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► **To cite this version:**

José Chabás, Bernard R Goldstein. The Master and the Disciple: The Almanac of John of Lignères and the Ephemerides of John of Saxony. *Archive for History of Exact Sciences*, 2018, 72 (1), pp.21-62. 10.1007/s00407-017-0199-2 . hal-02552943

HAL Id: hal-02552943

<https://hal.science/hal-02552943>

Submitted on 23 Apr 2020

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The Master and the Disciple: The Almanac of John of Lignères and the Ephemerides of John of Saxony*

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Abstract

In this paper we analyze and compare two sets of tables in the framework of Alfonsine astronomy composed by John of Lignères and his disciple, John of Saxony, respectively, both belonging to the first generation of scholars using the Alfonsine tables in Paris in the early fourteenth century. John of Lignères's almanac is limited to the five planets whereas the similar work by John of Saxony deals with the two luminaries as well. Moreover, there are other differences between these sets of tables concerning their principle of organization, precision, and accuracy.

Keywords

Parisian Alfonsine Tables, planetary periods of return, Azarquiel, Jacob ben Makhir, Regiomontanus

In a previous study, we addressed an almanac compiled by John of Lignères (fl. 1320–1335), uniquely preserved (as far as we knew) in an incomplete copy, in Philadelphia, Free Library, MS Lewis E.3, 3r–10r.¹ In this manuscript, the set of tables begins abruptly in the middle of a table for Saturn, and thus no complete copy of the almanac was known at the time. In a recent visit to the Vatican Library, we examined two more copies of it, hitherto not known to contain this work. Both manuscripts preserve a complete set of tables, and one of them includes a short text associated with the tables.² This work by John of Lignères has the characteristics of what has been called an almanac, that is, a set of true positions of the planets presented separately at intervals of a few days in a given period when the planet returns very nearly to its initial position.³ By introducing a set of corrections for the difference in longitude of any given entry from one period of return to the next, the entries in the almanac can be extended to other dates; thus, the aim of the set is to be valid in perpetuity. John of Lignères's work is well within the tradition of previous almanacs but for two distinctive features: it is based on the Parisian Alfonsine Tables and deals exclusively with the positions of the five planets, that is, true positions for the Sun and the Moon are not included.

In this paper we review the various tables in John of Lignères's almanac and we compare them with those in a similar work by John of Saxony, a disciple of John of Lignères and the author of the most widely disseminated canons to the Parisian Alfonsine Tables beginning *Tempus est mensura...* (1327).⁴

I. John of Lignères

* This research has been undertaken in the frame work of ALFA, a European Research Council project (Consolidator grant 2016 agreement no. 723085) funded for 2017-2022.

The three manuscripts of the almanac of John of Lignères that are now available are:⁵

- Philadelphia, Free Library, MS Lewis E.3, 3r–10r (tables, beginning missing), 10r (canons), late 14th century, England (henceforth MS A);
- Vatican, Biblioteca Apostolica Vaticana, MS Pal. lat. 446, 219v (canons), 220r–227v (tables), early 15th century (henceforth MS B); and
- Vatican, Biblioteca Apostolica Vaticana, MS Pal. lat. 1446, 36r–47v (tables) no canons, late 14th/15th century, Germany (henceforth MS C).

The canons in MSS A and B differ. However, both short texts contain essentially the same information. We are told that in order to use the almanac one has to subtract 1340 from the current year, indicating that the starting date is 1341. The text also specifies that after a period of return, that is, a complete cycle by each of the planets, the correction to be applied for Saturn is $+1;30^\circ$, for Jupiter $-0;30^\circ$, and for Mars $+1;40^\circ$; no correction is given for Venus or Mercury. These are exactly the same corrections as those in the almanac of Jacob ben Makhir (also known as Profatius Judaeus), a work compiled around 1300 based on the Toledan Tables.⁶ In the almanac of John of Lignères, the entries are rounded to the nearest degree, in zodiacal signs of 30° , and the years begin in January. In all cases the first year corresponds to 1341. For excerpts of the tables, below, the base manuscript is MS C.

1. True positions of Saturn (MS A, 3r; MS B, 220r–221r; MS C, 36r–37v)

The entries are displayed at 10-day intervals (days 1, 11, and 21 of each month) for a period of 59 years. MS A gives entries only for years labeled 40 to 59.

Table A: Saturn

	1	2	3	...	57	58	59
	Sgr	Cap	Cap	...	Sco	Sgr	Sgr
Jan 1	25	7	16	...	26	6	17
Jan 11	26	8	17	...	27	7	18
Jan 21	27	9	18	...	27	8	19
...							
	Cap	Cap	Cap		Sgr	Sgr	Sgr
Dec 1	3	12	25	...	3	14	22
Dec 11	4	13	26	...	4	15	23
Dec 21	5	14	27	...	5	16	24

Note: In MS B, the entries for December were left blank for years 1, 2, and 3.

