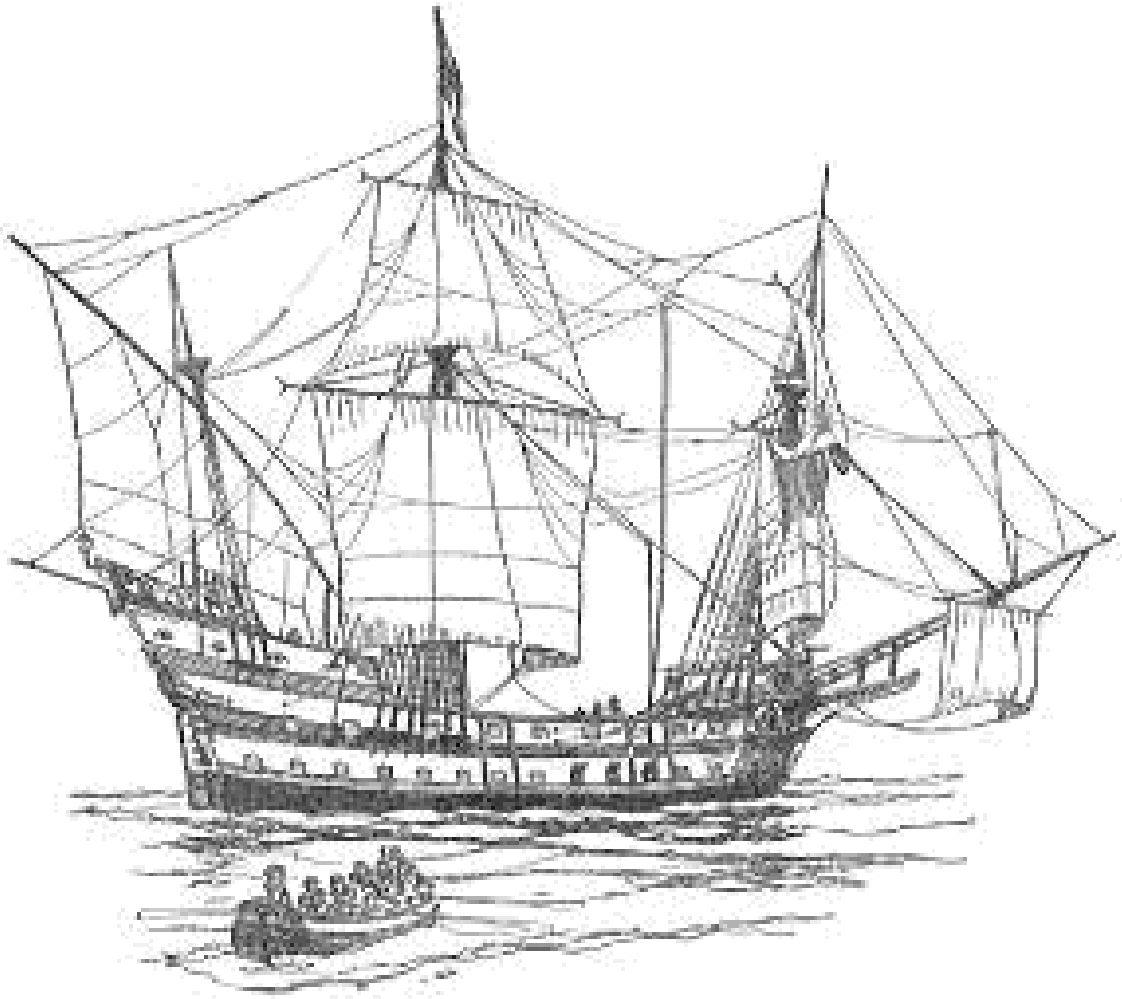
A Regiment for Alusian Seas



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Navigation Contents

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In which we list what advice we offer to Navigators.

The Introduction describes why Navigation is essential knowledge in this age, what is involved in Navigating, and what manner of person should become a Navigator.
The Glossary introduces and defines a number of useful terms that every Mariner must be familiar with.
The First Chapter shows what the 32 points of the compass are, and to what uses they may be put.
The Second Chapter treats of the golden numbers of Saros, showing the Epact, and thus the age of the Moon.
The Third Chapter teaches how to know by the age of the Moon what the time is, or when High Tide is at any place where you know what delay that place causes on the Tide.
The Fourth Chapter treats of the Sun and the Moon's course in the Zodiac, and how you shall know at what hours the Moon shall rise and set, and at what point of the compass, with other necessary things.
The Fifth Chapter is of a table of declination, commonly known by seafarers as the Regiment of the Sun, which will serve for every day of the month.
The Sixth Chapter shows how to take the height of the Sun with the Cross-staff or Astrolabe, and also how to find the true Meridian, with other necessary matters.
The Seventh Chapter shows how to handle the declination of the Sun, to know the altitude of the Celestial Pole above the Horizon, whether you are in normal climes, near the Equator, in the southern ocean, or near the Poles of the World.
The Eighth Chapter shows how you shall know the length of the day, and to know how much the day is shortened or lengthened by the Sun's declination.
The Ninth Chapter concerns the North Star
The Tenth Chapter shows you by using your compass, how far you sail to raise a degree, and how much you depart from the Meridian, etc.
The Eleventh Chapter shows how to know the distance of any land to you, if you know the distance between any two places, whether you run alongside the land, or directly towards the shore, or otherwise, with other necessary things.
The Twelfth Chapter treats of Longitude, etc.
The Thirteenth Chapter shows how many miles are in one degree of Longitude in every Latitude between the Equinoctial and the Poles, and also the diversity of aspects of the Moon.
The Fourteenth Chapter treats of the Longitude and Latitude of Certain of the most Notable Towns in the Baronies, and around all of Alusia; along with the different timing of the change of the moon, and the different lengths of the longest day in summer.
The Fifteenth Chapter shows how to sail by the Globe, and to know how much the water is higher than the level between any two ships on the sea, which grows by the roundness of the earth.
The Sixteenth Chapter is concerned with Charting, and of the three necessary things contained in all good charts, along with their uses.
The Seventeenth Chapter is of Longitude and declination of 32 notable fixed stars for Navigation, with tables of their shining, and at what point of the compass they do both rise and set; with tables for every month of the year, for mariners out from Seagate Port.
The Eighteenth Chapter shows you the making of a general Instrument, to know the hour of the day throughout the world.
The Nineteenth Chapter treats of the soundings of every major port, safe harbour and set of

shoals from Novadom along to Destiny; with other necessary matters for those that occupy or deal amongst sandbanks.
The Twentieth Chapter touches on the variation of the compass, called the Northeasting and Northwesting, and how to give a guess to know the Longitude.
The Twenty-first Chapter explains the importance of a good Ships Log, including examples from an actual log.
The Twenty-second Chapter shows the making and use of a Sun Compass, for those navigating on a vessel powered with Cavorite.
The Twenty-Third Chapter touches on some of the theories of the Behaviour of Planets, including which elements may concern Navigators, and which may safely be ignored.
The Twenty-Fourth Chapter lists some of the Navigational numbers for Alusia, along with comparisons to two other worlds explored by the author.
The Twenty-Fifth Chapter is a speculative work raising matters for consideration in Navigating through the Void of space when travelling to other worlds.
The First Exercise details how to find your latitude from three different measures.
The Second Exercise details how to locate where the Sun will be at any time and place.
The Third Exercise details how to locate where the Moon should be at any time and place, ignoring the effects of Saros and the Auge.
The Technical Appendix contains links to a collection of configurable tables that will save the casual Mariner much calculation.

Glossary

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This Glossary of Navigation introduces and defines a number of useful terms that the Mariner must be familiar with.

The names of certain things are necessary to be known by all mariners or seafarers, who wish to practise Navigation, and they include: the names of circles of the Sphere, and what they are, and their uses; and also the names of other things belonging thereunto, and what they are, and their uses.

The Horizon Circle

The Horizon is the parting of the earth or the Sea and the sky, that is to say, the half of the heavens being above over your head, and the other half hidden by the earth or the sea under them; and this Horizon circle does move as you move: for as you travel and change your place, so does the Horizon change in all points.

The Use of the Horizon Circle

The use of the Horizon circle is this: to take the height of the sun or any star, with the cross-staff, setting one end in line with the Horizon, and the other end with the Sun or the star, so that you have a true Horizon; and that must be done upon the sea, or upon level ground on the top of a hill, otherwise it is no true Horizon. And also if the Sun or Moon, or any star is to be seen, they must also be above the Horizon; if they are not to be seen, then they are under the Horizon.

The Meridian Circle

The Meridian is a circle beginning due South, and so passing by your Zenith (that is, right over the crown of your head) and heading due North, and so connecting the two Poles of the world; and if you travel due South or North, you do not change your meridian; but in going any other way, you change it.

The Use of the Meridian Circle

The Meridian circle is used to know the exact time of noon by the Sun; for as soon as the middle of the Sun is upon the Meridian, then it is noon, and when the Sun, Moon, or any Star is upon the Meridian, then they are farthest from the Horizon, and it is a good time to take their height so as to know the altitude or height of the Pole, whereby you may perfectly know how far you are to the North or South of any place.

The Equinoctial Circle

The Equinoctial is a fixed circle in the Heavens equally distant from both the Poles, and passes directly over the middle of the earth. It is called the Equinoctial, for if the Sun is there, then throughout the world the Sun is twelve hours above the Horizon and twelve hours under the Horizon, saving the two Poles for there the Equinoctial is at one with the Horizon, so they shall see half the Sun and no more, until the Sun departs from the Equinoctial. Also for those that live on the Equator, which is directly under the Equinoctial, the Sun, the Moon, and all the Stars will be twelve hours above the Horizon and twelve hours under it, at any time of year.

The Use of the Equinoctial Circle

The Equinoctial is used to know what declination the Sun or any other Star has from it, and on which side, and by that know the height of the Equinoctial, and from that, the height of either of the two Poles of the Worlds.

The North Tropic Circle

The North Tropic is the greatest declination that the Sun comes Northwards, and at that time are our longest Summer days and shortest nights. This tropic is a circle parallel to the Equinoctial. Here the Celestial Pole is at an altitude of 23 $\frac{1}{2}$ degrees at all times.

The South Tropic Circle

The South Tropic is the greatest declination that the Sun goes Southwards, and at that time are our shortest Winter days and longest nights. This tropic is a circle parallel to the Equinoctial. There is little use for these two circles in Navigation, being more an Astrological phenomenon.

The Arctic Circle

The Arctic circle is the southernmost part of the earth for which the sun stays above the Horizon during an entire day in midsummer, and does not rise for at least one once day during deepest winter. It is a circle parallel to the Equinoctial made by the pole of the Zodiac. Here the Celestial Pole is at an altitude of 66 $\frac{1}{2}$ degrees at all times.

The Antarctic Circle

The Antarctic circle is the southern twin to the Arctic circle, being the northernmost part of the earth for which the sun stays above the Horizon during an entire day in the Antipodean midsummer, and does not rise for at least one once day during their deepest winter. It is a circle parallel to the Equinoctial made by the pole of the Zodiac.

The Celestial Circle

The Celestial circle is centred on the Celestial Pole and touches the Horizon at due North, and so varies according to the place that you are in, widening and narrowing according to the altitude or height of the Pole; for as you go Southwards, then your Celestial circle narrows, until you come right under the Equinoctial line, and then you have no Celestial circle; and as you go Northwards, then your Celestial circle grows wider, and when you stand on the Arctic Circle, there your Celestial circle is co-extensive with the North Tropic circle, and under the Celestial Pole, your Celestial circle is the Equinoctial.

The Use of the Celestial Circle

The Celestial circle is used to know what stars never set for you; for all those stars or lights that you see under the Celestial Pole do not set; and by knowing the position of your stars, you may know your Northing immediately.

The Hidden Circle

The Hidden circle is centred on the Hidden Pole and touches the Horizon at due South, and is opposed to the Celestial circle, for however each circle widens and narrows always the other

circle is of the same size; so the Hidden circle does not differ from the Celestial circle, saving that the Celestial circle is above the Horizon and the Hidden circle is beneath.

The Use of the Hidden Circle

The Hidden circle is used to know what stars will never rise above your horizon. When the Equinoctial is to your north, the Celestial Pole is hidden, and the Hidden Pole shows in the heavens; here the roles of the Celestial and Hidden circles are also transferred.

The Zodiac Circle

The Zodiac is the greatest circle in all the Heavens, wherein all the wanderers or planets keep their courses, that is to say the Sun and Moon, the two inferior Aether Worlds Ariel and Freya, and the three exterior Aether Worlds Thunor, Wotan and Hela. The mystery that is Merlyn also stays within the Zodiac, when it is present at all, but should not be relied upon for Navigation. The Zodiac circle is said to be divided into fourteen equal parts, called the fourteen signs of the Zodiac, as Smith, Thief, Lover, Warrior, King, Mother, Magician, Wolf, Void, Reaper, Fool, Farmer, Maiden, Messenger, although other places and times have divided them otherwise. This circle stands oblique to the Equinoctial, crossing it at two opposite points: at its northernmost point the centre of the Zodiac reaches the North Tropic circle, and at its southernmost point the centre lies on the South Tropic circle. The Zodiac circle, unlike all other circles, is not a line, extending six degrees to the north and south of its centre, making the Zodiac twelve degrees broad.

The Use of the Zodiac Circle

The Zodiac is used to know in what sign the Sun and Moon and the other planets lie in as they move, and also to know the time of the change of the Moon, with all the other Aspects; and in like manner to know the aspects of all the other planets unto the Moon, and also the planets amongst themselves; and by the aspects in the fourteen signs is gather their effects, and in what country it may happen. Many more properties of the Zodiac are mastered in Astrology, and I leave further matters to those esteemed experts.

The Ecliptic Circle

The Ecliptic circle is the circle lying in the heart of the Zodiac, running through its centre from Tropic to Tropic, along which the Sun travels upon.

The Use of the Ecliptic Circle

The Ecliptic circle is used for tracking the variance of the wanderers through the Zodiac. If the Moon or other planet be to the North of the Ecliptic, it is said they have North latitude, and if they lie to its south, then the have south latitude, and also by this circle is known the eclipse of the Sun and the Moon.

The Seasonal Circles

The Seasonal, or Colour, circles divide the all the parallel circles and the Zodiac into four equal parts, the one of the circles crossing the Zodiac between the King and Mother, and again between Farmer and Maiden and passing through the two Poles of the World is called the Equinoctial circle, and the other circle crossing the Zodiac in the Thief and Void is called the Solstitial circle, and each circle meets the other at the two Poles of the World.

The Use of the Seasonal Circle

The use of the Seasonal circles is that as the Sun passes by them, it divides the year into four parts, and this can be used to precisely locate the Equinoxes and Solstices, being essential knowledge for both advanced Navigation and Astrology. From this, when the Sun lie in the Smith, Thief and Lover it is Summer, the King and Mother are Autumnal, the Wolf, Void and Reaper are Winter signs, and Farmer and Maiden are of the Spring, and the Warrior, Magician, Fool and Messenger are signs of change between these seasons.

The two Poles of the World

The two Poles of the World (that is, the Celestial and Hidden Poles, and their terrestrial counterparts the North and South Poles), are to be imagined as a single axletree, as the one Pole is always aligned directly with the other. The Celestial pole is always above our Horizon, and the Hidden Pole always under our Horizon, being fixed fast in the Heavens, and the Equinoctial lying equally between them. The reason why they are to be seen as an axletree is that the whole Heavens and all the lights of the firmament are carried round from the East to the West in twenty-four hours, so that no light or place remains stationary, except the two Poles of the Worlds around which all else revolves.

The Use of the Poles of the World

The Poles are used as the ends of the measure of latitude, which is to know how far you have travelled, and to know what climate and temperature you can expect.

The two Poles of the Zodiac

The two Poles of the Zodiac, or Ecliptic, are to be imagined as an axletree, as the one Pole is always aligned directly with the other, and the Ecliptic lies equally between them. And the Sun and the Moon and the planets and fixed stars are carried Eastwards in a year according to the standing of the Zodiac.

The Use of the Poles of the Zodiac

The Zodiac Poles are the meeting points of all the meridian lines which are the divisions between the fourteen signs of the Zodiac and also of the four circles of the seasons. The meridians between the Zodiac signs can then be used to classify stars that lie outside the Zodiac according to the signs.

The Zenith Point

The Zenith or vertical point is a point in the Heavens right over the crown of your head, and moves as we do, and is as an axletree to the Horizon circle; for as you travel from one point to another, so your Zenith and Horizon circle move also. And beneath your feet lies its opposite, the Nadir point.

The Use of the Zenith

The Zenith point is used to know how far or near any star is from your Zenith, by taking the true height of the star with an instrument, for the height of the Zenith is always 90 degrees from the Horizon on any side of you.

A Degree

A Degree is the part of a whole circle divided evenly into 360, howsoever big or small the circle is.

The Use of a Degree

Degrees are used to measure and track the course of the Sun and the Moon through the Zodiac, or any of the planets or wanderers, and to know at any time how many degrees they may be apart, or when they have the same aspect (location). And also, degrees are used to know what latitude and what declination any light or star has from the Ecliptic or Equinoctial, and also the degrees will show how many miles you have travelled to the North or South, for every degree is equivalent to 60 nautical miles when travelling North or South, and can be known by the altitude of the Celestial Pole or the number of degrees between the Equinoctial and your Zenith. This can be reckoned as from your Zenith to the Horizon is 90 degrees in all directions, and is half the compass of the visible Heavens, and as the earth hides the other half of the Heavens beneath it, twice of twice 90 makes 360, which is the contents of every great circle in the sky.

A Minute

There are two sorts of Minutes - those of time and of measure, and each is a sixtieth part of a greater time or measure, being Hours and Degrees. So a Minute of time is one sixtieth of an Hour, and a Minute of measure is one sixtieth of a Degree, or a nautical mile. A Minute of either sort can be sub-divided into 60 Seconds.

Altitude

Altitude is the height of any thing. Of Celestial bodies such as the Sun, Moon, Stars, or the various Poles, it is measured in degrees from the Horizon, and of Terrestrial objects it is measured in height from sea level or another level surface.

Latitude

Latitude is the Northing of any thing. Of Celestial bodies such as the Moon or Stars, it is measures in degrees of variation North or South from the Ecliptic, which is the path of the Sun. On the earth, Latitude is the number of degrees of variation from the Equator, wherein the North & South Poles have 90 degrees of Latitude from the Equator.

Longitude

Longitude in the Heavens is of a Celestial body relative to a sign of the Zodiac, and if it be in such a sign, and so many degrees of travel into it, then it is said that they have so many degrees Longitude in that sign. An example being that when the Sun is 13 degrees along in the Void, it is the day of the Winter Solstice. The Sun travels 360 degrees of Longitude through the Zodiac in a year of 364 days, and so each day the Sun progresses one degree of Longitude through its current Zodiac sign, except on the High Holidays, where it is reckoned that the Sun moves not. The Moon, while it travels through it's waxing cycle in 28 days, only takes 26 days to move through the Zodiac, so it moves through a sign in a little less than two days, except that it moves faster and slower depending on the Dragon and its Auge. And Longitude upon the earth is counted from the city of Tycho to the Westwards or Eastwards, that if any town be to the West so many degrees from Tycho, then it is said to be at so many degrees of Longitude West, and otherwise of degrees Longitude East. And Tycho lies on the

Prime Meridian, that is, neither East nor West, and that which is exactly on the far side of the earth from Tycho is of 180 degrees Longitude, and is neither East nor West. From this Longitude is known the difference in time of day from another location, as for every 15 degrees East one travels, an hour is lost, and the reverse when travelling Westwards, thence travelling to the West always is slightly faster, racing the Sun. Also is known the time of the changes of the Moon, or any other aspect, including Eclipses of the Sun or Moon, at that place.

Declination

Declination is counted only in the Heavens, where if the Sun or any other star is to the North or South of the Equinoctial, then it is said to have so many degrees of declination to the North or South. This is not the same as Celestial Latitude, which is the deviation from the Ecliptic who lies at an acute angle to the Equinoctial as shown above, but Declination is in true correspondence with Terrestrial Latitude.

The Properties of a Circle

Each circle has the same properties, regardless of its size, or if it be Heavenly or not. The Circumference is the encompassing of a circle around its outer edge. The Centre of the Circle is the middle point, equally distant from every edge. The Diameter is the breadth of a circle, passing right over the centre, from outside to outside. The Radius is the size of a circle, from the centre to the outside only. Two circles are Parallel if the closest points on their respective edges are equally distant in every place.

Auge

The Auge is a time where the Moon is furthest in its eccentricity, being nearer the Heavens and further from the earth than is common. To know this point, it is necessary to understand that the Sun and Moon do not travel in a perfect Circle around the earth (or the earth around the sun - it is of no matter which, to we mariners). There path is distorted lengthwise, and its distortion is its eccentricity, measured against the size of the circle it would otherwise travel. When the Moon travels furthest from the earth, this is the Apapsis of its path, and marks the time of the Auge, and when it is closest, this is the Periapsis of its path, and marks the opposition of the Auge. The Auge is used to know when the Moon is moving most slowly, for the closer the Moon is to the earth, the faster it moves. Also, weaker tides occur at the Auge, and stronger at its opposition. On Full and New Moons at the opposition the King Tides occur, leading to much flooding and disaster on the coast, and also rocks that otherwise are deep rise to the surface and rip the hulls of unwary mariners. Thus a good Navigator always knows not just the phase of the Moon, but its times of Auge.

The Dragon

The head of the Dragon Saros is the place where the Moon crosses over the Ecliptic line from South to North, and the tail of the Dragon is where it passes back to the South again. During these times are when there is the greatest chance of an eclipse of the Moon or Sun, and from its crossing times and Auge, one can know of what type and time the eclipse will be.

Introduction to a Regiment for the Sea

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A collection of useful writings, rules of thumb and tables that every Navigator should know.

This is a reworking of writings by William Bourne, with all tables and calculations updated to reflect conditions on Alusia accurately, including our Calendar, Zodiac and planets, and extended to include flying vessels. Some of the original sections have been omitted, expanded, or rearranged, and the language made much clearer. The original work is out of Copyright, having been written in 1574.

