

Sulpicius Severus's Construction of his 84-year Paschal Table*

Daniel Mc Carthy

Abstract: The structure and termini of the 84-year Paschal table with a 14-year saltus followed by the early mediaeval churches of Britain and Ireland remained a matter of conjecture until 1985, when Dáibhí Ó Cróinín identified a full copy of the table in MS Padua, Biblioteca Antoniana, I.27. This paper undertakes a detailed analysis of the Padua table and demonstrates that its achievement of Anatolius' Paschal termini of luna 14–20 between 26 March and 23 April resulted from Sulpicius Severus' skilful exploitation of the synchronism between his 14-year saltus and the 28-year solar cycle.

Keywords Paschal celebration, Paschal termini, 84-year Paschal tables, 28-year solar cycle, 84-year lunar cycles, epacts, saltus, feriae, bissextiles, Sulpicius Severus, Anatolius of Laodicea, Aldhelm of Malmesbury, *Romana Supputatio*.

Daniel Mc Carthy
Department of Computer Science (Emeritus)
Trinity College Dublin
mccarthy@cs.tcd.ie

Introduction

In early 1985 Dáibhí Ó Cróinín was hard at work in the *Deutsches Museum* in Munich, trawling through Menso Folkerts's unique collection of microfilms of manuscripts with some mathematical content. When he arrived at the Paschal table commencing on folio 76^r of Padua, Biblioteca Antoniana, MS I.27 his attention was arrested by its unfamiliar presentation, each year commencing with 'KL', and then by the incomplete heading 'INC P T L T RC S ...', for he knew from transcribing the *Munich Computus* that the word '*latercus*' was used by the early Irish computists to designate their 84-year Paschal table. His observation of 'Initium' marking the date of the start of Lent, and a count of the table's 84 years

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confirmed his initial intuition, and so this became the first recorded identification in over 1200 years of the 84-year Paschal table followed by the early mediaeval Irish and British churches. This was the table that Columba brought to Iona in AD 562, that Cummián dismissed in his epistle of c. AD 633, that was repudiated at the synod of Whitby in AD 664, that was attributed to Sulpicius Severus by Aldhelm in AD 672, that was abandoned by the Iona community in AD 716, and by British monastic communities in AD 768. Thus Padua I.27 fols 76^r–77^v preserve a unique witness to the Paschal and doctrinal conflicts that convulsed the early churches of both Ireland and Britain.¹

Back in Galway, however, analysis of the structure of the table presented some computational problems and so, on 1 May 1987, Dáibhí posted a copy of the table to me at Trinity College Computer Science department, expressing the hope that we might be able to resolve these. Two years later the solution emerged from his transcript of the *Munich Computus*; the Padua table employed both the unique lunar year and the Paschal termini of *De ratione paschali* (DRP), and so scheduled Pasch on luna 14–20 between 26 March–23 April inclusive.² The Latin tract of DRP was attributed by mediaeval scholars to Anatolius, bishop of Laodicea, († c. AD 282), but had been dismissed by scholarship as an Insular forgery since the eighteenth century. That the Padua table employed both the unique lunar year and Paschal termini of Anatolius's DRP, while replacing his 19-year lunar cycle with an 84-year cycle, confirmed that the attribution by Aldhelm, abbot of

¹ Daniel Mc Carthy & Dáibhí Ó Cróinín, 'The "lost" Irish 84-year Easter table rediscovered,' *Peritia* 6–7 (Cork 1987–88) 227–42: 227–29, *latercus* discovery and description; reprinted in Dáibhí Ó Cróinín, *Early Irish history and chronology* (Dublin 2003) 58–75; Immo Warntjes (ed), *The Munich Computus: text and transmission* (Stuttgart 2010) 184–86, references to *latercus*; Bede, *HE* III 4, Columba and Iona, III 19 Whitby, see Bertram Colgrave & R. A. B. Mynors (eds & trans), *Bede's Ecclesiastical history of the English people* (Oxford 1969) 220–25, Columba; 294–309, Whitby; Daniel Mc Carthy, 'The chronology of Saint Columba's life,' in Pádraic Moran & Immo Warntjes (eds), *Early medieval Ireland and Europe: chronology, contacts, scholarship. A Festschrift for Dáibhí Ó Cróinín* (Turnhout 2015) 3–32: 18 (Columba's journey to Iona in AD 562); Maura Walsh & Dáibhí Ó Cróinín (eds), *Cummián's Letter 'De controversia paschali' and the 'De ratione computandi'* (Toronto 1988) 82–87, Cummián's dismissal. Daniel Mc Carthy, 'The origin of the Latercus Paschal cycle of the Insular Celtic churches,' *Cambrian Medieval Celtic Studies* 28 (1994) 25–49: 38–40, Aldhelm's attribution; AT p. 185, 'Pascha in Eóla ciuitate commotatur'; John Williams ap Ithel (ed), *Annales Cambriae* (London 1860) 10, '768. CCCXXIV. Annus. Pasca commutatur apud Brittones [super Dominicam diem,] emendante Elbodugo homine Dei'.

² Warntjes, *The Munich Computus*, 186, *latercus* lunar year; Daniel Mc Carthy & Aidan Breen (eds & trans), *The ante-Nicene Christian Pasch: 'De ratione paschali' – The Paschal tract of Anatolius, bishop of Laodicea* (Dublin 2003) 50–51, Anatolius's lunar year and Paschal termini; Daniel Mc Carthy, 'Easter principles and a fifth-century lunar cycle used in the British Isles,' *Journal for the History of Astronomy* 24 (1993) 204–24: 210–17, relationship between the Padua *latercus*, *Munich Computus* and DRP; 217–19, reconstruction of the *latercus*.

