Mss. Madrid 9605, Munich 6364, and the evolution of two plinian astronomical diagrams in the tenth century (*)

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In 1955 A. Cordoliani described in great detail the contents of the computistical manuscript Madrid BN 9605 (1). Written in 1026 or later (2), the manuscript shows signs of a Spanish hand (3), but it is not known what materials the scribe had before him when he wrote his composite text. While Cordoliani's description is rather full, the text and diagrams on folio 12 are mentioned in only the briefest manner and not with sufficient precision. Folio 12r. has an abbreviated form of the astronomical excerpt from Pliny's *Natural History,* describing planetary apsides, followed by a peculiar version of a medieval diagram (Figure 1) developed to accompany the Plinian excerpt (4). Folio 12v. (upper part) contains an unusual form of a medieval diagram invented to show the latitudes of the planets according to Pliny (Figure 2), although there is no text to accompany the diagram here or elsewhere in the manuscript (5). The lower part of folio 12v. contains a decorative and symmetrical design of carefully interlaced circles, which are rectangularly tangent

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(1) CORDOLIANI, A (1955), Un autre manuscrit de comput ecclesiastique mal connu de la Bibliothèque Nationale de Madrid, *Revista de Archivos, Bibliotecas y Museos, 61,* 435-481.

(2) *Ibid.,* 436-7; this year may have been inserted by the scribe of this ms., or the year may have existed as a modification in his source.

(3) *Ibid.,* p. 441.

(4) *Ibid.,* p. 439, n. 11, describes this diagram as «une roue des trajectoires planétaires».

(5) *Ibid.,* p. 439, describes this as «un tableau en plan des trajectoires des planètes».

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and diagonally overlapping; the areas of overlap have the zodiacal names in proper sequence diagonally from upper left to lower right. The only purpose for this design is to list in order and in a attractive form the twelve signs of the zodiac (6). This last design is of no relevance for the Plinian diagrams. The two Plinian astronomical designs are very close to the apsidal (Figure 3) and latitude (Figure 4) diagrams in the Munich ms. CLM 6364, and the Madrid and Munich manuscripts together show an essential stage in the evolution of each of these two types of Plinian astronomical diagram. In addition, the Madrid diagrams derive from south German (and/or Swiss) innovations and were very probably copied from a South German or Swiss manuscript such as the Munich manuscript.

CLM 6364, a manuscript of 24 folia, has had all but its last leaves dated to the tenth century, while there is some difference of opinion about ff. 23-24, which have been dated to the eleventh century (7). This latter dating does not stand examination, since the hand of ff. 23-24, with the Plinian excerpts and diagrams, has all the characteristics of the hand of the previous folia. Aside from the general similarities of these regular, upright minuscule pages, I find that the symbol for the genetive plural ending «rum», the superscript symbol for third person singular passive «ur», the abbreviation for «pro», and the formation of «g» are among the significant identities across ff. 23-24 and the preceding leaves. There are, in fact, no significant differences except for a shift, which is gradual, in the number of lines per page from folio 22v. to 24. The whole manuscript is by the same hand and is from the later tenth century.

Folio 23v., 3-22, contains a complete text of the first of four common Plinian astronomical excerpts, «De positione et cursu septem planetarum», untitled in CLM 6364 (8). Following the excerpt appears one of two standard forms of diagram illustrating this text, a horizontal series of seven separate and equal circles, each with the name of a planet (in Plinian/Ptolemaic order) (9). Folio 23v., 23-29, contains a complete

(6) This design can be found in computistical tracts as a simple calendrical schema, *inter alia* its insertion into Bede's *De temporum ratione* in Cambridge Univ., St. John's ms. I, 15 (221), f. 55r. (s. XII).

(7) RÜCK, K. (1888), *Auszüge aus der Naturgeschichte des C. Plinius Secundus in einem astronomisch-komputistischen Sammelwerke des achten Jahrhunderts, Programm des Königlichen Ludwigs-Gymnasiums 1887/1888.* Munich, F. Straub, pp. 13-14, dates ff. 23-24 to s. XI and the rest to s. X, citing his agreement in these dates with the edition of Ludwig von Jan (1848), *Macrobii Ambrosii Theodosii Commentarii in Ciceronis Somnium Scipionis.* Quedlinburg, G. Bassius, pp. lxiv *sqq.*

(8) RÜCK, K. (1888), *op. cit.,* pp. 34-36, gives the text.

