The Longitudes of Winchester

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The cathedral city of Winchester, not far from the south coast of England, is on the site of a Roman town, Venta Belgarum. Its key position on the network of Roman roads meant that it kept its importance, and under Saxon bishops and king Alfred the Great it became not only a commercial centre but a centre of learning. It was adopted by the Danish king Canute as the seat of his govern-ment—he ruled from 1016 to 1035—and it was of especial value to the Norman kings after the Conquest of 1066, since from the port of Southampton, about 20 km away, they had easy access to their possessions in Normandy. As a centre of learning, astronomy and astrology were certainly practised there. We know of two astronomers who prepared astronomical tables with a Winchester connection, the first being Petrus Alfonsi who died perhaps after 1116 and who was responsible for a redaction of the tables of al-Khwārizmī, and the second Abraham Ibn Ezra (ca. 1090-ca. 1167). Charles Burnett has recently identified another astronomer, by the name of ᶜAbd al-Masīh—conjectured on the basis of an "Ebdelmessie" who is named in the explicits of the four completed books of a partial translation of Ptolemy's *Almagest*.[1] In view of his familiarity with members of the Norman royal house, Adelard of Bath might also have worked there.

   Any astronomer who wishes to establish planetary tables firmly on the basis of tables meant for another place needs to know the difference in longitude between the two centres. Determining longitude was no easy matter, but given the existence of a continuing astronomical tradition in any place one might expect a measure of consistency, if not of truth. The account that follows is a sorry morass of historical inconsistencies, into which I shall attempt to intoduce a measure of order.

   My starting point is a statement made in an English-language manuscript from a much later period. MS 384 of the Royal College of Physicians in London was penned near the very end of the fifteenth century at an unknown place. About a quarter of its material is in Latin and the rest is in English, although largely in the form of translations from the Latin, which in many cases come in turn from Arabic. Item 21 in the catalogue by Neil Ker should perhaps be divided into two parts.[2] The first opens with the words "As I had loked and seyn of [here is a blank space for 2 or 3 words] of planetis I fonde Mercurie havinge many dignites in the asc[endent]..." and is a summary account of the conse-

> Winchester is 19°W.
> Perhaps a tradition
> predating
> Abraham Ibn Ezra.

1 C. Burnett, "ᶜAbd al-Masīh of Winchester", in L. Nauta and A. Vanderjagt (eds), *Between Demonstra-tion and Imagination: Essays in the History of Science and Philosophy* (Leiden, 1999), pp. 159-169.
2 N. R. Ker, *Medieval Manuscripts in British Libraries, I: London* (Oxford, 1969), pp. 212-15.

quences of various types of astrological configuration, especially those in which a planet is in the ascendent. I suspect that the text should be split at fol. 83 v, and that these words begin a new piece:

> I have wryten these thingis of the boke of domes of revolucions of the yeris of the world the whiche Jacob the sone of Ysaak Alkyndy compyled of the booke that was tran[s]late out of Ebrewe into Latyne be Henry Bate. After that the planetis be more or gretter or nyer to the erthe...

At the end of fol. 84 r the writer (of the original, presumably Latin, text) launches into a discussion of a conjunction that had happened, I believe long previously, and offers this fragment of information concerning Winchester's position:

> The longitud Wynconie fro the est is 19 degrees. The longitud of hem fro the myddis of the wer[l]d is 11 degrees, the which be worth 4 horis and 44 minutis of an hore ascendent. The place of an evyn lyne, the which is clepyd Arin, was the 25 ascendant and 24 minutis of Aries.[3]

If the last sentence does not represent fossilized remains of the working, then as Charles Burnett has suggested to me, it probably refers to the ascendant of the city, as quoted in various astrological works. These "ascendants" are only remotely related to latitude and are unrelated to longitude, but are the ascendants of horoscopes related to the foundation of the city or the person of its founder.[4] The statement in the text concerning longitude of place is typically garbled, but if Winchester was indeed taken to be 4 equal hours ("hours ascendent") and 44 minutes from Arin, which is the equivalent of 71 degrees (not 11), this confirms the 19 degrees (the complement of 71), apart from the fact that they are from the west and not the east ("est"), as is wrongly stated.

