Chapter 2

Spañöädhikäraù - True Places of the Planets

1. The structure of the material world
    a. Texts 1 – 14; the causes of the motions of the planets
    b. Text 28; the maximum declination of the ecliptic and calculating the declination of a point on the ecliptic
    c. Texts 50 – 55; the cause of retrograde motion

2. Science
    a. Texts 15 – 27; calculation and table of sines
    b. Texts 31 – 33; finding the sines of intermediate angles
    c. Texts 28 – 58; calculating the true position of planets
    d. Texts 59 – 63; calculating the daily times of revolution and visibility for the planets and stars
    e. Text 64; calculating the position of planets in nakshatras
    f. Text 65 – 69; calculating the tithi, yoga and karana and their times

Text & Translation

2.01a adåçyarüpäù kälasya mürtayo bhagaëäçritäù/
2.01b çéghramandoccapätäkhyä grahäëäà gatihetavaù//

2.02a tadvätaraçmibhir *baddhäs tais savyetarapäëibhiù/ (2. naddhäs)
2.02b präk paçcäd apakåñyante yathäsannaà svadiìmukham//

2.03a pravahäkhyo marut täàs tu svoccäbhimukham érayet/
2.03b pürväparäkåñöäs te *gatià yänti påthagvidhäù//(2. gatér, påthagvidhäm)

2.04a grahät prägbhagaëärdhasthaù präìmukhaà karñati graham/
2.04b uccasaàjïo +aparärdhasthas tadvat paçcänmukhaà graham//

2.05a svoccäpakåñöä *bhagaëaiù präìmukhaà yänti yad grahäù/ (2. bhagaëät)
2.05b tat teñu dhanam ity uktam åëaà paçcänmukheñu *ca// (tu)

Forms of time, of invisible shape, stationed in the zodiac (bhagana), called the conjunction (sighrocca), apsis (mandocca), and node (pata), are the cause of the motion of the planets. The planets, attached to these beings by cords of air, are drawn away by them, with the right and left hand, forward or backward, according to nearness, toward their own place. A wind, moreover, called the provector (pravaha) impels them toward their own apices (ucca); being drawn away forward and backward, they proceed by a varying motion. The so called apex (ucca), when in the half orbit in front of the planet, draws the planet forward; in like manner, when in the half orbit behind the planet, it draws it backward. When the planets, drawn away by their apices (ucca), move forward in their orbits, the amount of the motion so caused is called their excess (dhana), when they move backward, it is called their deficiency (rina).

2.06a *dakñiëottarato +apy evaà päto *rähuù svaraàhasä/(2. dakñiëottarayor, rähuç ca raàhasä)
2.06b vikñipaty eña vikñepaà candrädénäm apakramät//

2.07a uttaräbhimukhaà päto vikñipaty aparärdhagaù/
2.07b grahaà prägbhagaëärdhastho yämyäyäm apakarñati//

2.08a budhabhärgavayoù çéghrät tadvat päto *yadä sthitaù/ (2. yathästhitaù)
2.08b tacchéghräkarñaëät tau tu vikñipyete yathoktavat//

In like manner, also, the node, Rahu, by its proper force, causes the deviation in latitude (vikshepa) of the moon and the other planets, northward and southward, from their point of declination (apakrama). When in the half orbit behind the planet, the node causes it to deviate northward; when in the half orbit in front, it drives it away southward. In the case of Mercury and Venus, however, when the node is thus situated with regard to the conjunction (sighra), these two planets are caused to deviate in latitude, in the manner stated, by the attraction exercised by the node upon the conjunction.

2.09a mahatvän maëòalasyärkaù svalpam eväpakåñyate/
2.09b maëòalälpatayä candras tato bahv apakåñyate/

2.10a bhaumädayo +alpamürtitväc chéghramandoccasaïjïakaiù/ (2. saàjïitaiù)
2.10b daivatair apakåñyante sudüram ativegitäù//

2.11a ato dhanarëaà sumahat teñäà gativaçäd bhavet/
2.11b äkåñyamäëäs tair evaà vyomni yänty anilähatäù//

Owing to the greatness of its orb (orbit?), the Sun is drawn away only a very little: the moon, by reason of the smallness of its orb (orbit?), is drawn away much more. Mars and the rest, on account of their small size, are, by the supernatural beings (daivata) called conjunction (sighrocca) and apsis (mandocca), drawn away very far, being caused to vacillate exceedingly. Hence the excess (dhana) and deficiency (rina) of these latter is very great, according to their rate of motion. Thus do the planets, attracted by those beings, move in the firmament, carried on by the wind.