Malmesbury († AD 709), of this 84-year table to Sulpicius Severus († c. AD 420) was indeed correct.³

Further comparison of this table with other well-established Paschal tables revealed that it possessed some very singular properties, some of which are tabulated in Figure 1. For example: where other tables executed their saltus at 8-, 12-, or 19-year intervals, Sulpicius executed his saltus at 14-year intervals; where others celebrated Pasch either on luna 15–21, or luna 16–22, Sulpicius celebrated on Anatolius's luna 14–20; where the Paschal termini of other tables ranged from 31 to 35 days, Sulpicius achieved a range of just the 29 days counted inclusively between 26 March and 23 April, in accordance with Anatolius's termini. Moreover, the tables of the *Romana Supputatio* and Victorius had exceptions in some years where they failed to provide Paschal dates in accordance with their own termini, but Sulpicius had no such exceptions.⁴

Authority	Lunar cycle years	Saltus interval years	Paschal table years	Lunar term luna	Paschal term	Range days	Exceptions
Sulpicius Severus	84	14	84	14–20	26 Mar. – 23 Apr.	29	0
<i>Romana Supputatio</i>	84	12	84	16–22	22 Mar. – 21 Apr.	31	2
Hippolytus of Rome	8	8	112	16–22	20 Mar. – 21 Apr.	33	0
Victorius of Aquitaine	19	19	532	15–22	22 Mar. – 24 Apr.	34	32
Dionysius Exiguus	19	19	95	15–21	22 Mar. – 25 Apr.	35	0

Figure 1. The lunar and Paschal years of known Paschal tables, together with their saltus intervals, their lunar and Paschal termini, the range in days of their Paschal termini, and their exceptions, if any.

These observations inevitably prompted the following questions: 1) How did Sulpicius discover such a good solution? 2) Is his solution unique? 3) Does his solution have the minimal possible range? 4) How does his solution compare with other 84-year Paschal tables? It is the purpose of this article to answer these questions.

³ Mc Carthy & Breen, *De ratione paschali*, 114–41, Anatolius's authorship of *DRP*; Mc Carthy, 'Origin of the Laterculus', 38–40, Aldhelm's attribution.

⁴ Mc Carthy, 'Easter principles', 218–19, Sulpicius's table; Alden Mosshammer, *The Easter computus and the origins of the Christian era* (Oxford 2008) 210–11, *Supputatio* with exceptions *saa.* 303 & 360; 123–24, Hippolytus's table; 73, Dionysius Exiguus's table; Bruno Krusch, *Studien zur christlich-mittelalterlichen Chronologie* (Berlin 1938) 27–52, Victorius's table; Daniel Mc Carthy, 'The Paschal cycle of St Patrick', in Immo Warntjes & Dáibhí Ó Cróinín (eds), *Late antique calendrical thought in the Early Middle Ages – Proceedings of the 3rd International Conference on the Science of Computus in Ireland and Europe – Galway, 16–18 July, 2010* (Turnhout 2017) 94–137: 113–15 Victorius's 28 exceptions at epact 25 and 4 exceptions at epact 27 & feria 6.

Structure of Sulpicius's Table

In Figure 2, I reproduce the heading and first eight years of the Padua table, which can be seen to be arranged in six columns as follows: columns 1–2 give the feria, or weekday, and lunar epact, or lunar age, both for the kalends or first of January, indicated by the initial 'Kl'; columns 3–4 give the Julian date and the lunar age of Pasch, indicated by the initial 'P'; columns 5–6 give the Julian date and lunar age of the Initium, or beginning of Lent, indicated by the initial 'Inī'.

INCEPTUS	TERCIVS	ET	ATNCLTS		
Kl	S	Lxxviii	P	virkap	Lxxvi Inī xmitōm Lvi.
Kl	o	Lxxv	P	xvirkm	Lxxv Inī vintōm Lvi.
Kl	nf	Lxxii	P	virkap	Lxxv Inī vintōm Lvi.
B Kl	nf	Lxx	P	xvirkm	Lxxv Inī vintōm Lvi.
Kl	uf	Lxviii	P	virkap	Lxxv Inī vintōm Lvi.
Kl	uf	Lxv	P	xvirkm	Lxxv Inī vintōm Lvi.
Kl	uf	Lxii	P	virkap	Lxxv Inī vintōm Lvi.
Kl	uf	Lx	P	xvirkm	Lxxv Inī vintōm Lvi.

Figure 2. The heading and first eight years of the 84-year *latercus*, or Paschal table, identified by Dáibhí Ó Cróinín in 1985 in Padua, Biblioteca Antoniana, I.27 fol. 76^r. Printed with the permission of the Librarian, Biblioteca Antoniana, Padua.

As both the Pasch and Initium depend on the preceding feria and epact it will be helpful to explain these. Since common Julian years comprise 365 days, or 52 weeks and one day, and every fourth year is bissextile and so comprises 366 days, or 52 weeks and two days, the feria of 1 January increments by one following a common year, and two following a bissextile year, unless these exceed seven, when this increment must be decremented by seven, i.e. modulo 7. This combination of the 4-year bissextile and the 7-day week results in a $4 \times 7 = 28$ year cycle of the relationship between the feria of 1 January and the Julian year which is known as the solar cycle. Since Sulpicius's first year has on 1 January 'S' for 'Sabbatum', or feria 7, and his third year is bissextile, this yields the 28-year cycle of his feria which is tabulated in the row labelled 'K-feria' in Figure 3, where the 'b's in the following row identify each bissextile year. In the row above these feriae the 28 years of this solar cycle are enumerated 1–28 to provide a precise year reference to the solar cycle.

Regarding the lunar epact on 1 January, this increases by eleven from year to year, except following every fourteenth year, when, with the execution of the saltus it increases by twelve, unless these increases should exceed thirty, when this increment must be reduced by thirty, i.e. modulo 30. Since Sulpicius's first year has epact 19 (cf. Figure 2), this results in the 84-year cycle tabulated in the three rows labelled 'k-epact 1–28', 'k-epact 29–56', 'k-epact 57–84' in Figure 3, where the saltus years are highlighted with a green background.