Introduction

In my opinion, which is also the saying and writing of all the Philosophers, those things are most principally to be taught and maintained, which are the most profitable and necessary. Then may I boldly say and affirm, that Navigation is not the least but one of the principal matters to be known in these times; considering that state and situation of our country, for we are nearly surrounded by the sea, so that we neither can visit far-away places, nor they that are of distant countries can come to us, but only by the Sea. These things considered, what can there be more necessary to be taught for those interested in travel and high adventure than Navigation, considering also what Navigation is - how to direct ones course through the sea, where one has no know path to the place intended, and how to attain the port in the shortest time, how also to preserve the ship and goods in all common disturbances, such as storms, dangers by the way, and otherwise. Moreover, it is not unknown how necessary Navigation is, both for the transport of our commodities to other countries, and also the brining of other commodities to us, by which means we receive no small measure of comfort. Given this situation, so that Navigation continues to be a chief force and strength of our country, I have written this Regiment for the Sea with a few rules of Navigation. While the learned sort of Mariner has no need of this book, yet it may be a necessary aid for the simplest sort of Seafarer; for that they shall find here the names of the circles in the spheres, with the names of diverse things good for Navigation, together with their uses, which the majority of seamen do mistake or misremember; neither do they know the use of those tables being most necessary for Navigation.

Navigation

Navigation is how to direct the course of a vessel in the Sea or Heavens to any place assigned, and to consider in that direction what things may be of use or hindrance, having consideration of how to preserve the ship in all storms and changes of weather that may happen by the way, to bring the ship safe into the port assigned, in the shortest possible time.

The Use of Navigation

The use of Navigation is first to know the direction of any place from you, by what winds or points of the compass, and also how far that place is away, and also to consider the tidal flows and currents, and which way they do set or drive the ship, and also to consider what dangers lie upon the way such as rocks and sandbars and other impediments, and also if the wind should change or shift, to consider which way to travel to resume the course, and to direct your course to the most advantage to attain the port in the shortest time, and also if any storms happen along the way, to consider how to preserve the ships and its crew and goods, to bring her safe into the assigned port. Also, it is important to consider and foresee that if

you have by occasion of contrary tempest or other dangers of the high sea, to go very much out of your course, to know how the place now bears, and what other ports may be visited or avoided, howsoever far you are off course, and thence by what point of the compass each port is from you, and how far. The way to know this is to first consider by what compass point or direction the ship has made her way, and how swiftly she has gone, and to consider how often the ship has altered her course, and how much she has gone each time, and then to mark all this on your chart, and so you may give a near guess as to by what point or wind it bears from you, and also how far it is there. You may have assistance from the Sun or stars to estimate the height of the Pole above the horizon, and also in some places you may guess by your sounding, both by the depth and the ground. It is also very useful and necessary to recognise any port or landmark by sight, from many angles.

Instruments

The use of most Navigational Instruments, whether Astrolabes, or common Rings, or Cross staffs is to take the height of the Sun or other stars, to help determine one's position on the sea, and the behaviour of the Celestial bodies, and hence the tide, weather, etc. All instruments to take the height of the Sun or any star, are either a circle or part thereof, whose divisions are marked with the 360 degrees of a circle, whatsoever form it may have; even the cross staff is marked according to the proportions of a circle, and every one of the marks is of equal degree, although their spacing on a line differs.

Navigators

Regarding those persons that are appropriate to take charge, that is, to be masters of ships in Navigation, they ought to be sober and wise, and not to be light or rash-headed, nor to be too quick-tempered or hasty, but one who can govern themselves, for else it is not possible for them to govern their company well; they ought not to be too common or friendly, but instead keep their company in awe of them (by discretion), doing their company no injury or wrong, but letting them have only that which seamen ought to have, and then to see that they do their labours in all points. And the principle point in governance is to cause oneself to be both feared and loved, and that occurs principally by cherishing men who do well, and for those men that are honestly addicted to the sea, let them have reasonable pre-eminence in the company, so long as it proves not hurtful to either the owner or master, and to punish those malefactors and disturbers of the company, and give gentle admonition to amend their ways for small faults. And the two principle points for a ship's master are to serve the Archangels and to see that all the company does so in like manner, at such times as it is convenient to do so; and to not gamble or play at dice or cards, not (as near as one can) to suffer any such play, for any sufferance thereof may do much hurt in diverse respects. Furthermore, the master ought to be one that knows the Moons course, whereby they know at what time it is high or low water, knowing in what quarter that the Moon makes high water at that place, and also the master ought to be acquainted with any place that they sail (unless they have taken a pilot), and expert in how the tide gates or currents flow from place to place, and not ignorant of such dangers lying on the way such as rocks, shoals, or sand banks, and also most principally to be able to direct a course to any place assigned, and to have capacity to handle the vessel directly, if there is need to shift all crew in foul weather or storms. It also behoves them to be a good coaster, that is, to know every place and mark by sight. Those that take charge for long journeys ought to have knowledge of charts and logs, and also of such instruments that are used to take the height of the Sun or stars, and have the capacity to correct those instruments, and to calculate the Sun's declination or have tables or other regimen to allow this, and know how to accounts for the Sun's declination.

1 Navigation with a Compass

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In which is shown what the 32 points of the compass are, and to what uses they serve.

The first and principle thing for any seafarer or traveller to know is to which part of the earth they mean to go, and the direction of their course; for on the sea there is no path or mark to travel by, but only the use of the Needle and Compass.

1.1 The Compass

There are four cardinal winds or points, and they are the only points that have proper names, from which all others are derived. Of the capital points, South is directly from the Meridian, and North is directly against it, and East comes from the Equinoctial point towards parts where the Sun is rising, and West towards where the Sun is setting, and the four are equally spaced, with the Meridian being the determiner settling all argument. Between these lie the four secondary points, being the Northeast, Southeast, Southwest and Northwest, and each lies exactly halfway between their cardinal points. Altogether these eight points are known as the head winds, and sometimes also as the capital points. And then there are eight inferior points or winds, halfway between every one of these capital points, and they are the North Northeast, East Northeast, and so forth as shown below. And now between every one of these inferior points and every one of the head winds, there is a by point; but it having no true name of its own, it is known by the name of the closest head point, and to which side it lies, as in North and by East, Northeast and by North, Northeast and by East, East and by North, and so forth as shown below. There are then sixteen by points, so with the eight capital points and the eight inferior points, the points of the compass are thirty-two.

1.2 The Needle

The major use of these points is to set a course to sail to an assigned place, and to hold the ship to that course, to arrive safely and rapidly at your destination. And this is done by use of the Needle, which floats over the compass rose, and always stands due South and North, but in its own manner and timing, as will be spoken about further. And the Needle will always stand correct, except that it be jammed, or tilted, or filled with grit; or that cold iron disrupts its magick. For the Needle is tuned and stroked with lodestone by masters of this recondite art, to train it to stand true in all weathers and conditions and even near large quantities of iron, so long as this last is not moved; for the Needle, like the migrating birds above and the cold fish below, rely on the steady pull of that intangible wind that is distorted by iron, so the needle will stay bent and off true until the cold iron returns to its place, and the needle stops quivering, but calms down and sets once more to its task.

1.3 Boxing the Compass

No.	Compass point	Abbr.	Bearing	Wind point
1	**North**	N	0°00’	Cardinal
2	North by east	NbyE	11°15’	Bypoint
3	North-northeast	NNE	22°30’	Inferior
4	Northeast by north	NEbyN	33°45’	Bypoint
5	**Northeast**	NE	45°00’	Capital
6	Northeast by east	NEbyE	56°15’	Bypoint
7	East-northeast	ENE	67°30’	Inferior
8	East by north	EbyN	78°45’	Bypoint
9	**East**	E	90°00’	Cardinal
10	East by south	EbyS	101°15’	Bypoint
11	East-southeast	ESE	112°30’	Inferior
12	Southeast by east	SEbyE	123°45’	Bypoint
13	**Southeast**	SE	135°00’	Capital
14	Southeast by south	SEbyS	146°15’	Bypoint
15	South-southeast	SSE	157°30’	Inferior
16	South by east	SbyE	168°45’	Bypoint
17	**South**	S	180°00’	Cardinal
18	South by west	SbyW	191°15’	Bypoint
19	South-southwest	SSW	202°30’	Inferior
20	Southwest by south	SWbyS	213°45’	Bypoint
21	**Southwest**	SW	225°00’	Capital
22	Southwest by west	SWbyW	236°15’	Bypoint
23	West-southwest	WSW	247°30’	Inferior
24	West by south	WbyS	258°45’	Bypoint
25	**West**	W	270°00’	Cardinal
26	West by north	WbyN	281°15’	Bypoint
27	West-northwest	WNW	292°30’	Inferior
28	Northwest by west	NWbyW	303°45’	Bypoint
29	**Northwest**	NW	315°00’	Capital
30	Northwest by north	NWbyN	326°15’	Bypoint
31	North-northwest	NNW	337°30’	Inferior
32	North by west	NbyW	348°45’	Bypoint

2 Navigation using the Epact

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Which treats of the golden numbers of Saros, showing the Epact, and thus the age of the Moon.

It is convenient and necessary for Seafarers to know both the Prime or Golden number, and the Epact, which shows the age of the moon or its change day within 12 hours either way; and by the age of the Moon, you may know at what time it rises, and wherever you know what bearing of Moon makes high water, you will also know when it will reach that bearing, and so reckon the behaviour of the tides at any time of day or night; therefore it is important to know the Epact, and also that which is the Golden number.

2.1 The Epact

The Epact is the day of the month where the Full Moon should lie, if it is not overly affected by your longitude, or by the Golden Number, and the change day of the Moon is the day it is New, and is 14 days from the Epact. It decreases by two days for each month from the beginning of summer, and another day for each season change, for the Full Moon occurs every 28 days, more or less. Also it has previously been mentioned that for every 15 degrees you find yourself West of Tycho an hour is lost, and an hour is likewise gained for every 15 degrees you travel to the East.

2.1.1 Finding the Epact

Month	Epact	Change
–	Beltane	Samhain
Meadow	28	14
Heat	26	12
Breeze	24	10
Fruit	21	7
Harvest	19	5
Vintage	17	3
Frost	14	28
Snow	12	26
Ice	10	24
Thaw	7	21
Seed	5	19
Blossom	3	17

2.2 The Golden Number

The Golden number is the timing of the dragon Saros, in that he moves the Moon differently each year. The last year with a Golden number of 1 was 793 WK, and the number increments by seven every year, with 18 being subtracted from it each time it grows too high; and therefore 811 WK is the next year with a Golden number of 1. This number is used to look up the value of the Draconic regression and Anomalistic progression of the Moon, from which the Epact is adjusted. The Golden Number works in a complex manner measuring the various epicycles, and it is long and tedious to calculate its influence, so instead I present some prepared tables for each Year, based on its Golden Number.

2.2.1 Finding the Golden Number

Year	Golden No.
807	9
808	16
809	5
810	12
811	1
812	8

Year	Golden No.
813	15
814	4
815	11
816	18
817	7
818	14

Year	Golden No.
819	3
820	10
821	17
822	6
823	13
824	2

To find the time of the Full and New Moon, consult the Epact charts. Below is the Epact Chart for Seagate in 808WK.

2.2.2 The Epacts for Seagate 808WK

Date	Time	Sun Alt	Bearing	Moon Alt	Bearing	Type
Beltane	00:00	-36°20'	4°54'	38°53'	182°40'	Full
14 Meadow	18:20	5°38'	291°09'	5°15'	290°28'	New
28 Meadow	00:50	-28°56'	15°40'	32°31'	196°32'	Full
13 Heat	05:10	5°10'	64°19'	0°31'	65°32'	New
26 Heat	04:15	-5°39'	55°28'	7°58'	239°22'	Full
11 Breeze	05:30	5°07'	67°28'	0°18'	71°38'	New
24 Breeze	05:00	-2°51'	64°43'	4°25'	249°03'	Full
8 Fruit	06:05	6°20'	77°39'	0°28'	81°49'	New
21 Fruit	03:15	-27°15'	52°13'	28°35'	235°27'	Full
5 Harvest	17:55	5°13'	270°36'	0°05'	270°03'	New
19 Harvest	00:50	-53°11'	18°32'	53°41'	199°07'	Full
3 Vintage	17:30	1°50'	259°27'	0°21'	259°10'	New
17 Vintage	01:45	-55°29'	50°48'	54°31'	228°56'	Full
Samhain	17:00	0°48'	248°13'	1°58'	249°36'	New
14 Frost	06:45	-2°56'	113°08'	0°33'	291°11'	Full
28 Frost	16:45	0°10'	241°11'	3°08'	244°43'	New
12 Snow	17:15	-5°17'	244°27'	0°50'	66°58'	Full
26 Snow	13:30	26°41'	202°08'	32°09'	205°35'	New
10 Ice	17:20	-3°53'	246°23'	0°26'	71°03'	Full
24 Ice	07:35	5°42'	117°45'	10°16'	114°29'	New
7 Thaw	17:40	-3°26'	255°15'	0°15'	79°28'	Full
21 Thaw	06:30	0°09'	101°34'	0°31'	97°11'	New
5 Seed	18:05	-3°56'	268°26'	0°19'	90°08'	Full
18 Seed	17:45	2°07'	270°16'	0°04'	271°01'	New
3 Blossom	18:25	-3°16'	281°41'	0°08'	100°29'	Full
16 Blossom	18:05	3°01'	282°47'	1°53'	280°06'	New

3 Navigation of the Tides

Which teaches how to know by the age of the Moon what the time is, or when High Tide is at any place where you know what delay that place causes on the Tide.

Now, by the age of the Moon, you may know the tidal flow at any hour, at any place where you know what Moon makes high water or high tide, which rule of thumb mariners call the shifting of the Sun and Moon; and there are many ways to do it.

3.1 Tidal Change each Day

The best way to know of the tides is to observe the Moon at high water, and then high water will only occur at the same position of the Moon, regardless of the time of day. And there being two tides a day, then high water will also occur half a day from this time.

The other way is harder, but it works during the day, and when the Moon is occluded by cloud or foul weather, and even if you are in your cabin. First, divide one hour into nine parts, and take eight of those parts, discarding the ninth. This figure serves as the amount to alter 24 hours. And the eight parts are 53 minutes and 20 seconds, and the ninth part of an hour is 6 minutes and 40 seconds. Each flood and ebb happens in a half day and four parts of an hour, or12 hours 26 minutes and 40 seconds, later on average than its predecessor. And so each day the tide is eight parts, or 53 minutes 20 seconds later than the day before. For example, if a high tide occurs at midnight on a day, it will also occur at 53 minutes past midnight then next day, and so on, as shown below. For the course of the tides is nothing else but to add eight parts of an hour for every day of the age of the Moon, and by this you may at all times know at what time it flows, by putting to every flood and ebb, four parts of an hour, and to two floods and ebbs, eight parts. Now, as the Moon goes slower near the Auge, and faster in opposition, so these times are truly between three and five parts per tide, and so it can take between 26 and 30 days for the tides to return to their starting times, but this rule of thumb is enough to get by, for those that want only rough estimates or are looking few days ahead.

3.1.1 Tide Change or Moon Zenith

Day	High Tide
1	0:00
2	0:53
3	1:46
4	2:40
5	3:33
6	4:26
7	5:20
8	6:13
9	7:06
10	8:00

Day	High Tide
11	8:53
12	9:46
13	10:40
14	11:33
15	12:26
16	13:20
17	14:13
18	15:06
19	16:00
20	16:53

Day	High Tide
21	17:46
22	18:40
23	19:33
24	20:26
25	21:20
26	22:13
27	23:06
28	–
29	0:00

3.2 How the Auge affects Tides

The Sun passes through the Zodiac in exactly 364 days, this being our year. But the Moon passes through the Zodiac far quicker, in but 26 days, the same time that the sun takes to move through one of the 14 signs. This means that in 26 days the Moon has not yet caught the Sun, for the Sun is still one sign further on; it takes two more full days for the Moon to catch the Sun, nearly two degrees into the next sign. So the time between each change of the moon is 28 full days, and so the moon changes from New to Full to New in these 28 days, and so it is throughout the year excepting that the Moon may change sometimes in less time, and sometimes more, as it moves faster or slower through the Zodiac. The Moon being in its Auge goes little more then 10°15' in 24 hours, and in opposition, as fast as 17°20' in 24 hours, and on average, 13°50'. So this is the reason why sometimes the Moon may change sooner or stay longer than 28 days. This point of Auge is moveable, and passes in a cycle through the Zodiac every 18 years, and it sometimes causes the Full Moon to happen sooner or later, and in like manner all the quarters of the Moon, and all the other aspects the Moon has with the Sun or any of the planers or Stars. But notwithstanding, I would not wish the common Mariners to trouble themselves with these matters, but follow their accustomed order, to allow for every day of the age of the Moon an extra 8 parts of an hour. But some Navigators will take it upon them to correct the Almanacs as concerning the change and quarters of the Moon, holding the opinion that every Moon ought to be equal in the number of days and hours, and the full moon to be just the half of this period, and the quarters in like manner, so that every quarter falls on a Moon day. Wherein they are notably deceived, as sometimes in the year you shall see the Moon rather than at some other time, for example, in Summer you shall see the Moon within 24 hours after the change, because she has North declination of the Sun, and makes a bigger arc than the Sun during New Moon, but in Winter you shall not see her until a full three days after the change, because her declination is to the South, but you may see her within 24 hours before her change.

3.3 Tides at any Place

There was going to follow a table of tides about certain places of this coast. However, given that those who travel regularly between certain ports will already know their timings with respect to the Moon, it is more useful to provide a method that can be used with some confidence to find the difference of tides between nearby places so that only the major ports need to be learnt, and with less accuracy to determine when it be high water at any port or coast without any local knowledge, and this shall work on any world which has a Moon and tides.

First, on the open ocean, and at any atolls or other small specks far from substantial amounts of land, high tide occurs at a South Moon, and has variance of but 1 $\frac{1}{2}$ fathoms from ebb to flow. The position of the Moon at a high tide is sometimes named the tidal point, and so we shall call it. At any time there are two swells of high water on opposite sides of the globe, and these roll from East to West, one directly under the Moon, and the other opposite, so that high water at a Southeast Moon will also be at a Northwest Moon, except that a Moon to the Northwest is beneath the Horizon. These swells are slowed by land, and by being forced into narrow channels, or behind islands or peninsulas, or deep inland. All these features of harbours change or slow the tidal swell, and delay which Moon it is under, and so move the tidal point westwards. If from the Northeast to Southeast is all land, then add one point, and if it is from the North to the South, add another, and if from the Northwest through all the East to the Southwest is land, add a third point. If there is substantial land to the West, and none to the East, subtract a point. If the land lies roughly North-South and is vast with at least 500 miles between an East/West passage, then add or subtract an additional point

as above. If the sea must pass through a channel at least three times narrower than long or steadily narrowing, add a point per 50 miles of channel. If the port is between an island of at least 20 miles in size and the coast, add a point. If the port is in a deep cove or harbour, add a point, and add additional points if the harbour is 20 miles long or branches over many mud banks. If there is open sea to the East, count each of these one less, but if the only sea is to the West, count them twice. If points have been added for any two of land, channel, and port, add another, and add again if all three rules have delayed the tide. Finally, if in an estuary or tidal river, then count an additional point per twenty miles inland, or if at Sea, strong winds from the West or East may add or subtract an additional point.

All these rules can be added together, to find the point of the compass where the Moon will be when it is high water. Nonetheless the tidal point will be more accurate if it is based on the point of a nearby location, modified by the difference in the points as listed above, and this is the recommended way.

3.3.1 Tidal Point

Open Sea	**South**
Major Land Masses	
Land Eastwards from Northeast to Southeast	+1
Land Eastwards from North to South	+1
Land Eastwards from Northwest to Southwest	+1
Land to the West and not the East	- 1
Above land is at least 500 miles North-South	+/- 1
Narrow Seaways	
Channel at least three times longer than wide	+1
Sheltering Island of at least 20 miles and near coast	+1
Harbours	
Deep Cove or Harbour	+1
Harbour is at least 20 miles long	+1
Harbour branches, has many submerged banks	+1
Only open sea to the West	*double*
Open sea to the East	- 1
Other Rules	
Any two of Land Masses, Seaways, Harbours delay tide	+1
All three of Land Masses, Seaways, Harbours delay tide	+1
Estuary or tidal river (*per 20 miles*)	+1
Strong Westerly Winds if not in a Harbour	+1
Strong Easterly Winds if not in a Harbour	- 1

3.3.2 Tidal Strength

And when the Moon has been found, the variance or strength of the tide may also be known. For high water at a South Moon, it varies by 1 $\frac{1}{2}$ fathoms, and this increases by at least a foot for every point it is delayed until it be a West Moon which is also an East Moon, and decreased by a foot for each point from a South Moon to a South East Moon, and from a East Moon to a South East Moon it decreases by a full half fathom per point. And on a river or long harbour this variance is reduced by half, as it is in the eastern half of the inland sea, being the coasts of Azuria, Rokar, Arabie, Ellenia, and the Lunar Empire. And on narrowing and gently shelving banks known as washes or in narrow channels between larger bodies of water the height of the swell may increase, so that I have heard of a bay at the end of a channel between two southern seas where the tidal swell is nearly 10 fathoms, and the rising tide cannot be outrun on foot but takes men under no matter how fast they be.

3.3.3 Special Rules

Now there is one special rule to note, which is that in a harbour or tidal river that has any distance to the Sea, it flows one point of the compass more in the Spring streams than in the other quarters of the Moon when there is neither rage of winds nor any other cause to hinder or further this effect. So, if the tidal point in a harbour is a South and by West Moon, then when the Moon is Full or in its change, it flows at a South Southwest Moon, for there is more water to move upstream and so it is delayed.