2.12a *vakrätivakrä vikalä mandä mandatarä samä/ (2. vakränuvakrä)
2.12b tathä çéghratarä çéghrä grahäëäm añöadhä gatiù//

2.13a taträtiçéghrä çéghräkhyä mandä mandatarä samä/
2.13b åjvéti païcadhä jïeyä *yä vakrä sätivakragä//(2. +anyä vakrädikä matä)

The motion of the planets is of eight kinds: retrograde (vakra), somewhat retrograde (anuvakra), transverse (kutila), slow (manda), very slow (mandatara), even (sama); also, very swift (sighratara), and swift (sighra). Of these, the very swift (atisighra), that called swift, the slow, the very slow, the even – all these five are forms of the motion called direct (riju); the somewhat retrograde is retrograde.

2.14a tattadgativaçän nityaà yathä dåktulyatäà grahäù/
2.14b prayänti tat pravakñyämi sphuöékaraëam ädarät//

By reason of this and that rate of motion, from day to day, the planets thus come to an accordance with their observed places (dris) – this, their correction (sphutikarana), I shall carefully explain.

2.15a räçiliptäñöamo bhägaù prathamaà jyärdham ucyate/
2.15b tat tadvibhaktalabdhonamiçritaà tad dvitéyakam//

2.16a ädyenaivaà kramät piëòän bhaktvä *labdhonasaàyutäù/(2. labdhonitair yutaiù)
2.16b *khaëòakäù syuç caturviàçajyärdhapiëòäù kramäd amé//(2. khaëòakais)

2.17a tattväçvino +aìkäbdhikåtä rüpabhümidharartavaù/(224, 449, 691)
2.17b khäìkäñöau païcaçünyeçä bäëarüpaguëendavaù//(890, 1105, 1315)

2.18a çünyalocanapaïcaikäç chidrarüpamunéndavaù/(1520, 1719)
2.18b viyaccandrätidhåtayo guëarandhrämbaräçvinaù//(1910, 2093)

2.19a muniñaòyamaneträëi candrägnikåtadasrakäù/(2267, 2431)
2.19b païcäñöaviñayäkñéëi kuïjaräçvinagäçvinaù//(2585, 2728)

2.20a randhrapaïcäñöakayamä vasvadryaìkayamäs tathä/(2859, 2978)
2.20b kåtäñöaçünyajvalanä nagädriçaçivahnayaù//(3084, 3179)

2.21a ñaöpaïcalocanaguëäç candraneträgnivahnayaù/(3256, 3321)
2.21b yamädrivahnijvalanä randhraçünyärnavägnayaù//(3372), 3401)

2.22a rüpägnisägaraguëä vasvagnikåtavahnayaù/(3431, 3438)
2.22b projjhyotkrameëa vyäsärdhäd utkramajyärdhapiëòikäù//

2.23a munayo randhrayamalä rasañaökä munéçvaräù/(7, 29, 66, 117)
2.23b dvyañöaikä rüpañaòdasräù sägarärthahutäçanäù/(182, 261, 354)

2.24a khartuvedä navädryarthä diìnägäs tryarthakuïjaräù/(460, 710, 853)
2.24b nagämbaraviyaccandrä rüpabhüdharaçaìkaräù//(1007, 1171)

2.25a çararëavahutäçaikä bhujaìgäkñiçarendavaù/(1345, 1528)
2.25b navarüpamahédhraikä gajaikäìkaniçäkaräù//1719, 1918)

2.26a guëäçvirüpaneträëi pävakägniguëäçvinaù/(2123, 2333)
2.26b vasvarëavärthayamaläs turaìgartunagäçvinaù//(2548, 2767)

2.27a naväñöanavaneträëi pävakaikayamägnayaù/(2989, 3213)
2.27b gajägnisägaraguëä utkramajyärdhapiëòakäù//(3438)

