

How to cite this document:

Naṣīr al-Dīn al-Ṭūsī. *al-Risāla al-Muʿīniyya*, book 3, chapter 5. In F. Jamil Ragep, Fateme Savadi, Sajjad Nikfahm-Khubravan. *al-Risāla al-Muʿīniyya (al-Risāla al-Mughniya) and its Supplement*. Vol. II, *English Translation* (Tehran: Mirath Maktoob), 114–118.

CHAPTER FIVE

On the Characteristics of Localities Whose Latitude Is
Greater than the Complement of the Obliquity, up to
Where the Latitude Reaches [Its] Maximum

[1] In these localities, the solstice point that is in the direction of the visible pole, along with two equal arcs on its two sides, are permanently visible. The two endpoints of those two arcs are the two points whose declinations are equal to the local colatitude. Those two points become tangent to the horizon along their day-circles and do not set. The other solstice point, along with two arcs that correspond in opposition to these two [above-mentioned] arcs, are permanently invisible. The two points that are those arcs' endpoints become tangent to the horizon and do not rise. Their point of tangency is the north or south point. [All] other parts of the zodiacal orb rise and set: one half in regular order, and one half in reverse order. That which rises in regular order, sets in reverse order, and that which rises in reverse order, sets in regular order. In northern localities the Arian arc rises in reverse order, and in southern localities the Libran arc.

[2] The altitude of the visible solstice has two extremes: one beyond which it does not go higher, and one beyond which it does not go lower. Describing a single cycle, this can easily be imagined. Whenever the visible solstice point is on the meridian circle, it is at the highest altitude, the invisible solstice point is below the Earth in the other direction, the two equinox points are on the eastern and western [horizon], and the visible pole of the zodiacal orb is at its lowest altitude on the meridian in the opposite direction of the visible solstice. Afterwards, when the visible solstice point heads west, the pole of the zodiacal orb on the other side [of the meridian] begins to increase in altitude; one equinox point sets, the [other] one rises, and the arc connecting them begins to rise and set sequentially. The rising place of each [zodiacal]

degree and the setting place of the point directly opposite it get farther away from the rising and setting places of the equinox.

[3] Whereupon the shift comes to the two opposite points [on the zodiacal equator], one of which comes to be tangent to the horizon but does not set, and the other comes to be tangent to the horizon but does not rise, these two points become tangent to the horizon at the two poles of the circle of the initial azimuth, the permanently visible point in the direction of the visible pole and the permanently invisible point in the opposite direction. The visible half of the zodiacal orb is toward the west, from north to south, and the other half, which is invisible, is directly opposite it. The places of intersection between the horizon and the zodiacal orb are the two poles of [the circle of] the initial azimuth. The visible pole of the zodiacal orb is toward the east, between the lowest and highest altitudes on the circle of the initial azimuth, the other [pole] being directly opposite to it.

[4] Then the endpoint of the arc that is tangent to the horizon on the meridian circle and is permanently visible rises from the horizon and begins to gain altitude obliquely in the eastern region. The arc that is connected to the [aforementioned endpoint] beneath the Earth begins to rise in reverse order such that every part that rises gets closer than the preceding part to the rising place of the equinox. The diametrically opposite point drops below the horizon, and the arc that is connected to it begins to set in reverse order, every part opposite another, whereupon the shift comes to the two equinox points to rise and set in reverse order, and the pole of the zodiacal orb will have reached the meridian circle at [its] highest altitude. The visible half of the zodiacal orb will be toward the north; the intersection of the zodiacal orb and the horizon will be at the two points of rising and setting of the equinox; the invisible half of the [zodiacal orb] will be facing [in the opposite direction] this half [i.e., the visible half]; the visible solstice point will be at its lowest altitude on the meridian; and the invis-

ble solstice will be directly opposite it, at the closest possible situation with respect to the horizon.