(9) The other standard form of diagram for this excerpt is a set of seven concentric planetary circles around the earth.

text, also untitled, of the second common excerpt, «De intervallis earum», presenting the harmonic intervals from earth to the fixed stars (10). Here again there follows one of two standard illustrations for the excerpt, which runs to the bottom of the page in tandem with the text of the third excerpt. The illustration for intervals is simply a vertical list of planetary names with the appropriate harmonic intervals written in between (11). At the bottom of folio 23v., line 29, begins the third of the commonly linked Plinian excerpts, which is the only one found in Madrid 9605. «De absidibus earum» is so titled in CLM 6364 and takes the final 16 lines of f. 23v. and all 19 lines given to text on f. 24r. (12). The same excerpt in Madrid 9605, f. 12r., has the title given, omits the first 31 lines according to Rück's edition, and begins with «Absida grecum est quod est latine circulus» instead of «Absides autem dicuntur circuli earum greco vocabulo», given in CLM 6364 and Rück's edition (13). Madrid 9605 and CLM 6364 have much the same text thereafter to the end of the excerpt (14).

Below the excerpt for planetary apsides there appears in each of the two manuscripts an apsidal diagram occupying the remaining two-thirds of the page. The basic purpose of these and all other Plinian apsidal diagrams is to identify the zodiacal sign under which each planet has its apogee, or far point from the earth (15). The text very simply and directly lists six planets and the signs for *absis,* or apogee; the moon is considered concentric to the earth and therefore without an apogee. There are two basic approaches to diagramming this text. One, which appeared earlier, is far more widespread, and is not used in our two manuscripts, is to show all twelve zodiacal signs in natural order and to show (and label) an eccentric circle with properly placed apogee for each of the six planets (16). The other approach starts with the natural zodiac

(10) RÜCK, K. (1888), *op. cit.,* pp. 36-37, gives the text.

(11) The alternative standard illustration is a set of concentric planetary circles with the harmonic intervals written in the intervening spaces.

(12) Text in RÜCK, K. (1888), *op. cit.,* pp. 37-40.

(13) *Ibid.,* p. 39, line 10, except for the erroneous spelling «eorum» instead of «earum» in CLM 6364.

(14) The only significant variants between the Madrid (M) text and the Munich (C) text here are (a) «is» in M, «his» in C, at Rück 39, II; (b) «necesse» in M, «maiores» in C, at Rück 40, 4. M and C share a variant reading peculiar to many mss. of south German/Swiss derivation, the omission of «terrae» at Rück 39, 16.

(15) Pliny's *Naturalis Historia,* II, 63-65, ed. Jean Beaujeu (Paris: Les Belles Lettres, 1950), pp. 27-28, gives three different uses for «absis», and the sense of apogee is present, but not simply and exclusively, in one of the three. The obscurity and ambiguity of Pliny's usage does not survive in the excerpt current in the 9th-11th centuries, which suggests only apogee.

(16) This type of apsidal diagram, using the complete, natural zodiac, appears, for examples, in Baltimore Walters 10.73, f. 5r.; Bern 347, f. 24r.; Erfurt Amplon. Q. 8, f. 1r.; Florence

and then eliminates the six signs under which no planetary apogee is supposed to occur. This leaves a circular design still having twelve segments but with six segments lacking zodiacal signs, since the six are irrelevant to the special concern of the apsidal text and diagram.

At this point an interesting process begins, a process of rearranging the six remaining zodiacal signs solely in the interest of visual symmetry. This rearrangement of zodiacal signs, which will, of course, carry with them the labeled apogees of the planets, occurs in various ways but within certain limits. From the extant apsidal diagrams which I have been able to locate (17), some basic rules emerge, and a few stages in the evolution of the rearranged apsidal diagram become clear. The initial stage, after removal of six zodiacal signs, is still a naturally ordered zodiac, but there seems to be no example of this form any longer in existence. All examples I have been able to find proceed beyond the initial pattern, beginning the rearrangement by first shifting Gemini so that it opposes and balances Scorpius. The interval Virgo —blank space— Scorpius is never changed as reordering develops. If Leo and Virgo are separated (by one space), Sagittarius and Capricorn are always separated. Capricorn and Sagittarius may be placed in various ways, but within strict limits and always in the interest of symmetry of the diagram.

Given the rules based on the nine discovered examples of reordered zodiacs in apsidal diagrams, we can now classify these designs. They fall into two major groups with a minor third group. Five of the diagrams are the same type. In CLM 14436, Zürich Car. C. 122, Bodleian D'Orville 95 (palimpsest), Vat. Palat. 1577, and Bern 265 (18), there are reordered zodiacs which distribute the six signs at equal intervals and in the same zodiacal sections, assuming a constant orientation of the pages on which they are drafted (19). According to a twelve-hour clock, the signs come as follows: Virgo at 1, Leo at 3, Gemini at 5, Capricorn at 7, Sagittarius at 9, Scorpius at 11. When these are read in counter-clockwise

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Laur. Plut. 51.14, f. 73r.; Leiden Voss. Q. 79, f. 93v. (the original for which I have dated to A.D. 579); Madrid 3307, f. 65v.; Oxford Bodl. Canon. class. lat. 279, f. 33v.; Paris 5239, f. 125v.; Paris n.a.l. 1615, f. 160v. Many more examples can be cited.