The eighth part of the minutes of a sign is called the first sine (jyardha); that, increased by the remainder left after subtracting from it the quotient arising from dividing it by itself, is the second sine. Thus, dividing the tabular sines in succession by the first, and adding them, in each case, what is left after subtracting the quotients from the first, the result is twenty-four tabular sines (jyardhapinda), in order, as follows: 225, 449, 671, 890, 1105, 1315, 1520, 1719, 1910, 2093, 2267, 2431, 2585, 2728, 2859, 2978, 3084, 3167, 3256, 3321, 3372, 3409, 3431, 3438. Subtracting these, in reverse order, from the half diameter, gives the tabular versed sines (utkramajyardhapindaka): 7, 29, 66, 117, 182, 261, 334, 460, 579, 710, 853, 1007, 1171, 1345, 1528, 1719, 1918, 2123, 2333, 2548, 2767, 2989, 3213, 3438: these are the versed sines.

2.28a paramäpakramajyä tu saptarandhraguëendavaù/(1397)
2.28b tadguëä jyä trijéväptä taccäpaà kräntir ucyate//(2. iñyate)

The sine of the greatest declination is 1397; by this multiply any sine, and divide by the radius; the arc corresponding to the result is said to be the declination.

2.29a grahaà saàçodhya mandoccät tathä çéghräd viçodhya ca/
2.29b çeñaà kendrapadaà tasmäd bhujajyä koöir eva ca//(2. kendraà padaà)

2.30a gatäd bhujajyä viñame gamyät koöiù pade bhavet/
2.30b *yugme tu gamyäd bähujyä koöijyä tu gatäd bhavet//(2. same)

Subtract the longitude of a planet from that of its apsis (mandocca); so also, subtract it from that of its conjunction (sighra); the remainder is its anomaly (kendra); from that is found the quadrant (pada); from this, the base sine (bhujajya), and likewise that of the perpendicular (koti). In an odd (vishama) quadrant, the base sine is taken from the part past, the perpendicular from that to come; but in an even (yugma) quadrant, the base sine (bahujya) is taken from the part to come, and the perpendicular sine from that past.

2.31a liptäs tattvayamair bhaktä *labdhaà jyäpiëòikaà gatäm/(2. labdhä jyäpiëòikä gatäù)
2.31b gatagamyäntaräbhyastaà vibhajet tattvalocanaiù//(225)

2.32a tadaväptaphalaà yojyaà jyäpiëòe *gatasaàjïake/(2. gatasaàjïite)
2.32b syät kramajyävidhir ayaà utkramajyäsv api småtaù//

2.33a jyäà *projjhya çeñaà tattväçvihataà tadvivaroddhåtam/(2. projjhyänyattattvayamair hatvä)(225)
2.33b saàkhyätattväçvisaàvarge *saàyojya dhanur ucyate//(2. saàyojyaà) (225)

Divide the minutes contained in any arc by two hundred and twenty five; the quotient is the number of the preceding tabular sine (jyapindaka). Multiply the remainder by the difference of the preceding and following tabular sines, and divide by two hundred and twenty five. The quotient thus obtained add to the tabular sine called the preceding; the result is the required sine. The same method is prescribed also with respect to the versed sines. Subtract from any given sine the next less tabular sine; multiply the remainder by two hundred and twenty five, and divide by the difference between the next less and next greater tabular sines; add the quotient to the product of the serial number of the next less sine into two hundred and twenty five; the result is the required arc.

2.34a raver mandaparidhyaàçä manavaù çétago radäù/ (14, 32)
3.34b yugmänte viñamänte tu nakhaliptonitäs tayoù//

2.35a yugmänte +arthädrayaù *khägnisuräù süryä navärëaväù/(2. khägniù suräs)(75, 30, 33, 12, 49)
2.35b oje dvyagä vasuyamä radä rudrä gajäbdayaù//

2.36a kujädénäà *ataù çéghrä yugmänte +arthägnidasrakäù/(2. tataç çaighryä)(235)
2.36b guëägnicandräù *khanagä dvirasäkñéëi go+agnayaù//(2. khägäç ca)(133, 70, 262, 39)

2.37a ojänte *dvitriyamalä dviviçve yamaparvatäù/(2. dvitrikayamäù)(132, 72)
2.37b khartudasrä viyadvedäù çéghrakarmaëi kértitäù//(260,40)

2.38a ojayugmäntaraguëä bhujajyä trijyayoddhåtä/
2.38b *yugme våtte dhanarëaà syäd ojäd ünädhike sphuöam// (2. yugmavåtte)