2. True positions of Jupiter (MS A, 3v–5r; MS B, 220r–223r; MS C, 38r–40v)

The entries are given at 10-day intervals (days 1, 11, and 21 of each month) for 83 years. In MS A the entries for years 62 to 83 are given for days 10, 20, and the last day of each month. As this is not the case in MSS B and C, we conclude that this is a copyist's error in MS A.

Table B: Jupiter

	1	2	3	...	81	82	83
	Lib	Sco	Sgr	...	Cnc	Leo	Vir
Jan 1	14	11	8	...	8	12	14
Jan 11	15	12	10	...	6	11	14
Jan 21	15	13	12	...	5	10	13
...							
	Sco	Sgr			Leo	Vir	Lib
Dec 1	6	1	26		14	14	11
Dec 11	8	2 ^a	28	...	14	14	12
		Cap					
Dec 21	10	5	0	...	13	14	13

a. MSS A, B: 3

3. True positions of Mars (MS A, 5v–7r; MS B, 223v–225r; MS C, 41r–43v)

The entries are given at 10-day intervals (days 10, 20, and the last day of each month) for 79 years.

Table C: Mars

	1	2	3	...	77	78	79
	Sgr	Ari	Sgr	...	Psc	Sco	Ari
Jan 10	5	28	20	...	19	17	6
		Tau					
Jan 20	12	3	28	...	25	23	13
		Cap			Ari		
Jan 31	19	9	6 ^a	...	4	29 ^b	20 ^c
...							
	Ari	Sco	Tau		Lib	Psc	Sco
Dec 1	13	27	43		22 ^d	16	14
		Sgr					
Dec 20	17	5	22	...	28 ^e	22	20
					Sco		
Dec 31	23	13	23	...	4 ^f	29 ^g	27

- a. MS B: 0 b. MS A: 0 c. MS B: 19 d. MS B: 23
 e. MS A: Sco 4 f. MS A: 11 g. MS A: 30

4. True positions of Venus (MS A, 7v; MS B, 225v; MS C, 44r–v)

The entries are given at 5-day intervals (days 1, 6, 11, 16, 21, and 26 of each month) for 8 years.

Table D: Venus

	1	2	3	...	6	7	8
	Sgr	Aqr	Sgr	...	Sgr	Psc	Cap
Jan 1	23	14	20	...	8	0 ^a	6
Jan 6	24	20	26	...	13	5	12
			Cap				
Jan 11	26	26	2 ^b	...	18	10	20
...							
	Cap	Sgr	Aqr		Aqr	Sgr	Sgr
Dec 16	25	1	21		16	19	25
	Aqr						
Dec 21	2	8	25	...	19	25	24
						Cap	
Dec 26	8	14	29	...	25	1	23

- a. MS B: 9 b. MS B: 22

5. True positions of Mercury (MS A, 8r–10r; MS B, 226r–227v; MS C, 45r–47v)

The entries are given at 5-day intervals (days 5, 10, 15, 20, 25, and the last day of each month) for 46 years.

Table E: Mercury

	1	2	3	...	44	45	46
	Cap	Cap	Aqr	...	Aqr	Cap	Sgr
Jan 5	4	21	5	...	6	6	26
		Aqr					Cap
Jan 10	13	0	13	...	4	4	2 ^a
					Cap		
Jan 15	22	8	20	...	29	6	10
...							

	Sgr	Cap	Cap		Cap	Sgr	Sgr
Dec 20	23	8	19		15	19	12
	Cap						
Dec 25	1	15	26	...	14	19 ^b	19
			Aqr				
Dec 31	12	26	6	...	10	21	28

Note: In MS B, the entries for Dec. 20 and 25 for years 1, 2, and 3, are those for Dec. 25 and 31, respectively, in MSS A and C.

a. MS B: 21 b. MS B: 29

The number of years in a cycle for each of the planets is the same as in the Almanac of Azarquiel and the Almanac of Jacob ben Makhir.⁷ However, the number of years in these three almanacs differs from Ptolemy's cycle for Jupiter. The frequency of the entries in a month for each of the planets follows the Almanac of Azarquiel for Saturn and Venus, and the Almanac of Jacob ben Makhir for Jupiter, Mars, and Mercury.

To have a sense of the accuracy of the entries in John of Lignères's almanac, we have recomputed selected planetary positions given in the text, all corresponding to noon of arbitrary days, evenly spaced, in 1341, the first year for which this almanac is valid (see Table F). For that purpose, we have used a spreadsheet to compute Alfonsine longitudes made by Lars Gislén. As the entries are only given to degrees, it is difficult to decide whether they were computed for Toledo or Paris (0;48h east of Toledo). In 0;48h, the swiftest planet, Mercury, travels a mean distance of 0;6° in anomaly, much less than the precision of 1° used in John of Lignères's almanac.

