second station, perform the same operation, but God knows better.

CHAPTER TEN. On the Knowledge of Apogee and Epicycle Sectors. The sun and the other planets in the eccentric orbits have four sectors. The beginning of the first sector is the apogee, and the beginning of the third sector is the perigee. But (as for) the beginning of the second sector and the fourth (sector), if it is (reckoned) on the basis of distance it will be there where the distance(s) of the sun or of the epicycle center from the center of the universe and from the eccentric center are equal.

But if it is (reckoned) on the basis of movement, it will be there where the sun's movement would not be speedy and not slow. And other than the sun, of the planets, in the epicycle there are also four sectors. The beginning of the first and third will be the apparent epicyclic apogee and perigee, and the beginning of the second and fourth, according to distance will be there where the distance of the planet and the center of the epicycle from the center of the universe are equal. And according to movement (it) will be there where the movement, according to the center,
is alone (i.e., the only one). And both of these, because of the difference in distance of the epicycle center from the center of the universe, differ. And we, having taken from the (Khāqānī) Zīj the beginnings of the apogee sectors (reckoned) according to distance, in order that they be known, we made on the deferent of every planet some marks. So the apogee sectors can be determined by means of the marks.

As for the epicyclic sectors, if on the plate a mark of the center and of the longitudinal difference had been made, the edge of the alidade is put along the mark of the center, and look along to the difference mark.

If it is on the right of someone who is facing the alidade under the condition that the mark of the center fall opposite the head of that person, and hence if the distance of the center mark from the [difference] mark is larger than the distance of the center mark from the center of the plate, the planet must be in the first sector, and if it is less, it will be in the second. And if the mark of longitudinal difference is on the left of that person, and the distance of the center mark from the mark of the

*The word اختلاف is lacking in the text.
TRANSLATION

f.31r

1 difference is less than the distance of the center mark from the center of the plate, it will be
2 in the third sector, and if it is more it will be in the fourth sector.
3 And whenever the planet is in the first and second sectors it will be
4 increasing in the number of the computation, and in the third and fourth sectors it will be
5 decreasing. But the condition of the moon is opposite this in the increase
6 and decrease of the computation. And if the planet is in the first or
7 fourth sector it will be decreased in magnitude and light, but if it is in the second
8 or third it must be increased. But as for the increase and lessening in light of the
9 moon, it will be according to its distance from the sun, but in magnitude
10 it is like the other planets, but God knows better. CHAPTER
11 ELEVEN. On the Determination of Lunar Eclipses. (At) any true opposition
12 which is in the night or which falls on (either of) the two sides of the day,
13 less than two hours and four minutes having passed from the first of the day
or remaining from the end of the day, and the moon's latitude being less than the amount of the sum of [half]* the diameter of the moon and half the diameter of the shadow circle,
a lunar eclipse is possible. Otherwise, if the amount of the sum is half the two diameters the moon will be tangent to the shadow circle, and a lunar eclipse will not occur. And if it is greater than the sum of half the two diameters a lunar eclipse will not be possible. So if the distance of the moon from one of the two nodes is greater than twelve degrees a lunar eclipse will not be possible, but if it is less than twelve degrees and [the lunar latitude at conjunction]* more than twenty-nine minutes a partial lunar eclipse will occur, and if it is less than this a total lunar eclipse will befall.

So, any time it become known that a lunar eclipse is to befall, put the edge of the alidade along the first of Aries and elevate the minutes of the moon's latitude into degrees, and to the amount of these

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*Lacking in the text.
elevated degrees in divisions of the diameter on the plate make a mark.

And the pointer of the alidade is moved until it reaches one of the two solstices,

and it is necessary that the edge of the alidade be beside the mark.

And the edge of the ruler is put alongside this mark in such fashion that

the lunar eclipse mark, which is on the ruler, fall on this mark,

and the other head of the ruler, which is near the mark of

first totality, fall on the edge of the alidade. Without fail, from the edge of the

ruler and the alidade an angle is formed. So observe that between the vertex of the angle and the center of the alidade how many

of the divisions of the alidade there are. Whatever it is, double it,

then depress it one (sexagesimal) place, i.e., count each degree a minute.