The degrees of the Sun's epicycle of the apsis (mandaparidhi) are fourteen, of that of the Moon, thirty-two, at the end of the even quadrants; and at the end of the odd quadrants, they are twenty minutes less for both. At the end of the even quadrants, they are 75, 30, 33, 12, 49; at the odd (oja) they are 72, 28, 32, 11, for Mars and the rest. Farther, the degrees of the epicycle of the conjunction (sighra) are, at the end of the even quadrants, 235, 133, 70, 262, 39; at the end of the odd quadrants, they are stated to be 232, 132, 72, 260, 40, as made use of in the calculation of the conjunction (sighrakarman). Multiply the base sine (bhujajya) by the difference of the epicycles at the odd and even quadrants, and divide by radius (trijya); the result, applied to the even epicycle (vritta), and additive (dhana) or subtractive (rina), according as this is less or greater than the odd, gives the corrected (sphuta) epicycle.

2.39a tadguëe bhujakoöijye bhagaëäàçavibhäjite/
2.39b tadbhujajyäphaladhanur mändaà liptädikaà phalam//

By the corrected epicycle multiply the base sine (bhujajya) and perpendicular sine (kotijya) respectively, and divide by the number of degrees in a circle: then, the arc corresponding to the result form the base sine (bhujajyaphala) is the equation of the apsis (manda phala), in minutes, etc.

2.40a *çaighryaà koöiphalaà kendre makarädau dhanaà småtam/(2. çaighre)
2.40b saàçodhyaà tu *trijéväyäà karkyädau koöijaà phalam//(2. trijévätaù)

2.41a tadbähuphalavargaikyän mülaà karëaç caläbhidhaù/
2.41b trijyäbhyastaà bhujaphalaà calakarëavibhäjitam//

2.42a labdhasya cäpaà liptädiphalaà *çaighryam idaà småtam/ (2. çaighram)
2.42b etad ädye kujädénäà caturthe caiva karmaëi//

The result from the perpendicular sine (kotiphala) of the distance from the conjunction is to be added to radius, when the distance (kendra) is in the half orbit beginning with Capricorn; but when in that beginning with Cancer, the result from the perpendicular sine is to be subtracted. To the square of the sum or difference add the square of the result from the base sine (bahuphala); the square root of their sum is the hypotenuse (karna) called variable (cala). Multiply the result from the base sine by radius, and divide by the variable hypotenuse: the arc corresponding to the quotient is, in minutes, etc., the equation of the conjunction (saighrya phala); it is employed in the first and fourth process of correction (karman) for Mars and the other planets.

2.43a mändaà karmaikam arkendor bhaumädénäm athocyate/
2.43b *çaighryaà mändaà punar mändaà çaighryaà catväry anukramät//(2. çaighraà)

2.44a madhye çéghraphalasyärdhaà mändam ardhaphalaà tathä/
2.44b madhyagrahe *mandaphalaà sakalaà çaighryam eva ca//(2. punar mändaà)

2.45a ajädikendre sarveñäà *çaighrye mände ca karmaëi/(2. mände çaighre)
2.45b dhanaà grahäëäà liptädi tulädäv rëam eva ca//

The process of correction for the apsis (manda karman) is the only one required for the Sun and Moon: for Mars and the other planets are prescribed that for the conjunction (saighrya), that for the apsis (manda), again that for the apsis, and that for the conjunction – four, in succession. To the mean place of the planet apply half of the equation of the conjunction (sighraphala), likewise half the equation of the apsis; to the mean place of the planet apply the whole equation of the apsis (mandaphala), and also that of the conjunction. In the case of all the planets, and both in the process of correction for the conjunction and in that for the apsis, the equation is additive (dhana) when the distance (kendra) is in the half orbit beginning with Aries; subtractive (rina), when in the half orbit beginning with Libra.

2.46a arkabähuphaläbhyastä grahabhuktir vibhäjitä/
2.46b bhacakrakalikäbhis tu liptäù karyä grahe +arkavat//

Multiply the daily motion (bhukti) of a planet by the Sun's result from the base-sine (bahuphala), and divide by the number of minutes in a circle (bhacakra); the result, in minutes, apply to the planet's true place, in the same direction as the equation was applied to the Sun.