Table F: Recomputation of selected entries in the almanac of John of Lignères

		Text Pal. lat. 1446	Computation for Paris	T – C (°)
Jan. 10, 1341	Mars Mercury	Sgr 5° Cap 13°	244; 4° 286;11°	+1 –3
Jan. 11, 1341	Saturn Jupiter Venus	Sgr 26° Lib 15° Sgr 26°	269;56° 195;39° 261;52°	–4 –1 +4
Feb. 10, 1341	Mars Mercury	Sgr 26° Psc 12°	265;29° 343; 6°	+1 –1
Feb. 11, 1341	Saturn Jupiter Venus	Cap 0° Lib 15° Cap 15°	272;56° 195;15° 285;10°	–3 –1 0
Mar. 10, 1341	Mars Mercury	Cap 16° Ari 10°	284;55° 11;27°	+1 –1
Mar. 11, 1341	Saturn Jupiter Venus	Cap 1° Lib 12° Aqr 14°	274;44° 192;37° 314; 9°	–4 –1 0
Apr. 10, 1341	Mars Mercury	Aqr 8° Ari 2°	306;39° 3;22°	+1 –1
Apr. 11, 1341	Saturn	Cap 1°	275;16°	–4

	Jupiter	Lib 9°	188;44°	0
	Venus	Psc 17°	349;13°	-2
May 10, 1341	Mars	Aqr 29°	326;59°	+2
	Mercury	Tau 21°	51; 6°	0
May 11, 1341	Saturn	Cap 0°	274;15°	-4
	Jupiter	Lib 6°	186;12°	0
	Venus	Ari 23°	24;17°	-1
Jun. 10, 1341	Mars	Psc 19°	346;36°	+2
	Mercury	Cnc 18°	108;19°	0
Jun. 11, 1341	Saturn	Sgr 28°	272; 5°	-4
	Jupiter	Lib 6°	186;16°	0
	Venus	Gem 0°	61; 8°	-1
Jul. 10, 1341	Mars	Ari 4°	1; 9°	+3
	Mercury	Leo 8°	129;12°	-1
Jul. 11, 1341	Saturn	Sgr 26°	269;48°	+3
	Jupiter	Lib 9°	188;58°	0
	Venus	Cnc 7°	97;14°	0
Aug. 10, 1341	Mars	Ari 13°	7;52°	+5
	Mercury	Leo 9°	128;21°	+1
Aug. 11, 1341	Saturn	Sgr 25°	268;22°	-3
	Jupiter	Lib 14°	193;44°	0
	Venus	Leo 16°	134;58°	+1
Sep. 10, 1341	Mars	Ari 9°	1;48°	+7
	Mercury	Vir 28°	178;35°	-1
Sep. 11, 1341	Saturn	Sgr 26°	268;29°	-2
	Jupiter	Lib 19°	199;53°	-1
	Venus	Vir 17°	173;12°	-6
Oct. 10, 1341	Mars	Ari 2°	355; 3°	+7
	Mercury	Sco 14°	225;33°	-2
Oct. 11, 1341	Saturn	Sgr 28°	270; 5°	-2
	Jupiter	Lib 25°	206;22°	-1
	Venus	Sco 1°	210;40°	0
Nov. 10, 1341	Mars	Ari 3°	358;59°	+4
	Mercury	Sco 19°	230;57°	-2
Nov. 11, 1341	Saturn	Cap 1°	272;56°	-3
	Jupiter	Sco 2°	213; 1°	-1
	Venus	Sgr 7°	249;46°	-3
Dec. 10, 1341	Mars	Ari 13°	10;49°	+2
	Mercury	Sgr 6°	247; 3°	-1
Dec. 11, 1341	Saturn	Cap 4°	276;18°	-2
	Jupiter	Sco 8°	218;49°	-1
	Venus	Cap 19°	287;38°	+1

Of the 60 cases, the differences, T(ext) – C(computation), in 33 cases are -1° , 0° , or $+1^\circ$, and reach values as high as -6° or $+7^\circ$ in three cases.

To sum up, John of Lignères compiled an almanac following the same pattern as in the almanac of Jacob ben Makhir, using the same cycles and the same corrections for the planets. In contrast to Jacob's almanac, which is based on the Toledan Tables, the positions of the planets in John's almanac were computed using Alfonsine parameters. Calculating the planetary positions in an almanac with the new tables was certainly a step forward, but in terms of precision of the entries it was a regression, because John of Lignères's precision was to degrees,

whereas in Jacob's almanac the entries were given to minutes. This situation was soon to change.