And near an island of some hundreds of miles North to South, then the tides work under different rules, for the tidal swell will go around this island, either anticlockwise if no other land is near, or in both directions, starting from the seawards side. And in either case, then only the difference of tides between nearby locations can be ascertained through this method, for it is too complex to give a general rule for. And Palestrina is one of these, as is Delph, Kinlu, and the Insel der Freiheit.

And if you sail to the Antipodes all the rules are the same, except that you must transpose South and North, so that features that delay the tidal flow move the tidal point clockwise, rather than anticlockwise, and likewise with the usual tidal flow around large islands, for the Moon is to the North. And under the Ecliptic, it may be either way, depending on the Dragon and the Auge of the Moon, excepting that the tidal flow around a large island be fixed, no matter where the Moon is.

4 Navigation by the Sun and Moon

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Comprising the Sun's and Moon's course in the Zodiac, and the hours of moonrise and moonset, and at what point of the compass they rise and set, with other necessary things.

When the Sun has North declination, the further North you go the longer the days and the shorter the nights, and the further you travel South the shorter your days and the longer your nights. Contrariwise, when the Sun has South declination, the further North you go the shorter the days and the longer the nights, and the further you travel South the longer your days and the shorter your nights. And under the Equinoctial, the days and nights are all the same length no matter what declination the Sun has. Furthermore, the Sun, by its motion through the fourteen signs of the Zodiac throughout the year, causes the change in its declination. Now it is necessary for Seafarers to know in which declination the heavenly bodies take from Equinoctial to Equinoctial, and it is to be noted that as the Sun has declination, so does the Moon, and by their declination we know the time that they shine above the horizon.

4.1 Bearings for Rising and Setting at Seagate

Now the following rule is for Seagate, or any other place that has a Latitude or elevation of the Pole of 37 degrees. When the Sun or Moon are to be found on the cusp of the Maiden sign of the Zodiac, they rise due East, and set due West, and shine for 12 hours. On the cusp of the Messenger, they rise and set 12°30' further North which is near East by North and West by North and shine for 13 hours. On the cusp of the Smith, they rise and set 23° further North which is near East Northeast to West Northwest and shine for 13 hours 55 minutes. On the cusp of the Thief, they rise and set 29° further North which is from between East Northeast and Northeast by East to between West Northwest and Northwest by West, and shine for 14 hours 30 minutes. On the cusp of the Lover, it is as for the Thief. And on the cusp of the Warrior it is as it was for the Smith. And on the cusp of the King it is as it was for the Messenger. And on the cusp of the Mother, it is as it was for the Maiden. On the cusp of the Magician, they rise and set 12°30' further South which is near East by South and West by South and shine for 11 hours. On the cusp of the Wolf they rise and set 23° further South which is near East Southeast to West Southwest and shine for 10 hours 5 minutes. On the cusp of the Void, they rise and set 29° further South which is from between East Southeast and Southeast by east to between West Southwest and Southwest by west, and shine for 9 hours 30 minutes. And the Reaper is like the Void, and the Fool like the Wolf, and the Farmer like the Magician.

Now by this rule you shall know the rising and setting of the Sun and Moon forever. First the Sun is tied to the Zodiac by the time of the Year, so it rises and falls the same each year. For those who wish it easy, the chart below shows the progress of the Sun through the Zodiac, and also the length of the days and the compass bearing of sunrise and sunset at Seagate - for these vary with your location.

4.1.1 Rising and Setting at Seagate

Zodiac Sign	Date of cusp	Seagate Sunshine	Sunrise	Sunset
Maiden	Spring Eqx	12 hours	East	West
Messenger	11 Blossom	13 hours	E by N	W by N
Smith	6 Meadow	13 hours 55 min	ENE	WNW
Thief	2 Heat	14 hours 30 min	NE by E	NW by W
Lover	28 Heat	14 hours 30 min	NE by E	NW by W
Warrior	24 Breeze	13 hours 55 min	ENE	WNW
King	19 Fruit	13 hours	E by N	W by N
Mother	Autumn Eqx	12 hours	East	West
Magician	11 Vintage	11 hours	E by S	W by S
Wolf	6 Frost	10 hours 5 min	ESE	WSW
Void	2 Snow	9 hours 30 min	SE by E	SW by W
Reaper	28 Snow	9 hours 30 min	SE by E	SW by W
Fool	24 Ice	10 hours 5 min	ESE	W SW
Farmer	19 Thaw	11 hours	E by S	W by S

4.2 The Moon in the Zodiac

Second the Moon is tied to the Zodiac by its cycle, and I have shown you before several times that it only takes 26 days for the Moon to move through the Zodiac and so it moves through each sign of the Zodiac in a little less than two days, or seven full signs in 13 days. But there is a further matter for the exact number, which is the Latitude of the Moon from the head or tail of the Dragon, and this means that the Moon moves faster or slower through the Zodiac, depending on whether it is near the Auge. And all this shows that it is sufficient to know that the Moon moves about half a sign each day, and from that and knowing any of the location of the Moon in the Zodiac, the bearing of the Moon rise or Moon set or the length of the Moon shine, being from the previous day, one can know all of these for the coming day.

And if you do not know of the Moon for the last several days, then it is enough to know how long since the last change or New Moon, for you will know which sign of the Zodiac the Sun dwells within, and for every day that the Moon is past new, the Moon will be half a sign to the East of the Sun. And this is more accurate for it takes a full 28 days for the Moon to change, being 26 days to encompass the Zodiac and 2 more to catch the Sun that has moved on. So if the Sun has just entered the sign of the Mother, and it is 10 days past the New Moon, then the Moon is 5 signs on, which is the start of the Fool, and thus it shines for 10 hours 5 minutes. And careful calculation with the Auge and many charts reveals it is 10 hours and 1 minute, but this is near enough for any Mariner.

4.2.1 Moon Zenith

It has been explained in the previous chapter on Tides how the Moon is due South at different times during the month, and a table was included called Tide Change or Moon Zenith. This table is also to be applied to find the Moon Zenith. For the Moon is at its Zenith at noon during its change and at midnight during the Full Moon. And it rises 53 minutes later each night, or between 40 and 66 minutes later, depending on if it is close to the Auge. And this chart is to be used to find when the Moon is at its Zenith, or eight parts of an hour can be added from the time of Zenith the previous night.

4.2.2 Moonrise and Moonset

Now when you want to know the time of Moon rise or Moon set, first find out what Zodiac sign the Moon is in, how long it shines, and when it is at its Zenith, as above. Then divide the length of shining into two equal parts, one before the Zenith and one after, and you have your Moon rise and Moon set. Continuing the example from above, if the Sun has just entered the sign of the Mother, and it is 10 days past the New Moon, then the Moon is 5 signs on, which is the start of the Fool, and thus it shines for 10 hours 5 minutes. Then it is at its Zenith at eight o'clock in the afternoon, and it rises 5 hours and 2 minutes before, and sets 5 hours and 2 minutes after, that is it rises just before 3 in the afternoon and sets after 1 in the morning. And it so happens that the Moon was just past the Auge, having delayed it by 47 minutes, so that it rises at 15:46 and sets at 1:48, but this error can be reduced by knowing the Moon Zenith one day earlier and not ten.

4.3 Six o'clock Shadow

And there is yet one thing which I wish Seafarers to reconsider, although a great number be expert in it. The sun being in the Smith or Thief or the Moon likewise, or any time when the Sun or Moon has North declination, they will set their compass before them, and when they see the Sun give an East shadow, they will say that it is six o'clock, and when the Sun is in the Thief it is not much more than half past three in the afternoon, and the more they are Southwards, the more they err. And similarly, when the Moon is in the Thief, and they see it give an East shadow by their compass, they will say the Moon is to the West, but they do not consider that the Thief comes so near our Zenith or vertical point, right over our heads, therefore they must judge East or West from the Pole Star to judge truly. Wherefore I also recommend the Equinoctial Dials for the exact truth.

5 Navigation and Seasonal Declination

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This contains the table of declination, commonly known by seafarers as the Regiment of the Sun, which will serve for every day of the month.

5.1 Seasonal Declination

Now follows a table of declination or Regiment, being calculated for Seagate, and will serve all the Baronies without much error, or any other country or place that has similar Longitude, in the East reaching to the Lunar Empire and Arabie, and to the Elven Isles and Pasifika in the West, and those parts Southwards as far as the Poles of the World.

5.1.1 Summer

All declination is to the North. On Beltane the Sun has a declination of 16°32' N.

Meadow	
Day	Degree
1	16°49'
2	17°06'
3	17°23'
4	17°39'
5	17°55'
6	18°11'
7	18°26'
8	18°41'
9	18°56'
10	19°10'
11	19°24'
12	19°38'
13	19°51'
14	20°04'
15	20°17'
16	20°29'
17	20°41'
18	20°53'
19	21°04'
20	21°15'
21	21°25'
22	21°35'
23	21°45'
24	21°54'
25	22°03'
26	22°11'
27	22°19'
28	22°27'
29	22°34'
30	22°41'

Heat	
Day	Degree
1	22°47'
2	22°53'
3	22°58'
4	23°03'
5	23°08'
6	23°12'
7	23°16'
8	23°19'
9	23°22'
10	23°25'
11	23°27'
12	23°28'
13	23°29'
14	23°30'
Sol.	23°30'
16	23°30'
17	23°29'
18	23°28'
19	23°26'
20	23°24'
21	23°22'
22	23°19'
23	23°16'
24	23°12'
25	23°08'
26	23°03'
27	22°58'
28	22°52'
29	22°46'
30	22°40'

Breeze	
Day	Degree
1	22°33'
2	22°26'
3	22°18'
4	22°10'
5	22°02'
6	21°53'
7	21°44'
8	21°34'
9	21°24'
10	21°14'
11	21°03'
12	20°52'
13	20°40'
14	20°28'
15	20°16'
16	20°03'
17	19°50'
18	19°37'
19	19°23'
20	19°09'
21	18°54'
22	18°40'
23	18°25'
24	18°09'
25	17°54'
26	17°38'
27	17°21'
28	17°05'
29	16°48'
30	16°31'

This Regimen of tables is very necessary for those that travel by land or sea, and is one of the principle tools in Navigation for long voyages, and the cause why I have named this collection of notes the Regiment of the Sea, for I know that not every person that goes to ship as the master of a ship has the capacity to calculate the Sun's declination by the place of the Sun and the season.

5.1.2 Autumn

Initially declination is to the North. After the Equinox declination is to the South. On Lugnasad the Sun has a declination of 16°12' N.

Fruit	
Day	Degree
1	15°55'
2	15°37'
3	15°19'
4	15°01'
5	14°42'
6	14°23'
7	14°04'
8	13°44'
9	13°25'
10	13°05'
11	12°45'
12	12°24'
13	12°04'
14	11°43'
15	11°22'
16	11°01'
17	10°40'
18	10°18'
19	9°57'
20	9°35'
21	9°13'
22	8°51'
23	8°28'
24	8°07'
25	7°44'
26	7°22'
27	6°59'
28	6°36'
29	6°14'
30	5°51'

Harvest	
Day	Degree
1	5°28'
2	5°04'
3	4°41'
4	4°18'
5	3°55'
6	3°31'
7	3°08'
8	2°44'
9	2°21'
10	1°57'
11	1°34'
12	1°10'
13	0°46'
14	0°23'
Eqx.	0°01'
16	0°25'
17	0°48'
18	1°12'
19	1°36'
20	1°59'
21	2°23'
22	2°46'
23	3°10'
24	3°33'
25	3°57'
26	4°20'
27	4°43'
28	5°06'
29	5°30'
30	5°53'

Vintage	
Day	Degree
1	6°15'
2	6°38'
3	7°01'
4	7°24'
5	7°46'
6	8°09'
7	8°31'
8	8°53'
9	9°15'
10	9°37'
11	9°59'
12	10°20'
13	10°42'
14	11°03'
15	11°24'
16	11°45'
17	12°05'
18	12°26'
19	12°46'
20	13°06'
21	13°26'
22	13°46'
23	14°05'
24	14°25'
25	14°44'
26	15°02'
27	15°21'
28	15°39'
29	15°57'
30	16°15'

5.1.3 Winter

Declination is to the South. On Samhain the Sun has a declination of 16°32' S.

Frost	
Day	Degree
1	16°49'
2	17°06'
3	17°23'
4	17°39'
5	17°55'
6	18°11'
7	18°26'
8	18°41'
9	18°56'
10	19°10'
11	19°24'
12	19°38'
13	19°51'
14	20°04'
15	20°17'
16	20°29'
17	20°41'
18	20°53'
19	21°04'
20	21°15'
21	21°25'
22	21°35'
23	21°45'
24	21°54'
25	22°03'
26	22°11'
27	22°19'
28	22°27'
29	22°34'
30	22°41'

Snow	
Day	Degree
1	22°47'
2	22°53'
3	22°58'
4	23°03'
5	23°08'
6	23°12'
7	23°16'
8	23°19'
9	23°22'
10	23°25'
11	23°27'
12	23°28'
13	23°29'
14	23°30'
Sol.	23°30'
16	23°30'
17	23°29'
18	23°28'
19	23°26'
20	23°24'
21	23°22'
22	23°19'
23	23°16'
24	23°12'
25	23°08'
26	23°03'
27	22°58'
28	22°52'
29	22°46'
30	22°40'

Ice	
Day	Degree
1	22°33'
2	22°26'
3	22°18'
4	22°10'
5	22°02'
6	21°53'
7	21°44'
8	21°34'
9	21°24'
10	21°14'
11	21°03'
12	20°52'
13	20°40'
14	20°28'
15	20°16'
16	20°03'
17	19°50'
18	19°37'
19	19°23'
20	19°09'
21	18°54'
22	18°40'
23	18°25'
24	18°09'
25	17°54'
26	17°38'
27	17°21'
28	17°05'
29	16°48'
30	16°31'

5.1.4 Spring

Initially declination is to the South. After the Equinox declination is to the North. On Candlemansa the Sun has a declination of 16°12' S.

Thaw	
Day	Degree
1	15°55'
2	15°37'
3	15°19'
4	15°01'
5	14°42'
6	14°23'
7	14°04'
8	13°44'
9	13°25'
10	13°05'
11	12°45'
12	12°24'
13	12°04'
14	11°43'
15	11°22'
16	11°01'
17	10°40'
18	10°18'
19	9°57'
20	9°35'
21	9°13'
22	8°51'
23	8°28'
24	8°07'
25	7°44'
26	7°22'
27	6°59'
28	6°36'
29	6°14'
30	5°51'

Seed	
Day	Degree
1	5°28'
2	5°04'
3	4°41'
4	4°18'
5	3°55'
6	3°31'
7	3°08'
8	2°44'
9	2°21'
10	1°57'
11	1°34'
12	1°10'
13	0°46'
14	0°23'
Eqx.	0°01'
16	0°25'
17	0°48'
18	1°12'
19	1°36'
20	1°59'
21	2°23'
22	2°46'
23	3°10'
24	3°33'
25	3°57'
26	4°20'
27	4°43'
28	5°06'
29	5°30'
30	5°53'

Blossom	
Day	Degree
1	6°15'
2	6°38'
3	7°01'
4	7°24'
5	7°46'
6	8°09'
7	8°31'
8	8°53'
9	9°15'
10	9°37'
11	9°59'
12	10°20'
13	10°42'
14	11°03'
15	11°24'
16	11°45'
17	12°05'
18	12°26'
19	12°46'
20	13°06'
21	13°26'
22	13°46'
23	14°05'
24	14°25'
25	14°44'
26	15°02'
27	15°21'
28	15°39'
29	15°57'
30	16°15'

6 Navigation by Cross-Staff

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In which we are shown how to take the height of the Sun with the Cross-staff or Astrolabe, and also how to find the true Meridian, with other necessary matters.

6.1 The Use of a Cross-Staff

To take the true height of the Sun at sea, the best way is to do it with the Cross-staff, as the sea is always in motion, and causes the ship to heave and yaw to varying amounts, and also as the degrees are marked more clearly and larger upon the Cross-staff than the Ring or Astrolabe; in addition, with a large instrument any error is seen sooner and better than it is with a small instrument.

Now to take the height of the Sun, that is to know the Altitude of the Pole above the Horizon, first take a bearing on the Sun with a compass, so as to know when the Sun approaches the Meridian. As soon as you see the sun has come to the South and by East, then begin to take the height of the Sun with the Cross-staff in the following manner. Put the Transitory or cross-piece on the long staff, then set the end of he long staff against the corner of your eye, closing the other eye, and moving the Transitory forwards or backwards until you see the lower end of it is at the Horizon and the upper end is in line with the middle of the Sun. Once both ends agree with the Sun and the Horizon at one time, you have the true height of the Sun; this done, continue to observe until you see the Sun at its highest and beginning to descend, and then you have finished. Notwithstanding the above comments, it is best to take the height of the Sun with the Cross-staff with the Sun is under 50 degrees above the Horizon, for two reasons. The first is that until the Sun is 50 degrees in height, the degrees are well spaced and clearly marked on the Cross-staff, but after this, the marks are closer together, and smaller. The other is that when the Sun is under 50 degrees in height, you may easily take the height, as you may easily see both the upper and nether end of the Cross-staff at one time; but if it exceeds 50 degrees, then due to casting your eye upwards and downwards so much, you may soon make an error. So that if the Sun passes 50 or 60 degrees in height, you must put down the Cross-staff and use the Mariner's Ring, or Astrolabe.

6.1.1 Customising a Cross-Staff

For readings when the Sun is bright, a smoked glass at the upper end of the Transitory will reduce the strength of the light on your eyes. If you do not have a smoked glass upon your staff, instead you can cover the Sun with the end of the Transitory, up to the very upper brink of the Sun (so that you need not behold its brightness), and with the other end of the Transitory, take a true reading of the Horizon. That being done, as the Sun is 30 minutes in diameter, you shall rebate 15 minutes or $\frac{1}{4}$ of a degree from the measurement of the altitude or height of the Sun, and what remains is the true height of the Sun as if read from the centre of the Sun.

And furthermore there is some error in taking a sighting of the Sun or a star with the Cross-staff, and that occurs by this means; that the true centre of the reading is based on the sight of the eye, and is thus within the middle of the eye and not in the outside of the eye or the end of the long staff. So the end of the long staff, when set into the corner of your eye stands somewhat further out that the sight of the eye, wherefore you much pare away a little of the end of the staff; for some men more, and others less, because some men's eyes be further into their head than others, and the bones of some men's face stand further out than some others do.

6.2 The Use of an Astrolabe

The Astrolabe is best used to take the height of the Sun if it is very high, at least 60 degrees, and this is because when the Sun comes near the Zenith, its light has great strength, and can pierce the sights of the Astrolabe, and then it is not good to use the Cross-staff, and so this way you may preserve your eyes.

Now to take the height of the Sun with the Common Ring or Astrolabe, follow these steps. Once the Sun is near the Meridian or South, observe it until it reaches its greatest height. Hold the Ring upon one of your fingers, and turn the Alhidada or sights up and down, until you see the show of the Sun pierce or pass through both the sights, being sure that the Astrolabe hangs upright. You may prove that it hangs true in this manner; look at the number of degrees and minutes the Alhidada marks on the Astrolabe, then turn the Alhidada to the same number of degrees and minutes on the other side of the Astrolabe, and the take the height of the Sun again, if the two agree, then the Astrolabe hangs upright, but if it does not, measure the height of the Sun on this side, and measure the diversity between the two readings. Subtract from the greater height half the difference, or add half the diversity to the lesser height, and that shall be the true height of the Sun, even though the Astrolabe does not hang upright.

There are many types of astrolabe, each with its own adherents. More information on them can be found here, here, and even here.

6.3 Finding the True Meridian

It is moreover convenient to know the true Meridian, or South, which you must do either with a good Compass, or with a perfect dial or Needle, but if you are on land, you may do the following instead. On a piece of timber, or any other fixed surface, mark a circle with a pair of compasses, then in the middle or centre where the foot of the compass stood, set a wire upright as carefully as you can, and then you may take your measurements.

1. First, look in the morning as the Sun rises (ensure it is on plain ground so that you can see the Horizon circle, without any interference), for the shadow of the wire, and there set a mark; then at the setting of the Sun, set another mark, both at the circumference of the circle. Then divide that with your compasses evenly in two pieces, and draw a straight line from the wire or centre of the circle to the middle dividing mark, and that shall be true meridian.
2. Or else (still ensuring the wire stands upright), first look before noon for when the top of the wire shadow touches or crosses the edge of the circle, and there make a mark, and in the afternoon in like manner at the very point the shadow leaves the circle, make a mark; this done, as carefully as you can divide these two marks in the middle, as was said before, draw a line form the centre or wire to the middle mark, and that line shall be your true meridian.
3. Yet another approach is to look and watch when the wire gives the shortest shadow, and there make a mark, then draw a line from that mark to the wire, which shadow shall be true meridian; but this is least accurate of all the methods.

7 Navigation using Declination

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Which shows how to handle the declination of the Sun, to know the altitude of the Celestial Pole above the Horizon, whether you are in normal climes, near the Equator, in the southern ocean, or near the Poles of the World.

7.1 Preliminaries

First, the altitude of the Celestial Pole where you are is the same as your Latitude, for your Latitude is the number of degrees you are from the equinoctial, and when you are under the equinoctial, which is when you are at the equator, the Celestial Pole lies on your Horizon, with no altitude, and the North Star is barely visible. And as you travel north, for every degree or 60 miles that you travel north, the Celestial Pole rises one degree into the sky, so while Latitude is the width that you are from the Equinoctial and Altitude is the height of the Celestial Pole, so they are one and the same. Likewise, the distance between the Equinoctial and your Zenith is the distance of the Celestial Pole from the Horizon, and so the height of the Celestial Pole is the distance of the Zenith from the horizon less the altitude of the Equinoctial which is the height of the Sun without any declination; that your Latitude is 90 degrees less the height of the Sun adjusted for seasonal declination.

Therefore you must know the seasonal declination of the Sun, to whit, you much also know what season you are in, and what part of the month to within a day, as each day the Sun moves along the Ecliptic and so its declination changes. So, if you do not know the declination of the Sun, then refer to the notes on Seasonal Declination until you know the current declination of the Sun.