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3 A "London" latitude of 51° is stipulated in Paris, BN, Lat. MS 7272, fol. 67va (13th cent.), for which see Lynn Thorndike, *The Sphere of Sacrobosco and Its Commentators* (Chicago, 1949), p. 474. That it is an alteration from 15° is irrelevant, since that would have been a natural mistake at the time of copying. The original, however, gives London as 19° from Arim, a nonsensical figure that has been altered to 57°. The error was in fact not in the number but in the name "Arin", which should have referred to the west. It is hardly different from the error in the "est" of our English text. See below on the figure of 19°.

4 He mentions such lists in the *Epitome* of John of Seville, and a whole section at the end of part IV of Albumasar's *De magnis coniunctionibus.*. See Ptolemy's *Tetrabiblos* II.3-5 for a fairly basic text. A more remote possibility is that the odd English reference is related to a not uncommon Latin phrase "horoscopus signi secundum terram Arin", which is effectively 90 degrees in excess of the right ascension corresponding to any point of the ecliptic. Thus (dropping the requirement that we increase by 90°) it might simply mean that a longitude of 24° corresponds to a right ascension of 25°. This is roughly true for Capricorn, but not for Aries. This option seems unlikely, however.

<div style="border:1px solid">
Abraham
(MS Arundel 377 canons):
Winchester is 24°W.
</div>

There are more disturbing complications, however. Writing in the mid-twelfth century, Abraham Ibn Ezra tells us that on the basis of observations of the same eclipse in Pisa and Bordeaux he believed the longitude of Angers (virtually on the Bordeaux meridian) to be about the same as that of Winchester, approximately 24 degrees from the west.[5] This is not the 19 we might have expected, but as I promised earlier, the literature of this period is often surprisingly confused.

For instance, notes added to the text of Petrus Alfonsi associated with the (modified and supplemented) tables of al-Khwārizmī in Corpus Christi College, Oxford, MS 283 make out that (a) from Toledo to Winchester is 9° 36', while (b) Toledo is 28° 39' from the west (contrast al-Khwārizmī's 11° but compare with 28° 30' implied by the canons to the Toledan tables),

<div style="border:1px solid">
Petrus Alfonsi:
Winchester is 19;03°W.
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and (c) Winchester is 19° 3' (itself a corrected figure) from the west. This implies that Winchester is to the west of Toledo. (We now know that it is 2;43° to the east.) Another writer adds another note to the effect that Master Anselm contradicted this, and put Toledo further west than Winchester.[6] It required the word of a master to make this weighty conclusion plausible. The central error here is in the longitude for Toledo, which was being quoted from a source pointing back to the base meridian adopted by Ibn al-Zarqēllu ("Azarchel"), and then combined with Khwarizmian data based on a different base meridian. Putting the error aside, it is interesting to see that here we have another *Winchester* source taking the longitude of the place to be about 19° (using the older norm).

In view of his link with Winchester it is instructive to ask what values for his longitudes Abraham Ibn Ezra assumed. Our knowledge of the northern version

<div style="border:1px solid">
Abraham's Tables:
London is 19°W.
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of the Ibn Ezra tables (I use that description to distinguish them from the Pisa version, but leave it vague for reasons that will become clearer) is chiefly based on MS Digby 114 and the more complete MS Arundel 377, both of which leave much to be desired. They contain assortments of material from incongruous sources—pages from different codices and inter-

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5 See note 12. — Abraham Ibn Ezra, *El Libro de los Fundamentos de las Tablas Astronomicas*, J.Millás Vallicrosa, ed. (Madrid/Barcelona, 1947), p. 88: "et secundum horam eclipsis quam in Burdegali probavi, iudicavi longitudinem Andegavis esse 23 graduum, et eius differenciam ad Pisam 36 minuta hore". Note the figure of 23 rather than 24.

6 O. Neugebauer, *The Astronomical Tables of Al-Khwārizmī, Translated with Commentaries of the Latin Version Edited by H. Suter* (Copenhagen, 1962), pp. 229-30.

mingled copies of tables by different authors.[7] Those connected with Abraham are now generally taken to have been composed for London. There is no clear rubric overall, but on the table for the radices of mean motus of the Sun we find the following heading:

> Medius cursus solis ad annos domini collectos super Londonias [sic] quarum longitudo est xix graduum.[8]