Tabulation of these 84 epacts as three groups of 28 years discloses a unique and invaluable property of Sulpicius's table, namely that for any point in the solar cycle the kalends epact will always have the same least significant digit (lsd), and these are tabulated in the row 'k-lsd 1–3'. For example, at solar cycle 1, the epacts for years 1, 29, and 57 are luna 19, 29, and 9 respectively, so they all have the k-lsd 9; at solar cycle 2, epacts for years 2, 30, and 58 all have the k-lsd 0, and so forth. Consequently, I shall identify this cycle with the designation 9/19/29, the epacts at solar cycle 1 arranged in increasing magnitude. This property is a consequence of the synchronism between Sulpicius's 14-year saltus and the 28-year solar cycle, together with the fact that in 28 years there will be 26 years with an epact increment of eleven and two saltus years with an epact increment of twelve, so that the total epact increment in one solar cycle equals $26 \times 11 + 2 \times 12 = 286 + 24 = 310 \bmod 30 = 10$. Since the addition of ten cannot change the least significant digit of the epact, this least significant digit remains the same after every 28 years. This property greatly simplifies the task of identifying the combinations of feria and epact that can cause extreme Paschal dates, as will be demonstrated in detail below. We further note that, if the saltus is executed at any other interval, as for example the 12-year saltus of the 84-year *Romana Supputatio*, then this valuable property is lost.

solar-cycle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
k-feria	7	1	2	4	5	6	7	2	3	4	5	7	1	2	3	5	6	7	1	3	4	5	6	1	2	3	4	6
bissexus			b				b				b				b			b				b				b		
k-epact 1-28	19	0	11	22	3	14	25	6	17	28	9	20	1	12	24	5	16	27	8	19	0	11	22	3	14	25	6	17
k-epact 29-56	29	10	21	2	13	24	5	16	27	8	19	0	11	22	4	15	26	7	18	29	10	21	2	13	24	5	16	27
k-epact 57-84	9	20	1	12	23	4	15	26	7	18	29	10	21	2	14	25	6	17	28	9	20	1	12	23	4	15	26	7
k-lsd 1-3	9	0	1	2	3	4	5	6	7	8	9	0	1	2	4	5	6	7	8	9	0	1	2	3	4	5	6	7

Figure 3. Tabulating for the solar cycle 1–28: Sulpicius's 1 January feriae and bissextiles, followed by his 1 January epacts for years 1–84 arranged in three cycles of 28, and the least significant digits of these three cycles of epacts. Saltus years are shaded in green.⁵

⁵ Based upon Mc Carthy, 'Easter principles', 218–19, Table 3.

I next consider the relationship between the feria and epact of 1 January, and Sulpicius's Paschal dates and moons, and tabulate these graphically in Figure 4. Horizontally across the bottom are tabulated the modern and Julian dates from 20 March (13 kal. Apr.) to 29 April (3 kal. Mai), while the heavy vertical lines mark the Paschal termini at 26 March and 23 April, inclusive, which Sulpicius took from Anatolius's *De ratione paschali*. Then vertically for each epact 1–30 the seven adjacent squares identify the seven days of luna 14–20 when Sulpicius's Pasch may occur in common years of 365 days. For example, for epact 1 on 1 January in a common year the first luna 14 after 25 March falls on 12 April, and if 1 January falls on feria 5 then 12 April falls on feria 1, Sunday, so that Pasch is on 12 April, luna 14.⁶ So the inscribed 5 and epact 1 identify the feria-epact combination that result in Pasch on 12 April, luna 14, in a common year. But should 1 January fall on feria 4 in a common year then Pasch will fall one day later on 13 April, luna 15, and so forth until if 1 January falls on feria 6 then Pasch will fall on 18 April, luna 20. Thus the inscribed feriae 5, 4, 3, 2, 1, 7, 6 identify for epact 1 in a common year the date and lunar age of Pasch.

However, in a 366-day bissextile year Julian February has an additional day, which day is also included in the lunar calendar, so luna 14 still falls on 12 April. But if 1 January falls on feria 5, because of the additional bissextile day, 12 April now falls on feria 2, Monday, so Pasch must be deferred by six days to Sunday, 18 March, luna 20. Thus in order to locate the Pasch in Figure 4 for bissextile years Sulpicius's tabulated feria must be first incremented by one modulo 7, so $5+1 \bmod 7 = 6$. For example, the third year of Sulpicius's table is bissextile with feria 2, epact 11 (cf. Figure 2), so to locate its Pasch we increment the feria, $2+1 \bmod 7 = 3$, and then in row eleven of Figure 4 at feria 3 we find Pasch on 7 April (7 id. Apr.) luna 19, in accordance with his table.

In Figure 4 I have identified the $3 \times 21 = 63$ feriae of the common years in Sulpicius's table in yellow squares, and the 21 bissextile years in green squares located on Sulpicius's tabulated feria plus one modulo 7; plain squares identify epact-feria combinations that do not occur in his table. From this it can be seen that Sulpicius carefully chose the lunar structure of his table so that only Paschal dates falling between 26 March and 23 April inclusive could occur in accordance with Anatolius's *DRP*. Hence his table had no exceptions, as shown in Figure 1.



⁶ Regarding luna 14 on 12 April with epact 1, this is a consequence of Sulpicius using Anatolius's unique lunar year where lunar March has 29 days, whereas all other Paschal traditions assign 30 days to lunar March so that their luna 14 falls on 13 April, cf. n. 3.