That which results is the time of immersion. And if the lunar

eclipse is total, that which was done with the lunar eclipse mark
do it with the mark of (first) totality [so that] the hours of
totality can be ascertained. Then the time of
opposition,
put it in five places: from the first subtract the time of immersion and
from the second the time of totality, and the
third, put it in
its (previous?) place, to the fourth add the
time of totality,
and to the fifth the time of immersion, so that from the first the
time of beginning of the lunar eclipse, and from the second the beginning of totality,
and from the third the middle of the lunar eclipse, and from the fourth the beginning of clearance,
and from the fifth the end of clearance result. But if the lunar eclipse
is not total the time of opposition is put in three
places. The result from the first will be the
time of the beginning of the lunar
eclipse, and from the second the middle of the
lunar eclipse, and from the third the
end of the lunar eclipse. Then, according to the elevate of the lunar latitude,

*MS. has $\frac{4}{3}$ for $\frac{5}{3}$. 
in divisions of the ruler, from that head which is in the vicinity of the mark of totality, in front of the division, the digits are sought, and from that face of the ruler the lunar eclipse digits are ascertained, but God knows better. CHAPTER TWELVE.

On the Determination of Solar Eclipses. If a conjunction befalls during the day or on one of the two sides of the night, and the part of the conjunction (is) after the head (i.e. ascending node) and before the tail (i.e. descending node), and the distance of that part from the node is less than sixteen degrees; or before the head, and after the part from the node (is) less than sixteen degrees; or before the head and after the tail and the distance of the part from the node is less than seven degrees, a solar eclipse is possible. So, whenever a solar eclipse is possible, opposite the part of the conjunction and the hours of the

*Passage in braces is repeated also in the text.*
TRANSLATION

f.33v

(Table of Adjusted Lunar Parallax Components)

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(Restorations have been made by comparison with [23], f.164v, and consideration of tabular differences.)
distance from the table of the difference of hours (parallax), each one of the hours of difference and the difference of latitude, obtain them. And the hours of difference of distance, add (them) to the time of the conjunction if the conjunction is westerly, and subtract them from the time of the conjunction if it is easterly, so that the time of the middle of the solar eclipse result. After that, the lunar latitude at the middle of the solar eclipse is obtained; if (it is) northerly (take) the difference between it and between the difference, and if it is southerly they are added, so that the apparent latitude result. (If it is) less than thirty-three minutes a solar eclipse will occur, and otherwise not. And when it is to be eclipsed, do with the apparent latitude and the mark of the solar eclipse as had been done with the lunar latitude and the lunar eclipse mark so that the times of the beginning of the solar eclipse and the middle
and the middle* of the solar eclipse and clearance become known. And the solar eclipse digits are determined like the lunar eclipse digits. And the determination of the hours of conjunction and opposition, let it come in the conclusion, if God will, He is exalted!

CHAPTER THIRTEEN. On the Determination of the Mean of Transfer by Means of the True Longitude of the Sun at a Given Time, and the Hours after the Transfer. The pointer of the alidade is put according to the true longitude of the sun at the assumed time on the divisions of the ring, and the edge of the ruler having been put along the fictitious center, make it parallel to the alidade. And at the place of intersection of the edge of the ruler with the circumference of the plate let a mark be made. Then the edge of the alidade is put along this mark; the place of the pointer of the alidade in divisions of the ring will be the mean of transfer. Then the mean is extracted on the approaching noon at the assumed time, and this mean,

* is repeated from the previous page.
let it be subtracted from the mean of transfer; the remainder is divided by the motion (in) one mean hour.

The quotient will be the distance of the transfer from the coming noon. CHAPTER FOURTEEN.

On the Determination of the True Altitude from the Apparent and the Determination of the Apparent Altitude from the True, and the [Parallax]*

in the Altitude Circle. The pointer of the alidade is placed at the first of Cancer, and from the center, on the side of the first of Cancer in the case of the moon, one division and two minutes is taken of the divisions of the alidade, and in the case of the sun, if the instrument is large, a little more than two minutes is taken. And for Venus two minutes is taken, and near the end a mark is made on the plate, and we call this the mark of [parallax]*.