Finally it is good to know roughly what part of the globe you are in, for there are different ways of finding your Latitude depending on while circle you lie within. But if for some reason you do not know, each method will give the same result or no result at all, some being easier or harder depending on where you are, but none shall give a wrong result.

Knowing all this, now take the height of the Sun at noon with your Cross-staff or Astrolabe, or however you choose to do it. And if you do not know how this is done, you need to refer to the preceding chapter, where I have explained it all in sufficient detail.

7.2 Finding your Latitude between the Ecliptic and the Arctic Circle

Given you have the height of the Sun at noon, and the declination of the Sun for the current day of the Season, if the Sun has North declination (it being summer or above the Equinox), then subtract the declination from the height of the Sun, and the remainder shall be the true height of the Equinoctial. Removing this value from 90, in degrees and minutes, that which remains shall be the true height of the North Pole above the Horizon, which is your Latitude. But if the Sun has South declination (it being wintry and below the Equinox), then add the declination from the height of the Sun, and the remainder shall be the true height of the Equinoctial, and that sum being removed from 90, the remainder shall be the true height of the North Pole above the Horizon, or your Latitude.

7.2.1 An Example

The Sun when measured due South with a Cross-staff is 48°30’ above the Horizon, and has a North declination of 15°35’ and that makes 42°55’, which I take away from 90° leaving 37°05’, so you may affirm that the North Pole is 37°05’ above the Horizon; thus your Latitude is that of Seagate.

7.3 Finding your Latitude between the Equinoctial and the Sun

Furthermore, if you are under the Ecliptic being in the Tropics, that is near the equinoctial, and the Sun has some declination either to the South or North, and you find yourself between the Sun and the Equinoctial, when you have taken the true height of the Sun with your Astrolabe, to know the height of either of the two Poles of the World, first seek the declination of the Sun for that day, then add the declination of the Sun to its height, and it will exceed 90 degrees. If it does not, then you are not between the Ecliptic and the Equinoctial and may find your Latitude as above. Now look how many degrees it exceeds 90 and that shall be the true height of the Celestial Pole, that is whichever of the North and South Pole that is towards the side that the Sun is on, because your Equinoctial is the number of degrees above 90 (which is your Zenith) to the contrary from Sunwards.

And to find whether you are under the Equinoctial that being on the Equator, take the height of the Sun, and add the declination, and if the number is 90, then you are under the Equinoctial, and if it is less the Equinoctial lacks that amount of the Zenith, and the Celestial Pole is that much above the Horizon to the Sunwards. But if it is more than 90 degrees, then it signifies that you are between the Sun and the Equator, under the Ecliptic on the side that the Sun is on.

7.3.1 An Example

The Sun when measured at your South Meridian with an Astrolabe is 81°15' above the Horizon, and has South declination of 22°35' and that makes103°50', from which I take away 90° leaving 13°50', so you may conclude that the Equinoctial is 13°50' to the North of your Zenith, and the South Pole is 13°50' above the Horizon.

7.4 Finding your Latitude beyond the Equinoctial

And if you are to the South beyond the Equinoctial and between the Ecliptic and the South Pole, then to use the declination of the Sun to know the height of the South Pole, it being your Celestial Pole, then the above method suffices, but whereas we in the North add the South declination to the height of the Sun and subtract the North declination, so the contrary Antipodeans must rebate the South declination, and add the North declination.

7.4.1 An Example

The height of the Sun being 28° above the Horizon due North at noon, and the declination of the Sun being 21° to the North, I add the declination of the sun to its height which makes 49° being the height of the Equinoctial above the Horizon, and removing that sum from 90°, there remains 41°, which is the distance between the South Pole and the Horizon, or your southern Latitude.

7.5 A General Rule for Latitude

When handling declination, the true height of the Poles is known. Always consider which Pole is above the Horizon, and if the North Pole is above the Horizon, always add the South Declination to the height of the Sun, or subtract the North declination. Contrariwise, if the South Pole is above the Horizon, you must add the North declination or take away the South declination from the height of the Sun. Now to know which of the Poles is above the Horizon is a very easy matter, and is known in two ways. If the North Pole is above the Horizon you may know it by the Stars around the Pole, being the North Star and the Wains and Guards. Neither do I believe that you can pass so quickly beyond the Equinoctial that it is not known to you. Also you may know it by the arc or bearing of the Stars and lights around you.

7.6 Finding your Latitude beyond the Arctic Circle

For more accurate determination of the Sun's declination, if you have any occasion to travel to the North or South beyond the Arctic circles, or 67° of Altitude, and if the Sun has any great declination towards those parts that you are in, then the Sun shall not go down under the Horizon in a long time, and if you were right under either of the Poles of the World, then the Sun would not go under the Horizon in half a year, so there should continually be day. Moreover, it is easy to lost track of the Meridian in these parts, for the methods for finding the Meridian rely on sunrise and sunset, or on the height of the Sun changing significantly as she moves across the sky, or on the compass having a known or constant variation, but none of these hold at the extreme Latitudes. Despite this, it is possible to take the height of the Sun at or about noon, the height of the Sun changing little across any short period.

However, it is also possible to find your Latitude by the height of the sun at midnight, or when the Sun is at its lowest, so long as it cannot set that day. First with your Cross-staff observe the Sun at its lowest, taking the true distance between the Horizon and the Sun. Then take the declination for that day, or if the declination is changing rapidly each day, it being Spring or Autumn, then take half the difference between that day's declination and the next, for even though the sun is up, it is midnight, and halfway between the days. The Sun's true declination being known, subtract the height of the Sun from its declination and so you have the true amount in degrees and minutes that the Equinoctial is under the Horizon, and then removing that amount from 90, the remainder is the height of the Pole above the Horizon, or your Latitude. And if the Sun's declination is less than the height of the Sun at midnight, then you have made a grievous error and should check your instruments and tables.

7.6.1 An Example

Now suppose I were far to the North on the Summer Solstice, the Sun being at a Northern declination of 23°30' and I take the Sun due North it her lowest point, being just 6° above the Horizon. Then subtracting the height from the declination I am left with 17°30' for the depth of the Equinoctial beneath the Horizon, and subtracting this from 90° there remains 72°30' for the true height of the North Pole being my Latitude.

7.7 Observations on far Northern Climes

The above methods of determining Latitude is very necessary for those who occupy Swenway and Finmark, and also those that would attempt any voyages of discovery into the North, whether to the Northeast above Ruska, or the Northwest seeking a passage beyond Terranova, either way to the lands of the Far East. If either where attempted, there is no doubt that they should find it navigable either to the East or West, and I am of the opinion that the thing most feared in journeying northwards does not deserve to be feared so greatly as it is, that being the reason why they are so loathe to go very far into the North, which is the frozen zone. But my opinion is that in summer time it is not to be feared, as the further into the north the more temperate or warm it is, by means of the long continuance of the Sun; and as we see by common experience that a thing made warm cannot suddenly be made cold, neither is there any doubt of any great cold until the Sun return south of the Equinoctial in mid Autumn. And I believe that if a ship should sail northwards beyond 80° they would find it very temperature and warm until the middle of Harvest, for there is a space of nine weeks from 14 Meadow to 16 Breeze when the Sun should come no closer to the Horizon than 10° to the North or 20° to the South, and shine without respite for 18 weeks between 12 Blossom to 18 Fruit. And yet is it possible that it may be cold there until the end of Meadow, for the Sun must have some time to make the air warm. For as a thing once being cold cannot be suddenly made warm, likewise a place being once warm cannot be suddenly made cold.

8 Navigation and Daylength

In which one shall learn how to know the length of the day, and to know how much the day is shortened or lengthened by the Sun's declination.

8.1 The Day varies by the Suns Declination

The common people fall into a number of errors concerning the length of the day, holding an opinion that every 30 days the day is an hour longer or shorter. The truth is this; the day keeps no such rule in its lengthening and shortening, but lengthens and shortens according to the swiftness or slowness of the sun's declination, for when the sun has a swift declination, then the day lengthens and shortens apace; and when the declination is slow, then the days lengths and shortens slowly.

8.2 What a Day is

And you must note that a day is from the rising of the Sun, where it is but half above the Horizon, until the setting of the same half under the Horizon, and not from daylight until daylight. For before the Sun rises, and after it has set, does not count as part of the day, even thought the day light will appear by the time that the Sun reaches 17° below the Horizon before sunrise, and will not be clean gone until the Sun is more than 17° under the Horizon after sunset. And you may perceive this if you travel but to 50° North in mid Meadow, when the Sun has the greatest declination to the North, the daylight remains all night, as the Sun goes under the Horizon a maximum of 16°30'.

8.3 Length of Days in Seagate Port

And yet the best part of the common people of Seagate hold the opinion that by Twelfth Night the day needs to be a full half hour longer than the Solstice, and yet the sun has declined or come towards the Equinoctial less than 1 degree, which will not make even a quarter hour in the length of the day. Wherefore, I think it good to declare throughout the whole year when the day is an hour longer or shorter here in this port of Seagate for the Latitude of 37 degrees. Our longest summer day is 14 hours and 34 minutes long, and this day is the 14th or 16th of Heat, and then the sun has the least declination southwards; and our shortest winter day is 9 hours and 26 minutes from sunrise to sunset, and this shortest winter day is the 14 or 16th day of Snow, and then the sun has the greatest declination southwards.

8.3.1 Day Length at Seagate

Summer		Autumn		Winter		Spring	
Beltane	13:45	Lugnasad	13:45	Samhain	10:15	Candlemansa	10:15
9 Meadow	14:00	6 Fruit	13:30	9 Frost	10:00	6 Thaw	10:30
3 Heat	14:30	19 Fruit	13:00	3 Snow	09:30	20 Thaw	11:00
Solstice	14:34	2 Harvest	12:30	Solstice	09:26	3 Seed	11:30
27 Heat	14:30	Equinox	12:00	27 Snow	09:30	Equinox	12:00
21 Breeze	14:00	27 Harvest	11:30	21 Ice	10:00	28 Seed	12:30
		10 Vintage	11:00			11 Blossom	13:00
		24 Vintage	10:30			24 Blossom	13:30

And you will find this matter more thoroughly spoken of for all places throughout the world, in the rest of this chapter.

8.4 Length of Days outside the Arctic Circles

I think it is convenient for Seafarers to know the length of the day in any place that they have occasion to go to, for they have occasion to travel into all the climates and places of Alusia, transporting themselves many times quickly from one place unto another. And although the ancient writers have described various climes, and have made tables very exact for the longest or shortest day in any of those climes, and other places of similar elevation of the pole, yet they have not provided any way to give a method for travellers to know when the day is an hour longer or shorter, whereby they might at all times know the length of the day, which is very necessary for those that are abroad under sail both night and day, and likewise for those that must keep account of hours and times exactly, as should anyone keeping a Ships Log. Wherefore it is most necessary for Navigators to know the true time of the Sun rising and setting, which you may know from the length of the day.

First, under the Equinoctial, the sun rises twelve hours from its setting, regardless of its declination, so that it rises at 6 am and sets at 6 pm, forever. And the further you get from the Equinoctial, the more the length of the day varies. The day length can be found by knowing the declination of the Sun and your Latitude. At any given Latitude, there is a fixed change in Declination which results in a day being one hour longer. This Declination per hour and the length of the longest day at various Latitudes is shown here.

8.4.1 Day Length

Latitude	Longest Day	Decl./hour
00°00’	12 hours	N/A
10°00’	12 hrs 35 min	40°05’
16°43’	13 hours	23°30’
20°00’	13 hrs 13 min	19°21’
30°00’	13 hrs 56 min	12°07’
30°46’	14 hours	11°45’
37°00’	14 hrs 34 min	9°09’
40°00’	14 hrs 51 min	8°14’
41°21’	15 hours	7°50’
45°00’	15 hrs 26 min	6°50’
48°59’	16 hours	5°53’
50°00’	16 hrs 10 min	5°39’
54°28’	17 hours	4°42’
58°25’	18 hours	3°55’
60°00’	18 hrs 31 min	3°36’
61°16’	19 hours	3°21’
63°20’	20 hours	2°56’
64°48’	21 hours	2°37’
65°46’	22 hours	2°21’
66°19’	23 hours	2°8’
66°30’	24 hours	1°58’
70°00’	62 days	1°40’
80°00’	127 days	0°50’
89°00’	177 days	0°05’

From this method you may know at all times the true length of the day in any Latitude between the Equinoctial and the Arctic circles, by knowing the declination of the Sun, which you may know by the Regiment in a previous chapter.

9 Navigation by the North Star

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Concerning the North Star, and its uses and limitations.

9.1 The North Star

It is said by many sailors that the North Star is always to be found due North, but this is not true as any real Mariner shall tell you, and the proof of this is to be found when on land or moored, on a clear night. For like all starts and Celestial bodies, the North Star moves through the sky around the Celestial Pole, and its position shall vary by a full 3 $\frac{1}{2}^\circ$ either side of North, or 7° in all. Yet it is still of use to the informed, for it is a clear and bright Star of the first magnitude which is easily found, and from the declination or Altitude of the North Star you can immediately learn your true Latitude, and from its direction your course or way.

9.2 The Wains and Guards

Near the North Star are several distinctive stars of the second and third magnitude, the closest pair being the Wains, and around them the Guards. The Wains are to be found on the further side of the North Pole from the North Star. To find the Pole, draw a line between the North Star and either of the Wains, wherein the Pole is to be found close to this line and a third of the way along. Being that the Wains are a full point from the North Star, so the North Star is almost a third of a point, or 3°30' from the North Pole, in almost the opposite direction from the Wains. But when taking a bearing or declination on the deck of a ship at sea, it is not wise to judge the third of a distance between two Stars, it being better to instead take the measure of a Star, and then to adjust it as necessary. So must we provide the rule for adjusting the position of the North Star to find the North Pole.

9.3 The Capital Points

1. If the Wains are above the North Star, then the North Star is 3° below the North Pole and 1°30' to the left.
2. If the Wains are above and to the right of the North Star, then the North Star is 3°30' below the North Pole and is 30' to the left.
3. If the Wains are to the right of the North Star, then the North Star is 1°30' below the North Pole and 3° to the left.
4. If the Wains are below and to the right of the North Star, then the North Star is 30' above the North Pole and is 3°30' to the left.
5. If the Wains are below the North Star, then the North Star is 3° above the North Pole and 1°30' to the right.
6. If the Wains are below and to the left of the North Star, then the North Star is 3°30' above the North Pole and is 30' to the right.
7. If the Wains are to the left of the North Star, then the North Star is 1°30' above the North Pole and 3° to the right.
8. If the Wains are above and to the left of the North Star, then the North Star is 30' below the North Pole and is 3°30' to the right.

10 Navigation and Raising a Degree

Which shows you by the use of your compass, how far you must sail to raise a degree, and how much you depart from the Meridian in doing so.

Furthermore, because there are some that desire to know the alteration of a point, so that in running on a course, they know when they have raised or laid a degree. For in sailing due South, and keeping to one Meridian, you raise the Pole after 60 miles, and lay the same after sailing 60 miles due South. But in sailing East or West, you neither raise nor lay your Pole, but only alter your Meridian at a degree every 60 miles at the Equinoctial, or less depending on your Latitude. Whereas, in sailing any other point you alter both your Pole and your Meridian. Wherefore I will list for you, when sailing upon any point, how far you must sail to raise or lay one degree North or South, and what distance you have departed from your Meridian in doing so.

10.1 Raising a Degree of Latitude

Now we list the distance to travel, and the Meridial departure which is the number of nautical miles travelled East or West, to raise one degree of Latitude on various headings. The values are given for sailing North and East, but the same may be used in any other quadrant.

10.1.1 Miles to Raise a Degree

Point	miles/°	Mer. Dept
N	60.0	0.0
NbE	61.2	11.9
NNE	64.9	24.9
NEbN	72.2	40.1
NE	84.9	60.0
NEbE	108.0	89.8
ENE	156.8	144.9
EbN	307.5	301.6
E	–	–

And again, having travelled 60 nautical miles which is 1 degree in a Great Circle, we list the number of minutes of Latitude that have been raised, and the nautical miles travelled East or West.

10.1.2 Minutes raised after 60 miles

Point	’ Raised	Mer. Dept
N	60.0’	0.0
NbE	58.8’	11.7
NNE	55.4’	23.0
NEbN	49.9’	33.3
NE	42.4’	42.4
NEbE	33.3’	49.9
ENE	23.0’	55.4
EbN	11.7’	58.8
E	0.0’	60.0

10.2 Raising a Degree of Longitude

While mariners all know that the distance of a degree of Longitude is greatest under the Equinoctial, where it equals the degree of Latitude, it is not so common to know the distance to travel to raise a degree of Longitude at various Latitudes. Wherefore I have listed these values for you.

10.2.1 Miles to Raise a Degree

Latitude	Mer. Dept
0°	60.0
10°	59.1
20°	56.4
30°	52.0
37°	47.8
40°	46.0
50°	38.6
60°	30.0
70°	20.5
80°	10.4

10.3 Units

But here is one thing to be noted, that some charts measure distances in land miles, being only 8 furlongs or 5280 feet; furthermore charts of far-off lands being most commonly made in Destiny, they allow for every degree only 17 1/2 of their leagues, at 32 furlongs apiece. But as I take it, we in Carzala should allow 60 nautical miles to one degree, and there being 3 miles to a league, wherefore 20 of our leagues should be one degree. A nautical mile contains 6080 feet, which is not a good number of furlongs, chains, or rods, but it is exactly one minute of Latitude, and thus better than any round number of paces.

11 Navigation Distances

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In which is shown how to know the distance of any land to you in knowing the distance between any two places, whether you run alongside the land or directly towards the shore or otherwise, with other necessary things.

11.1 Navigating near Land

As I know that it is necessary and profitable for Seafarers to know how near or far they are from the land, I will provide several diverse rules for your consideration. First, because in running alongside the land there may be dangers that are a certain distance into the sea, that they may sail either inside or outside them. And likewise, as when at one distance for the land, it may rise up in such a shape or fashion, while if you are nearer, the land may rise in another form, for being far off, you shall see the inland hills, and when nearer, the hills or cliffs at the sea coast may take away this sight. Furthermore, it is very necessary to know in what fashion the land rises at diverse points of the compass, as often as the land alters, and to note it in some book in this manner: first the points of the compass, then the shape, and last the distance.

11.2 Landmarks to One Side

You may know how far you are from the land if there are two places on the sea coast that you know the distance between, and which are visible. While travelling parallel to the coast, wait until one place is athwart or beside you, and take a bearing on the other landmark. From the number of points between the bearings, you shall be a certain multiple of the distance between them from the shore, as shown in the table below. And in all cases one of the places must be directly beside you, to make it exact and true. And if the landmarks are not on the coast, but you know how one bears from the other, then if you can sail in that direction and have one of the places abeam of your vessel, then the same method shall also work.

11.2.1 One Landmark Athwart

Angle	to Shore
1 point	x 5
2 points	x 8/3
3 points	x 3/2
4 points	x 1
5 points	x 2/3
6 points	x 2/5

11.2.2 An Example

Let us suppose that the two places are East and West from each other, and are 3 leagues asunder. Then when I have brought one of the places due South (or North) of me, I take a bearing on the other and find it bears 3 points of difference. Then the distance to the nearer landmark is 1 $\frac{1}{2}$ times their mutual distance, or 4 $\frac{1}{2}$ leagues.

11.3 Landmarks to Either Side

And if you come directly into land, having no cause to be athwart any of these known places, then to know how far you are from the land, you must find two landmarks one on each side

of the bow, and take bearings on them as above. And the number of points between these bearings and your course can be used in the following table to determine how much further you are from shore than the landmarks are apart, which also having their mutual distance, provides the distance of your vessel from the shore.

11.3.1 Landmarks either side of Bow

		Starboard				
		1 point	2 points	3 points	4 points	5 points
Port	1 point	x 5/2	x 8/5	x 7/6	x 5/6	x 3/5
	2 points	x 8/5	x 6/5	x 11/12	x 5/7	x 1/2
	3 points	x 7/6	x 11/12	x 3/4	x 3/5	x 4/9
	4 points	x 5/6	x 5/7	x 3/5	x 1/2	x 2/5
	5 points	x 3/5	x 1/2	x 4/9	x 2/5	x 1/3

11.3.2 An Example

Let us suppose that we know the two places are 3 leagues asunder. Then at one time with my bow due North, the first landmark bears Northeast by North, and the other North Northwest, being 5 points of difference. Then the distance to the shore is nine-tenths their mutual distance, or just over 8 miles.

11.4 Bearings between Headlands

If you do not know how one headland bears from another, then in running along the coast, when you see one headland just starting to appear from behind the other, take a bearing with your compass, and how they both bear from you is how one bears from the other. And by this, you can correct your charts by doing this as often as you see two notable places together, whether they be islands, rocks, headlands, mouths of havens, sandbanks, or whatever else may be worthy of noting.

11.5 Distances between Uncharted Headlands

You may also know the distance between them if you know your ship's way. Having run along the coast and taken your bearing as above, as you will not want to come near to them, you will hove off from the land until you have brought your ship far enough out to sea at your discretion, and then when you are athwart of the first headland, take a bearing on the second headland. Then you shall set a course parallel to the two headlands by the first bearing you took, and take your ship's speed. At the time that you are athwart of the second headland, note the time that has past from the first headland, and then reckon the distance between them, and using the second bearing, you may also know how far you are from them.

11.6 Distances to an Uncharted Shore

In similar manner you may know how far it is to shore as you directly approach it, although you do not know the distance between any two places. First take the bearing between any two places on the shore with your cross-staff, and then move the Transitory or cross-piece exactly halfway along the remainder of the long staff. By running the ship in towards shore until the ends of the transitory agree again with the two marks, you shall be halfway to shore; then look how far the ship has gone, by its way and the time taken to run in, and the same distance remains between the ship and the land. And if you move the Transitory only a quarter of the distance, then at the place where the two marks line up, you shall be a quarter of the

distance between the shore and your first observation, and it shall be three times the distance travelled to reach the shore.