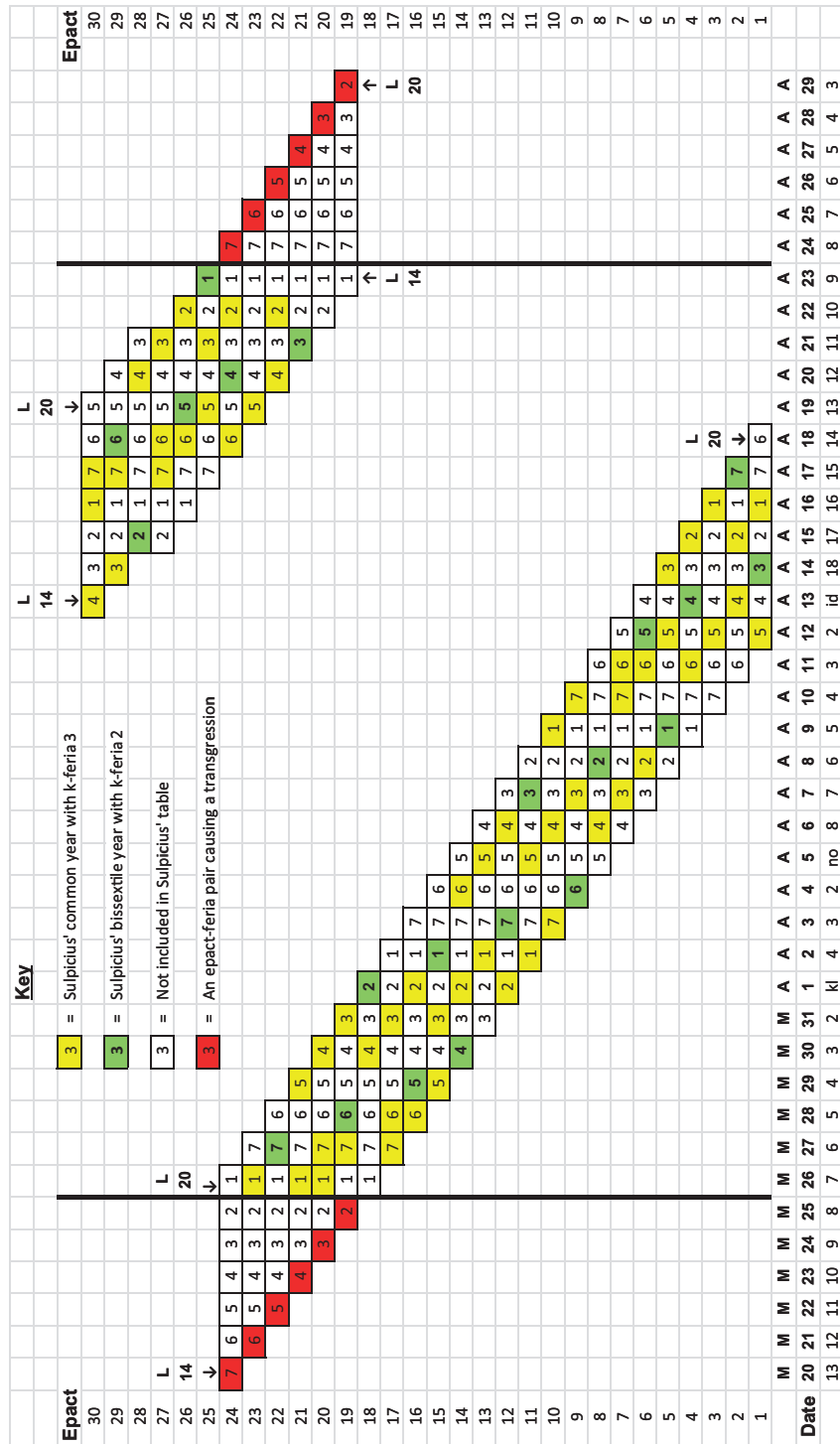


Figure 4. A graphical representation of Sulpicius's Paschal table identifying for each epact 1–30 and feria 1–7 the Paschal dates and moons in common years, and the combinations of epact and feria that would cause transgressions of Anatolius's Paschal termini 26 March–23 April. Sulpicius's common years are highlighted in yellow, bissextile years in green, and transgressions in red.

Epact-feria Combinations Causing Transgressions

However, initially of course Sulpicius had only Anatolius's lunar year and his Paschal termini from *DRP*, so the question arises how did he discover an 84-year lunar table that so precisely preserved Anatolius's termini? The reason to present Sulpicius's table in graphic form in Figure 4 is that it enables us to easily identify the epact-feria combinations that could cause a transgression of Anatolius's termini, had Sulpicius chosen a different lunar table. On the one hand it is clear from the figure that for epacts 1–18 and 25–30 no epact-feria combination can cause a transgression of Anatolius's termini, because for each of these epacts the Paschal luna 14–20 are all located within the termini. On the other hand, starting at epact 19 we see that, if it had combined with feria 2 in a common year, then the only dates within the luna 14–20 termini are 25 March or 29 April, both transgressing Anatolius's 26 March–23 April termini, and likewise if feria 1 had occurred in a bissextile year. Consequently, in Figure 4 I highlight these two transgressions in red. However, if any feria other than 2 were combined with epact 19 in a common year, or any feria other than 1 in a bissextile year, then it is clear graphically that a Paschal date and lunar age were available within Anatolius's termini. Next, considering epact 20, if combined with feria 3 in a common year or feria 2 in a bissextile year, then the only dates within luna 14–20 are 24 March or 28 April, both transgressing Anatolius's termini, which combinations are highlighted in red. But again, if any feria other than 3 were combined with epact 20 then an appropriate Paschal date and lunar age were available within Anatolius's termini. Continuing this process for epacts 21–24 we derive for each epact 19–24 a feria combination which would result in transgressions, and I abstract these epact-feria combinations and the resulting transgressions into the table shown in Figure 5.

k-epact		k-feria		k-feria		Paschal
		c.		b.		transgressions
24	&	7	or	6	→	20 March or 24 April
23	&	6	or	5	→	21 March or 25 April
22	&	5	or	4	→	22 March or 26 April
21	&	4	or	3	→	23 March or 27 April
20	&	3	or	2	→	24 March or 28 April
19	&	2	or	1	→	25 March or 29 April

Figure 5. Tabulating from Figure 4 the combinations of 1 January epacts and feria in common (c.) and bissextile (b.) years that will result in Paschal dates transgressing Anatolius's termini of 26 March–23 April.

With this information we return to the tabulation of the 28-year solar cycle of Sulpicius's feria shown in Figure 3 and now identify from Figure 5 for each year the epact that may cause a transgression, and this is shown in the row labelled 'transgr. epact' in Figure 6. Here, for example, since the first year of Sulpicius's solar cycle has feria 7 and is common, and Figure 5 shows that epact 24 when combined with feria 7 in a common year will cause a transgression, we enter the epact 24 below solar cycle 1 as the transgression epact. Further, since at solar cycle 12 and 18 we see that feria 7 also occurs in a common year, so we likewise enter 24 as the transgression epact below these. Further, Figure 5 shows that epact 24 combined with feria 6 in a bissextile year will also cause a transgression so we enter 24 below solar cycle 23. The occurrence of epact 24 at any of the solar cycle years 1, 12, 18 or 23 will result in a Paschal date transgressing Anatolius's termini. Repeating this procedure for epacts 23–19 identifies all of the possible combinations of epact and feria that can cause transgressions beyond Anatolius's termini of 26 March–23 April.