(17) I have found a total of nine, including the two focused on in this study. The other seven are: Zürich ZB ms. Car. C. 122, f. 41v.; Vat. Palat. 1577, f. 81v.; St. Gallen 250, p. 23; Oxford Bodl. D'Orville 95, f. 31r. (palimpsest); CLM 14436, f. 60v.; CLM 6362, f. 74v.; Bern 265, f. 58v. Of the nine, six have been shown to be south German or Swiss, and only the Madrid ms. has been shown not to be.

(18) See above, n. 17, for exact pages in these mss.

(19) On the basis of placements and sizes of the planetary circles in the designs (and other factors for the Bodleian palimpsest), these five examples subdivide into two groups: 1) CLM 14436, Zürich Car. C. 122, Bodleian D'Orville 95; 2) Vat. Palat. 1577, Bern 265.

directions, we can see that the zodiacal signs still have the natural sequence, even though the intervals, and therefore the order, are unnatural. From the surviving examples it seems that the reordered zodiac was supposed to retain the natural sequence of the six signs, which places another limit on the possible amount of reordering in such a design. This group of five diagrams represents the final stage of development for the reordered zodiacs.

Another, minor group of reordered zodiacs appears in CLM 6362 and Sankt Gallen 250. Here the above rules still apply, but a special problem arises with the introduction of a seventh zodiacal sign and a seventh eccentric planetary circle in order to introduce an apogee for the moon. Although the historical path leading to this new element is indirect, the desire to give an apogee to the moon derives ultimately from a confusion of two contiguous texts in Pliny's *Natural History,* one of which gives the *absides* we are considering, the other of which gives astrological *absides* (definitely not to be confused with apogees), and the moon is said to have its astrological *absis* in Taurus (20). Because seven zodiacal signs do not permit any easy symmetry when distributed over the twelve spaces available, this special version of the reordered zodiacal pattern does not fit so clearly into one or another stage in the evolution of the apsidal diagrams.

With no examples of the primitive stage for the diagrams' evolution, we have five examples of the fully evolved pattern and two examples of an offshoot or irregular type. We are left with only two more examples, Madrid 9605 and CLM 6364, which show us something about the intermediate stage(s) of development and more about themselves as well. Each of these two diagrams contains an unexpected peculiarity. The Madrid example has the two signs Capricorn and Sagittarius in improper, reversed sequence, but the rationale for this apparently unique pattern seems to be a desire to distribute the planets around the diagram (counter-clockwise) according to the Plinian/Ptolemaic ascending sequence of planets. This planetary sequence cannot be achieved with Capricorn and Sagittarius in their proper sequence. The Munich

(20) Pliny, *N. H.,* II 65 (ed. Beaujeu, p. 28). The medieval diagrams including a lunar apogee in Taurus do not necessarily correspond to the text in the ms. In CLM 6362, f. 74v., is the diagram with apogee in Taurus; on f. 75v. in the text of «De absidibus earum» there is no mention of a lunar apogee at all. In St. Gallen 250, p. 23, is the diagram with lunar apogee; there is no accompanying Plinian text at all, but on p. 129, an outer marginal gloss at line 5 adds «lune in tauro» to the list of planetary apsides in Bede's *De natura rerum,* c. 15 (De absidibus earum), which is taken from Pliny's description of the same subject.

example retains the proper zodiacal sequence but has the two planets Mercury and Venus in the same sequence as the Madrid design. That is, the apsidal labels for Mercury and Venus in the Munich manuscript have been erroneously reversed. However, this error arouses some suspicions, because it coincides with the placing of planetary labels in the Madrid manuscript, where zodiacal signs have been reversed instead. The Madrid diagram breaks the apparent rules for reordering the zodiac but assigns the planetary apsides correctly to their signs. The Munich diagram stays within the limits for reordering the zodiac but assigns the planetary apsides incorrectly. The two are clearly related —by at least one common and unusual omission in the text on apsides, by the curious inverse relationship of the error impropriety in the apsidal diagram, and, as we shall see, even more by the striking similarities in their unusual version of the Plinian latitude diagram. We can close the gap between the two manuscripts further and argue that there is good reason to assume the Madrid manuscript diagram was copied either from the Munich manuscript or from one with an identical diagram. The likely reason for the Capricorn-Sagittarius reversal is our clue to this connection of the diagrams. If the reordered zodiac is a south German invention, its rationale is not likely to have been transparent to a scribe working and/or trained elsewhere. When a design like the Munich apsidal diagram came before the scribe for the Madrid manuscript, he would have been confronted with two apparently irreconcilable choices. As drawn, the Munich diagram presents *both* the zodiacal names and the planetary names in their natural sequences when read counter-clockwise. However, the scribe knew, if he had considered the text, that one and only one of the sequences could be correct, for Mercury should follow Venus in order to show those apogees correctly, *or* Sagittarius should follow Capricorn in order to connect those zodiacal signs properly with their planetary apogees. If the scribe, apparently a Spanish (Spanish-trained?) scribe, did not know the rules followed in creating the reordered zodiac, he would have seen more disorder in the zodiacal sequence before him than in the planetary sequence. That is, the zodiac in CLM 6364 has remarkably unnatural intervals, while the intervals in the planetary sequence are strictly dependent and of no concern in an apsidal diagram. The question which probably occurred in the mind of the Spanish scribe, much more conscious of correct detail than his model, was, «Since the zodiac must be disordered to achieve symmetry, can I not retain the natural planetary sequence and reverse the positions of Capricorn and Sagittarius?» I suggest that the scribe for the Madrid diagram asked himself such a question, answered it affirmatively, and proceeded to produce a much more satisfactory design symmetry than his model offered. He also happened to contravene one of the limits of