In the margin there is a very misleading column of information. Nowhere are we told the radix date from which the table commences. The text tells us that it is the equivalent of our 1 March (noon), and the evidence of the complete data for all planets, as well as other historical evidence, fixes the first line at "1149", that is, 1 March 1150. The marginal column has the word "Radix" opposite the first row, and then below it 29, 49, 69, and 89. Saturn, Mars, and Mercury have similar marginal columns, but the manuscript is too tightly bound to check the remainder. The copyist of MS Digby 114 had no idea how to interpret this. At first he took the "radix" line to mean 1009, the next to be 1029, and so on. Later he reverted half-heartedly to the shorter figures, or omitted them. Some later users of the Arundel manuscript also clearly misunderstood the short "Radix" column, since they continued the sequence, in one case into the 300s. What was probably meant by the original writer or translator, however, was simply that the numbers given were the *terminations* of the collected years within any century, and not that they belonged to the rows in the adjacent table. The author does not refer to a "radix" date (shifting or unique) by that name, but always refers to the unique base time "according to the beginning of the book", *iuxta libri initium*. This is not an authorial reference to the time of composition—although it might be that too—but "the opening date of the ledger", so to speak.

The isolated statement of London's longitude ("xix") is even more misleading, but for reasons that will only emerge at a later stage. Raymond Mercier deduced from these and Ibn Ezra's Pisan tables of radices of mean motion (it is reasonable to assume that the tables in question are indeed for that place) that he regarded London as lying 10;30° east of Toledo, and Pisa 14;0° further east still.[9]

Mean motion radices imply sundry longitude differences, as discussed later.

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7 Bodleian Library, MS Digby 114, fols 25r-29v and the fuller version in British Library, MS Arundel 377, fols 7r-35r. The Digby collection intersperses Toulouse and Toledo tables with the Ibn Ezra material, which cover only the tables for Sun and Moon. This material is so badly arranged that is is hard to believe that it was ever used seriously, despite the great energy that must have been expended on copying it. Both manuscripts have one quality that reinforces the conclusion: both number the radix years wrongly, making them 140 years too small (so that 1009 is to be understood as 1149, and so on). Collected years (for the mean motions) are in steps of 20.

8 MS Arundel 377, fol. 7v.

9 "Astronomical Tables in the Twelfth Century", in Charles Burnett, ed., *Adelard of Bath: An English Scientist and Arabist of the Early Twelfth Century* (London, 1987), p. 110-111.

Indeed, in a separate study Mercier even went so far as to suggest emendations to the London tables to make them conform to this last longitude difference.[10]

> Abraham's Canons:
> Pisa is 33°W,
> Angers & Winch. 24°W,
> difference 9°.

In the Latin version of the text which Abraham wrote by way of explaining his procedures, as edited by J. Millás Vallicrosa, Pisa is expressly placed at 33;0° from the east, which Millás corrects to "west", while Angers is given as 23° from the west, and the equivalent of 9° from Pisa.[11] The Angers figure is plainly a scribal error for 24°, as is confirmed by the statement in the canons in the most important of all manuscript copies of the relevant Ibn Ezra material for England (MS Arundel 377) that Winchester is 24° from the west, and that Angers is much the same.[12] The corrections are straightforward enough, but still the figures do not hang together with the differences derived from the radices of mean motion and the "xix graduum" of the caption to the table.

> If Abraham deliberately placed London 10;30° from Toledo, and took the latter place to be 11° from the west, then on this reckoning London would have been 2;30° *west* of Winchester. (The true difference was about 1;10° east, taking the centre of population in old London into account.) Obtaining the longitude of Pisa by adding another 14°, Mercier's figure found from the tables that are supposedly for London in one case and Pisa in the other, produces a longitude of 35;30° from the west. This does not fit with the stated 33°, whether it was meant to be from east or west.

This entire network of data is so riddled with inconsistencies that it is tempting to brush it all to one side as yet another sign of medieval incompetence. There are ways of smoothing out the inconsistencies, however. First, we accept without more ado that the 33° for Pisa was intended to be from the *west*. This makes it 14° in excess of the *traditional* figure of 19° from the west of Angers and Winchester. But it also makes it 14° in excess of the "xix graduum" attached to the name of London. Does either of these facts have any relevance to our problem? And what of the text of the "Tractatus Magistri Habrahe" in MS Arundel 377 that provides a figure of approximately 24° as the longitude of Winchester from the west, rather than 19°? This is no copyist's error, for the text goes on to confirm the figure by giving not only the longitude difference

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10 "The lost zīj of al-Sūfī in the twelfth-century tables for London and Pisa", in *Lectures from the Conference on al-Sūfī and Ibn al-Nafis, Investigating Astronomy and Medicine and Science... AD 5-8 October 1987, University of Jordan* (House of Contemporary Thought: Beirut, Lebanon, 1991), pp. 38-72.