II. John of Saxony

In addition to his canons to the Parisian Alfonsine Tables, John of Saxony is the author of a text beginning *Cum animadverterem quam plurimus magistros et scolares in studio Parisiensi...* dealing with ephemerides he had composed, which differs in many ways from the almanac compiled by John of Lignères. If we are to judge from the number of manuscripts preserved of John of Saxony's work, it had a much greater success than that of his master. In our study of 2003 we knew of 12 copies of it.⁸ Five other manuscripts (Edinburgh, Erfurt F 389, London, Oxford 176, and Vatican) can now be added to this list:⁹

- Cambridge, Gonville and Caius College, MS 110/179, 199–201 (canons), 202–294 (tables);
- Cambridge, Gonville and Caius College, MS 174/95, 93–95 (canons);
- Cracow, Biblioteka Jagiellońska, MS 604, 1–56 (tables);
- Cracow, Biblioteka Jagiellońska, MS 715, 65r–67v (canons);
- Cracow, Biblioteka Jagiellońska, MS 1849, 1r–60r (tables);
- Cracow, Biblioteka Jagiellońska, MS 1931, 6–83 (tables);
- Edinburgh, Royal Observatory, MS Crawford 2.123, 19r–95v;
- Erfurt, Universitäts- und Forschungsbibliothek, MS Amplon. F 386, 62r–63r (canons), 63v–107v (tables);
- Erfurt, Universitäts- und Forschungsbibliothek, MS Amplon. F 387, 1r–v (canons), 2–46 (tables);
- Erfurt, Universitäts- und Forschungsbibliothek, MS Amplon. F 389, 1r–55r (tables);
- Erfurt, Universitäts- und Forschungsbibliothek, MS Amplon. Q 360, 56r–77r (tables), 77v–78v (canons);
- London, British Library, MS Royal 12.C.XVII, 191r–200v (tables, incomplete);
- Nuremberg, Stadtbibliothek, MS Cent. VI,16, 2r–103r (tables);
- Oxford, Bodleian Library, MS Digby 176, 73r–87r;
- Oxford, Bodleian Library, MS Rawlinson D.1227, 3r–4v (canons), 5r–31v (tables);
- Vatican, Biblioteca Apostolica Vaticana, MS Pal. lat. 1409, 1r–52v (tables); and
- Vienna, Österreichische Nationalbibliothek, MS 5192, 2r–51r (tables), 51v–53r (canons).

The author of the canons, explicitly given in the text as *Ego Iohannes de Danekone dictus de Saxonia*, indicates that in his work he followed the tables of Alfonso, king of Castile; his computations refer to the meridian of Paris, and they range from 1336 to 1380. John of Saxony used signs of 30° in all his tables, as did his master, John of Lignères, in his almanac. This is indeed a noteworthy feature that clearly is incompatible with the claim that both authors, founding fathers of Alfonsine astronomy in Paris, used extensively sexagesimalization, considered as a characteristic of the “new” astronomy developed by the Parisians. In contrast to the almanac of John of Lignères, which only has tables for the true positions of the five planets, John of Saxony's ephemerides also include tables for the true positions of the two luminaries and, as will be seen, he increased the precision of the entries. The organizational principle of the entries also differs substantially in these two sets because John of Saxony no longer used cycles. Rather, he gives the true positions of the planets and the luminaries for some number of years that differ from one planet to another, with no intention of extending the table to dates in other years. In our view, this distinguishes this work of John of Saxony from an almanac; in fact, these tables are ephemerides, with their own characteristics.¹⁰

1. Solar correction

In this short double argument table, the entries are given in minutes and seconds of arc and represent the increments to be added to the true longitude of the Sun for each month of the year after four years have elapsed. The argument at the left of the table is the year number, normally ranging from 1340 to 1384 at intervals of 4 years, and the columns correspond to the months in a year. In some manuscripts, the argument starts later (1368 in MS Cracow 604). The first entry, for 1340 and January, is 1;46' and indeed 0;1,45,32,40" is the increment in solar longitude in Alfonsine astronomy after a cycle of 4 years.¹¹

2. Daily true position of the Sun

The entries in this tables are displayed in signs, degrees, and minutes, and represent the true longitude of the Sun for each day in a period of four consecutive years beginning in January. Although not explicitly said, they were computed for noon at Paris (0;48h east of Toledo). We note the use of zodiacal signs of 30°, normally given as a number (MSS Erfurt 386, Erfurt 360, London, Vatican, and Vienna) and less often by the usual name of the zodiacal sign (MSS Cambridge and Oxford). In most manuscripts, the 4-year period is 1336–1339. However, in some others (MSS Cracow 604, Cracow 1931, and Vatican) the entries for the solar positions have 2' systematically added, indicating that the initial year of the 4-year cycle is no longer 1336 but 1340 (after adding 2', which is a rounded value of 1;46', as we are told in the table for the solar correction). As will be seen below (Table G), John of Saxony computed the entries in this table very accurately.