the south German invention, because he was uninstructed in those intended limits...

The common features, all significant, in the Madrid and Munich apsidal diagrams are these: 1) identical placement of the four zodiacal signs Gemini, Leo, Virgo, Scorpius; 2) a central circle for the earth not cut by the radial lines of the design; 3) a concentric circle cutting the radial lines and representing the moon; 4) use of apsidal, eccentric circles all having the same radius throughout the diagrams; 5) placement of the perigee (point nearest the center) of each planetary circle between the two concentric circles for earth and moon; 6) placement of the geometrical apogees of the planets on the radial lines for the signs rather than in the centers of the signs, as was far more commonly done. This last similarity is, however, not perfectly observed, for the Munich diagram does so with only five of the six planets, placing Jupiter's apogee in the center of its sign.

The differences between the two apsidal diagrams, aside from the placing of Capricorn, Sagittarius, and their planetary apsides, which we have already considered, are apparently minor, yet interesting and characteristic. The Madrid design is so close to a fully symmetrical layout that we may wonder why the copyist or designer did not move «Leo» and «absis martis» one sign towards Gemini, for such a move would have completed the symmetry. As it is, there is full symmetry of the apsidal circles themselves, disregarding the positions of the names. The six apsidal circles are arranged so that the apogee of each falls directly on a radial line, with the centers of these equal apsidal circles being equidistant from the center of the whole diagram. Thus *every* intersection of each apsidal circle with every other apsidal circle takes place (or is meant to) on one of the equally spaced radii making up the basic diagram. Actually, of the thirty such intersections, five occur just far enough away from a radius to produce an uninked space between the radius and the intersection of the two circles. The concentric lunar circle also takes part in this symmetry of intersection points, for the lunar circle is made the right size to intersect with the intermediate of the three intersection points occurring on every alternate radius. The overall effect of this design is to produce regularly spaced sets of both central and eccentric almonds, or leaves, formed by the intersections of the planetary circles. While this effect suggests a decline of interest in simple and straightforward presentation of astronomical information, the design corresponds with an increasing interest in geometrical symmetry as found in church architecture and windows. Such twelfth-century creations as the rose window in the romanesque cathedral at Troia in Apulia show a similar sense of design symmetry.

Unlike the Madrid pattern, the Munich diagram, which does contain some of the same elements of construction, makes no serious attempt to present an impression of complete symmetry. While the planetary circles are equal in size, their centers are not equidistant from the center of the diagram and they are not all arranged so that apogees (and perigees) fall on the radii. The general impression is not one of geometrical symmetry or anything approaching that, but rather a general and inexact sense of balance. The six zodiacal signs with absides are spaced something like the outline of a bird in flight or a cross. The designer (or the copyist) of the Munich pattern shows a less developed sense of the possibilities for symmetry in his design. One final difference should be noted, the presence of a seventh, unlabeled eccentric circle in the Munich diagram. We might suppose that it is the result of an error —a misplaced circle which was left rather than eradicated, since the diagram shows other signs of error and carelessness. However, we may suspect more, because the extra circle is placed so that its apogee comes just before Gemini and on the radius at six o'clock. Such a circle is well placed to be labeled as the *absis* of the moon, for Taurus is the zodiacal sign just before Gemini. This suggests, perhaps, an additional closeness between CLM 6364 and the two previously discussed diagrams with a labeled lunar apogee, in CLM 6362 and St. Gallen 250. However, the diagram alone is inconclusive in the absence of labels in CLM 6364; the extra circle may indeed be an abandoned first attempt for the sun's apsidal circle, which is next to it.

The apsidal diagrams in Madrid 9605 and CLM 6364 are alone in showing an intermediate stage in development of such diagrams with reordered zodiacs. Various similarities reinforce the conclusion that they are both from the same tradition and that the Madrid diagram was most likely developed from the pattern of the Munich diagram. How many manuscripts, if any, may have intervened is unknown. The background tradition, the south German development of the reordered zodiac for diagramming apsides, is clearly as much a part of the Madrid figure as of the Munich figure.