Next, in order to establish with which epacts Sulpicius could have commenced his table, we realise that, because Figure 1 demonstrates that if epact N , $0 \leq N \leq 9$ appears at solar cycle k , then so do epacts $N+10$ and $N+20$, so it is only necessary to examine $0 \leq N \leq 9$. Consequently, it is sufficient to examine the least significant digits of the ten possible cycles commencing in the range 0–9, and this has been done in the last ten rows of Figure 6.

solar-cycle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
k-feria	7	1	2	4	5	6	7	2	3	4	5	7	1	2	3	5	6	7	1	3	4	5	6	1	2	3	4	6
bissextus			b				b				b				b				b				b				b	
transgr. epact	24		20	21	22	23		19	20	21	23	24		19	21	22	23	24	19	20	21	22	24		19	20	22	23
Latest Pasch							Possible epact cycles commencing with k-lsd 0–9																					
29 April	0	1	2	3	4	5	6	7	8	9	0	1	2	3	5	6	7	8	9	0	1	2	3	4	5	6	7	8
24 April	1	2	3	4	5	6	7	8	9	0	1	2	3	4	6	7	8	9	0	1	2	3	4	5	6	7	8	9
29 April	2	3	4	5	6	7	8	9	0	1	2	3	4	5	7	8	9	0	1	2	3	4	5	6	7	8	9	0
25 April	3	4	5	6	7	8	9	0	1	2	3	4	5	6	8	9	0	1	2	3	4	5	6	7	8	9	0	1
29 April	4	5	6	7	8	9	0	1	2	3	4	5	6	7	9	0	1	2	3	4	5	6	7	8	9	0	1	2
26 April	5	6	7	8	9	0	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8	9	0	1	2	3
29 April	6	7	8	9	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	0	1	2	3	4
22 April	7	8	9	0	1	2	3	4	5	6	7	8	9	0	2	3	4	5	6	7	8	9	0	1	2	3	4	5
28 April	8	9	0	1	2	3	4	5	6	7	8	9	0	1	3	4	5	6	7	8	9	0	1	2	3	4	5	6
23 April	9	0	1	2	3	4	5	6	7	8	9	0	1	2	4	5	6	7	8	9	0	1	2	3	4	5	6	7

Figure 6. The row 'transgr. epact' identifies the epact and feria combinations that will cause transgressions outside Anatolius' termini 26 March–23 April. The ten rows headed 'Possible epact cycles commencing with k-lsd 0–9' identify all the possible lsd epact cycles, and the values enclosed there in rectangles identify occurrences of transgressions. The 'Latest Pasch' identifies the latest Pasch for each possible cycle.

Here, wherever 'transgr. epact' indicates a hazard we examine each column below to locate the occurrence of the least significant digit of that transgression epact.

So, for example, at solar cycle 1 we have the transgression epact 24, and since a 4 occurs in the fifth row then 84-year cycles commencing with epacts 4/14/24 are all excluded. Hence we enclose this 4 in a rectangle to show that this cycle is excluded. At solar cycle 2 there is no transgression epact, but at solar cycle 3 there is transgression epact 20, and we find a 0 in the penultimate row and so mark 84-year cycles commencing 8/18/28 as excluded with a rectangle. When we complete this process for solar cycle 4–28 we find that rows commencing 0–6, and 8 all have exclusion rectangles, and in the left hand column are tabulated the latest Paschal date implied by these exclusions. For example, at solar cycle 19–22 in the row commencing 0 the epacts with lsd 9, 0, 1, 2 are enclosed, and lsd 9 implies an occurrence of epact 19 and feria 1 in a bissextile year and so a latest Paschal date of 29 April, tabulated in the left-hand column; likewise for all the other exclusion rectangles.

The remarkable outcome of this process is that there are two rows without any exclusion rectangles, namely those commencing with 7 and with 9, implying that 84-year cycles commencing with 7/17/27 or with 9/19/29 could accommodate Anatolius's Paschal termini 26 March–23 April and luna 14–20. However, the latter of these two, 9/19/29, accommodates these termini perfectly, as Figure 4 shows, whereas 84-year cycles commencing 7/17/27 have 22 April as their latest Paschal date, so their range is just 28 days. Presented with this choice Sulpicius chose 9/19/29, which precisely preserved Anatolius's Paschal termini.⁷

In order to serve as a practical table to schedule the celebration of Pasch Sulpicius's lunar epacts had also to synchronize closely with the real moon, since the Paschal Sunday should fall within the seven days beginning with the spring full moon. We know from Sulpicius's written works that he compiled his table after AD 406 and, of course, before his death circa AD 420.⁸ Within this interval, as Immo Warntjes demonstrated, the year AD 410 corresponds to solar cycle 1 and epact 9, and that Sulpicius's Paschal luna 14 on 4 April synchronized closely with the real full moon on 5 April of that year, and likewise for the following decade (cf. Figure 7, column 'Difference'). Thus, by a truly remarkable coincidence, the only 84-year lunar cycle precisely accommodating Anatolius's Paschal termini also synchronized closely with the real moon at the time that Sulpicius discovered it.

⁷ Figure 4 shows that Pasch on 23 April occurs only when epact 25 is combined with feria 1 in a common year or feria 7 in a bissextile year. Examination of the 7/17/27 row of Figure 6 shows that the least significant digit 5 occurs at solar cycle 9, 18, and 28 with respectively feria 3, 7, and 6 in common years. Consequently, the cycle ~~7/17/27~~ does not include Pasch on 23 April, and so 22 April is its latest Pasch.

⁸ Mc Carthy, 'Origin of the Laterculus', 38–40, date of compilation.