3. Daily true position of the Moon

The entries, also computed for noon at Paris, are given in signs, degrees, and minutes. The period covered by the entries varies considerably among the manuscripts examined: 1336–1380 (MS Erfurt 386), 1360–1368 (MS Cracow 1931), 1360–1380 (MS Erfurt 360), 1361–1368 (MS Cracow 1849), 1361–1380 (MSS Oxford and Vatican), 1364–1379 (MS Vienna), and 1369–1380 (MS Cracow 604).

All in all, MS Erfurt F 386 is the most complete manuscript and the one beginning earliest for both luminaries (1336), thus possibly the closest to the actual work by John of Saxony. And this is the manuscript on which we have based our calculations. In Table G we have recomputed the entries for the Sun and the Moon for noon of two days evenly separated in each month of year 1336. The columns T – C display the differences between text and computation.

Table G: Solar and Lunar Daily True Positions (MS Erfurt F 386: Sun, 64r; Moon, 66r)

	Sun			Moon		
	Text Erfurt, F 386	Computation for Paris	T – C (^o)	Text Erfurt, F 386	Computation for Paris	T – C (^o)
Jan. 1, 1336	9s 19; 6 ^o	289; 5,38 ^o	0	4s 16; 5 ^o	136; 4,30 ^o	0
Jan. 15, 1336	10s 3;23 ^o	303;22,43 ^o	0	10s 10;48 ^o	310,49, 9 ^o	-1
Feb. 1, 1336	10s 20;37 ^o	320;36,37 ^o	0	6s 4;15 ^o	184;14,56 ^o	0
Feb. 15, 1336	11s 4;42 ^o	334;41,40 ^o	0	11s 28;59 ^o	358;57,56 ^o	+1
Mar. 1, 1336	11s 19;39 ^o	349;38,43 ^o	0	6s 25; 5 ^o	205; 4,42 ^o	0
Mar. 15, 1336	0s 3;28 ^o	3;28,10 ^o	0	0s 22;16 ^o	22;15,27 ^o	+1

Apr. 1, 1336	0s 20; 6°	20; 5,35°	0	8s 9;23°	249;23,23°	0
Apr. 15, 1336	1s 3;40°	33;39,40°	0	2s 15;25°	75;26, 6°	-1
May 1, 1336	1s 19; 2°	49; 2, 9°	0	9s 11;27°	281;28,19°	-1
May 15, 1336	2s 2;25°	62;25,17°	0	3s 24;15°	114;15,19°	0
Jun. 1, 1336	2s 18;36°	78;35,49°	0	10s 26;46°	326;46,12°	0
Jun. 15, 1336	3s 1;54°	91;54, 8°	0	5s 15;17°	165;18, 3°	-1
Jul. 1, 1336	3s 17; 7°	107; 6,40°	0	0s 1;41°	1;42,27°	-1
Jul. 15, 1336	4s 0;27°	120;26,55°	0	6s 19;43°	199;43,21°	0
Aug. 1, 1336	4s 16;44°	136;43,46°	0	1s 22;20°	52;20,57°	-1
Aug. 15, 1336	5s 0;13°	150;13,18°	0	8s 5;25°	245;26,37°	-2
Sep. 1, 1336	5s 16;46°	166;45,45°	0	3s 15;57°	105;57, 9°	0
Sep. 15, 1336	6s 0;30°	180;30, 7°	0	9s 19;57°	289;56,15°	+1
Oct. 1, 1336	6s 16;22°	196;21,34°	0	8s 25;10°	145; 8,16°	+2
Oct. 15, 1336	7s 0;22°	210;22,29°	0	10s 22; 3°	322; 3,22°	0
Nov. 1, 1336	7s 17;33°	227;32,34°	0	6s 15;36°	195;36,23°	0
Nov. 15, 1336	8s 1;47°	241;47,16°	0	0s 8;17°	8;16, 5°	+1
Dec. 1, 1336	8s 18; 8°	258; 7,46°	0	7s 20; 4°	230; 3,21°	+1
Dec. 15, 1336	9s 2;28°	272;28,27°	0	1s 13;47°	43;47,42°	-1

In the case of the Sun, the 24 entries were correctly computed and transmitted. One couldn't do better. This is quite exceptional among medieval lists of computed values in astronomy. In the case of the Moon, the result is very good, although not as spectacular as that for the Sun. Of the 24 differences, $T - C$, for the Moon, 22 lie between $-1'$ and $+1'$, and the other two are $-2'$ and $+2'$. This change in computational accuracy probably derives from the fact that the algorithm for determining solar positions is less complex and involves fewer interpolations and roundings than that for the lunar positions. The conclusion seems obvious: John of Saxony computed the positions of the two luminaries carefully and accurately, to the minute.

4. True position of the lunar node

Here too, the entries are in signs, degrees, and minutes, but in this case they are given at intervals of about 10 days (days 10, 20, and the last day of the month) for a period normally of the same duration as that for the lunar position in the preceding table.