The Plinian diagrams for planetary latitudes exist in two general types, with each of these types having many variants. The earlier form of latitude diagram is the circular pattern, in which the twelve degrees of zodiacal latitude are represented by thirteen concentric circles. The planets are shown on this zodiacal band by eccentric circles, which present the maximal latitudes for the planets (21). Before the end of the

(21) This circular pattern for planetary latitudes can be found in Paris n.a.l. 1615, f. 161r. (s. IX[1]); Madrid 3307, f. 66r. (s. IX m.); and Bern 347, f. 25r. (s. IX[2]).

ninth century there appears the second type (22), a rectangular grid on which the latitudes of the planets are shown by the vertical number of spaces above and below the central line of thirteen horizontals. The twelve vertical spaces, or degrees, are set against thirty horizontal spaces, giving a total of 360 squares in the grid. However, the horizontal axis of this grid seems to mean only time or space in general. The 30 spaces may indicate either a month or a sign of the zodiac, but the horizontal divisions are never labeled. Labels appear on this axis only in the later pattern, where twelve horizontal divisions replace the thirty and are labeled for the zodiacal signs (23).

The rectangular grid diagrams found in Madrid 9605, f. 12v. (Fig. 2) and CLM 6364, f. 24v. (Fig. 4) are the only two I have found which cannot be classified with either the early or the later, zodiacally labeled, latitude grids. These two manuscript diagrams clearly establish and, at present, constitute an intermediate class of grid patterns. They use a grid of 12 x 24 and set down planetary zig-zag paths intended to be fully symmetrical with each other across the grid. While the planets are named at the left side, a commonplace for latitude diagrams, the horizontal divisions receive no label.

Madrid 9605 carries no text for the planetary latitudes, while CLM 6364 does. Neither of these two manuscript diagrams follows the Plinian text in any case. CLM 6364 presents an incomplete text of the latitude diagram, omitting the 2° found in Pliny's text for the sun and making no mention of Saturn at all (24). The diagram below includes a path for Saturn, the third planetary line down from the top in this as in many Plinian latitude diagrams, though the planet's name has been worn away by use. The sun's name is entered at the left, but no path is drawn. This does not fit with the text presented, for it mentioned a «sinuous serpentine path», despite the omission of the amplitude of this path. In fact, other paths, given canonically in the Munich manuscript text, are also represented divergently in the zig-zag diagram. Venus is supposed to exceed the grid by one degree above and below, but there is no attempt to show this in the figure. Mercury has 8° in the text, 7° in the

(22) The earliest known examples appear in: Bern 347, f. 24v., immediately before a version of the circular latitude diagram (It is not common to find both forms in the same ms.); Vat. Regin. 1573, f. 52r.

(23) Known by the 11th century, examples are Cambridge Trin. R. 15.32, f. 4v., and Oxford, St. John's 17, f. 38r. The St. John's diagram appears to derive immediately from the Trinity College ms.

(24) CLM 6364, f. 24v., 6-7, reads «... Sol deinde medio fertur flexuoso draconum meatu inequalis... Iovis media et supra eam duabus. Tres superiores...» *Cf.* ed. RÜCK, K. (1888), *op. cit.*, p. 41, 4-7.

design. Mars has 4° in the text, 6° in the diagram. Jupiter is given 3° by the text, 6° according to the diagram. Only the moon has the same latitude in both text and diagram. The obvious conclusion, especially when we find a latitude for Saturn in the figure but not in the text at all, is that the Munich diagram was either copied directly from or modified on the basis of another diagram. This is hardly surprising, and it must, of course, be assumed for the Madrid diagram.

The copyist for the Madrid figure continues to demonstrate in the latitude diagram the same goal observed in his version of the apsidal diagram —thoroughgoing visual symmetry. Like the Munich diagram, the Madrid latitude diagram begins the six planetary courses at lines 1, 3, 5, 9, 11, 13 of the thirteen horizontals. The Madrid copyist, however, was more consistent in drawing the full planetary courses across the grid. He preserved the vertical separation of two spaces between the lines in each group of three planets as they interwove from the left to the right side. He took great care to insure that each planetary line intersected grid lines only at their own intersections. He then highlighted the symmetry of the intersection points by placing a large dot at every, or almost every, such point. Of the 112 possible intersection points of the planetary lines the scribe failed to place an emphasizing dot at only 15. Thus his two pairs of three lines each seem to interlace almost like woven threads, creating a very concrete visual effect, despite the abstract nature of the diagram as a representation and the erroneous character of its informative content. By contrast, the copyist for the Munich example placed his planetary lines without concern for their exact intersections with the grid. Because his grid spaces are more irregular than the Madrid copy, the Munich manuscript scribe maintained parallelism of the planets' paths only by allowing the paths of Mercury and Saturn to travel almost a full space too far on their two downward runs. Likewise he did not carry the upper, middle peaks of the Mercury and Saturn lines quites as far as he should have; each of these two planets peaks about a half space below its proper apex. Even the final peak for Jupiter is a bit too low.

