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[11] The Arabs divide these constellations in a different way. They imagine twenty-eight stations close to the equator, and these they call the "mansions of the Moon," since a complete revolution of the Moon is accomplished in approximately twenty-eight nights. The names of the mansions are: (1) Sharaṭayn; (2) Buṭayn; (3) Thurayyā; (4) Dabarān; (5) Haqʿa; (6) Hanʿa; (7) Dhirāʿ; (8) Nathra; (9) Ṭarf; (10) Jabha; (11) Zubra; (12) Ṣarfa; (13) ʿAwwā; (14) Simāk; (15) Ghafr; (16) Zubānā; (17) Iklīl; (18) Qalb; (19) Shawla; (20) Naʿāʾim; (21) Balda; (22) Saʿd-i dhābiḥ; (23) Saʿd-i bulaʿ; (24) Saʿd-i suʿūd; (25) Saʿd-i akhbiya; (26) Fargh muqaddam; (27) Fargh muʾakhkhar; (28) Rashā.

[12] Every $2+\frac{1}{3}$ of these mansions is a zodiacal sign, and the relation of the stars of the mansions to the mansions is exactly the relation of the stars of the constellations to the constellations. Anyone who wants to learn about the fixed stars in detail should consult books on this science, which is an art unto itself. The best book done on this subject is the *Ṣuwar al-kawākib* by ʿAbd al-Raḥmān Ṣūfī. This is all we intended to say about the fixed stars—with God is success.

CHAPTER FOUR

An Exposition of the Orbs and the Motions of the Sun

[1] When the circumstances and motions of the Sun were observed, it was found to be moving from west to east by its own proper motion such that it makes one revolution in one solar year. However, it does not cut equal arcs on the [zodiacal] orb in equal periods of time but rather moves faster in one half of the [zodiacal] orb and slower in the other half. Considering the uniformity of circumstances that must pertain in celestial matters, this fastness and slowness in speed is possible by either one of two ways.

[2] The first is that the Sun's body moves on the circumference of an orb whose center is eccentric to the center of the World, while it en-

compasses the Earth, such that when the Sun is nearer to the Earth in one half of that [eccentric] orb and farther from it in the other half, equal arcs on that orb seem unequal with respect to the center of the World. Therefore, in one half, faster motion is produced and in the other half, slower motion. Such an orb is called an eccentric.

[3] The second is that the body of the Sun moves on the circumference of an orb whose center is not the center of the World; its circumference does not enclose the Earth, but rather is a small orb situated in the thickness of a body that does encompass the Earth. That body has uniform motion. Now there is no doubt that the motion of the Sun on the circumference of that small orb, in one half, will be in the same direction as the motion of the encompassing body with respect to the Earth and in the opposite [direction] in the other half. Therefore, in the half going in the same direction, the motion of the Sun appears to be composed of the sum of the two motions and is faster, while in the other half is composed of the excess of the motion of the encompassing body over the motion of the small orb, and [consequently] appears slower. Such a [small] orb is called an epicycle.

[4] Ptolemy chose the eccentric orb for the Sun because it is simpler, since from the motion of the Sun on the circumference of the epicycle, and the motion of the epicycle on the circumference of the orb that carries it, a circuit will be produced for the Sun, eccentric to the center of the World. Therefore, by positing the epicycle it is necessary to posit an eccentric too, but positing the eccentric does not necessitate positing the epicycle. This being the case, the eccentric is simpler and more appropriate to be posited.

[5] The result of this consideration is that the Sun has two orbs, one of which has the same center as the Earth and two parallel surfaces encompassing it: the upper surface, which is called the convex, is tangent to the lower surface of the orb of Mars; the lower surface, which

is called the concave, is tangent to [the upper surface of] the orb of Venus. The equator and two poles of this orb are in the plane coinciding with the equator and poles of the zodiacal orb. This orb is called the parecliptic orb, meaning [it has been] likened to the zodiacal [ecliptic] orb.

[6] The second orb is one that encompasses the Earth. Its center is eccentric to the center of the World, and it is within the thickness of the parecliptic orb, so that its convex surface is tangent to the convex of the parecliptic at one common point, and its concave surface is tangent to the concave of the parecliptic, also at one common point directly opposite the first point. The equator of this orb is in the same plane as the equator of the first orb, and its axis is parallel to the axis of that [first one]. This orb is called the eccentric orb.

[7] The Sun [itself] is a solid spherical body in the thickness of this eccentric orb, such that its convexity is tangent to both surfaces of the eccentric orb. The eccentric moves with the mean motion of the Sun—which is 0;59,8 daily—and carries the Sun along with itself. Therefore, in one half, i.e., the upper half, the amounts of the arcs appear smaller, hence it cuts smaller [arcs] from the zodiacal orb than the amount of the mean motion, and the motion is slower, and in the lower half vice versa.

[8] The midpoint of the slow days, which is also the farthest point from the center of the World, is called the apogee, and the farthest distance. The point that is directly opposite it, which is the midpoint of the fast days, is the nearest point to the center of the World; it is called the nearest distance and the perigee. Ptolemy did not find any motion for the apogee and perigee and stated that the apogee is at 5;30 in Gemini, and it is fixed. However, the moderns have found it moving with the motion of the fixed stars. So they attributed this motion to the parecliptic orb, so that when it moves with this motion it carries all parts of

the eccentric orb with it; thus the apogee and perigee also move with this motion.

[9] The mean distance of the Sun is where the two lines extending from the center of the World and the center of the eccentric to it are equal. This occurs at two points on either side of the apogee.