5. True position of Saturn

As in all the other tables for the positions of the celestial bodies, the entries for Saturn are displayed in signs, degrees, and minutes. As was the case for the lunar node, the entries are given at intervals of about 10 days (days 10, 20, and the last day of the month). Again, the period covered is not the same in all manuscripts (as was the case in the table for the lunar positions) ranging from 1336–1383 in MS Erfurt 386 to 1367–1380 in MS Cracow 604. The most common period is 1360–1380.

6. True position of Jupiter

The entries, also in signs, degrees, and minutes, are here spaced at intervals of about 8 days (days 8, 16, 24, and the last day of the month). The period covered varies from manuscript to manuscript and does not necessarily agree with those for the other planets in the same manuscript.

7. True position of Mars

The precision of the entries is the same as in the rest of the planets, and the interval is shorter, for it is now about 6 days (days 6, 12, 18, 24, and the last day of the month).

8. True position of Venus

Again, the entries are to minutes, and the interval becomes even shorter, in this case about 4 days (days 4, 8, 12, 16, 20, 24, 28, and the last day of the month).

9. True position of Mercury

Both the precision of the entries and the intervals used are the same as in the case of Venus.

It is worth noting that, even though the intervals used by John of Saxony in his tables for the planets more or less agree with those in the almanac of John of Lignères, the days chosen to compute the planetary positions totally disagree, in such a way that for none of the planets is a direct comparison between entries for the same day possible. As will be demonstrated below, John of Saxony's calculations are much more accurate than those of his master.

Table H displays the recomputation of the entries for the five planets for noon of two days in each month of year 1341, and their comparison with the entries in MS Erfurt F 386. The column T – C displays the differences between text and computation.

Table H: True Positions of the Planets

		Text Erfurt, F 386	Computation for Paris	T – C ($^{\circ}$)
Jan. 20, 1341	Saturn	9s 0;54 $^{\circ}$	270;53,37 $^{\circ}$	0
Jan. 24, 1341	Jupiter	6s 15;49 $^{\circ}$	195;49,22 $^{\circ}$	0
	Mars	8s 13;40 $^{\circ}$	253;41,16 $^{\circ}$	-1
	Venus	8s 29;43 $^{\circ}$	269;42, 9 $^{\circ}$	+1
	Mercury	10s 12;11 $^{\circ}$	312;11, 5 $^{\circ}$	0
Feb. 20, 1341	Saturn	9s 3;38 $^{\circ}$	273;38,24 $^{\circ}$	0
Feb. 24, 1341	Jupiter	6s 14;14 $^{\circ}$	194;14,10 $^{\circ}$	0
	Mars	9s 5; 7 $^{\circ}$	275;14,40 $^{\circ}$	-8
	Venus	9s 28; 9 $^{\circ}$	298; 9, 5 $^{\circ}$	0
	Mercury	0s 3;46 $^{\circ}$	3;45,57 $^{\circ}$	0
Mar. 20, 1341	Saturn	9s 5; 2 $^{\circ}$	275; 1,57 $^{\circ}$	0
Mar. 24, 1341	Jupiter	6s 10;59 $^{\circ}$	190;59, 6 $^{\circ}$	0
	Mars	9s 24;42 $^{\circ}$	294;42,59 $^{\circ}$	-1
	Venus	10s 28;37 $^{\circ}$	328;37, 7 $^{\circ}$	0
	Mercury	0s 0;41 $^{\circ}$	0;40,54 $^{\circ}$	0
Apr. 20, 1341	Saturn	9s 5; 7 $^{\circ}$	275; 6,29 $^{\circ}$	0
Apr. 24, 1341	Jupiter	6s 7;22 $^{\circ}$	187;22, 6 $^{\circ}$	0
	Mars	10s 16;22 $^{\circ}$	316;21,10 $^{\circ}$	+1
	Venus	0s 4;20 $^{\circ}$	4;20,26 $^{\circ}$	0
	Mercury	0s 22;34 $^{\circ}$	22;34,17 $^{\circ}$	0
May 20, 1341	Saturn	9s 3;42 $^{\circ}$	273;41,41 $^{\circ}$	0
May 24, 1341	Jupiter	6s 5;52 $^{\circ}$	185;52,20 $^{\circ}$	0
	Mars	11s 6;16 $^{\circ}$	336;15,38 $^{\circ}$	0
	Venus	1s 9;40 $^{\circ}$	39;41, 1 $^{\circ}$	-1
	Mercury	2s 17;42 $^{\circ}$	77;42, 7	0
Jun. 20, 1341	Saturn	9s 1;20 $^{\circ}$	271;20,10 $^{\circ}$	0