11.7 The Ships Way

The best manner in which to know the ship's way or speed, is to have a piece of wood to throw out overboard, tied to a small line of great length which you make fast at one end, and along that line at certain fixed intervals are pieces of line made fast with a small thread so they stand like a crow's foot. And so that the piece of wood should drive a stern as fast as the ship moves away from it, you should always have the line coiled so that it goes out as fast as the ship travels. And also you should have a half-minute glass, or else a known phrase that takes that length to speak, or some other way of keeping time, so that the line being thrown out is made fast again just as the glass empties, or the phrase is complete. At this point, the line is hauled in again, and the number of marks is counted, and this is the number of nautical miles that you are travelling each hour. And the ship's way should be taken on every heading, and every change of wind strength, so that a reckoning of the ship's position can be made from knowledge of the speed and course alone. And all this to be recorded in the Ship's Log, first named from this very piece of wood.

12 Navigation and Longitude

Which treats of the Longitude, etc.

12.1 Longitude

Now, there are some who are very inquisitive and wish to have a way to get their Longitude, but that is too tedious. For they must realise that the whole frame of the firmament is carried round from the East to the West every 24 hours, so that there remains neither light nor mark that stands still, except the two Poles of the World, which always stand fast. And there are other opinions as to whether the world or the Heavens do move, but it is all the same for the Navigator, who sees one move and stands on the other. But when travelling directly East or West the lights of the firmament make the same manner of arch according to their latitude or declination, but the travelling alters the Meridian, causing planets to have their aspects of rising and setting at varying hours, altering the time of the changing of the Moon, and also the time of the Eclipses. And by such ways you shall know your Longitude. Now the Latitude comes from the Poles, but the Longitude you must bring from another place, which for us is Tycho. And why Tycho has a Longitude of zero, from which everywhere is either East or West, I reckon because it was the easternmost place known by the ancients.

12.2 A Degree of Longitude

While each degree of Latitude is the same, being 60 nautical miles or 20 sea leagues, the degrees of Longitude start the same under the Equinoctial, but get less and less as they approach the Poles, but whatever distance a degree of Longitude is, travelling West that degree gains you one minute in the day, and travelling East loses that same minute. And therefore 15 degrees of Longitude is an hour, and an entire day is 360 degrees of Longitude, which returns you to the spot where you first started. And in our Latitude of Seagate at 37° every 48 miles is a degree and 720 miles is an hour of time, but under the Equinoctial it is 900 miles to an hour, and at 60°N, it is 450 miles to an hour.

12.3 Longitude at the Eclipse

And now to get the Longitude, you may do it at the time of the Eclipse of the Moon, for that Eclipse occurs at one point in time for all places on the earth or the sea such that she is above your Horizon. And consider your Almanac which states what hour and minute the Eclipse shall occur, and also place where the Almanac was prepared, that done, with a precise instrument you shall take the time of the Eclipse, and from that you shall know the alteration of your Longitude from where the Almanac was printed, by the rule of every 4 minutes being a degree, and every hour being 15 degrees of Longitude.

12.4 Avoid the Ephemeredes

It is said you might know your Longitude with the Ephemeredes, by the conjunction of the Moon with other fixed Stars, but this is prevented by the parallax of the Moon, which the semi-diameter of the Earth causes by the proximity of the Moon to the Earth, so that the Moon is viewed from a different angle as it rises from when it sets. Therefore let no Navigator trouble themselves with any such rule, but let them keep a perfect account or reckoning of the way and course of their ship, whether the ship goes to leeward or makes good, considering always what things be with them or against them, such as tides, currents, winds, or such like.

13 Navigation and Latitude

Which shows how many miles are in one degree of Longitude in every Latitude between the Equinoctial and the Poles, and also the diversity of aspects of the Moon.

13.1 A Degree of Longitude

Now I will teach you the rule for how many nautical miles there are in one degree of Longitude, for it varies for every degree of Latitude between the Equinoctial and the Poles. First, under the Equinoctial there are 60 nautical miles in one degree East to West. And the number of miles in a degree of Longitude decreases as the degrees of Latitude increase, in a simple curve.

13.1.1 Longitude at each Latitude

Latitude	Longitude (nm)
0°	60
5°	60
10°	59
15°	58
20°	56
25°	54
30°	52
35°	49
40°	46
45°	42
50°	39
55°	34
60°	30
65°	25
70°	21
75°	16
80°	10
85°	5
90°	0

13.2 A Card for Distances

First is the making of the instrument. Around the curve of a half circle, evenly mark the degrees of Latitude from 0 to 90. Then evenly mark the number of miles in the line of the diameter or straight edge from 0 to 60 so that the mark for 0 miles is also the 90 degrees mark and the mark for 60 miles is also the mark for the equinoctial. Take a length of string which is as long as the diameter of the circle and fasten it to the 90 degree mark. To know how many miles there are in a degree at any Latitude, first lay the thread onto the Latitude mark on the curved edge. Then hold the string at the point it crossed the mark in degrees, and swing it to the line of the diameter and read off the number of miles. This instrument is simple to make and accurate in any conditions, so no Ship need be without it and no excuse can be given for not knowing how to find the length of a degree of Longitude at any Latitude.

13.3 Longitude affects the aspects of the Moon

Now if you have an Almanac or table of Ephemeredes, it will predict the times of the Eclipses and of the changing of Aspects of the Moon. However it should be known that this time is only true for the location where the Almanac was written, and for those places lying direction North or South of it. Now you must consider your distance East or West from where the book was printed. First you must know the distance in miles from your vessel to the printer's Longitude measures at your current Latitude. Then reckon this distance in degrees, with every degree in miles as per your current Latitude. And for every degree you are to the West, the Moon shall change 4 minutes earlier, and for every 15 degrees, an hour earlier. And this is because they shall touch your Meridian before theirs by one hour as time is reckoned locally. And for every degree you are to the East, the Moon shall change 4 minutes later, and for every 15 degrees, an hour later. So by this rule you may know at what hour and minute the Eclipses and changes of the Moon will happen, if you know what place your Almanac was made for.

13.4 Knowing the Aspects of the Moon

Only this much have I said touching the true time of the changes of the Moon, for though some people do say 'why do they not give or make rules for ever to know the hour and minute of the new, full and quarters of the Moon?' and yet they are utterly void of any knowledge in the sciences, whereby they might know the true time of the changes of the Moon; for it is a question Astrological to know the Moon's motion, and question Geometrical to know the true time of the aspects, and thirdly it is a question Cosmographical to know the true Longitude of the place one is in, and the time the Moon changes.

14 Navigation by Towns

Which treats of the Longitude and Latitude of Certain of the most Notable Towns in the Baronies, and around all of Alusia; along with the different timing of the change of the moon, and the different lengths of the longest day in summer.

Now furthermore, because you would know better, I would draw out certain of the chief places about the Baronies and Alusia, both their Longitude and Latitude, by which you shall know what manner of arch the Sun and the other Stars shall make, and also by the Longitude you may know at what time the Eclipses of the Sun or Moon, also the change, quarters and full Moon, may occur.

14.1 Location of Key Towns

Town	Latitude	Longitude	Longest Day	Time Difference
The Guild	37° 00' N	17° 00' W	14 hrs 34 min	+0 hr 0 min
Seagate, Carzala	37° 04' N	16° 57' W	14 hrs 34 min	+0 hr 0 min
Sanctuary, Ranke	38° 53' N	19° 11' W	14 hrs 45 min	-0 hr 8 min
MMHS, Midheim	44° 01' N	16° 49' W	15 hrs 19 min	+0 hr 0 min
Gracht	45° 02' N	16° 48' W	15 hrs 27 min	+0 hr 0 min
Innesburg	43° 49' N	18° 03' W	15 hrs 18 min	-0 hr 4 min
Eltran	38° 43' N	28° 39' W	14 hrs 44 min	-0 hr 46 min
Westport, Eltrandor	37° 14' N	30° 10' W	14 hrs 35 min	-0 hr 52 min
Soulport, Eltrandor	36° 31' N	28° 12' W	14 hrs 31 min	-0 hr 45 min
Brandenburg	37° 14' N	24° 55' W	14 hrs 35 min	-0 hr 31 min
Caulder, Brandenburg	37° 07' N	25° 35' W	14 hrs 34 min	-0 hr -25 min
Grobbenbonk's Tower	38° 13' N	25° 25' W	14 hrs 41 min	-0 hr 33 min
Freetown, Aladar	39° 01' N	23° 06' W	14 hrs 45 min	-0 hr 24 min
Cauldersfield	41° 25' N	25° 52' W	15 hrs 1 min	-0 hr 35 min
Drakenberg	41° 58' N	25° 40' W	15 hrs 5 min	-0 hr 34 min
Glissom	38° 57' N	25° 49' W	14 hrs 45 min	-0 hr 35 min
Destiny	41° 42' N	38° 00' W	15 hrs 3 min	-1 hrs 24 min
Elven Isles	37° 00' N	49° 59' W	14 hrs 33 min	-2 hrs 12 min

14.2 Location of Foreign Lands

Town	Latitude	Longitude	Longest Day	Time Difference
Lunar City	42° 37' N	9° 39' E	15 hrs 9 min	+1 hrs 46 min
Tac	45° 26' N	4° 13' W	15 hrs 30 min	+0 hr 50 min
Tycho City	40° 10' N	5° 52' E	14 hrs 53 min	+1 hrs 31 min
Sheapur	30° 09' N	14° 25' W	13 hrs 57 min	+0 hr 10 min
Izmiraldi	29° 11' N	13° 02' W	13 hrs 52 min	+0 hr 15 min
Ajepar	29° 44' N	11° 35' W	13 hrs 55 min	+0 hr 21 min
Kirkul	30° 26' N	9° 56' W	13 hrs 58 min	+0 hr 28 min
Sakukorum	31° 28' N	8° 39' W	14 hrs 4 min	+0 hr 33 min
Bright City	28° 52' N	3° 48' E	13 hrs 51 min	+1 hrs 22 min
Tower Hill	29° 21' N	5° 35' E	13 hrs 53 min	+1 hrs 30 min
Thought	27° 57' N	6° 33' E	13 hrs 47 min	+1 hrs 33 min
Kyoshin, Kin Lu	28° 00' S	172° 00' E	13 hrs 47 min	+12 hrs 35 min

15 Navigation with a Globe

In which is shown how to sail by the Globe, and to know how much the water is higher than the level between any two ships on the sea, which grows by the roundness of the earth.

15.1 The World is a Globe

Now it is convenient to speak of why and when to sail by the Globe. For generally seamen plot their course as though the earth were a platform, for they do not consider that the earth is a Globe, and that the Meridians grow narrower towards the Poles. It is impossible to draw both the face of the earth and of the sea truly on a flat surface. If you describe the lands true, then the seas shall not be true, for as you go towards northern parts, your Meridians grow closer together, so to make your lines according to the art of Hydrography, the Sea must be broader to the North parts than it is. Now if you would describe the Sea truly, with lines, courses, distances, havens and dangers, then likewise your land should be broader to the north than it is. For your better understanding, I will list the circumference of the earth under sundry parallels or circles. First, under the Equinoctial (where the earth is of greatest girth), by going directly East or West, by a straight line over Sea and Land, the two Poles being on your Horizons, you will travel 21,600 nautical miles to return to the place you departed from. Under the North Tropic Circle, the North Pole being raised 23°30', going directly East and West it is 19,810 miles in circumference. At our circle of Seagate where the North Pole is raised 37° it is 17,250 miles, and under the Arctic Circle where the North Pole is raised 66°30' it is only 8,610 miles. By this you see that the distance East to West is much lesser to the North than it is to southwards, wherefore when you shall have any occasion to attempt any voyage to the north, it is best to sail by a Globe; for so shall you better see the distances and size of the lands, and in like manner your lines and courses.

15.2 The Use of a Globe

To sail by a Globe, first keep a perfect account and reckoning of the ship's way (according to your accustomed manner), noting by what course or point your ship has made her way, then you must resort to your Globe. Consider next what place and parallel you are in, which you may do by the Sun by day, and the Stars by night. Now tilt your Globe until the elevation of your Latitude is highest, and rotate it until the place of your Zenith is centred. Your location is then level and flat, and courses and bearings may be set as if on a chart. This requires a Compass Rose, which is to be constructed from your East West Latitude line, with the exact quarter of a circle inscribed around your location from this line Polewards, and divided into the 8 points of your compass, doing so likewise on the other sides. And thus you must do as often as possible, for the oftener you observer this customer, the better and more perfect shall your course be.

But for those that travel to southern parts, and yet not so far south that the weather again turns chill and the sun's declination great, nothing is better than their charts. And again, for those proceeding into the pitiless Southern Ocean, a Globe is of more use than a chart, and yet precious little help will either provide in these fierce latitudes, and a Holy Book may serve better than both.

Now thus I briefly make an ending of sailing by the Globe.

15.3 Ships over the Horizon

Furthermore, that you may better understand that the Earth is a Globe or Circular, you can perceive it thus; if you see a ship at any far distance, you may perfectly see its sails, but not its hull, due to the circularity of the earth and the water of the sea, for the water rises between you and the other ship, according to the distance between both ships. This is because the distance to the centre of the earth or water is the same in every place. And the amount of water between the ships is due solely to the distance between them, in addition to any occasional swells or waves.

I will also say a little whereby you may discern how far it is possible to see a ship upon the sea, by a list of distances and how far the water rises between ships at this distance. And if the water is risen 10 feet between the ships then each observer must also be raised ten feet to see each other, or however much one is lower than this, the other must be likewise raised, and this is why a lookout should be posted on the highest point of the mast.

15.3.1 Water between Ships

Distance	Height of water
1 mile	3 inches
3 miles	2 feet
5 miles	5 feet 6 inches
10 miles	22 feet
15 miles	50 feet
20 miles	88 feet

15.4 The Distance Ships can be Seen

And 20 miles is as far and rather farther than it is possible to see any ship upon the Sea; neither it is possible to see any land further, except land that is very high, wherefore 20 miles is called a *ken*. Now the circularness of the earth is the reason that you may see a ship or land further out when high on the top mast than upon the hatches; wherefore it is plain that the Earth and Sea are not flat, but circular, as we have already declared.

16 Navigation and Charting

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Which is concerned with Charting, and of the three necessary things contained in all good charts, along with their uses.

16.1 Over-decoration of Charts

On the making of charts, and the science of Hydrographia, I mean to say little, for that is sufficiently covered in other works. Having said this, I would wish that the makers of charts did not paint their compasses with so many colours, nor the Land with so many flags, for that does more harm than good. Although it may be said they are only painted in otherwise vacant places, I would wish them to furnish those vacancies with two other matters, in this order.

16.1.1 Marking of Full Tides

First in some vacant place with a compass, to place against every point of the bottom half of the compass, letters or other figures or characters, then in like manner to place that letter or character at each haven, port or place according to when the moon makes a full sea at that place. And where it runs quarter or half-tide under the other, a further mark should be made.

For example, I place A at the East point, B at East and by South, C at East Southeast, D at Southeast and by East, and so on consequently to all the point unto the West. Then, where a tide runs high under an East moon, I mark that place with an A, and where it does so under an East and by South moon, I mark that place with a B, and so forth.

16.1.2 Marking of Headlands

It is also very necessary to furnish the remaining places on the chart by drawing the shape or silhouette of every headland or high point along every coast that is needed to be recognised, at what point of the compass the land is of that form, and at how far off that land rises in that fashion; and to so draw the land as often as the land alters its form and fashion, for being on one side, the land rises in one manner, and on another, it is of another form, and being near the land it will be in one fashion, and far off, in another again. And the reason for these drawings is that there is nothing more needful and necessary for a Mariner than to know the land when it is before them, and these is no better way to recall it that to have notes and drawings on how the land rises upon every side. And what greater inconvenience may there be than occurs by mistaking a place? For it is twenty times better to be thoroughly persuaded that you don't know where you are, than to think you know it, but are mistaken. For whereas the first thinks to prevent unknown dangers, the other may willingly run upon the dangers, believing they are not present.

16.2 The Use of Charts

The use of charts is most necessary for Navigation for long voyages, first for that it shows you how one places bears from another, second that it shows the distance between any places, third that it shows in what Latitude any place is. And these are shown by the lines of the compass, by the scale or measure, and by the line of degrees, if the chart be made true.

16.2.1 Taking a Bearing

Now, to direct your course through the Sea by the chart to any place assigned, you must first look on which point of the compass it bears from you, from the place you mean to set off from, to the place you would first seek landfall. And some say you shall know this by laying a straight edge rule between these two points, and then while keeping the edge at a constant angle, move the rule to the nearest compass rose. From here, you can read off the bearing, taking care that it is from the place you would depart from and to the landfall, and not the reverse. But others say that you should use your compasses instead, and they recommend that you open your compass to measure between your departure point and the nearest part of a line from a compass rose, and then run along that line until you reach your destination. And if the distance from the line to the destination is the same, then this line is your true bearing, and if the compasses fall short, then take the next line from the compass rose to test for your bearing. And this method is most accurate, if your course lies on one of the 32 points, but when it lies between, the laying of an edge is a better measure, so both methods should be taken, and the better bearing used to decide the point of the compass to lay your course.

16.2.2 Measuring Distances

If you would know how far any place is from you, set one foot of your compasses upon your current location, and stretch out the other foot unto the place assigned, then set the compasses against the scale of the chart, and that shall show you exactly how many miles or leagues it is from one to the other. If the distance between the two places is more than the compasses will reach in a single span, then first set your compasses against the scale, opening them to a convenient amount such as 100 miles, as your scale and compasses give you leave; after that, set one foot at your location, and the other foot towards the destination as best you estimate, and step your compasses as often as the distance between then requires, and from this you may conclude it to be just as many hundreds of miles (or other convenient amount) as the compasses did step. But if there is any odd measure left and the end, then reduce the span of your compasses to this distance, and set them against the scale, and it will show you the amount of extra distance to add on to the amount just concluded.

16.2.3 Determining Latitude

And touching upon the third commodity, being the Latitude of any place, set one foot of the compass against the place assigned, and open the compasses to the nearest place of the next East-West line, then carry than span to the line of degrees, keeping one foot on the same East-West line, and it will show exactly the number of degrees that the Pole is above the Horizon, being your Latitude.

16.2.4 Using Contrary Charts and Tables

Many sets of Navigational Tables also list common ports and havens with their Latitude and Longitude, and this is also good to use if the table is drawn by the same people who have drawn the chart, but if the two values be different, then the chart is to be preferred even if it be wrong, for if your courses are laid by a chart, and your position recorded on that chart, then that chart is a true record of where you are, wherever the Sun and Stars may put your actual Latitude.

16.3 Tracking a Course on a Chart

Now with all these values you may think you know how to attain the port or place assigned with the utmost ease. Yet there is to be considered, whenever directing the course of a ship, what impediments may be along the way, such as tides, currents, the force of the winds which may blow a ship to leeward of the course, as may the surging of the seas. And all this must be considered by the Master or Navigator. Likewise also in long voyages, the wind may often shift, and sometime the wind may be such that the vessel cannot lay her course, wherefore the Navigator must keep a perfect account of the ship's way, and consider on what point the ship has truly made her way, and not just where she points or what course was laid. And every time that the wind shifts so the ship can no longer lay her course, to note on the chart in what place the ship may be, having a special regard for the swiftness of the ship and so what progress has been made on the last course. And if the weather is clear either by night or day, to take the true Altitude of the Pole, and thus the Latitude of the ship, for by that, they may correct the ship's way, and give a very near guess as to how the destination bears from them, and how far it is from the ship, saving if you have set an East or West course, and then there is no other help but only the way as accounted in the Ship's Log.

16.4 Correcting Dead Reckoning of a Course

And to correct their dead reckoning by the Latitude, they must do the following (especially if the ship has often veered from her course due to contrary winds): first set your compasses against the line of degrees, with one foot on the observed Latitude, and the other on the nearest East-West line, and then carry them to the place where you suppose your ship to be, leaving the second foot on the same East-West line. Then bring forward with the other set of compasses or the straight edge rule what point of the compass the ship has sailed by, and at the meeting of the two measures make a mark for the ships location and record the date and time. Now from this place you may use your compasses to see how your destination bears, and how far off you still lie. And if you have plotted several points since your last true reading of the Latitude, you must pull back or extend your overall course from that last true mark, and not from your most recent mark from dead reckoning, for you don't know which of the later marks may be wrong, and it is most likely that it is all of them.

16.5 Other Uses of a Chart

As I have explained in an earlier chapter, you may know how far land is from you if you know the distance between any two landmarks. Now, by setting the landmarks with your compasses, you may do the same with your chart, by measuring the distance between the landmarks on the scale, or more accurately the distance between them as lies parallel to your position, so you know that they are so many miles or leagues asunder, then take bearing to each of the landmarks by the points of the compass, and mark these bearings on your chart. Then where these bearing cross, so lies your ship. And setting the compasses on this location and the nearest part of land, then adjourning them to the scale, shall reveal the distance to shore. But as there are always inaccuracies, then the distance between the landmarks and the number of points between the bearings should be applied as explained in an earlier chapter, which also gives a distance from shore. And if these are similar, then your position is known, but if they differ by much, then your distance from shore is uncertain, and you must carefully re-measure and re-plot, or use dead reckoning of the distance to shore.

17 Navigation by the Stars

Which is of the Longitude and Declination of 32 notable fixed stars for Navigation, with tables of their shining, and at what point of the compass they do both rise and set; with tables for every month of the year, for mariners out from Seagate Port.

17.1 The Uses of the Stars

It is convenient for diverse reasons to show the Longitude and Declination of certain of the most notable fixed Stars that lie between the Tropic Circles, which are very necessary for Navigation in diverse respects, as if you are far to the North, where the North Pole is raised more than 50 degrees, then the North Star is too high to be observed or taken with the cross staff, and it is not uncommon (particularly to the North) that the sun is not to be seen exactly at Noon, and then any of these Stars may serve in their turn. And furthermore, they are very good for those who have occasion to sail beyond the Equinoctial, where the North Star is always under the Horizon, to be used for knowing the declination as also described in earlier chapters, again with the Sun often being obscured for days in the southern oceans. And furthermore, they are very useful for Seafarers to know the passing of the hours of the night, both by their position on the Meridian, and by their rising and setting; you may know the true time of their rising and setting in every Latitude by their declination North or South from the Equinoctial, as is explained in an earlier chapter on the declination of the Sun. And furthermore by any of these Stars, you may measure the variation of your compass by night.