2.47a svamandabhuktisaàçuddhä madhyabhuktir niçäpateù/
2.47b dorjyäntarädikaà kåtvä bhuktäv åëadhanaà bhavet//

2.48a grahabhukteù phalaà käryaà grahavan mandakarmaëi/
2.48b dorjyäntaraguëä bhuktis tattvanetroddhåtä punaù// (225)

2.49a svamandaparidhikñuëëä bhagaëäàçoddhåtä kaläù/
2.49b karkyädau tu dhanaà tatra makarädäv åëaà småtam//

From the mean daily motion of the Moon subtract the daily motion of its apsis (manda), and, having treated the difference in the manner prescribed by the next rule, apply the result, as an additive or subtractive equation, to the daily motion. The equation of the planet's daily motion is to be calculated like the place of the planet in the process for the apsis: multiply the daily motion by the difference of tabular sines corresponding to the base-sine (dorjya) of anomaly, and then divide by two hundred and twenty five; Multiply the result by the corresponding epicycle of the apsis (mandaparidhi), and divide by the number of degrees in a circle (bhagana): the result, in minutes, is additive when in the half-orbit beginning with Cancer, and subtractive when in that beginning with Capricorn.

2.50a mandasphuöékåtä à bhukti à projjhya çéghroccabhuktitaù/
2.50b taccheça à vivareëätha hanyät trijyäntyakarëayoù//

2.51a calakarëahåta à bhuktau karëe trijyädhike dhanam/
2.51b åëam üne +adhike projjhya çeña à vakragatir bhavet//

Subtract the daily motion of a planet, thus corrected for the apsis (manda), from the daily motion of its conjunction (sighra); then multiply the remainder by the difference between the last hypotenuse and radius, and divide by the variable hypotenuse (cala karna): the result is additive to the daily motion when the hypotenuse is greater than the radius, and subtractive when this is less: if, when subtractive, the equation is greater than the daily motion, deduct the latter from it, and the remainder is the daily motion in a retrograde (vakra) direction.

2.52a dürasthitaù svaçéghroccäd grahaù çithilaraçmibhiù/
2.52b savyetaräkåñtatanur bhavet vakragatis tadä//

2.53a kåtartucandrair vedendraiù çünyatryekair guëäñöabhiù/(164, 144, 130, 83?)
2.53b çararudraiç caturtheñu kendrä à çair bhüsutädayaù//(115)

2.54a bhavanti vakriëas tais tu svaiù svaiç cakräd viçodhitaiù/
2.54b avaçiñöä à çatulyaiù svaiù kendrair ujjhanti vakratäm//

2.55a mahattväc chéghraparidheù saptame bhågubhüsutau/
2.55b añöame jévaçaçaijau navame tu çanaiçcaraù//

When at a great distance from its conjunction (sighrocca), a planet, having its substance drawn to the left and right by slack cords, comes then to have a retrograde motion. Mars and the rest, when their degrees of commutation (kendra), in the fourth process, are, respectively, 164, 144, 130, 163(?) and 115, become retrograde (vakrin): and when their respective commutations are equal to the number of degrees remaining after subtracting those numbers, in each several case, from a whole circle, they cease retrogradation. In accordance with the greatness of their epicycles of the conjunction (sighraparidhi), Venus and Mars cease retrograding in the seventh sign, Jupiter and Mercury in the eighth, Saturn in the ninth.

2.56a kujärkigurupätänä à grahavac chéghraja à phalam/
2.56b väma à tåtéyaka à mända à budhabhärgavayoù phalam//

2.57a svapätonäd grahäj jévä çéghräd bhågujasaumyayoù/
2.57b vikñepaghny antyakarëäptä vikñepas trijyayä vidhoù//

2.58a vikñepäpakramaikatve kräntir vikñepasa à yutä/
2.58b digbhede viyutä spañöä bhäskarasya yathägatä//

To the nodes of Mars, Saturn, and Jupiter, the equation of the conjunction is to be applied, as to the planets themselves respectively; to those of Mercury and Venus, the equation of the apsis, as found by the third process, in the contrary direction. The sine of the arc found by subtracting the place of the node from that of the planet – or, in the case of Venus and Mercury, from that of the conjunction – being multiplied by the extreme latitude, and divided by the last hypotenuse – or, in the case of the Moon, by Radius – gives the latitude (vikshepa). When the latitude and declination (apakrama) are of like direction, the declination (kranti) is increased by the latitude; when of different direction, it is diminished by it, to find the true (spashta) declination: that of the Sun remains as already determined.