AD	Sulpicius' 1 January feria	Sulpicius' 1 January epact	Sulpicius' Paschal luna 14	Redshift full moon	Difference days
410	7	9	4 April	5 April	1
411	1	20	24 March	26 March	2
412	2 b	1	12 April	13 April	1
413	4	12	1 April	2 April	1
414	5	23	19 April	21 April	2
415	6	4	9 April	10 April	1
416	7 b	15	29 March	29 March	0
417	2	26	16 April	17 April	1
418	3	7	6 April	6 April	0
419	4	18	26 March	27 March	1
420	5 b	29	14 April	14 April	0

Figure 7. Immo Warntjes's comparison for AD 410–20 of Sulpicius's Paschal luna 14 against the full moon dates computed by the astronomical programme 'Redshift'.⁹

However, as can be seen from Figure 2, Sulpicius did not commence his table with epact 9 at AD 410 but instead with epact 19, two solar cycles earlier at AD 354 = 410 – 2 × 28. While there is no surviving explanation for his choice we can identify a number of likely reasons for this retrospective beginning to his table. Following the death of his wife, Sulpicius adopted Christian monasticism, and in this he was principally inspired by the sanctity and monastic example of Saint Martin of Tours († 397), so that shortly after Martin's death he compiled his influential *Vita Sancti Martini*.¹⁰ The available evidence suggests that Martin was baptized in or close to AD 354, so that for Sulpicius this year marked a very important development in Gaulish monasticism.¹¹

⁹ Immo Warntjes, 'The Munich computus and the 84 (14)-year Easter reckoning', *PRIA* 107C (2007) 31–85: 37 Table 1; cf. Fred Espenak, *Six millennium catalog of phases of the moon* (2019), published at <http://astropixels.com/ephemeris/phasescat/phasescat.html> *saa.* 410–20.

¹⁰ Sulpicius Severus, 'Vita Sancti Martini', see Carolus Halm (ed), *Sulpicii Severi libri*, in *Corpus scriptorum ecclesiasticorum latinorum* 1 (Vienna 1866) 109–37, 'Vita Sancti Martini'; Clare Stancliffe, *St Martin and his hagiographer: history and miracle in Sulpicius Severus* (Oxford 1983) 15–19, Sulpicius's conversion; 48–54, his monasticism.

¹¹ Stancliffe, *St Martin*, 124, Martin's baptism *c.* AD 354.

While Martin's baptism *c.* AD 354 would be sufficient in itself to explain Sulpicius's choice for his initial year, there are even more fundamental features of the early years of his table that undoubtedly also influenced his decision. These arise from the beliefs held by Latin Christians of Late Antiquity concerning the chronology of Jesus's Passion and Resurrection, which beliefs derived from the chronicle of Hippolytus († 236), and the Paschal canon attributed to him. As Philipp Nothaft has written:¹²

According to the inscribed [Hippolytan] 'canon,' Jesus's ... crucifixion took place on Friday, 25 March, AD 29. ... Since Hippolytus puts the crucifixion on the day of the Passover full moon and hence on 14 Nisan, this means that he followed the Passion chronology of John, which implies that Jesus was crucified on the afternoon of 14 Nisan.

The first Pasch in Sulpicius's table is Sunday 27 March (vi Kal. Apr.), luna 16, implying Good Friday on 25 March, luna 14, in accordance with both Hippolytus's 25 March date for the Passion, and with his Johannine luna 14 Passion chronology, here identified by Nothaft.

A second aspect of late antique Christian belief emphasized by Nothaft is 'the impressive number of subsequent late antique Latin sources that link either 25 March or AD 29 ... or both to the Passion of Christ'.¹³ When we examine Sulpicius's table for its year synchronized to AD 29 we find it at AD 365 = 29 + 4 × 84, which, since his first year is at AD 354, falls at the twelfth year of his table. This year has epact 20, feria 7, and Pasch on Sunday 27 March, luna 17, so Passion on Friday 25 March, luna 15, in accordance with the Passion chronology of the Synoptic Gospels, which place the Passion on luna 15.¹⁴ Consequently, by commencing his table at AD 354 Sulpicius brought both Johannine and Synoptic Passion chronology to the first and twelfth years of his table, and demonstrated that his table located the Passion on 25 March in AD 29 in accordance with the then prevailing Latin belief.

Comparing 84-year Paschal Tables

Since Nothaft has shown that in the third century the chronicle and canon of Hippolytus established in the Latin world the year AD 29 and date of 25 March

¹² C. Philipp E. Nothaft, *Dating the Passion – The life of Jesus and the emergence of scientific chronology (200–1600)* (Leiden & Boston 2012) 47, 49.

¹³ Nothaft, *Dating the Passion*, 49.

¹⁴ Johannine–Synoptic Passion conflict: Charles Jones, *Bedae opera de temporibus* (Cambridge MA 1943) 7; Mosshammer, *The Easter computus*, 45; Nothaft, *Dating the Passion*, 23–25; Daniel McCarthy, 'The Council of Nicaea and the celebration of the Christian Pasch', in Young Richard Kim (ed.), *The Cambridge companion to the Council of Nicaea* (Cambridge 2021) 177–201: 179.

for Jesus's Passion, and Latin 84-year Paschal tables flourished from the fourth to the eighth centuries, it is of interest to compare how they handled this particular year. The earliest well-attested such cycle is the *Romana Supputatio*, for which the preface to the table in MS Ambrosiana H 150 Inf. states that it began in the year of the consulship of Faustus and Gallus, that is AD 298. In this table the six saltus are executed at 12-year intervals from AD 309 to 369, and in his reconstruction Eduard Schwartz judged that the table had been compiled c. AD 312. Since 1 January, 298, fell on feria 7 and AD 300 was bissextile, both the *Supputatio* and Sulpicius's table were synchronized to the same solar cycle.¹⁵ The earliest surviving witness to the *Supputatio*'s 1 January lunar epacts with their 12-year saltus is the *Fasti consulares* of the *Chronography of 354*, where, together with the Roman planetary weekday, these epacts are tabulated for AUC 245–753 (509–01 BC) and then AD 1–354.¹⁶

The best attested 84-year Paschal table after Sulpicius is that preserved in the fragments found by Augustus Cramer in 1816 lining the covers of the manuscript Zeitz fol. 33, now Berlin, Staatsbibliothek, MS lat. qu. 298.¹⁷ These fragments show that the table was compiled in AD 447 and that its first cycle commenced in AD 29 and its saltus was executed at 12-year intervals. Finally, in MS Lucca, Bibl. Cap., 490 we have just the preface to an 84-year table compiled by a Carthaginian computist in AD 455 that provides sufficient details to infer that its saltus was executed at 12-year intervals and that its first year corresponded with AD 29.¹⁸

The *Chronography of 354* is a very substantial compilation of Roman secular and christian material, with the latter comprising a Paschal table for AD 312–411,

¹⁵ *Supputatio* reconstructions: Bruno Krusch, *Studien zur christlich-mittelalterlichen Chronologie. Der 84-jährige Ostercyclus und seine Quellen* (Leipzig 1880) 62–64; Eduard Schwartz, *Christliche und jüdische Ostertafeln*, Abhandlungen der Königl. Gesellsch. der Wissensch. zu Göttingen, phil.-hist. Klasse, Neue Folge, 8, no. 6 (Berlin 1905) 46–49; Mosshammer, *The Easter computus*, 210–11. Date of *Supputatio*: Schwartz, *Christliche und jüdische Ostertafeln*, 44 'es spricht alles dafür, dass 298, oder vielmehr etwas später, vielleicht erst 312, der Cyclus neu eingestellt wurde'.