17.2 The Notable Tropical Stars

And in the list of notable fixed Stars that lie between the Tropic Circles we list the sign of the Zodiac that each falls within, the Longitude of the Star within that Sign, their Declination from the Equinoctial, their Magnitude or Brightness when observed, and at what point of the compass the star rises and set when seen from Seagate, along with the time it shines, in all seasons. But if you desire to know the length of time that any of these stars is above the horizon or where it sets or rises in Latitudes other than Seagate, then refer to earlier chapters, as you may know this by their declinations, even as you know the length of the day, and the bearings for sunrise and sun set by the Sun's declination.

17.3 The 32 most notable Tropical Stars

Star Name	Zodiac Sign	Longitude	Declination
The Hammer	Smith	7° 02’	4° 23’ N
Horseshoe	Smith	19° 16’	17° 34’ S
The Knife	Thief	5° 02’	1° 40’ N
Thief’s Purse	Thief	14° 06’	4° 52’ S
Thief’s Mask	Thief	21° 27’	20° 16’ N
Lover’s Foot	Lover	9° 09’	23° 55’ S
The Rose	Lover	19° 51’	16° 56’ N
Shield Boss	Warrior	0° 34’	4° 35’ N
Spear Butt	Warrior	13° 59’	14° 17’ S
The Crown	King	3° 47’	20° 13’ N
Sceptre Base	King	11° 48’	11° 41’ S
The Orb	King	18° 46’	2° 31’ N
Spinning Wheel	Mother	12° 14’	18° 29’ S
The Awl	Mother	21° 57’	6° 44’ N
The Wand	Magician	7° 04’	13° 45’ N
Robe Hem	Magician	19° 34’	13° 32’ S
Wolf Paw	Wolf	1° 58’	22° 56’ S
Dog’s Balls	Wolf	12° 44’	17° 13’ S
Lost Hope	Void	12° 51’	2° 22’ S
Scythe Head	Reaper	3° 45’	15° 00’ N
Scythe Butt	Reaper	11° 59’	9° 43’ S
Scythe Tip	Reaper	23° 44’	23° 43’ N
Pig Bladder	Fool	7° 48’	10° 28’ N
Fool’s Belly	Fool	21° 01’	4° 46’ N
Wheat Bushel	Farmer	2° 55’	16° 52’ S
Farmers Eye	Farmer	14° 02’	20° 44’ N
Sickle	Farmer	22° 42’	13° 36’ N
The Garter	Maiden	5° 36’	11° 44’ S
Maid’s Ankle	Maiden	17° 02’	21° 07’ S
Messenger’s Head	Messenger	0° 44’	20° 00’ N
The Baton	Messenger	9° 15’	4° 14’ S
The Scroll	Messenger	18° 55’	6° 34’ N

Star Name	Brightness	Rises	Sets	Visible for
The Hammer	Third Magnitude	84° 30’	275° 30’	12:26
Horseshoe	A Great Star	112° 10’	247° 50’	10:09
The Knife	Second Magnitude	87° 50’	272° 10’	12:10
Thief’s Purse	Third Magnitude	96° 10’	263° 50’	11:30
Thief’s Mask	Third Magnitude	64° 20’	295° 40’	14:09
Lover’s Foot	Second Magnitude	120° 30’	239° 30’	9:23
The Rose	A Great Red Star	68° 40’	291° 20’	13:46
Shield Boss	Second Magnitude	84° 20’	275° 40’	12:27
Spear Butt	Third Magnitude	108° 00’	252° 00’	10:31
The Crown	Second Magnitude	64° 20’	295° 40’	14:08
Sceptre Base	Third Magnitude	104° 40’	255° 20’	10:48
The Orb	A Very Great Star	86° 50’	273° 10’	12:15
Spinning Wheel	Third Magnitude	113° 20’	246° 40’	10:03
The Awl	A Great Star	81° 30’	278° 30’	12:40
The Wand	A Great Blue Star	72° 40’	287° 20’	13:25
Robe Hem	Third Magnitude	107° 00’	253° 00’	10:36
Wolf Paw	Second Magnitude	119° 10’	240° 50’	9:31
Dog’s Balls	Third Magnitude	111° 50’	248° 10’	10:11
Lost Hope	Fourth Magnitude	93° 00’	267° 00’	11:45
Scythe Head	A Great Star	71° 10’	288° 50’	13:33
Scythe Butt	Second Magnitude	102° 10’	257° 50’	11:00
Scythe Tip	A Very Great Star	59° 40’	300° 20’	14:34
Pig Bladder	Third Magnitude	76° 50’	283° 10’	13:04
Fool’s Belly	A Great Star	84° 00’	276° 00’	12:28
Wheat Bushel	Third Magnitude	111° 20’	248° 40’	10:14
Farmers Eye	Second Magnitude	63° 40’	296° 20’	14:12
Sickle	A Great Star	72° 50’	287° 10’	13:24
The Garter	Second Magnitude	104° 50’	255° 10’	10:47
Maid’s Ankle	Second Magnitude	116° 50’	243° 10’	9:44
Messenger’s Head	Second Magnitude	64° 40’	295° 20’	14:07
The Baton	Third Magnitude	95° 20’	264° 40’	11:34
The Scroll	Second Magnitude	81° 50’	278° 10’	12:39

17.4 The Stars at their Meridian

Now for all days of any month of the year, it is very necessary to know the time that a star is to be found touching your Meridian, being due South (or North, for distant explorers), as this serves Mariners well to take their height with their instruments, or to know the time as it passes through the night. And knowing their Meridial time and the number of hours that they shine, then as shown in earlier chapters, you may know when they rise and set, this being exactly half the time they are visible either removed from or added to their Meridial time. And as it is known for every star that is above the Horizon at night the exact times that it rises, reaches its Zenith, and sets, so no Mariner should ever be uncertain of the time, being that they can see one of Eastwards, Westwards or directly overhead.

Now this table does not list every day, this being too many tables and charts for any Mariner to carry, but only the Meridial times for the four High Holidays. And to know the time for other days, remove 4 minutes from the time for each day of the Season. That doing, you shall know the rising, setting and Zenith times of these 32 Tropical stars on any day, at any Latitude.

17.4.1 Meridial Times for the Tropical Stars

Star Name	Beltane	Lugnasad	Samhain	C-mansa
The Hammer	12:54 p.m.	6:54 a.m.	12:54 a.m.	6:54 p.m.
Horseshoe	1:43 p.m.	7:43 a.m.	1:43 a.m.	7:43 p.m.
The Knife	2:28 p.m.	8:28 a.m.	2:28 a.m.	8:28 p.m.
Thief's Purse	3:05 p.m.	9:05 a.m.	3:05 a.m.	9:05 p.m.
Thief's Mask	3:34 p.m.	9:34 a.m.	3:34 a.m.	9:34 p.m.
Lover's Foot	4:28 p.m.	10:28 a.m.	4:28 a.m.	10:28 p.m.
The Rose	5:11 p.m.	11:11 a.m.	5:11 a.m.	11:11 p.m.
Shield Boss	5:36 p.m.	11:36 a.m.	5:36 a.m.	11:36 p.m.
Spear Butt	6:30 p.m.	12:30 p.m.	6:30 a.m.	12:30 a.m.
The Crown	7:32 p.m.	1:32 p.m.	7:32 a.m.	1:32 a.m.
Sceptre Base	8:04 p.m.	2:04 p.m.	8:04 a.m.	2:04 a.m.
The Orb	8:32 p.m.	2:32 p.m.	8:32 a.m.	2:32 a.m.
Spinning Wheel	9:49 p.m.	3:49 p.m.	9:49 a.m.	3:49 a.m.
The Awl	10:28 p.m.	4:28 p.m.	10:28 a.m.	4:28 a.m.
The Wand	11:11 p.m.	5:11 p.m.	11:11 a.m.	5:11 a.m.
Robe Hem	12:01 a.m.	6:01 p.m.	12:01 p.m.	6:01 a.m.
Wolf Paw	12:33 a.m.	6:33 p.m.	12:33 p.m.	6:33 a.m.
Dog's Balls	1:16 a.m.	7:16 p.m.	1:16 p.m.	7:16 a.m.
Lost Hope	3:00 a.m.	9:00 p.m.	3:00 p.m.	9:00 a.m.
Scythe Head	4:06 a.m.	10:06 p.m.	4:06 p.m.	10:06 a.m.
Scythe Butt	4:39 a.m.	10:39 p.m.	4:39 p.m.	10:39 a.m.
Scythe Tip	5:26 a.m.	11:26 p.m.	5:26 p.m.	11:26 a.m.
Pig Bladder	6:05 a.m.	12:05 a.m.	6:05 p.m.	12:05 p.m.
Fool's Belly	6:58 a.m.	12:58 a.m.	6:58 p.m.	12:58 p.m.
Wheat Bushel	7:29 a.m.	1:29 a.m.	7:29 p.m.	1:29 p.m.
Farmers Eye	8:13 a.m.	2:13 a.m.	8:13 p.m.	2:13 p.m.
Sickle	8:48 a.m.	2:48 a.m.	8:48 p.m.	2:48 p.m.
The Garter	9:22 a.m.	3:22 a.m.	9:22 p.m.	3:22 p.m.
Maid's Ankle	10:08 a.m.	4:08 a.m.	10:08 p.m.	4:08 p.m.
Messenger's Head	10:46 a.m.	4:46 a.m.	10:46 p.m.	4:46 p.m.
The Baton	11:20 a.m.	5:20 a.m.	11:20 p.m.	5:20 p.m.
The Scroll	11:58 a.m.	5:58 a.m.	11:58 p.m.	5:58 p.m.

18 Navigation Instruments

Which shows you the making of a general Instrument with which to know the hour of the day throughout the world.

18.1 The Equinoctial Dial

Now for the making of your standard instruments, you should repair to your usual Ship's Chandler or Instrument Maker. However, there are some instruments that are not as common as they should be, one being the Equinoctial Dial. This Dial is used to know the hour of the day, in all latitudes throughout the whole world, for your compass does not know the hour of the day during Summer, neither in the morning nor evening, neither can you know when the Moon is East or West when she has North declination, as I have shown earlier, and also because your compass stands as flat as your horizon. Wherefore it is good for Mariners to use Equinoctial Dials, for they show the true hour of the day in all latitudes, and also the Moon gives a true Shadow in the Dial in all Latitudes.

18.2 The Use of the Moon's Shadow

Now this is useful for many mariners are deceived as to when High tide flows on an East and West Moon, or and point between the Southeast and Northeast, because in setting the Moon with their compass she seems to be East, when she is near the East Southeast in her actual course, and in like manner when the Moon seems West by the compass she shall be a little more than West Southwest in her course. And this is a very perilous matter for those that should put into a tidal channel, harbour or haven knowing that there is enough water if they come in on a full Sea, and then by the error of the compass in reading the Moon's shadow they are deceived.

And when this error is found, many Navigators think that the cause is due to the occasion of some great storm that is likely to follow, whereas this error is caused by no other means than of receiving a false shadow by the Horizontal compass. And this error is especially severe if the Moon is in her greatest declination to the North, that is in the Zodiac signs of the Smith, Thief and Lover, and also the effect is most pronounced if the Dragon's head is three or four Zodiac signs behind the Moon, for then she shall have up to 5 degrees more declination from the Equinoctial than if the Dragon's head be elsewhere, so that if these situations both occur, the Moon will be declined 28 and a half degrees to the North of the Equinoctial.

18.3 The Equinoctial Dial Recommended

But to avoid any of these infirmities of readings, I would recommend the use of the Equinoctial Dials. And furthermore I do not think that the Equinoctial dials are used amongst our Mariners here in the Baronies, no matter how good they may be as Navigators, not least because the charge for them is so great, and yet they serve no purpose except to know the hour of the day, and to show the true shadow of the Moon. But not withstanding, I would wish them that are Seafarers to accustom themselves to the dials, for they serve two notable uses, both in coastal journeys and also in long voyages, and to this end I advise that the can be made with a very low charge, for whereas in the Arts of Navigation they are only accepted in brass, they may be made also from wood in the following manner.

18.4 The Making of a Wooden Dial

Take a piece of board end at least six inches broad (at your discretion) and half an inch in thickness, then having cut it into a round circle and planed it smooth, you may either engrave in it the 32 points of the compass, or else paint them upon it with some colours, with the 24 hours also upon both sides, as shown in this figure:

That done, take a wire of exactly the diameter of the Instrument and pierce it through the exact centre of the Instrument, than make it fast so that one end be halfway through on one side, and the other half on the other side; this done, make a frame with three pieces of board end to hang the Instrument or Dial from, with one upright board attached by a pin on the East point, and another on the West point, and the third board serving as a level base between the uprights. Then take another board end, being square, and with a pair of compasses draw a quarter circle of exactly the size of the quarter of the dial, and cut all that away; and then the inner curve on the rest of the square is to be divided into 90 equal parts, marking it thus: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90. Last of all, let this board be placed in the middle of the frame in parallel to the uprights, so that the mark 90 may stand right under the very middle of the dial, and there made fast. This board should be in such a position that the very end of the wire runs up to the hollow curve howsoever the dial be tilted on its pins, and so it is finished, and will stand altogether in this form.

18.5 The Use of an Equinoctial Dial

The use of this Dial is most necessary in a ship, as you oft have occasions to transport yourselves into all manner of climates. And to know the true hour of the day do this: set the Dial to point North-South by your compass with the curved degrees to the South, and then set the end of the wire right against that degree which is your Latitude, and then other end of the wire will point just to the Pole. Then look what shadow the wire gives by the sun against the sloping dial; that is the true hour of the day. In like manner you may know the true hour of the night by the Moon's shadow, and also where the Moon's shadow falls is its true bearing.

19 Navigation and Port Soundings

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Which wishes to treat of the soundings of every major port, safe harbour and set of shoals from Novadom along to Destiny; with other necessary matters for those that occupy or travel amongst sandbanks.

It is very necessary for every Navigator to collect soundings of the major channels and ports to which they may be assigned. And while these soundings are mere features of the seas, and available to any to discover, it is customary not to record them in a Ship's log and instead for the soundings to be held in memory, for there are many dangerous places that a Master or Navigator must travel, and such a record is considered in some places as Spying, the punishment of which is death or similar treatment. And whereas my patrons and their nautical allies have advised that the publishing of soundings into their ports may be encouraging to their enemies, and whereas I which neither to offend neutral ports nor to provoke their enemies, I will not record my soundings of channels and havens collected along the length of the Baronies, but encourage you to do likewise, bearing in mind the offence this can cause port reeves in times of conflict.

19.1 An Example Course of Soundings

However, it seems that an example course of soundings to approach an unnamed port, and clearly stopping short of the port itself, should not violate any wishes; for those that recognise the course will already have the soundings, and learn nothing except perhaps a useful way to record such information, and those who do not, cannot apply it without risking their vessel and their very life by steering the given course in the wrong channel. The names of isles, channels, and headlands have also been changed to prevent revealing the destination

1. Follow this course when your soundings find a bottom at 100 or 90 fathoms, for you are near the start of the seams.
2. The seam starts at 80 fathoms where you shall find cockle shells and dents in the tallow of the lead, and in this sounding hold your course to the North until you change sounding.
    a. If you rise to 60 or 64 fathoms you shall find fine sands and shifting ground, and shall be near the coast of Ushant.
        (i) If you have time and spare daylight, go seek the coast in the Northeast, and you will be about 25 miles from the Isle.
    b. If you set your course around Basefreed, you shall find coarse red and brown sand, and soundings at 40 fathoms.
    c. If you are towards the banks of Scilly, you shall have soundings at 86 or 90 fathoms, and when you find stony ground in the tallow you are well shot towards the banks of Scilly.
    d. When you are at 80 fathoms you shall find small black sand, and are well towards the Lizard. (i) When you are at 60 or 64 fathoms you shall find white sand and white soft worms, and are very close to the Lizard.
3. Between the coast of Samwell and Ushant in the middle of the channel you will find 70 fathoms, or near enough.
4. Between Dodman and the Forn in the channel you will have 40 or 50 fathoms.
5. When you are athwart of Eastleigh or Start Point, you shall find shifting ground and dents in the tallow, at soundings of 41 or 42 fathoms.
6. As you approach Sidmouth you shall have 35 fathoms and small shingle.
7. And when you are near to Sidmouth, 30 fathoms and stones like beans, and this sounding will last until south Aldam, when in the soundings you will find white stones like broken awls,

and then you are between South Aldam and the Isle of Wraiths.

a. A few miles from the Isle of Wraiths you shall find 25 fathoms, with dents and clefts in the tallow like small threads.

b. On the other side, a few miles from the Aldam Caskets you shall find 40 fathoms and big, ragged black stones.

c. Between the Isle of Wraiths and Ventnor the deepest point is 35 or 40 fathoms.

d. Between the Isle of Wraiths and Lanterngate the deepest point is only 25 or 30 fathoms.

e. Between the beaches and the Isle of Wraiths, a league from the land you shall find 38 fathoms, and pebbles as big as beans - go no closer to the beach.

8. Between Fairly and the waters of Summer the deepest channel is but 25 fathoms.

9. Between the People's Stone and Boulogne is a bank called the Ripper which breaks in low water, and it lies in the middle of the channel between the two nations, and hard to its West is a channel that is 26 or 27 fathoms. 10. In the straits of Calico is 30 fathoms, and in the roads or Calico it is 16 fathoms, and along the coast past our destination port is but 20 fathoms at the deepest.

19.2 Landmarks in Channels

And furthermore, those who are channellers and occupiers of sandbanks, small isles, and such like must have consideration of the following things. First, if you know how a channel lies right between any two shoals, you must view the land to take some leading marks for it. And you should do it thus: look straight down the channel for something that stands far inland which is easily recognisable, such as a crag, spire or steeple; then take another mark near to the waterside, so that the two are in line when you are in the middle of the channel. And then, if you know these two marks well, they will be leading marks for you to keep the channel for ever.

And then if it so happens that the channel turns or changes course, or else some danger lies in the way, you must find a thwart or side mark to know either when you must change course into the next channel and in what direction, or when you are clear of any danger. And that you should do as declared before, to take some mark within the land, and another near to the water, to be your twart marks when you align them.

And it is specially to be noted that the marks are to be preferred when they are far distant from each other, as those close together change more slowly and require some sailing distance to align, which can lead to misjudgements.

19.3 Soundings in Channels

And furthermore, as the weather is not always clear, but may be foggy or fouled by heavy rain or shadowed in twilight, when you have occasion to regularly pass through channels, it is good to sound the channels thoroughly, so as to know by the depth and tallow what side of the channel you are upon, and also how far you are into the channel. And also in like manner to know by the soundings anywhere in the channel, whether you are near any of the shoals, sandbanks, or dangers, and what breadth of warning there is. For some sands or shoals can be travelled easily and with pleasure by taking fair or good soundings, and these will warn you of danger in plenty of time. But there are some dangers that give no warning by soundings, as the water is deep right up to the sand or rock, and these are very dangerous shoals for any ship to come near, for they will be in deep water, and suddenly be aground.

And finally it is very good for channellers to know which way the tide flows at every time of the tides, for many times is happens that when the sands are under the water, the tide is flowing across the channel onto the sands, which is a dangerous matter if it is not known of by the Master or Pilot.

20 Navigation and Compass Variation

Which touches on the variation of the compass, called the Northeasting and Northwesting, and also on how to give a guess to know the Longitude.

20.1 Compass Variation

Sometimes in sundry places the compass varies, and especially when sailing long voyages running East and West or when far to the North, and this is called the Northeasting or Northwesting of the compass. I would not wish Mariners to meddle with their compass or whet the side of their needle to make it stand due North, but instead to patiently await the altering of the compass, and observe to what degree it alters, as you may do very accurately by the methods discussed above, and then let your compass well alone. For although it may vary even two or three points, you may make adjustment according to the variation as follows: first admitting that the Northwest point stands due North, and my desire is to go due West, I count the points round in the same direction, and sail Southwest. And if your compass allows, instead you may move the markings of the compass around the circumference so that they align with the Meridian, and this is easiest of all. And thus, by observation and adjustment of how I read my compass, I care not what point stands due North, for it is all one.

20.2 Compass Variation by the Sun

While it is possible to know the true meridian, or South bearing by use of a compass or needle, in long voyages going far to the west or east the compass varies, so to find the true Meridian you must adjust how you read your compass. First take a bearing on the Sun with your compass at her rising or first appearance, and then take another bearing on the Sun with your compass at her setting or last sighting. Then you shall perfectly know whether the compass has varied and by how much, for the Sun rises and sets evenly either side of the Meridian. For example, suppose that according to my compass the Sun rises due East, and sets West Northwest. From this I see my compass has varied one full point, that is, my compass reads true North as being North and by East, and the Meridian as South and by West.

And furthermore, as it is seldom that the sun rises and sets clear of all clouds and other impediments near the horizon, you may get the true Meridian by at any time before noon, first take a bearing on the Sun, then take its true height with a Cross-staff or Astrolabe, as you choose. Then in like manner observer the Sun in the afternoon, until you find the Sun at just the height that it was in the morning, at which point you take a bearing on it. Again, this works because the Sun reaches its Zenith at the Meridian, and descends evenly either side, until it reaches the Horizon. For example, suppose that in the morning, the Sun, when exactly South East by the compass, is 20 degrees above the Horizon, and then in the afternoon when the Sun drops to 20 degrees above the Horizon again, the compass reports the Sun is South and by West, then I see that the compass has varied by one half point, that is, my compass reads true North as being North and half East, and the Meridian as South and half West.