2.59a grahodayapräëahatä khakhäñöaikoddhåtä gatiù/
2.59b cakräsavo labdhayutä svähoräträsavaù småtäù//

Multiply the daily motion of a planet by the time of rising of the sign in which it is, and divide by eighteen hundred; the quotient add to, or subtract from, the number of respirations in a revolution: the result is the number of respirations in the day and night of that planet.

2.60a kränteù kramotkrammajye dve kåtvä tatrotkramajyayä/
2.60b hénä trijyä dinavyäsadalaà taddakñiëottaram//

Calculate the sine and versed sine of declination: then radius, diminished by the versed sine, is the day-radius: it is either south, or north.

2.61a kräntijyä viñuvadbhäghné kñitijyä dvädaçoddhåtä/
2.61b trijyäguëähoräträrdhakarëäptä carajäsavaù//

2.62a tatkärmukam udakkräntau *dhanaçané påthaksthite/(2. dhanahäné)
2.62b svähorätracaturbhäge dinarätridale småte//

2.63a yämyakräntau viparyaste dviguëe tu dinakñape/
2.63b vikñepayuktonitayä kräntyä bhänäm api svake//

Multiply the sine of declination by the equinoctial shadow, and divide by twelve; the result is the Earth-sine (kshhitjya); this, multiplied by radius and divided by the day-radius, gives the sine of ascensional difference (cara): the number of respirations due to the ascensional difference is shown by the corresponding arc. Add these to, and subtract them from, the fourth part of the corresponding day and night, and the sum and remainder are, when declination is north, the half-day and half-night; when declination is south, the reverse; these, multiplied by two, are the day and night. The day and the night of the asterisms (bha) may be found in like manner, by means of their declination, increased or decreased by their latitude.

2.64a bhabhogo +añöaçatéliptäù khäçviçailäs tathä titheù/
2.64b grahaliptäbhabhogäptä bhäni bhuktyä dinädikam//

The portion (bhoga) of an asterism (bha) is 800 minutes; of a lunar day (tithi), in like manner, 720. If the longitude of a planet, in minutes, be divided by the portion of an asterism, the result is its position in asterisms: by means of the daily motion are found the days, etc.

2.65a ravénduyogaliptäbhyo yogä bhabhogabhäjitäù/
2.65b gatä gamyäç ca ñaño̊ighnyo bhuktiyogäptanäòikäù//

From the number of minutes in the sum of the longitudes of the Sun and Moon are found the yogas, by dividing that sum by the portion (bhoga) of an asterism. Multiply the minutes past and to come for the current yoga by sixty, and divide by the sum of the daily motion of the two planets: the result is the time in nadis.

2.66a arkonacandraliptäbhyas tithayo bhogabhäjitäù/
2.66b gatä gamyäç ca ñaño̊ighnyo näòyo bhuktyantaroddhåtäù//

From the number of minutes in the longitude of the Moon diminished by that of the Sun are found the lunar days (tithis), by dividing the difference by the portion (bhoga) of a lunar day. Multiply the minutes past and to come of the current lunar day by sixty, and divide by the difference of the daily motion of the two planets: the result is their time in nadis.

2.67a dhruväëi çakunir nägaà tåtéyaà tu catuñpadam/
2.67b kiàstughnaà tu caturdaçyäù kåñëäyäç cäparärdhataù//

2.68a bavädéni tataù sapta caräkhyakaraëäni ca/
2.68b mäse +año̊akåtva ekaikaà karaëänäà pravartate//

2.69a tithyardhabhogaà sarveñäà karaëänäà prakalpayet/
2.69b eñä sphutagatiù proktä süryädénäà khacäriëäm//

The fixed (dhruva) karanas, namely Sakuni, Naga, catushpada the third, and Kinstughna, are counted from the latter half of the fourteenth day of the dark half-month. After these, the karanas are called moveable (cara), namely Bava, etc., seven of them: each of these karanas occurs eight times in a month. Half the portion (bhoga) of a lunar day is established as that of the karanas. Thus has been declared the corrected (sphuta) motion of the Sun and the other planets.