There is no reason not to assume that the copyist for the Munich diagram was aiming for complete symmetry, but he clearly failed in many details. Yet he was close enough for us to see that his goal was the same as that of the Madrid diagram, and these two latitude diagrams are intimately connected. Given the closeness of the pair of diagrams in each manuscript with the other, I am tempted to say that the copyist had the Munich diagrams before him and improved on their obvious faults. However, the lack of further similarities makes such a conclusion

hazardous. More probably, both Madrid 9605 and CLM 6364 have Plinian diagrams taken from a common model, which has now disappeared.

The apsidal diagrams in these manuscripts represent a transitional phase, not yet achieving the more balanced distribution of examples like CLM 14436 and Zürich Car. C. 122. Likewise the latitude diagrams appear to be transitional, but their symmetry, at least in the more careful example of the Spanish copy, can hardly be improved. Rather than presaging further symmetry, the latitude diagrams seem to have been moving towards a more explicit and simpler pattern. The shifts are from a grid of 12 x 30 to one of 12 x 24 to a later design of 12 vertical, zodiacal columns with or without 12 horizontal bands for the width of the zodiac. These successive changes do not show any increase in precision, but they do show a move from an unlabeled to a labeled horizontal axis. However, at no stage in the development can these grids be called graphs, because there is no consistency of units in the horizontal direction. The moon's period is a month; Saturn's period is thirty years; two Saturnian periods are set with the same horizontal span as one lunar period. Other planets present similar contradictions. The *relationship* between longitudinal and latitudinal dimensions seems not even to be attempted in these grids, and a modern may well wonder how the relationship was conceived by the designers of these Plinian diagrams. If the diagrams be taken alone as evidence, we can say that there was no understanding of how to represent the relationship of longitude to latitude. It is possible that the relationship not only was not represented but was not conceived; instead, either latitude or longitude was to be presented separately. However, we do not have adequate evidence for the latter, more extreme, suggestion.

Concluding briefly, we can say that the Plinian astronomical diagrams in Madrid 9605, when compared with and explained in conjunction with the virtually identical designs in CLM 6364, show both the roots and the rationales for the types of the two diagrams. The Madrid figures derive from south German (or Swiss) models like those in the Munich manuscript. Both manuscripts show that the diagrams are evolving in specific directions, and the emphasis on symmetry in this intermediate stage is realized much better by the Spanish than by the German copyist. In the case of the apsidal diagrams the evolution is towards equal distribution of apsides in a reordered zodiac, a more abstract pattern than the original conception of Plinian apsidal diagrams. In the case of latitude diagrams the evolution is towards simpler and more explicit designs. In neither case is there an apparent increase

in exactness (considering the text referred to) or attention to empirical evidence. What the Madrid diagrams show, along with the Munich examples, is the evolution itself in the Plinian astronomical diagrams.

Figure 1.—*Madrid BN ms. 9605*, f. 12r.