11 Abraham Ibn Ezra (ed. cit., J.Millás Vallicrosa, 1947), pp. 87-88.

12 See the previous reference to the Millás edition (1947), p. 88, and compare Burnett (1999), p. 165, n. 24, quoting from British Library, MS Arundel 377, fol. 56v: "He quidem tabule fuerunt composite secundum longitudinem Pise, cuius longitudo ab oriente est 33 graduum. Andegavensium vero longitudo ab occidente est 24 graduum fere. Eadem est Wintonie." Note, incidentally, that Winchester and Angers are (separately) said to approximate to the same figure. They are not said to be exactly equal.

(Winchester to Pisa) as 9° but its time equivalent as 36 minutes. In fact we can see exactly what has happened here. The 9°, as well as the explanation of it, have been lifted from the other text, in which the town was Angers, but only because both were taken to be near the same meridian. Abandoning the idea that the Pisa-Winchester difference should be 14°, are we to suppose that 14° was rather the accepted Pisa-London interval? The idea that London and Winchester were considered to be 5° apart would have been quite unpalatable, however, to anyone who had travelled from one place to the other, making a journey of only about 100 km. We are still in need of an explanation for the 14°.

There can be no doubt that in the course of converting the Pisan tables into their equivalents in the English manuscripts, the figure of 14° was used—not consistently, but following a fairly straightforward pattern. I select just three modes of comparison:

   A. Comparing the actual mean motion radices for 1 March 1150 in the English tables with the *inferred* values for Pisa for the same time, based on the quoted mean motions for 20 years. (The known Pisan tables only commence at "1169 complete".)
   B. Comparing actual manuscript values of both sets for 1 March 1170.
   C. Comparing actual manuscript values of both sets for 1 March 1190.

In all cases, the comparisons using tables for Saturn, Jupiter and Caput Draconis (the lunar node) must be dismissed. Small errors in calculation or copying are quick to produce nonsensical results with such slow-moving bodies, and they have done so here.[13] Omitting those three, however, comparisons along lines A and B lead to the following essentially similar conclusions:

   as between four pairs of tables (mean motion for the Moon, Mars, Venus and Mercury) the inferred longitude difference is close to 14°; for the tables of solar mean motion it is close to 8°; and for the lunar argument tables it is close to 9°.[14] Comparing by method C, all concordance is lost except for Mars and Mercury. This is what one would expect, however, as one moves further away from the date for which the tables were created, with the risk of introducing error every time a radix value is modified by the addition of the movement in the 20-year interval.[15]

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13 There are very small differences in the 20-year values for the mean motions of Saturn and Jupiter, but these make no serious contribution to the implied longitude differences.

14 In fact 7.9° and 8.8° respectively. For comparison A, we need to make trivial textual amendments to get agreement for Mars and Venus, changing 1s 19;49,19 to 1s 20;42,12 for Mars (mean motus) and 1s 22;31,51 to 1s 29;31,51 for Venus (mean argument). I am grateful to Fritz S. Pedersen for a discussion of some of the readings from Digby and Arundel MSS on the one side and Paris BN, lat 7272, and Vat. lat. 3119 on the other.

15 Since the canons tacitly use 1149 (complete) as starting point, the date of composition probably fell within the decade following, or at worst the two decades following.

How are we to reconcile these internal inconsistencies? We might suppose that the text of the canons—which must certainly be a somewhat modified version of Abraham's original, referring as it does to years "after the incarnation of the Lord", for example—contains the awkward "24-degree passage" only as an interpolation, alien to Abraham's belief. However, since in two of the nine cases the tables come so close to a difference of 9°, we can surely rule this idea out. A far more likely explanation is that Abraham underwent a change of mind—but from what to what? There are two obvious starting hypotheses. One is that he arrived in London, took 19° as its longitude, took Pisa's to be 33°, and so converted his Pisan tables for a difference of 14°. The other is that he made the conversion in Winchester, starting from a traditional longitude of 19°. It is inconceivable that *both* assumptions were made by a man who had travelled from one place to the other. The change of mind would have come when he gathered evidence that obliged him to convert at least one lunar table for Winchester use (longitude difference approximately 9°) and one or more for London use (longitude difference approximately 8°), if those were not meant for a single place.