Another way to know your true Meridian is by the height of the Sun, that is, take a bearing on the Sun at her greatest height above the Horizon, and so you shall know whether the compass has varied, and how much; but this is least accurate of all the methods. And what you do by the Sun, so you may do by any of the Stars you know perfectly, but you cannot do it so well and truly by the Moon, due to the swiftness of the Moon's motion through the Zodiac, and not by the course of the wanderers or planets, they being fickle and variable as is their name.

20.3 Compass Variation by the Stars

You may also find the variation of your compass by the North Star, as follows: take a bearing on the North Star with your compass; if the North point stands with the star then it is not varied, and otherwise the difference in the bearing is the variance. And this bearing must be taken when the two Wain stars, known as the points, are right under or over the North Star, but if the points are directly West of the North Star, then the North Star is a third of a point, or 4° to the East of the North Pole, and if the points are directly East of the North Star, then the North Star is a third of a point, or 4° to the West of the North Pole.

20.4 Compass Variation and Longitude

Furthermore, some are of the opinion that by the Northeasting or Northwesting of the compass, you may know the Longitude, but I am not of this opinion, for although I admit that the compass varies, that is, you being 90 degrees to the West from the place your compass was made), your North point should stand Northeast, and in like manner you being 90 degrees East, your North point should stand Northwest, then if the variation be even, the compass should vary by 1 point after 22°30', and that comes to 1350 nautical miles near the equator, and no master or pilot of a ship keeps such a poor account of their journey that they shall know what distance they have to any place better than by the varying of the compass, for any vessel more than a thousand miles off course has problems not with the compass but with the master.

Also I do not know whether it is so that a compass varies in proportion to its distance, and refer them to those that have tried the experience thereof. Wherefore I cease from writing much, although Mariners are very desirous to have some way to get the Longitude. But if it is true that the compass varies in proportion, then it would be very useful for those who travel Northwards, as the degrees are so short in those Latitudes.

20.5 Compass Variation and Minerals

Some also are of another opinion, that the compass does not vary in any proportion, but according to the nature of some kind of minerals, that is, there is some country or islands that draws the compass by the lodestone or magnetism that they create their compass with. But if this is the case, then no man has visited that place and returned.

21 Navigation Log

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Which explains the importance of a good Ships Log, and includes an extract from an actual voyage.

21.1 Points to Note

The Ship's Log is the most important book on any vessel. When leaving their vessel for any period, the Navigator should always take the Ship's Log with them. When in foreign or hostile waters, an armed sentry should always be nearby. If you seize or impound a vessel, always confiscate the Log, and if perchance your ship is about to fall into enemy hands, destroy the Log, even at the cost of your own life.

- Always date each entry. If relevant, also record the time.
- Make an entry every day, no matter how brief. This will help to keep track of the days.
- Record every port, island, or landmark, and the distance between these, if known.
- At each port of call or anchorage, record the latitude.
- At each anchorage, channel, island, river mouth, or uncivilised port, record the Moon bearing for high tide. Also record the strength of the tide, if unusual.
- In shallow anchorages, coves, or near shoals, record soundings and the type of sea bottom.
- Record unusual or inclement weather, along with any warning signs.
- If contact with locals is made, record any history and a recommendation for future contacts.
- All discoveries, whether scientific, cultural or military, should be recorded with as many facts and little speculation as possible.

21.2 A Log of a Northern Journey

21.2.1 Breeze

Upon Sunday the 23 of Breeze, I departed with the Searchthrift from Kolmogrov, whose latitude is 64° 25', and the variation of the compass, 5° 10' from the North to the East.

Wotansday (26) we came to the Island called Pozanka, which is within four leagues of the Berozoua bar. The high water here is at the East and by South moon.

Reapsday (29) in the morning we departed from Pozanka Island, and plied to the bar of Berozoua Gooba, whereupon we came to anchor at low water, and sounded the said bar with our two Skiffs, and found in the best channel in the shoals of the bar only 13 feet of water. The sea breaks upon this bar, in currents of only 3 foot of water, and an East Moon marks the high tide upon this bar.

Sunday (30) in the morning we departed from the bar of Berozoua, and plied along by the shoals in five fathoms of water, until I had sight of St. Nicholas road, and then we cast about to the Northwards, in line with a hummock, which is half a mile Eastwards of Coya Reca, which hummock and St. Nicholas' abbey lie South Southwest, and North Northeast, and between them are 11 leagues of water. Coya Reca is half a mile to the East of Coscaynos. Coscaynos and the middle of the Island called Mondeustoua, which is thwart of the bar of Berozoua lie South and by East and North and by West, and between them are 4 leagues; so from the Seaboard of the bar to Coscaynos are 3 and a half leagues.

Lugnasad at a Northeast and by East sun we were athwart of Coscaynos. Dog's Nose lies North Northwest from Coscaynos, and between them are eight leagues; and Dog's Nose looks like a Gurnard's head, if you be inward on either side of it. On the lowest point of Dog's Nose there stands a solitary cross.

21.2.2 Fruit

Duesday (1) From Dogs nose to Foxnose are three leagues, North, and by West.

The 2nd day of Fruit I went on shore 2 miles to the north of Dog's Nose, and measured the latitude of that place as 65° 47'. It flows ashore at this place, at an East moon high water, and the ship lay off to avoid the flood tide at a South Southeast Moon. So that it is to be understood, when it is a high tide on the shore, it is two points to ebb, before it is low water offshore. The variation of the Compass at this place is 4° from the North to the East.

This day (3) the North Northwest wind drove us back level with Dog's Nose, where a ship may ride beside a salt house, in 4 or 4 $\frac{1}{2}$ fathoms of water, and have some shelter from a North and by West wind; this Salt house is half a mile to the south of Dog's Nose.

Freysday (4) at a South Southwest Sun, we departed from this Salt house. It is to be noted that four miles to the North of Dog's Nose there grow no trees on the bank by the water side and the banks consist of fuller's earth.

Sunday (6) I sounded the bar of Zolatitsa, which the natives told me was a good harbour, but in the deepest part of it I found but 4 foot of water. At a South sun that we weighed anchor, the wind being at North and by East, and we beat to windward for half the ebb tide, with the ship's head to the East. And then when we cast her head to the West, we sounded, and had 22 fathoms with broken shells and gray sand; this present day was very misty, with frost on the shrouds as the mist fell.

Moonday (7) in the morning at an East sun, the mist broke up a little, the wind being a stiff gale from the North and by West, our shrouds and ropes overhead being covered with frost, and it likely to become a storm. I thought it good to seek a harbour, and so plied out to the Islands which are two leagues to the South of Cape Race, and within these Islands (thanks be to Raphael) we found harbour. There is at these Islands two full fathoms of water: it is high water in the harbour at this place at a South Southeast moon: and at sea it is high water at a South Southwest moon. The natives call this Island Tri Ostrou. Also within this great Island (if needs be) you may have a good place to ground a ship in, as the great Island is almost a mile long and a quarter of a mile wide.

This storm of Northerly winds lasted until the 16th of this month and then the wind came Southerly, but we could not get out for ice. I went on shore at the cross, and took the latitude, which is 66 ° 58' 30"; the variation of the Compass being 3 $\frac{1}{2}$° from the North to the East.

(From The voyage of M. Stephen Burrough, from Colmogro to Wardhouse)

22 Navigation by a Sun Compass

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In which is shown the making and use of a Sun Compass for those navigating a vessel powered with Cavorite, which is of particular relevance to those who own shares in the Princess Blade.

22.1 The Sun Compass

In Hydrographic Navigation, it is rarely most necessary to know at every instance of the day in what manner the Sun shines over the vessel, at what declination and degree. And when it is needed, the Sun being in the sky then its very shining makes its position clear to the Mariner, except when obscured by cloud or storm. However in some forms of Cosmographic Navigation, wherein the ship flies through the air or over the water, the exact position of the Sun matters as much or more than the quarter of the wind. One design of flying ship is the Aeir Ship, which can be propelled by the use of deflected Cavorite panelling being attracted to or repelled from heavenly bodies, primarily the Sun but also the Moon and other distant planets, and the vessel can make considerable way by using this force. Wherein the course set by the ship under Cavorite steerage can vary only slightly from the arc of the Sun, and the alternate method of propulsion of an Aeir Ship, being Sinusoidal, is both much slower and hard on those of faint constitution or flighty temperament, it is essential to know whether Cavorite deflection is best able to hold and carry the course, or whether a Sinusoidal course need be invoked, and the Sun Compass shall provide this knowledge. And the Ship's way can also be read from the Sun Compass when under Cavorite steerage.

22.2 Making a Sun Compass

Whereas the Equinoctial Dial may be made of wood, the Sun Compass requires curves in all directions like a globe, and is thus best cast in brass so as to be true. The half Sun Compass consists of a vertical Needle, which casts a shadow onto a partial dish etched with various arcs and markings. The shape of the dish is a semi-hemisphere, cut from a globe first horizontally to form a bowl, and then vertically which gives easy access to the inside. Next the inside of the dish is etched with a central dividing line, and two series of nine parallel and even lines, marking the surface into ten areas. The first line initially runs vertically before curving straight down to the base of the dish, and divides the dish into two equal parts. The next nine lines lie perpendicular to the first, are seen as straight when the dish is viewed from directly above, and are equally spaced with the vertical cut and the tangent of the bowl being lines nought and ten; these lines, when viewed from the side, will curve downwards to different extents, the least being widely spaced down the side, and the most closely spaced near the bottom. The last nine lines are seen as straight when the dish is viewed from directly to one side, and each touches the lowest point of its contrary upright line at its further extent being the initial vertical line, making them unevenly but precisely spaced. Furthermore, at the nine points of intersection the percentile numbers 10, 20, 30, 40, 50, 60, 70, 80, 90 are to be etched, with 0 etched at the centre of the bowl, and 100 at the lip. And the rim of the bowl should be marked with the degrees 10, 20, 30, 40, 50, 60, 70, 80, 90 on each side of the rim, with the centre being 0 degrees and the two corners being marked as 90 degrees; and in addition the middle horizontal line being similarly marked, or whichever line as is deep but still easily read. Finally, a wire or rod of the same height at the bowl is affixed to the centre as the Needle, and is made to stand vertical so that its tip is aligned with the bowl's lip. And the full Sun Compass is constructed as above, except that the dish is not cut vertically, or is made from two half compasses affixed together, so that nineteen vertical lines are etched rather than nine and the horizontal lines are etched in a full circle not half.

22.2.1 Mounting a Sun Compass

And as it is most important that the lip of the dish is level with the Horizon at all times, the dish is then fastened with a pin at its centre on a flat base of wood or brass so that it does not tilt or roll, but that it may rotate sideways about the centre point. And two pins are inserted in the base at the leeway bearings on either side, the leeway being the course deviation that the Navigator can coax from their ship from the direct line of the sun, and is in the order of 1 point or 11 degrees, but also varies due to the skill of the Navigator or Pilot and the shape and configuration of the ship, thus allowing the compass to be turned either way by this deviation, for uses as explained later. When installing the Sun Compass on board a ship, the base is best fixed with pins and hung from a gymble, so that it is flat and level howsoever the ship pitches and plunges, this being even more common on aerial than aquatic vessels.

22.3 The Celestial Compass

And for those planning a voyage amongst the stars, they will require the Celestial Compass, which is of clear crystal and perfectly round like a full globe or sphere, allowing the sunlight or starlight to enter from any angle and shine through the central cross hairs onto the markings etched on the inside of the surface in all three directions. And the vertical lines are now circles, and twice the number of horizontal lines, being nineteen, is required, and the central vertical wire is replaced with three wires in a knot, so that each end of wire stands at 90 degrees to four others, forming a star suspended centrally in the sphere. Furthermore, the device is to be suspended above the deck, such that it can be turned in any direction and locked in place. But the making of this device is for the shapers of glass, and is outside my knowledge as a Navigator.

22.4 The Use of a Sun Compass

The Sun Compass is used to know at what speed the ship travels under Cavorite propulsion, and in which direction, and how much the course is making good, this being the speed at which the ship is travelling towards the assigned port. And by knowing what way is made under Sinusoidal passage, it is possible to know whether a course held under Cavorite is faster although indirect than the slower but direct course, given the possible amount of course deviation.

22.4.1 Relative Direction of the Sun

To know the relative direction of the sun, the Sun Compass being fixed fore and aft so it can be read from behind, merely observe where the shadow of the Needle falls and read it off the lower of the two sets of degree marks. And if the Sun is coming from forward of the compass, it should be turned 180 degrees, and the reading made. And in any case, do not stand between the Sun and the Compass, but instead read it from one side or other, as otherwise your shadow will prevent all readings, as may your sails, masts, or idle deck passengers, none of which may easily be moved.

22.4.2 Determining your Speed

When travelling via attraction or repulsion of the Sun (or other heavenly bodies) by Cavorite shields, your speed is fastest when the Sun is directly behind or in front of the ship, and lies upon the Horizon, wherein the Sun Compass Needle lies on the 100 percentile marking. And when the Sun is at a different bearing or higher altitude, the ship speed is reduced, both in its seeming speed, and in its way made good. To know your best speed, you should lay out a

course that is aligned with the setting sun, and is of a fixed or known distance, and then cover this ground at your best speed just before dusk, accounting for the time until completion. And this course should again be run using only sinusoidal movement, and this speed recorded, along with the ratio of the two speeds as a percentile number.

And to know the speed across the ground when travelling with the Sun, find the point marked by the Needle, and run your eye across the Compass, following and staying between the horizontal lines, until you find the percentile numbering, and this is your speed across the ground relative to your best speed. Moreover, to know the speed made good against the course set, turn the Sun Compass until it is aligned with the desired destination, and then find the point shadowed by the Needle, and run your eye along staying between the vertical curving lines, until you find the percentile numbering, and this is your speed made good, relative to your best speed, which will always be less than your speed across the ground unless you can hold your desired heading.

22.4.3 Determining your Course

Whereas any Cavorite ship may be moved through the air by the use of the attraction or repulsion of the Sun, or by the use of Sinusoidal movement, each being at a different rate of travel and in a different direction, and the speed and direction of two of these being dependant directly on the position of the Sun, which is ever changing as observed previously, it is necessary for a Navigator or Pilot to know which form of travel is the best for their ship at any time, and without resort to tables for calculation. And only one of the pair of repulsion or attraction need be measured, for the sun's shadow for one falls within the half Sun Compass only when the other does not; and that which does not fall within the Compass would provide retrograde motion and not be of any use in progression. And as a truer course can be steered by coaxing a point or more of leeway from the ship, the compass may be turned away from the destination by the amount of this leeway, so the speed made good is better than it may otherwise be. And whereas the percentile of the sinusoidal motion against the best speed is fixed and known, and the percentile speed made good of the vessel by attraction or repulsion be easily and rapidly found by turning the compass to your destination still allowing for leeway, and taking a single reading, it is easy for the two values to be compared, and the bigger of the two is the faster method, and the best course.

And this method works at any Latitude, and for any declination or bearing of the Sun, and at any altitude from the earth, for the speeds are relative to each other in the same circumstances. Furthermore, to reset them for another world, you may simply determine your best speed by Cavorite attraction and by Sinusoidal travel, and use the new percentile number as your mark of comparison.

23 Navigation and Planetary Motion

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In which we touch on some of the theories of the Behaviour of Planets, including which elements may concern Navigators, and which may safely be ignored.

23.1 The Behaviour of the Planets

Ever since the discovery that Alusia was a globe, and that the Sun was merely a star in the heavens, a debate has raged as to whether Alusia circles the Sun, or the Sun circles Alusia, and some even argue whether they move in circles at all. A similar debate exists over the movement of the Moon, for although all sides agree that the Moon does circle Alusia, some say it travels around 27 times in a month, and others that it travels in retrograde fashion once a month. For the practical Navigator these discussions matter not, but the principles and explanations given by each side shed light on the behaviour of the Moon and Sun, and the tables presented in this and similar works each assume a certain behaviour of the Planets.

Herein I will describe the various theories of which I am familiar, along with their reasons for and against, and some of their consequences. And I will also show how the principles upon which the tables of this book are built will work with any or all of the more reasonable theories, showing that the arguments indeed have their proper place with the Philosopher and Astrologer, and not the practical Mariner.

23.2 The Geocentric Model

The first and most obvious explanation is that Alusia is the still centre, about which the Moon, the Sun, the moveable planets and even the fixed stars of the firmament rotate. It is usually explained as a series of concentric spheres, one for each heavenly body, ordered as Moon, Ariel, Freya, Sun, Thunor, Wotan, Hela, (Merlyn?), the starry Heavens, and the outermost being the firmament. This theory is most clearly backed by observation, for any person looking up at the sky at night sees all these bodies moving from East to West, at a similar rate. Now, that the Moon moves more slowly than the stars, circling only 27 times in 28 days, or that the sun moves more rapidly than the stars, making 364 turns when the stars make only 363, can be explained by the different celestial spheres upon which they rest move at slightly different rates. However, that the inner wanderers Ariel and Freya always stay close to the position of the sun, and vary both to and fro within that constraint, or that the outer wanderers Thunor, Wotan and Hela do vary in speed, and sometimes even move in retrograde, cannot be explained; nor can the waxing and waning of Thunor and to a lesser degree the other outer wanderers.

Furthermore, it is known that the seasons depend on the position and angle of the Sun, for in Summer the days are longer and the Sun higher in the sky, and in Winter the converse holds. But if the Sun went around Alusia, as it is observed clearly to be orbiting at an angle, when it is Summer in the Western and Northern Semi-Hemisphere, it would also be Summer in the Eastern and Southern Semi-Hemisphere, while being Winter in the Eastern and Northern, and the Western and Southern Semi-Hemispheres, and this is not true, the Seasons carrying only by which Hemisphere, being Northern or Southerm , you find yourself in. And, as we see that the Sun is almost 100 million miles away, for it to circle Alusia in one day, it would need to move at 25 million miles an hour, or nearly seven thousand miles per second. And all of the outer wanderers, the fixed Stars, and the firmament itself, each being outside the other, and all outside the Sun, must each be spinning at a greater rate than shown above. This seems unfeasibly fast, but we should suspend judgement hoping that other theories provide more reasonable figures.

23.3 The Heliocentric Model

The alternative explanation, being one often held by the ancients, and by many of the newer type of Philosopher, but always by the Church being steadfast in its search for the truth, is that the Sun is the still centre, with the wandered moving around it in order Ariel, Freya, Alusia, Thunor, Wotan, Hela, Merlyn, and with the stars and the firmament also fixed. And the Moon rotates about Alusia, with some of the other Wanderers also having their own children, such as Fear & Terror which circle Thunor, and the sightings of regular small occlusions of Wotan and Hela being ascribed to similar child bodies circling the planets.

And now the different rates of movement can be explained as follows. First, Alusia is not fixed, but spins nearly a full circle on its Poles every 24 hours, and this accounts wholly for the visible movement of the stars, and for most of the rest of the movement, being a regular East-West movement of all celestial bodies. And the differences are explained by the movement of the other planets, being that the Moon moves in retrograde around Alusia every month, making it appear to circle 27 times for each 28 rotations of Alusia. And Alusia circles the Sun once every year, explaining the apparent movement of the Sun through the houses of the Zodiac throughout the year, as different star constellations lie behind or opposite the Sun as Alusia circles. And the movement of the Moon through the Zodiac every 26 days is due to its movement around Alusia 13 times in the year plus one addition circle due to Alusia's movement around the Sun, with 14 orbits in a year giving 26 days before the Moon appears in front fo the same stars again. And the inner Wanderers, ling between Alusia and the Sun, and making smaller circles of the Sun, will always appear to be close o the Sun, and make small circles so finish their circling in less time, while the outer Wanderers in lying beyond Alusia may seem to move rapidly when away from the Sun, and more slowly when closer, this being when they are in fast further from Alusia, but moving still at a constant speed.

And the Seasons are due to Alusia not sitting upright when spinning, but now favouring the North, and now the South, like the child's spinning top which it resembles as it spins itself, and arcs in a circle around the Sun, as any top does when spinning. And this ensures that the Seasons are the same for the Eastern and Western Hemispheres at any time, for the tilt is not a wobble of the Pole, but the whole world elegantly slanting over to an extent of perhaps 23 degrees, and in one half of the year it being the Northern side that is closer to the Sun, and in the other, the South. But arguments about the spinning of Alusia can be raised, for first why do we not fly off due to a rate of spin which at the Equator is over 1000 miles an hour, reducing to nothing at the Poles? And the usual answer given, which is that this is from the same reason as that the Antipodeans do not fall off, being on the underside of the world, seems at best question-begging and at worst malicious. And the rate of Alusia circling the Sun, while reduced from the Geocentric model by 364 times, is still 20 miles a second or nearly 70,000 miles per hour. The figures from this model, while smaller, are hardly more reasonable than the Geocentric Model. And yet the explanations of the planetary movement, although more complex initially, seem to better fit the variation in types of movement, and holds better to observation.

23.4 Epicycles

And close measurement of the Moon, the Sun, Freya, and Thunor and to a lesser degree the other wanderers being harder to observe carefully, shown that they do not move in equal arcs across the sky each sky, but hasten and slow, and some do appear to move backwards. And to explain this behaviour, the notion of epicircles has been expounded, this being that the celestial spheres move in regular and even rotation, but that smaller circles are attached to each sphere, on which the planets are fixed, and these epicircles, rotating at different rates in epicycles, can explain the variations. And the most precise predictions of the planets have

up to 5 or perhaps 7 epicycles for a planet, each being a spinning plate on the rim of another spinning plate, and so forth, each moving in a perfect circle affixed to a larger spinning circle. And it seems to me to be an elegant explanation, except for the why of each planet sitting on so many spinning epicircles, and how they, being worlds like to Alusia, need all this construction and artifice, when Alusia, which seems not so different from them from the ground (I having stood on Thunor at least) is fixed and still. And the latter problem only arises when it is used with the Geocentric model and yet this is the model usually propounded by epicyclists.