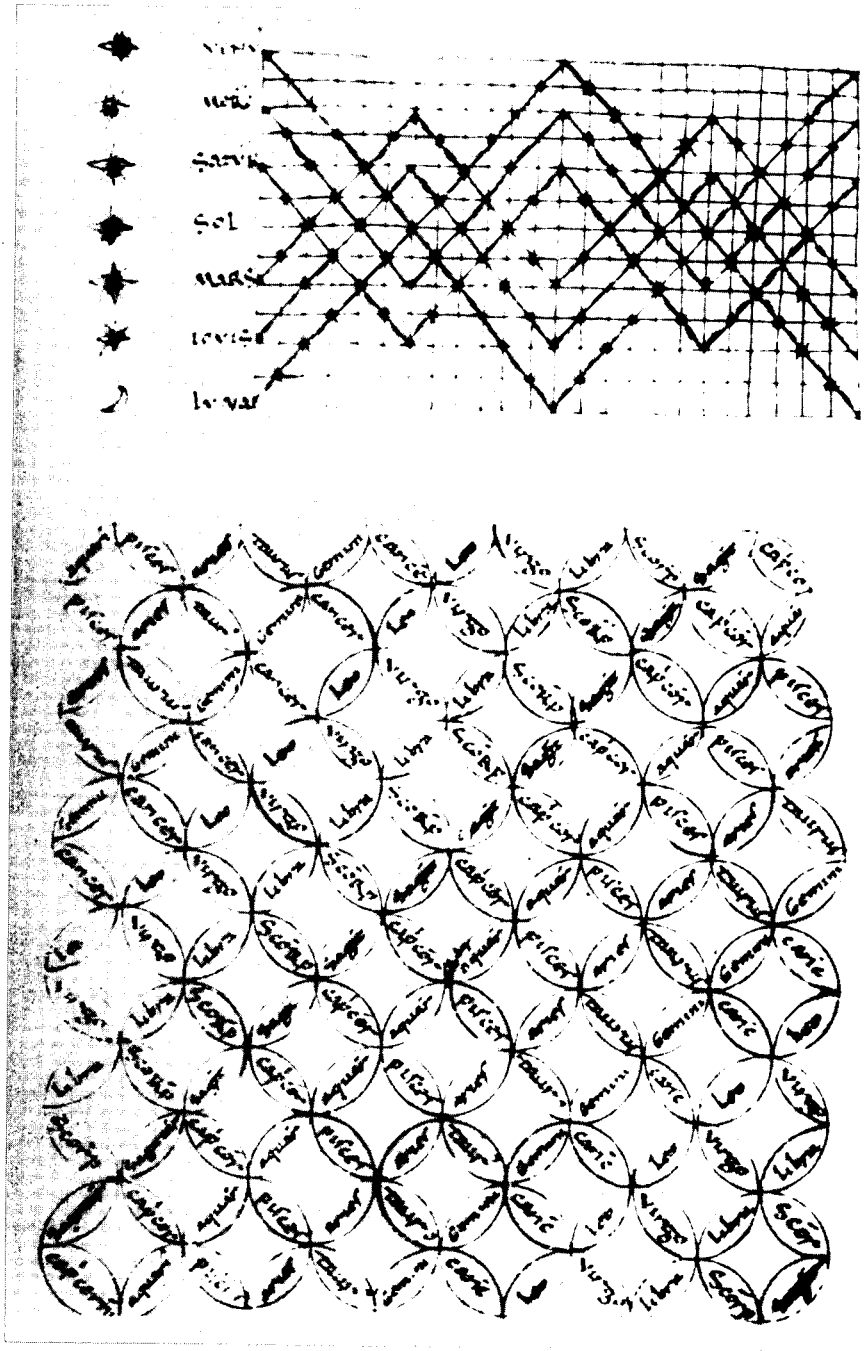

Figure 2.—*Madrid BN ms. 9605,* f. 12v.