The change of mind is unlikely to have operated in the opposite direction, from good to bad. In favour of a London start, there is the "xix" in the tables, and yet *this is a header to a table which it does not fit*. Is it likely that Abraham visited London first? It was there in 1158 that he was inspired by a dream to write his *Kerem Chemed*, as he tells us in the introduction to it:

> It was in the year 4919 [AD 1158] at midnight, on Sabbath eve, the
> 14th of Tebeth [7 December], that I, Abraham Ibn Ezra, a Spaniard,
> was in one of the cities of the island called the "corner of the Earth"
> [Angleterre] for it is the last of the seven divisions of the inhabited
> Earth.[16]

If he took a boat from Normandy (the Cherboug region) to England he would have gone to Winchester first. In favour of the tables having first been adapted to Winchester, only later to be modified there and then finally for London, we have the tradition of a longitude of 19° for Winchester, requiring a difference of 14° from Pisa. Another argument for Winchester is that the canons seem to be linked with that place, and make no mention of London. (Perhaps that is why Henry Bate refers to something he finds in various tables, among which he lists those of "Abrahe: in tabulis Pisanis vuintoniensibus et aliis", but no tables for London.)[17]

Since the canons correspond to a time after the modification of Pisa tables, the most likely sequence of events seems to be this: composition of the Pisa tables (longitude 33° from the west); Winchester tables (longitude 19°, difference

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16 Joseph Jacobs, *The Jews of Angevin England* (London:David Nutt, 1893), p. 35.
17 For a fuller quotation from his work on the astrolabe (1274) see Burnett, ibid., n. 17.

14°); Winchester tables (longitude 24°, difference 9°); canons mentioning the last difference and longitude; London tables (longitude approximately 20°, difference approximately 8°). Abraham's second and last visit to England in 1166—a year before his death—took him to London, where R. Joseph ben Jacob heard him comment on Exodus.[18]

Charles Burnett has raised the question of whether it is right to speak of Abraham's "Winchester" tables at all, but in a postscript he quotes two glosses drawn to his attention by Fritz S. Pedersen too late for him to investigate them. The fact that they are to a thirteenth-century manuscript now in Cambridge mentioning "tabule mediorum cursuum Solis ad meridiem Winton. ab Abrahamo condite", does nothing to harm our previous argument. There is in fact an ambiguous Winchester reference to an eclipse in a calendar in the same codex, but it provides no information that allows us to say how it was computed, since it concerns an unknown year and a conjunction, something on which it was notoriously difficult to get precise agreement.[19]

Finally, while the corrupt passage quoted earlier from the Paris manuscript (on the sphere, MS 7272) that confuses a distance of "London" from the west with a distance from Arim is easy enough for us to correct, what is more interesting about it is that the person correcting it in the manuscript has seemingly picked up a Pisa distance from Arin. It is hard to believe that adding and subtracting a handful of simple numbers should have been the occasion for so many misunderstandings, and I am sure that this note of mine will not have put an end to them. In a problem of this sort there can be no grand conclusion, for there is no simple thesis to be proved, unless it is this: that the numerous fragments of data relating directly or indirectly to the longitude of Winchester (especially those noted in the sidebars above) can all be reconciled, using a small number of plausible assumptions; and that reconciling them sheds a faint glimmer of light on the practice of astronomy in that city in the twelfth century.

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18 On this occasion he was probably coming from Rouen, as conjectured by Jacobs, ibid., p. 263.
19 Cambridge University Library, MS Kk.1.1, fol. 142va, opposite the month of January: "Locus eclipsis pridie ydus post meridiem hore 9 minuta 31 secunda 21 ad meridiem civitatis Winton.". For the postscript qualifying his mildly sceptical stance, see Burnett (1999), n. 27, referring to fol. 145v. We both owe our references to Fritz S. Pedersen. Another gloss to the calendar carries the date 1236. As far as I see there was no eclipse, lunar or solar, within the previous century on that day (12 January). There were easily visible partial lunar eclipses on 14 March 1169 (Pridie Idus Mart.) and 12 December 1228 (Pridie Idus Dec.), both within a couple of hours of the stated time using either the Ibn Ezra or the Toledan tables. The former eclipse would have been astrologically significant, since the Sun had just entered the first degree of Aries.