¹⁶ Theodor Mommsen (ed), 'Chronographus anni CCCLIII' in *Chronica Minora I*, MGH AA ix (Berlin 1892) 13–148: 50–61, *Fasti consulares*.

¹⁷ Augustus Cramer, *De fragmentis nonnullis vetustarum membranarum* (Kiel 1826) 3–16, discovery and partial edition. Editions and reconstructions: Theodor Mommsen (ed), 'Zeitzer Ostertafel vom Jahre 447', *Königl. Akademie der Wissenschaften zu Berlin* (Berlin 1863) 539–66; idem, 'Liber paschalis codicis Cizensis', in *Chronica minora I*, MGH AA ix (Berlin 1892) 501–10: 507–10; Krusch, *Studien I*, 116–23; Bruno Krusch, *Neue Bruchstücke der Zeitzer Ostertafel vom Jahre 447* (Berlin 1933) 996, transcription of the tabular criteria for AD 29–40; Daniel Mc Carthy, 'The Zeitz Paschal table', in Immo Warntjes & Tobit Loevenich (eds), *Pre-Carolingian Latin computus and its regional contexts: texts, tables, and debates* (Turnhout, forthcoming).

¹⁸ Carthaginian computist: Krusch, *Studien I*, 279–97, preface; Mosshammer, *The Easter computus*, 217–19, summary.

bishops' and martyrs' burials, and a papal and an Old Testament chronicle.¹⁹ Additionally, as mentioned above, the 84-year cycle of the *Supputatio*'s epacts has been interpolated into the *Fasti consulares*. Thus two of the christian elements of the *Chronography* make reference to Paschal celebration, so it is revealing to compare how these various 84-year tables scheduled Pasch in both AD 29 and 354. Consequently, in Figure 8 I tabulate for these four 84-year Paschal tables their Paschal date and moon for these years, where available.

Authority	Compiled AD	Saltus interval	AD 29 Pasch	AD 354 Pasch
<i>Romana Supputatio</i>	c. 312	12	27 Mar., l. 19	27 Mar., l. 17
Sulpicius Severus	c. 410	14	27 Mar., l. 17	27 Mar., l. 16
Zeitz	447	12	27 Mar., l. 17	27 Mar., l. 16
Carthaginian Computist of 455	455	12	27 Mar., l. 18	-

Figure 8. Four 84-year tables giving their authority, year of compilation and saltus interval, followed by their Paschal date and moon for AD 29 and AD 354.²⁰

Regarding the *Romana Supputatio* we see that in AD 354 its disciples celebrated the Passion according to the Hippolytan Passion date on 25 March but with the Synoptic luna 15, and so Pasch on Sunday 27 March, luna 17. However, when projected back to AD 29 their *Supputatio* did not reproduce this lunar date for Pasch, but luna 19 instead and hence luna 17 for the Passion. On the other hand, both Sulpicius and the Zeitz table scheduled Pasch for AD 29 on 27 March, luna 17, according to Hippolytus and Synoptic chronology, and then in AD 354 both scheduled Pasch on 27 March, luna 16, according to Johannine chronology. Finally, the Carthaginian computist, with his AD 29 Pasch on 27 March, luna 18, observed neither Synoptic nor Johannine Passion chronology.

From these comparisons the scale and extent of Sulpicius's achievement can be appreciated. For in circa AD 410 he managed not only to respect both Synoptic and Johannine Passion chronology, but also Hippolytus's Passion date of 25 March, AD 29, together with Anatolius's termini 26 March–23 April, in a table with no exceptions and a range of precisely 29 days. In these circumstances it

¹⁹ Richard W. Burgess, 'The Chronograph of 354: its manuscripts, contents, and history', *Journal of Late Antiquity* 5/2 (2013) 345–96: 346–52, surveys the contents of the *Chronography* — items IX, XI–XIV are christian.

²⁰ *Supputatio* dates: Krusch, *Studien* i, 62–64; Schwartz, *Christliche und jüdische Ostertafeln*, 46–49; Mosshammer, *The Easter computus*, 210–11; all *saa.* 354 & 365 = 29 + 4 × 84. Blackburn & Holford-Strevens, *Companion to the year*, 873; Sulpicius's dates *saa.* 354 & 365 = 29 + 4 × 84; Mc Carthy, 'Zeitz Paschal table', Figure 7, Zeitz: dates *saa.* 449 = 29 + 5 × 84 & 522 = 354 + 2 × 84; Mosshammer, *The Easter computus*, 218, Carthaginian date.

seems likely that Sulpicius, and those who followed his remarkable Paschal table, considered these features and synchronisms as a sign of Divine approval. Certainly, both the antagonism displayed towards his table by its opponents and the fact that these opponents abandoned the *Supputatio Romana* 84-year Paschal table with its 12-year saltus and termini, and instead adopted the Alexandrian 19-year lunar cycle and Paschal termini, suggests that they both feared Sulpicius's table and could not defeat it on its own terms. For example, in AD 444 and 455 pope Leo reluctantly abandoned the *Supputatio* and adopted Theophilus's Paschal dates, following which, in AD 457, in response to a request from Leo's archdeacon, Hilarus, Victorius of Aquitaine compiled a 532-year table employing the 19-year lunar cycle and endeavoured to accommodate both Roman and Alexandrian termini.²¹ Again, at this time the Latin author of the prologue to a 95-year Paschal table which is mis-attributed by its headings to Cyril († AD 444), bishop of Alexandria, emphatically endorsed Theophilus's Alexandrian Paschal table employing a 19-year lunar cycle, and attacked his opponents who employed an 84-year Paschal table with a 14-year saltus. Since these opponents also condemned the 35-day range of Theophilus's table because it exceeded 30 days, they could only be disciples of Sulpicius's table, as all other known tables exceed 30 days (cf. Figure 1).²²