[5] Afterwards, the arcs that are connected to the two equinoxes will be rising and setting in reverse order; the visible pole of the zodiacal orb begins to descend; and the solstice point begins to rise, until on the other side of the equinox point, when it will shift at the second point of the permanently invisible points. This point will be tangent to the horizon on the meridian, and the point directly opposite it, which is permanently visible, will be tangent to the horizon on the meridian in the other side. The visible half of the zodiacal orb will be on the eastern side, from north to south, and the invisible half in the opposite direction. The pole of the zodiacal orb will have reached the circle of the [initial] azimuth. Then the permanently visible point will rise above the Earth in the eastern direction, and the other point will drop [below the Earth]. The arcs that are connected to it will begin to rise and set in regular order. The rising and setting places of any part that rises and sets get closer to the east and west of the equinoctial, until when the shift is attained at the equinox point; then a complete revolution will have been made, and the first situation will have been returned to exactly.

[6] At such localities, daylight and nighttime are equal at the beginning of Aries and Libra. When the beginning of Aries has passed in northern habitations, and the beginning of Libra in southern habitations, daylight increases and nighttime decreases until it becomes all daylight. As long as the Sun traverses the permanently visible arc, daylight remains without night; night then reappears and increases until the [Sun] reaches the other equinox point, when daylight and nighttime become equal. Then nighttime increases and keeps increasing, until it is all nighttime. As long as the Sun traverses the permanently invisible arc, nighttime remains with no daylight; then once again daylight re-emerges and keeps increasing until it is equal to nighttime.

The shadow will be cast in all directions, but mostly in the direction of the invisible pole.

[7] When the local latitude reaches the limit, i.e., 90 degrees, the visible pole of the equinoctial will be aligned with the zenith, the other pole will be directly opposite to it, and the equinoctial circle will coincide with the horizon circle. The turning of the celestial sphere is in a spinning manner. None of the celestial parts rises or sets because of the rotation of the equinoctial; rather, half of the celestial sphere is permanently visible, and half is permanently invisible. The visibility and invisibility of the stars depends on the second motion: those whose latitude is less than the obliquity rise and set, while those whose latitude is more do not rise or set.

[8] For a period of six months the Sun is above and for a period of six months below the Earth. Therefore, every year will be a nycthemeron, with six months of daylight and six months of nighttime. Opposite that direction in which the perigee [of the Sun is found], i.e., in the northern direction inasmuch as the apogee is northerly, daytime is greater than nighttime; in the southern direction, nighttime is greater than daytime. Of the six months that are night, nearly seventy days is the period of dawn and nearly seventy days is the period of dusk, the darkness of nighttime being not more than forty days. The altitude of the Sun in such a locality can be no more than the obliquity. On the surface of the Earth there are no more than two spots with this characteristic, unlike the other characteristics whose type is specific to two circuits on the external surface [of the Earth]. In most of these localities the survival of animal species that are seen [elsewhere] is not possible.

[9] One may ask the practitioners of this discipline: [there are] three individuals in a location on the surface of the Earth, one stays and two travel. Of the travelers, one travels toward the east and returns to the

stationary individual from the west; the other travels toward the west and returns to the stationary individual from the east. All three have been counting the days. The easterner, for example, said: “Today is the hundredth day since we have left the stationary individual.” The westerner said: “No, it has been a hundred and two days.” The stationary individual said: “No, it has been a hundred and one days.” Or the easterner said: “Today is Saturday;” the westerner said: “It is Monday;” the stationary individual said: “It is Sunday.” None of them has made a mistake in counting. How can this be?

[10] Conceptually, this is [actually] true, since for the one who goes toward the east and returns from the west, one celestial revolution will be subtracted from his course because every day the Sun rises earlier for him, and so his nychthemeron gets shorter than those of the stationary individual; and during a [complete] revolution those deficits add up to a day. The Sun rises later every day for the one who sets out toward the west and returns from the east, and his nychthemeron gets longer than those of the stationary individual; those increments, distributed over the nychthemeron, add up to a revolution, which is one day. The stationary individual has his own standard [celestial] revolutions. These are the states of affairs of the locations of the Earth, which are dependent on the celestial conditions that have been mentioned—God the Almighty is all-knowing.

CHAPTER SIX

On the Co-ascension of the Zodiacal Signs, Which Is the
Rising of the Parts of the Equinoctial with the Parts of the
Zodiacal [Orb]

[1] For every location, the rising of the parts of the zodiacal [orb] with the parts of the equinoctial is different from any other location because of the declination, as has been mentioned previously. The