[10] The two bodies left from the parecliptic after removing the eccentric orb from it are called the complements.

[11] Since the Sun moves along the equator of the eccentric orb and this equator is in the plane of the zodiacal orb, the Sun always adheres to the equator of the zodiacal orb and has no latitude in any direction.

[12] When two lines are extended from the two centers—i.e., the center of the parecliptic, which is the center of the World, and the center of the eccentric—to the body of the Sun, and from there to the equator of the parecliptic orb, the position of the Sun with respect to the center of the World is obviously other than its position with respect to the eccentric center. This difference is called the equation of the Sun, and the angle occurring at the Sun's body by these two lines is called the angle of the equation.

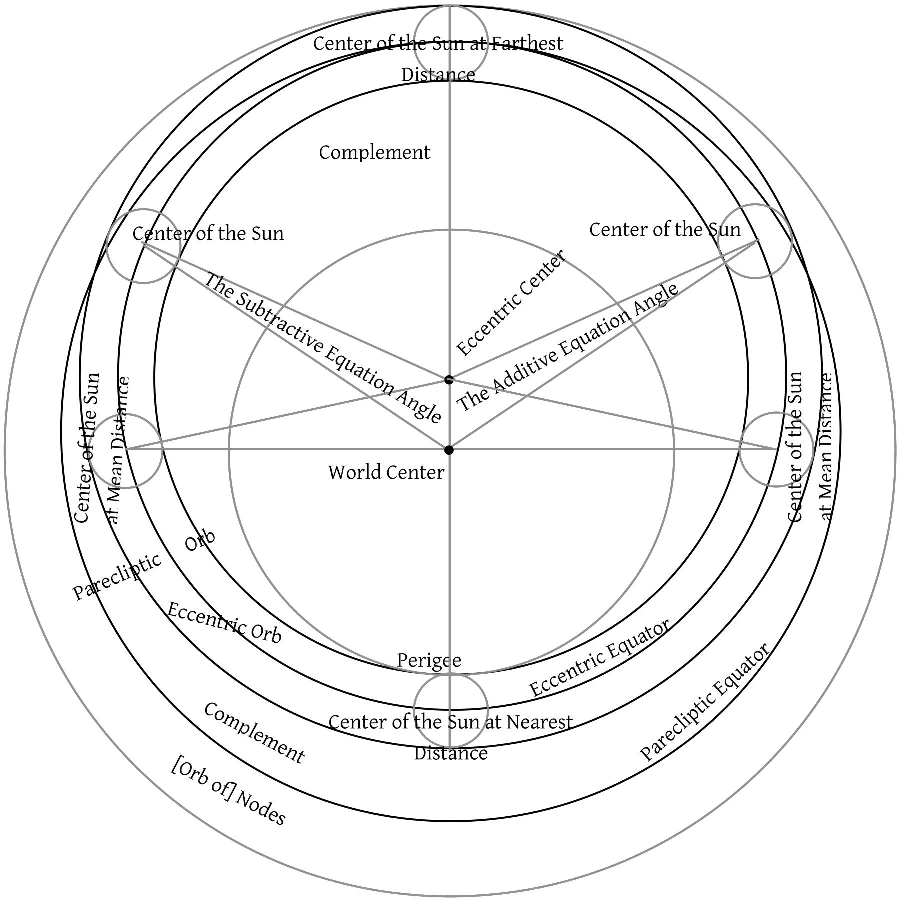
[13] The mean position of the Sun is [determined] with respect to the eccentric center, and the true position with respect to the World center. The mean Sun is an arc on the parecliptic equator between the vernal equinox point and the endpoint of a line extending from the eccentric center to the center of the Sun's body. When the point of farthest distance is taken as the initial point of this arc, this will be the arc of the Sun's center. The adjusted apogee or farthest distance is an arc between the beginning of Aries and the point of farthest distance. The true position is an arc along the parecliptic orb between the beginning of Aries and the endpoint of the line extending from the World center to the center of the Sun's body.

[14] Since the equation, which is the difference between the mean and the true position, arises from the difference between the two lines extended from the two centers to the body of the Sun, and since the endpoint of the line extended from the World center is always closer to the apogee, then while the Sun is between the apogee and perigee, the equation is subtractive from the mean and additive in the other half. At the apogee and perigee there is no equation, since both lines coincide.

[15] The distance between the two centers has been found to be 2;4,45 by observation—the radius of the eccentric being 60. This amount is used to find the equation. [The distance] is found to be 2;1—the radius of the parecliptic being 60. This amount is used to find the distance of the Sun from the Earth.

[16] It has been established then that the Sun has two orbs and two motions. Practitioners of geometry are satisfied with two circles: one being the equator of the eccentric and the other the equator of the parecliptic, on the condition that the eccentric equator passes through the center of the Sun and the parecliptic equator is tangent to it. This is an explanation of the configuration of the Sun's orbs. Here is its illustration.

[17] The two circles that are in black represent those with which the practitioners of the science of geometry are satisfied; they call them the parecliptic orb and the eccentric orb.



[Figure 1]

CHAPTER FIVE
An Exposition of the Orbs and Longitudinal Motions of the Moon

[1] When the situation of the Moon is considered, a faster and a slower motion will also be found in the course of its movement, and [also] an approach toward the Earth and a receding from it. [This] approach and receding of [the Moon] is determined by parallax. However, its situation in these positions is opposite to the situation of the Sun, since the Sun always has a slow speed when it is situated farther from the