Jun. 24, 1341	Jupiter	6s 7; 8°	187; 7,53°	0
	Mars	11s 24; 7°	354; 7, 3°	0
	Venus	2s 16;42°	76;42, 7°	0
	Mercury	4s 7;22°	127;22,38°	-1
Jul. 20, 1341	Saturn	8s 29;15°	269;14,34°	0
Jul. 24, 1341	Jupiter	6s 10;47°	190;46,59°	0
	Mars	0s 5;42°	5;42,55°	-1
	Venus	3s 23; 0°	113; 0,21°	0
	Mercury	3s 27;41°	117;40,47°	0
Aug. 20, 1341	Saturn	8s 28;14°	268;13,39°	0
Aug. 24, 1341	Jupiter	6s 16;13°	196;13,28°	0
	Mars	0s 6;30°	6;29,49°	0
	Venus	5s 0;57°	150;57,12°	0
	Mercury	4s 29;17°	149;17,29°	0
Sep. 20, 1341	Saturn	8s 28;48°	268;48,26°	0
Sep. 24, 1341	Jupiter	6s 22;39°	202;38,51°	0
	Mars	11s 27;32°	357;31,35°	0
	Venus	6s 9;28°	189;23,52°	+4
	Mercury	6s 22;23°	202;22,32°	0
Oct. 20, 1341	Saturn	9s 0;49°	270;48,54°	0
Oct. 24, 1341	Jupiter	6s 29;12°	209;11,47°	0
	Mars	11s 25;16°	355;20, 0°	-4
	Venus	7s 17; 1°	227; 1,11°	0
	Mercury	7s 26;42°	236;41,51°	0
Nov. 20, 1341	Saturn	9s 3;53°	273;53, 2°	0
Nov. 24, 1341	Jupiter	7s 5;39°	215;39, 8°	0
	Mars	0s 3;52°	3;54,35°	-3
	Venus	8s 26;10°	266;10,35°	-1
	Mercury	7s 19;59°	229;59,37°	-1
Dec. 20, 1341	Saturn	9s 7;23°	277;23,12°	0
Dec. 24, 1341	Jupiter	7s 10;57°	220;57,27°	0
	Mars	0s 17;42°	17;42,19°	0
	Venus	10s 3;59°	303;59,47°	-1
	Mercury	8s 29;36°	269;53,50°	-18

Again, the agreement is very good, although not as remarkable as that for the Sun because, of the 60 differences between text and recomputation, 55 are $-1'$, $0'$, or $+1'$, and the greatest value of $T - C$ is $-18'$, much less than one degree. This confirms the conclusion presented above: John of Saxony computed the positions of all celestial bodies carefully and accurately, to the minute. Taken altogether, for the 108 recomputed entries of the two luminaries and the five planets the results are:

T - C	$\leq -3'$	$-2'$	$-1'$	$0'$	$+1'$	$+2'$	$\geq +3'$
No.	4	1	15	79	7	1	1

This means that more than 93% of the entries were computed so accurately that they differ from our recomputation by 1 minute of arc or less. Therefore, John of Saxony not only was the author of the most widely diffused canons to the Parisian Alfonsine Tables, for which he is mostly known, he was also a careful and accurate computer, for which he also deserves credit. In any case, he was a much better computer than his master, John of Lignères, who was off by more than 1 degree in 27 out of the 60 cases of entries in his almanac that we have examined.

John of Saxony's ephemerides were favorably embraced by practitioners of astronomy at the time. This is attested by the large number of extant copies as well as by the testimonies given in Vienna, Österreichische Nationalbibliothek, MS 5145. This fourteenth-century manuscript contains various treatises on astronomical instruments and it is preceded by a text (1r–5v) beginning *Ad vera loca cuiuslibet planetarum per tabulas operari* and ending *Expliciant canones tabularum almanach*. The text corresponds neither to the canons to John of Lignères's almanac nor to the canons to John of Saxony's ephemerides. Early in the text, it is said that the tables mentioned in the *incipit* are computed for the meridian of Paris. To explain the use of the tables, several examples are given. In the case of the Sun (f. 1v), the date chosen in the example is Saint John the Baptist's day (June 24) 1343, and the entry to be found in the table for the true solar position is 3s 9;48°. This is indeed the entry in John of Saxony's ephemerides for that specific day in those copies where the solar positions range from 1340 to 1343. In the example for the Moon (f. 1v) the same day is chosen and we are told that the true lunar position found in the table is 4s 0;20°. Again, this is the entry in John of Saxony's ephemerides. Other examples for 1341 and 1343, together with some specific features of the tables mentioned in the text, confirm that it refers to the ephemerides of John of Saxony, whose name does not occur in the text.

III. Conclusion

In his canons to the Parisian Alfonsine Tables, John of Saxony mentions tables compiled by his master, John of Lignères and in another text, *Exposiciones canonum primi mobilis Iohannis de Lineriis*, beginning *Quia plures astrologorum...*, John of Saxony refers to John of Lignères as his master (*magister meus*).¹² These passages, and the fact that John of Saxony copied some canons by John of Lignères (in Erfurt, MS F 377, 26v–35r), are the only references that connect the two astronomers. The similarity of their work in computing the positions of the celestial bodies, with different practices although with the same objective, is yet another indication of their relationship.