Then, on the edge of the alidade, according to the distance of the sun or of the moon from the center of the universe, and according to half the distance of Venus

*MS. has *ruler, for A.
TRANSLATION

1 from the center of the universe a mark is made, and we call this the (parallax) mark of the planet. Then, if the apparent altitude is known
2 and it is desired to ascertain the true longitude, the pointer of the alidade is turned from the first of Aries along the succession (of the zodiacal signs) by the amount of the apparent altitude,
3 and, the edge of the ruler having been put along the parallax mark, turn it parallel to the alidade, and on the plate at the planet's mark,
4 a line is drawn alongside the edge of the ruler. Then the alidade is turned until the mark of the planet falls along this line, and the distance of the pointer of the alidade from the first of Aries is the true altitude of [that] * planet.
5 And the difference between the two altitudes is its parallax
6 in the circle of altitude. And if the true altitude
7 is known and the apparent altitude is wanted, the pointer of the alidade is turned
8 in the direction (of the signs) from the first of Aries to the amount of the true altitude.

*For ἓ I read ἦ.
and at the place of the mark of the planet, which had been made on the alidade,
a mark is made on the plate. Then the edge of the ruler is placed
along this mark and the mark of parallax, and the alidade is turned
parallel to the ruler. The distance of the pointer of the alidade from the first of
Aries is the apparent altitude of that planet, but God knows better.

CHAPTER FIFTEEN. On the Determination of the Equation of
Time. Those having to do with this art take the true day (nychthemeron)
from noon to noon so that in the difference of locality there will be no differing. So let the amount of the
true day be a rotation of the celestial equator (together)
with the rising (time) of that (arc through) which the sun in that day moves with respect to the (celestial)
equator. And the motion of the sun is different (i.e., variable),
since sometimes it is slow-travelling and sometimes fast-travelling,
and also the rising (times) of the divisions of the zodiac are not equal.
So the amounts of the true days are different with respect to both differences, and those concerned with computation need days equal in amount for the knowledge of mean motions of planets, and for (problems) other than that. So that excess over a revolution has been taken equal to the travel in one day of the mean sun, so that the days of the year be sufficient, and these equal days are called mean days. And the amounts of (each of) these is a rotation of the celestial equator (together) with an arc equal to the travel of the mean sun in one day, and the difference between these days and the true days is called the equation of time. So, with regard to the determination of the equation of time, the true longitude of the sun and its mean is obtained at the assumed time. Then to the sun's mean three degrees
and fifty-seven minutes and thirty seconds is added,
and the excess of the sum of this over the (right) ascension of the sun is obtained.
Then, for each degree (of arc) of this excess
four minutes of the
minutes of hours are taken, and for each ten
minutes of the minutes of the excess (take)
one minute of hours, and for each minute of
the
excess four seconds are taken. The sum of
the minutes and seconds of the hours will be the
equation of time. From the true days and
hours
decrease them, the mean days will remain, but
God knows better.
CONCLUSION. On the Operation of the Plate of
Conjunctions. Each one: the daily rate,
and the past distance, and the time of noon, and the duration of
night, should be ascertained. Then extend the longer ruler to the amount of the time of
noon, and the head of the night ruler, which is
in the second trough, is put opposite the duration of the day
on the divisions of the margin of the plate so that the distance of the head of the day ruler from the head of the night ruler is made (equal to) the amount of the hours of the day. And the next-day ruler is put according to the hours of the night on the night ruler. Then the right angle will be opposite the hours of noon of the coming day on the next-day ruler. And that which of the day ruler is opposite the night ruler let it be disregarded. After that, the edge of the turning ruler or thread is placed according to the daily motion (or rate) in the divisions of travel, and the finger or pen-point is placed according to the past distance of the divisions of travel, and is run along the line extending from that division until (it reaches) the edge of the ruler or thread. Then descend along the line which runs from here into the divisions of the hours and the divisions of the three-fold rulers. And note that that line, except for the segment which is (to be) disregarded, falls along which minute
of which hour and which ruler.

This is the hour of conjunction from the first (hour) of the day or the first (hour) of the night or of the coming day. And the place of that line on the divisions of the edge is the hours of the distance from the previous noon.

And if the beginning of the hours of the conjunction from the day or the night or noon is known, and the distance unknown, by the reverse of this operation the distance may be ascertained,

but God knows better.

Finished.