23.5 Ellipses

And given the complexity of the epicyclic model of motion, it is not surprising that another theory has been proposed from time to time. And this theory is that the celestial bodies do not move in perfect circles, but in ellipses, these being circles extended somewhat in one direction by having two centres of rotation. And this shape is best demonstrated with two pins and a loop of string, for by placing the loop of string around the two pins, being fixed to a board close together, one may draw a shape with a pencil placed through the loop so as to keep it taut at all times, and by varying the placement of the pins, the circle or ellipse is broadened at will. Now the theory of ellipses has a number of problems, being first how the celestial spheres are replaced with these irregular oval shapes not being stable in rotation but prone to wobbling at any speed as a model will demonstrate, and second that it is less accurate than the epicycle model, although as accurate as perhaps any 2 epicircles could allow for. And the first problem arises only when it is combined with the Geocentric model which requires far greater speeds, and may be why the Heliocentric model is preferred by Ellipists.

23.6 A Compromise Model

As stated above, no Mariner wishes to worry about whether Alusia is a spinning top, or if the Sun is moving too fast, or whether the planets circle one celestial body or another. And yet, to predict the movement of the Sun or the Moon, some model must be selected that is accurate enough, and yet is not opposed to any discovery, so that our tables and regiment need not be changed with every appointment of a new Head Astrologer at MMHS University. And the compromise model used in this and most Navigational Almanacs is as follows.

To someone on Alusia, the following observations always hold: That the Moon appears goes around Alusia 27 time every 28 days; that the Sun rises in the East, with a variation North or South according to the Seasons, and sets in the West, with a corresponding variation. That the Sun's declination varies smoothly between Summer and Winter by 23.5 degrees each way from the Equinoxes. That the Sun varies slightly in its Zenith time, not being exactly 24 hours after the last, and this variation is due to the addition of two smooth variations, one being an annual variation up and down by 15 minutes, and the other being a semi-annual variation up and down by a similar amount, the two never combing to more than 24 minutes of variation. That the Moon varies in a more radical manner, having first the pair of variations of the Sun, on a basis not of a year or a 28 day month, but the first variation being once per Anomalistic month, and the second variable being twice per Draconic month, with no variation at both the head and the tail of the Dragon, as explained in previous chapters. And the Anomalistic month is a little longer than the Sidereal Month (the 26 days it takes for the Moon to pass through the Zodiac), and the Draconic month is a little shorter than either. And that the tides are moved by the Moon, being a full Sea at the same point each day, excepting that you be inland on a large river at a Spring tide, as noted in a previous chapter, with neither model explaining why the tides move as they do, particularly how they circle around large islands in keeping with the movement of the Moon.

23.6.1 Geocentric Variations

And the annual variation of the Sun is due to the sum of the two epicircles of the Sun, one being a cycle completing every year, and one completing every half year, with each appearing to slow or hasten the Sun's movement in its true circular orbit. And the Anomalistic variation of the Moon is due to an epicycle of just over 26 days, and the semi-Draconic variation of the Moon is due to an epicycle of just under 13 days, both appears to slow or hasten the Moon's movement it its true circular orbit.

23.6.2 Heliocentric Variations

And the annual variation of the Sun is due to the elliptical orbit travelled by Alusia, with the Sun being at one of the pins or centres of the ellipse, so that sometimes Alusia is further from the Sun and so the Sun appears to move more slowly, as does any object at a greater distance. And the semi-annual variation of the Sun is due to the tilt of Alusia as it spins, for as Alusia tilts from the upright, the Sun appears further to the North or South, but also, due to the angle of the tilt, seemingly further to the East or West. And the Anomalistic variation of the Moon is due to the elliptical orbit of the Moon taking slightly longer to complete its ellipse than it takes to compete its orbit, as if the two pins were very slightly turning as well (turning but 7 times in 18 years). And the semi-Draconic variation of the Moon is due to Alusia's tilt combined with the the Moon's own orbital tilt of just over 5 degrees, with the Moon's tilt completing a cycle of wobbling around Alusia not at a smooth 26 days, but slightly faster at once per Draconic month.

23.6.3 Understanding the Variations

And no Navigator need understand the explanation of how the observations fit within either model, except to be able to agree with either school of Philosopher, and so escape mental or physical abuse from being caught on the wrong side of an academic debate, for which model best describes the Behaviour of the Planets is true is all of a muchness when you are at Sea. And the tables provided here work with all models, but the automatic tables are written with a Geocentric model using epicycles measured as a proportion of the true circle in the manner of ellipses, being the easiest way to describe the variation for the author, being a practical Navigator and Mariner and not fully conversant with the methods of Philosophers and Astrologers. And any theoretician who is offended by my dismissal of the relevance of their field, please bear in mind that this is only when in the context of judging the position of a pitching ship far from land, and that the model matters more for those fixing the position of stars and planets, and for those who are daring enough to travel between them, as discussed at some length in a later chapter.

24 Navigation on other Planets

In which we list some of the Navigational numbers for Alusia, along with comparisons with two other worlds explored by the author.

24.1 Types of World

There are many types of plane or planet (a planet is one of several complete worlds within a plane). Some worlds are flat and circular, with defined edges, or which extend infinitely in all directions. Others are spherical. Toroidal and hollow spherical worlds have been reported. Some planes have no bodies of water at all, such as some of the elemental planes, or the Void. Many very small worlds are an artificial or abstract shape, while others have no objective form or structure at all. Alusia is a spherical world, as are most of the more conventional worlds visited, or at least sailed upon. For the Navigator, it is important to realise that only the Spherical worlds obey more than the smallest portion of the rules and regularities spelt out within this guide. Longitude and Latitude, Declination and Bearings, the Circles (Equinoctial, Arctic, Zodiac, etc), and other key concepts simply do not apply to these other worlds. If a Navigator must ply these foreign waters, a Pilot is heartily recommended.

24.2 Types of Spherical World

In that all spherical worlds are similar, the underlying principles of navigation do not change; but in that the details of each world or planet differ, so must the values applied to the principles of navigation. From the travelling of various Navigators, it seems that Alusia is one of a number of worlds with very similar properties, and the same values can be applied within each of these worlds, except when actual differences are noted. A second type of world, of which Earth is a typical member, is broadly similar to Alusia, but with a number of small changes leading to much more unstable patterns; these worlds are almost invariably much lower in magic than Alusia. A third world type, included as way of illustration, is the world of Thunor, a planet in the planes of both Alusia and Earth, and also some of their analogues.

24.3 Properties of Spherical Worlds

It is very necessary that upon first setting foot on a foreign world a Navigator determine some basic facts, before they rely on their existing knowledge which may steer them into tragic error. The local season, length of the year, day since the start of the season, current cycle of the Moon and Latitude is usually sufficient, for other matters can be observed and fixed from these. However, for calculations of greater precision such as the reliable predicting of eclipses, more information is required such as the position of the Dragon's head and tail, the Epact or place in the Saros cycle, and so forth. A local Almanac or Astrologer can usually provide this information. And to use a system of tables and charts, you will need to update the list of seasonal constants with the values found below, remembering that the calculated values need not be replaced. And this will serve you well for the first 364 days after the first day of Summer, but the Western Kingdom calendar prevents the display of the 365th day and so on, this being of little annoyance on Earth, but a great deal on Thunor where the last 306 days of each year are not covered, and where the length of the day is not 24 hours, but nearly 40 minutes longer, and many tables do truly founder. Upon this occurrence, still an able student may work out any required numbers from first principles, or by adapting and modifying the associated tables and charts, or if I have sufficient leisure and receive direct request, the relevant tables may be further modified for such purposes.

24.3.1 Table of Properties

	Alusia	Earth	Thunor	Comments
Nautical mile	6080	6079	3240	Feet in a nautical mile
Solar Constants				
Day Length	24 hrs	24 hrs	24:40	Hours in a Day
Year Length	364	365 $\frac{1}{4}$	670	Local Days in a Year
Solar Tilt	23°30'	23°28'	25°	distance from the Elliptic
Solar Eccentricity	6/360	6/359	6/60	Ellipse of sun movement
Solar Ellipse Offset	60	63	??	Day closest to sun
Solar Tilt Offset	45	203	??	Day of Summer Solstice
Solar Calculations				
Solar Arc Day	0.99°	0.98°	0.54°	Movement through Zodiac/day
Solar Arc Minute	0:03:59	0:03:59	0:04:06	Time to move 1° through sky
Lunar Constants			(Phobos)	
Full Moons / Year	13	239/19	3 / day	Full Moons/year
Lunar Tilt	5°06'	5°06'	1°	variance from sun's path
Lunar Eccentricity	20/360	20/361	20/2000	Ellipse of moon movement
Lunar Ellipse Offset	152	variable	–	Day moon closest in Saros 1
Lunar Tilt Offset	7	variable	–	Day of alignment in Saros 1
Draconic Prog.	3	0.9	–	Tilt regression / Saros
Anomalistic Prog.	-7	-2.1	–	Perigee progression / Saros
Sidereal Freq.	252	241	–	Sidereal Months / Saros
Draconic Freq.	255	242	–	Draconic Months / Saros
Anomalistic Freq.	245	239	–	Anomalistic Months / Saros
Lunar Calculations				
Synodic Month	28	29.53	??	Days between Full Moons
Sidereal Month	26	27.32	–	Days to complete Zodiac
Saros Year	6552	6584.4	–	Days for path to repeat
Saros Cycle	18	18.027	–	Years for path to repeat
Draconic Month	25.694	27.208	–	Days for wobble to repeat
Anomalistic Month	26.743	27.55	–	Days for elliptical orbit
Synodic Arc	12.857°	12.191°	1080°	slippage each day
Sidereal Arc	13.846°	13.177°	–	Movement through Zodiac/day
Orbital Arc	13.462°	13.067°	–	Movement through Orbit/day
Regressive Arc	0.165°	0.049°	–	Tilt regression/day
Lunar Orbit	24:53	24:50	8:13	Apparent orbit time
Lunar Speed	0:04:09	0:04:08	0:01:22	Time to move 1° through sky

25 Navigation to other Planets

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Which is a speculative work raising matters for consideration in Navigating through the Void of space when travelling to other worlds.

25.1 Travel to Thunor

Whereas there is an analogue world to Alusia, and on there they regularly travel via Cavorite vessel to Thunor that they call Ares, and having visited Ares via portal myself and discussed this matter with them in some detail, it seems to me that it is highly feasible to travel to Thunor directly through the Aether void between worlds, without the use of portals.

25.2 Propulsion

And the means of this journey would be as above, that being a Cavorite ship which can by continually deflecting itself from the Sun, steadily push faster and faster towards the other reaches of the Aether, until a wise captain chooses to attract itself to the Sun again, slowing its passage sufficiently that they may land on rather than pass through any planet that lies on their path.

And journeys across a great deal of Alusia, including passage to Seagate from Insel de Freiheit via the North Pole being 8,800 miles, and more than halfway around Ares that is Thunor being over 6,000 miles, have shown a capacity of acceleration by attracting or repulsing the Sun of perhaps 40 miles per hour, or a little more if the air blows with the ship. This power allowed to run through the Void without the air pushing back on the ship may result in 1,200 miles per hour increase each day. And the further the ship gets to Thunor the less this force would be for theory shows that the force decreases with distance, so the ship would need to change to attract the Sun less that half way across, or risk going past Thunor at some awful speed and out into the Deep Aether Void, and yet the change in speed on Ares being Thunor was nearly the same as on Alusia, giving hope this would not be a great factor.

And in so much as tentative journeys, although confined to the breathable atmosphere below 20 thousand feet in altitude, have shown by attracting or repulsing the ship from Alusia an acceleration of 30 feet per second until slowed by the howling of the wind in the rigging, and there being no wind or air in the Aether, it seems that the initial part of the voyage, and the final part near Thunor, would provide an extra degree of acceleration, and a leeway for imprecision in the middle of the journey.

25.3 Steering

In that the first part of the journey would be repelling the ship from Alusia for a day, then from the Sun for some months, it would be prone to the slightest initial deviation, and with no air or coax the ship leeward, the deviation would become an unalterable course. And in that the second part of the journey would be attracting the ship back towards the Sun to slow our outwards speed, again no course correction would be possible there being no objects except the Sun with a notable effect on the ship. And in the final part being repelling the ship from the planet we plan to berth at, any initial deviation or failure to allow for the passage of the planet during our journey, or any miscalculation of the time taken to travel this vast distance may mean the planet is not directly in front of us, and as repelling from the planet will multiply and further any deviation, we are almost bound to miss the planet altogether unless we can slow our outwards speed faster than we gain lateral speed, and then make landfall from beside the planet rather than directly from the Sun. And in that there

are so many uncertainties and unknowns in calculating the rate of travel, or even the distance to the planet, it seems more than likely that the ship would miss Thunor altogether, it being directed outwards towards an expected position.

And against this picture of risk and danger is that the Imperial Navy of this other world regularly sends vast fleets of ships, many with rather sub-standard commanders, across the void between their Home world and Ares being Thunor. And knowing that this journey takes but six months and is travelled every two years when the planets align and are only 50 million miles apart, it seems that these doubts are easily overcome with a little planning and confidence.

25.4 Crew

Obviously, an all-volunteer crew would be required. Given the close confines of an air-tight vessel for up to a year, with no opportunity respite from each other, a healthy toleration and even respect for each other is essential. In addition, the Navigation, Cook, and Healer roles, being the only essential roles, would need to be duplicated, and three sets of watches would be required. It seems that a crew of six would be minimal, with two or three Master Navigators, and two or three competent Healers included. At least one crew member with ability to portal from a void to more pleasant climes would enhance both the chance of survival and the morale of the crew greatly.

25.5 Supplies

In that the ship must be able to travel to Thunor, and return to Alusia, with the crew and Master all well, supplies sufficient for the return journey must be provided. And if this journey is of six months either way, then the food requirement is 500 pounds per man and the liquid 1 tonne per man, being no more than 10% spirits and 25% wine. Wherefore a skeleton crew of 6 would require 8 tonnes of water and 2 tonnes of food. All cooking and heating would be magical, for firewood or coal for this extended period would be excessive, as well as creating problems with air.

25.6 Air

It is said that the quantity of air used up or made bad is 10 pounds of air per day per man being 1 $\frac{1}{2}$ tonnes of air per man in a year. It is well known that air cannot be transported in such massive quantities, it being easier to create an air spring, this requiring an item, for no Air mage should be locked in a small wooden vessel surrounded by the Aether Void for a year on end, and neither should any crew be subjected to said Air Mage. As a temporary or desperation measure it would be possible to turn some of the supply of water into air every few hours, this being practical except that the casting of Transmutation 10 times a day runs a risk of calamity, and also that the stale air building up over months may damage ship and crew.

26 Navigation Exercise 1

For beginning Navigators.

26.1 Problem

Calculate Seasonal Tilt, using either the Chapter Five charts, or the advanced formulae. Use this to deterine your Latitude.

26.1.1 You will need

- Days from Equinox (negative during Northern Winter)
  and one of:
- The Sun's Elevation at Noon
- Hours of Sunlight
- Bearing at Dawn

26.1.2 Latitude from Elevation at Noon

- Latitude = Seasonal Tilt + (90 - Sun Elevation at Noon)

Note This method is covered in more detail in Chapter Seven

26.1.3 Latitude from Hours of Sunlight

- Latitude = Arctangent(Sine((SunlightHours-12)*7.5) / Tan(Seasonal Tilt))

Note This method is wildly sensitive to measurement errors during the middle months of Spring and Autumn, and is not great during the rest of these seasons.

26.1.4 Latitude from Bearing at Dawn

- Latitude = Arccosine(-Sine(Seasonal Tilt)/Cosine(Bearing at Dawn))

Note This method is wildly sensitive to measurement errors except near the Arctic circles in local Summer.

26.2 Maximum Day Length

- Latitude = Arctangent(Sine((Maximum Daylength - 12)*180 / 24) / Tan(Tilt))
- Declination / hour = Tilt/(Maximum Daylength - 12)
- Maximum Daylength = 12 + (Arcsine(Tan(Tilt)*Tan(Latitude))) / 180*24

Note this only applies to Latitudes between the Arctic circles.

27 Navigation Exercise 2

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For Junior Officers.

27.1 Problem

No matter where you are the Sun will follow the same path through the sky at the same time each year. There are a series of easy formulae you can use to find the bearing and altitude of the Sun at any time, and the time and bearing of sunrise and sunset for the current day.

27.1.1 You will need

- Current Latitude (negative for Southern Hemisphere)
- Days from Equinox (negative during Northern Winter)
- Current Time of Day
- Alusia's Elliptic Tilt (23.5°)

27.1.2 Seasonal Declination

The simpler the approximation, the greater the error. #4 may be up to 1.4 days, 25 miles or 0.4 degrees out.
- Declination = value from Navigation and Seasonal Declination.
- Declination = Arcsine(Sine(Days From Equinox/91*90)*Sine(Tilt))
- Declination ≈ Sine(Days From Equinox)*Tilt

27.1.3 First Results

- Hours of Sunlight = 12 + (Arcsine(Tan(Declination)*Tan(Latitude)))/7.5
- Dawn (Hours) = 12 - HoursOfSunlight/2
- Dusk (Hours) = 12 + HoursOfSunlight/2
- Sun Bearing at Dawn = Arccosine(-Sine(Declination)/Cosine(Latitude))
- Sun Bearing at Dusk = 360 - Sun Bearing at Dawn
- Sun Elevation at Noon = (90-Latitude)+Declination

27.1.4 Second Results

- Day Progression = (Number of hours from Zenith)*360 / 24
- Sun X-Axis = Cosine(Day Progression)*Cosine(Declination)*Sine(Latitude) - Sine(Declination)*Cosine(Lati
- Sun Y-Axis = -Sine(Day Progression)*Cosine(Declination)
- Sun Z-Axis = Cosine(Day Progression)*Cosine(Declination)*Cosine(Latitude) + Sine(Declination)*Sine(Lat

Note Sun X-Axis^2 + Sun Y-Axis^2 + Sun Z-Axis^2 = 1

27.1.5 Final Results

- Sun Bearing = Arctangent(Sun Y-Axis / Sun X-Axis)
- Sun Elevation = Arcsine(Sun Z-axis)

28 Navigation Exercise 3

For Officers of the Watch.

28.1 Problem

The Moon does not always follow the same path through the sky at the same time; instead, it varies on an eighteen year cycle due to the Dragon Saros. Wherefore determining the actual location is too advanced for this guidebook. Ignoring the variation of the Moon due to Auge, it is possible to find the average or expected position of the Moon at any time, and the time and angle of Moon Rise and Moon Set. Beyond the Arctic Circle, this method is unreliable. The method used is the same as for the Sun, except as the Lunar Declination changes far more rapidly, this is calculated for the precise time instead of the entire day.

28.1.1 You will need

- Current Latitude (negative for Southern Hemisphere)
- Days from Equinox (negative during Northern Winter)
- Current Time

28.1.2 Alusian Constants

These values vary for other planes.
- Days in a Year = 364.
- Full Moons in a Year = 13.
- Days between Full Moons = 28.
- Days for Moon to pass through the Zodiac = 26.
- Average Moonday Length = 24 hours 53 minutes 20 seconds.
- Maximum Declination = 28.8 degrees

28.1.3 Lunar Declination

Unlike the Sun's seasonal declination, the Moon's declination changes significantly during one day. You need to calculate the Declination at the current time.
- Current Lunar Declination = Arcsine(Sine((Days from Equinox + time since midnight) / 26*360)*Sine(Maximum Declination))

28.1.4 First Results

- Hours of Moonlight = Moonday/2 + (Arcsine(Tan(Current Lunar Declination) * Tan(Latitude)))/180*Moonday
- Lunar Dawn (Hours) = Moonday /2 - Hours of Moonlight /2
- Lunar Dusk (Hours) = Moonday /2 + Hours of Moonlight /2
- Moon Bearing at Lunar Dawn = Arccosine(-Sine(Lunar Declination at Dawn) / Cosine(Latitude))
- Moon Bearing at Lunar Dusk = 360 - Arccosine(-Sine(Lunar Declination at Dusk) / Cosine(Latitude))
- Moon Elevation at Lunar Zenith = (90-Latitude) + (Lunar Declination at Zenith)

28.1.5 Second Results

- Day Progression = (Number of hours from Lunar Zenith)*360 / Moonday
- Moon X-Axis = Cosine(Day Progression)*Cosine(Current Lunar Declination)*Sine(Latitude) - Sine(Current Lunar Declination)*Cosine(Latitude)
- Moon Y-Axis = -Sine(Day Progression)*Cosine(Current Lunar Declination)
- Moon Z-Axis = Cosine(Day Progression)*Cosine(Current Lunar Declination)*Cosine(Latitude) + Sine(Current Lunar Declination)*Sine(Latitude)

Note $\text{X-Axis}^2 + \text{Y-Axis}^2 + \text{Z-Axis}^2 = 1$

28.1.6 Final Results

- Moon Bearing = Arctangent(Moon Y-Axis / Moon X-Axis)
- Moon Elevation = Arcsine(Moon Z-axis)

To determining the actual location, you will need to allow for the correct Moon Zenith, the regression of the elliptical orbit relative to the sun, and the progression of the nodes. You'll need to find the Lunar Declination at Zenith, by approximating Lunar Zenith, calculating the Lunar Declination at this time, and use this to calculate a more precise Zenith estimate. Three iterations give a precision of +/- 2 minutes outside the Arctic circle. Calculating the Draconic and Anomalistic progressions is too hard to outline here.

A Navigation Appendix

For Master Navigators.

Several of the methods of calculating the position and behaviour of the Sun and Moon are tiresome and long. It is thus reasonable to provide calculations and tables for the more common results. With the magic of the printed word and the extraordinary resources of Messer's Wiki, it is possible to include far more tables than would normally be feasible. These are included below.

A.1 General Use Tools

- Seagate Sun and Moon
- Sun and Moon for a Season

A.2 Tools For Navigators

- Plotting a Great Circle Course
- Determining your Latitude
- Locating the Sun
- Full Moon times

A.3 Tools For Serious Navigators

- Minute by Minute location of Sun and Moon
- Step by Step navigation of the Princess Blade

A.4 Tools For Predicting Eclipses

- Solar and Lunar Eclipses in a Year
- Solar and Lunar Eclipses by Month
- Path and Coverage of a Solar Eclipse