A salient feature of John of Saxony's ephemerides is the precision of the entries for the positions of all celestial bodies, to minutes of arc, whereas in John of Lignères's almanac it is to degrees. It is worth noting that the precision of the entries in two almanacs computed at the beginning of the fourteenth century, the almanac of Jacob ben Makhir and the almanac of 1307, was to minutes of arc, differing in this respect from all previous almanacs where the precision was only to degrees.¹³ It would seem that John of Saxony considered the precision used by his master insufficient and that a more precise set of planetary tables in the framework of Alfonsine astronomy was needed.

Another notable feature is that the entries computed by John of Saxony are not presented according to the scheme of cycles, different for each planet, with a constant increment, also different for each planet, to be added or subtracted to the corresponding positions in the first cycle for subsequent or previous cycles, as in all previous almanacs, including that of John of Lignères. Rather, John of Saxony presented the entries as ephemerides, that is, for selected days in each month (daily for the Sun and the Moon) for a sequence of years. It is this scheme that finally prevailed. More than a century later, Regiomontanus (1436–1476) compiled new ephemerides, with a different format, arranging the true positions of the five planets, the Sun, and the Moon in a single table.¹⁴ In this format a row begins with a date and is followed by the positions of each planet in turn, that is, planetary positions are arranged in columns for each planet, rather than in separate tables for each planet, as John of Saxony had done. Thanks to printing and the fame of the author, the format used by Regiomontanus was widely diffused and

much appreciated by astrologers and other practitioners of astronomy, for it facilitated their task as they did not have to consult different tables to find the positions of all planets on a specific date.

¹ J. Chabás and B. R. Goldstein, *The Alfonsine Tables of Toledo* (Dordrecht, 2003), pp. 282–284.

² This visit was sponsored by the European Research Council, Project ALFA (Alfonsine Astronomy), 2017–2022, led by Matthieu Husson (Observatoire de Paris).

³ The values for these periods of return are already found in *Almagest* IX.3, where Ptolemy defines “the smallest period in which it [each of the planets] makes an approximate return in both anomalies”: G. J. Toomer, *Ptolemy’s Almagest* (New York and Berlin, 1984), pp. 423. For Ptolemy, 59 returns in anomaly correspond very nearly to 59 solar years (Saturn), 65 returns in anomaly to 71 solar years (Jupiter), 37 returns in anomaly to 79 solar years (Mars), 5 returns in anomaly to 8 solar years (Venus), and 145 returns in anomaly to 46 years.

⁴ For John of Saxony, see Chabás and Goldstein, op. cit. (n. 1), pp. 284–289; for the Parisian Alfonsine Tables, see E. Ratdolt (ed.), *Tabule astronomice illustrissimi Alfontij regis castelle* (Venice, 1483).

⁵ For Vatican, BAV, MS Pal. lat. 446, see https://digi.vatlib.it/view/MSS_Pal.lat.446; for Vatican, BAV, MS Pal. lat. 1446, see https://digi.ub.uni-heidelberg.de/diglit/bav_pal_lat_1446.

⁶ J. Chabás and B. R. Goldstein, “The Almanac of Jacob ben Makhir” in M. Husson, C. Montelle, and B. van Dalen (eds.), *Editing and Analysing Numerical Tables: Towards a Digital Information System for the History of Astral Sciences*. (Turnhout, 2019). See also J. Boffito and C. Melzi d’Eril, *Almanach Dantis Aligherii sive Profhacii Judaei Montispessulani Almanach Perpetuum, ad annum 1300 inchoatum* (Florence, 1908).

⁷ On the almanac of Azarquiel, see J. M. Millás, *Estudios sobre Azarquiel* (Madrid–Granada, 1943–1950), pp. 72–237.

⁸ Chabás and Goldstein, op. cit. (n. 1), p. 285.

⁹ For Vatican, BAV, MS Pal. lat. 1409, see https://digi.vatlib.it/view/MSS_Pal.lat.1409.

¹⁰ We use the term “ephemerides”, already invoked in the 15th century (see n. 14), to distinguish John of Saxony’s work from previous almanacs.

¹¹ Chabás and Goldstein, op. cit. (n. 1), p. 287.

¹² See Ratdolt, op. cit. (n. 4), a5v; and Erfurt, MS F 386, 26ra, line 6.

¹³ On the almanac of 1307, see J. Chabás, “El almanaque perpetuo de Ferrand Martines (1391)”, *Archives Internationales d’Histoire des Sciences*, 44, 1986, pp. 261–308.

¹⁴ Johannes de Montereio, *Ephemerides: 1484–1506* (Venice, 1484). See also E. Zinner, *Regiomontanus: His Life and Work*. Trans. E. Brown (Amsterdam, 1990).