*

two sides giuen which are the sines of the complements of the latitudes of the twoo places as OP, FP: LP, FP: RP, FP: AP, FP: together with the angle intercepted that is the difference of their longitudes: whereby FA: FO: FL: FS, the distances of the sines of latitude being found by the 2, 3, 4, 5, *Copernic. de Triangulis planis*, the lines also subtending the distances of the places may most easily be found by the 3. *Copernic. de Triang. plan.* For the squares of the distance of the sines, and of the difference of the sines of their latitudes (if both be northerly or both southerly) or of the summe of the sines of their latitudes (if one be northerly another southerly) are equal to the square of the line subtending the distance of the places §. c 12. *Ram 47. pr. 1. Eucl.*

With no lesse facilitie also by helpe of the former Tables, and the Canon of Triangles, any two places being giuen, there may arithmetically and most exactly be found out, first, by their longitudes and latitudes, the rumbe, and distance measured in the rumbe: secondly, by their distance, and latitudes, the rumbe and difference of longitude: thirdly, by their rumbe, and latitudes, the distance and difference of longitude: fourthly, by their longitudes, rumbe, and one latitude, the other latitude and distance: fifthly, by the rumbe distance and one latitude, the other latitude, and the difference of longitude: or any other nauticall or geographical probleme that by the Chart may mœchanically be performed: and the whole Arte of Nauigation arithmetically (as some call it) may as easily be pra-

## *A correction of Errors*

Etised : So as, hauing onely the longitudes and latitudes of the places (by which, and to which you are to saile) set downe in a Table, you may by arithmetically calculation onely (if you list take the paines) without any chart, mappe, or globe, shewe the course and distance from anie place to other : and so giue most exact direction for the performance of an whole voyage to any knowne place assigned, how oft soeuer you haue trauerfed or bin tossed this way and that way by reason of scant, violent, or contrary windes, or any other occasion.

But seeing the first groundes of this Art, that is, the obseruations of the latitudes, but especially of the courses at sea, cannot but be farre from such exquisite truth as is to be found in those arithmetically operations : howe exact soeuer you be in the rest of the meanes, you can look for no more truth in conclusion then such as is answerable to the first groundes and principles, out of which the conclusion is gathered. So as the Mariner shall not need to trouble himselfe any further herewith, but only to cast vp his accounts vpon the chart truly made (as before is shewd) which of al other is most fit & ready for his ordinarie vse. Now therefore it may be sufficient, onely to shewe how the former Problemes may mechanically be performed vpon the nautical planisphere before described.

First, By the longitudes and latitudes of both places giuen, the rumbe and distance may thus be found : drawe parallels by both latitudes : take the distance of those parallels : according to which distance drawe a parallel to the æquinoctiall. Then  
from

### *in the sea Chart.*

from the end of the difference of longitude reckoned from the concurse of the rumbes in the æquinoctiall erect a perpendicular crossing the saide parallel: A line drawn by this crossing from the concurse of the rumbes is the rumb of the two places. Now to finde out the distance, take so manie degrees of the æquinoctiall as the the difference of latitude containeth: and guiding one foote of the compalles in the æquinoctiall, with the other foot carried parallel wise at equall distance from the æquinoctiall, crosse the rumb newly found out: take the distaunce of this crossing from the concurse of the rumbes, and let both feete of the Compalles in the equinoctiall, for the degrees intercepted shew you the distance desired.

Secondly, By the distance & latitudes (knowing which place is more eastwardes, or westwardes) the rumb & difference of longitude is thus found: Take with the compalles so many degrees and minutes of the æquinoctiall, as the difference of latitude containeth: According to that distance draw a parallel to the æquinoctiall, take so many degrees of the æquinoctiall with your Compalles as the distance giuen commeth to: then one foote being set in the concurse of the rumbes in the æquinoctiall, with the other crosse the parallel aforesaide: A line drawne by that crossing from the concurse of the rumbes in the æquinoctiall giueth you the rumb desired. Then both latitudes being noted in the graduated meridian, therein take their difference with the compalles, and guiding one foote in the æquinoctiall, with the other carried at that di-