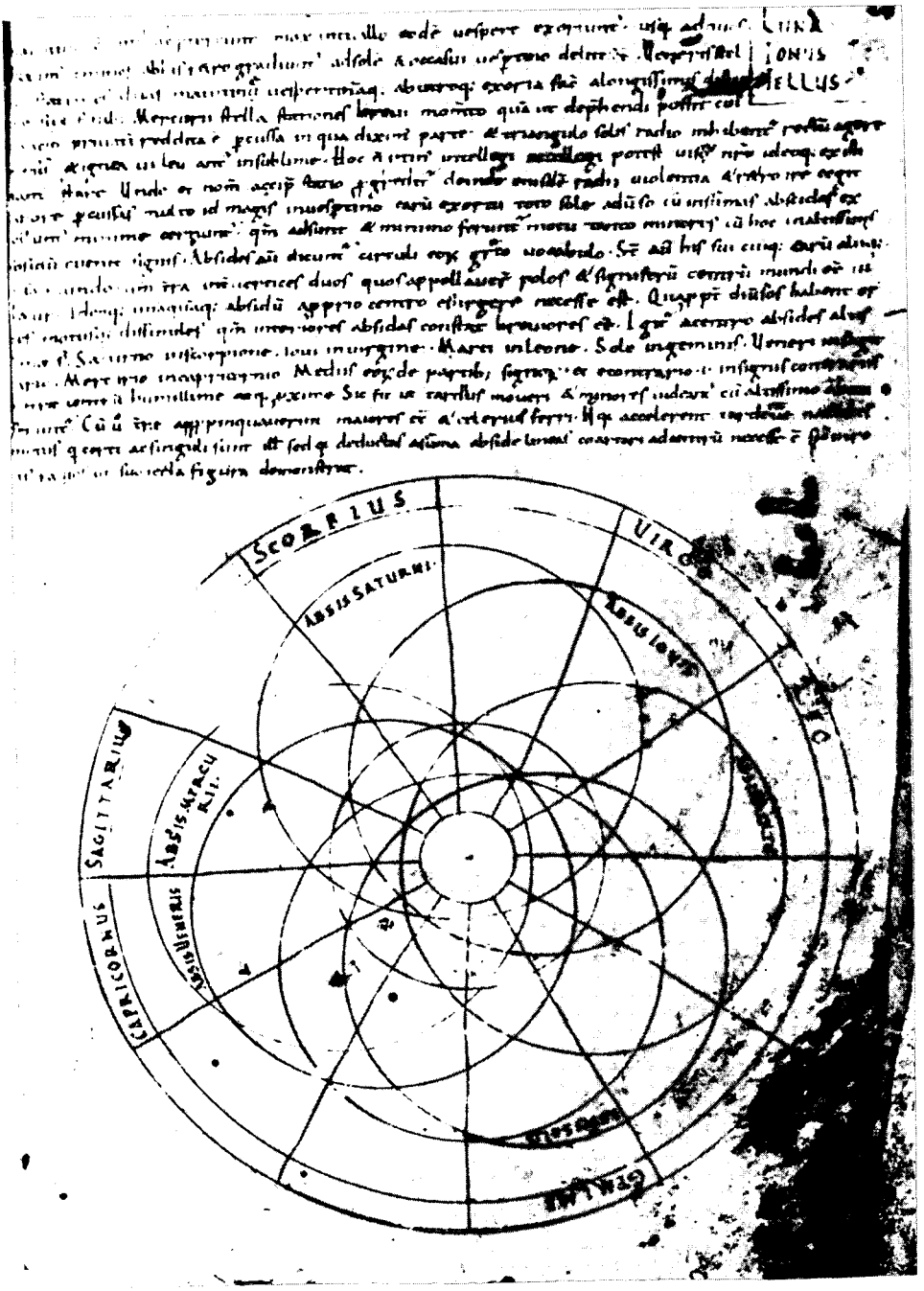

Figure 3.—*Munich CLM 6364*, f. 24r.

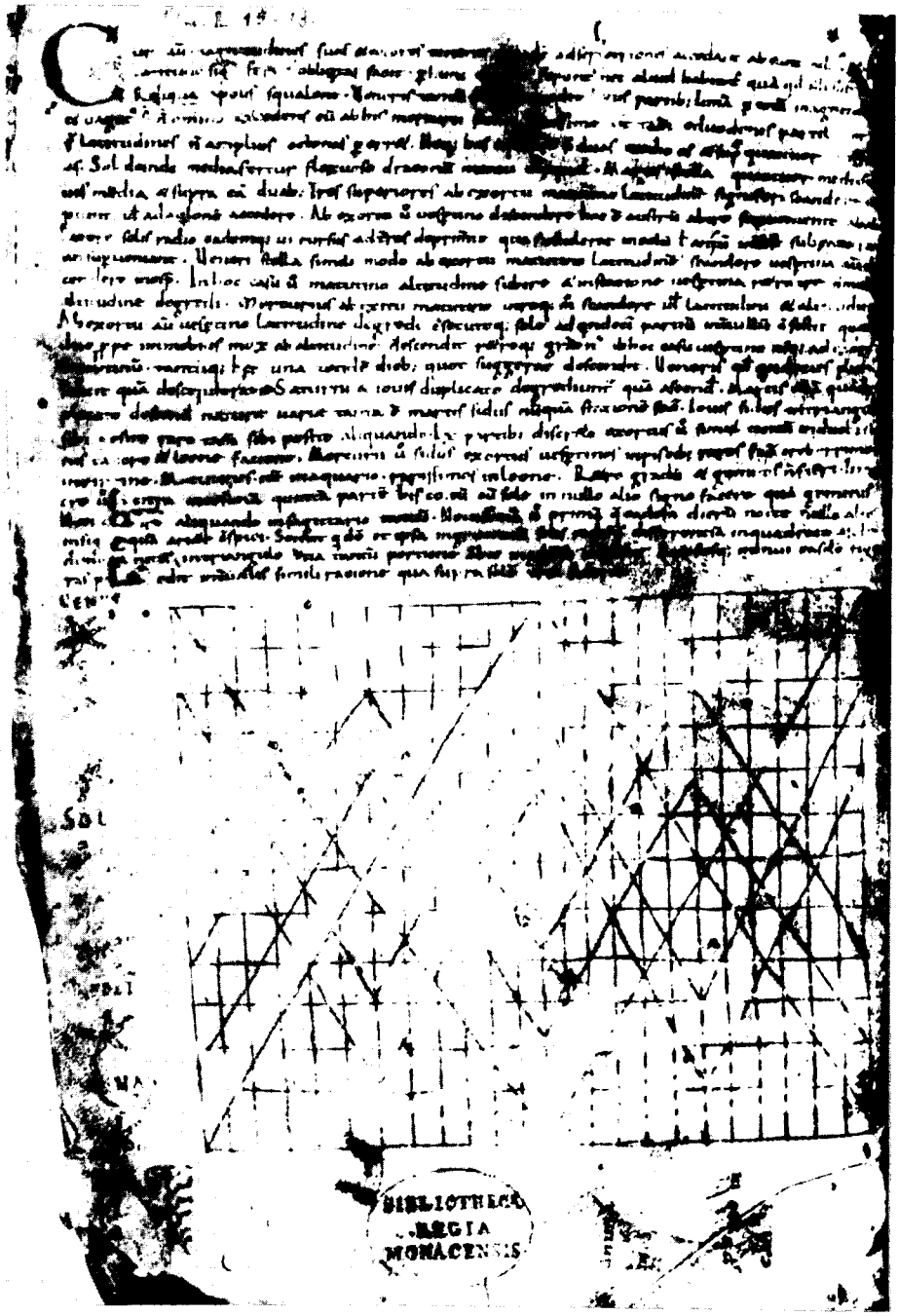

Figure 4.—*Munich CLM 6364*, f. 24v.