The 84-year Period and the 12-year versus the 14-year Saltus

The facts that the epacts of the *Supputatio* commence in AD 298 and that the *Chronography of 354* tabulates these epacts from 509 BC to AD 354 show that the 84-year period was used by Roman Christians as a Paschal cycle at least by the mid-fourth century. Indeed, Anatolius in *DRP* includes the 84-year cycle amongst the list of Paschal cycles that he dismisses, so it had clearly been in Christian use by the later third century.²³ For this period to serve as a lunar cycle requires the execution of six saltus every 84 years, and this results in its calendar moon gaining on average one day on the real moon in about 65 years, which

²¹ Mosshammer, *The Easter computus*, 239–44, the Paschal cycle of Victorius; cf. n.4 for Victorius' exceptions.

²² Krusch, *Studien* i, 89–91, commentary; 337–43, edition; Alden Mosshammer (ed), *The Prologues on Easter of Theophilus of Alexandria and [Cyril]* (Oxford 2017) 114–29, edition and translation; 133–62, commentary; 119–23, endorsing Theophilus's table; 115, 123, his opponents' 84-year table with a 14-year saltus; 121, 127, defending Theophilus's range for exceeding 30 days. Daniel Mc Carthy, 'Christian Paschal tables and their lunar cycles' (forthcoming) for an evaluation of the prologue attributed to Cyril.

²³ Mc Carthy & Breen, *De ratione paschali*, 45, 'Alīi xxv, alīi xxx, nunnulīi lxxxīīī annorum circulum computantes'.

compares poorly with the 19-year lunar cycle, which retards by only one day on average in about 310 years.²⁴

When we compare the structure of the *Supputatio* and Sulpicius's table we find that they share the following significant features:

- a) Both tables employ the 84-year period;
- b) Both tables commence at the same year of the solar cycle;
- c) With its six saltus in 84 years the *Supputatio*'s average saltus period of $84/6 = 14$ years corresponds to the interval between Sulpicius's consecutive saltus.

It seems clear from these correspondences that both tables derive from the same chronographic tradition, which executed its saltus at 14-year intervals, and this then prompts the following questions. Did the 84-year table with a 14-year saltus have to have a sixth saltus at year 84, or did a version exist which, like the *Supputatio*, omitted a saltus at that final year? If it had a sixth saltus at year 84 then it provided an 84-year lunar cycle, and to retrospectively provide a Pasch in AD 29 on 27 March, *luna 17*, requires that it did include the sixth saltus. Indeed, the fact that the Padua table has the heading '*latercus*', and that this table was in use in the British Isles until the mid-eighth century, demonstrates that it certainly did serve as a lunar cycle, and so the *latercus* definitely executed that sixth saltus.²⁵ However, if there existed a secular version that omitted the saltus at year 84, then this would form the basis for a much more accurate lunar table with some very attractive properties. Firstly, with just five saltus in 84 years it would only gain on average one day on the real moon in about 297 years, and so would compare favourably with the 19-year cycle.²⁶ Secondly, each 84-year period of its table would preserve the synchronization of the least significant digits of its epacts with the 28-year solar cycle, as demonstrated in Figure 3, k-epact 1–84. This synchronization makes the table much simpler to write and to remember, and so less prone to scribal errors; each least significant digit needs only to be written once, and these form simple incrementing sequences (cf. Figure 3 k-1sd). Thirdly, while this table would require

²⁴ The 19-year cycle distributes 235 calendar months over 19 Julian years = $19 \times 365.25 = 6939.75$ days, whereas $235 \times \text{mean synodic months} = 235 \times 29.53059 = 6939.68865$ days, so its calendar moon *trails* the real moon by 0.06135 days after 19 years, or by one day after $19/0.06135 = 309.6984$ years. Similarly the 84-year cycle distributes 1039 calendar months over 84 Julian years = $84 \times 365.25 = 30681$ days, whereas $1039 \times \text{mean synodic months} = 1039 \times 29.53059 = 30682.28301$ days, so its calendar moon *leads* the real moon by 1.28301 days after 84 years, or by one day after $84/1.28301 = 65.471$ years.

²⁵ By the eighth century the *latercus* Paschal lunae 14 were on average four days in advance of the real full moon, and it is likely that it was this conspicuous and steadily increasing discrepancy that prompted its abandonment.

²⁶ By omitting the sixth saltus at year 84 this calendar moon would lead the real moon by just $1.28301 - 1 = 0.28301$ days after 84 years, or by one day after $84/0.28301 = 296.8093$ years.

an update at the start of each 84-year period, this update would consist simply of decrementing each epact by one; consequently this update preserves the synchronization of the least significant digits of the three 28-year cycles of the epacts. Fourthly, such a table would provide a practical and simple lunar calendar for 84-year periods for all those persons using the Julian calendar and seven-day week who needed to have a good approximation to the lunar phase. For example, such a table would be of value to such as mariners needing to anticipate tides, astrologers wishing to estimate sun-moon configurations, and military strategists planning night-time missions. This therefore suggests the co-existence of both an 84-year lunar cycle with six saltus, and an 84-year lunar period executing just five saltus at 14-year intervals. It seems that it was just such a secular version that provided Sulpicius's basis when he sought a lunar cycle to accommodate Anatolius's termini.

Regarding the origin of the *Supputatio's* 84-year cycle, since its 12-year saltus eliminates the synchronization of the epacts' least significant digits while maintaining an average 14-year saltus, it seems clear that it also is a derivative of this secular 84-year period with a 14-year saltus. The preface to the table of the *Supputatio* in Milan, Biblioteca Ambrosiana, H 150 inf., states that its 84-year cycle commences in AD 298, and since it commences at this year with epact 1 this suggests that its lunar cycle was adapted from the secular 84-year period commencing 84 years earlier with epact 1 in AD 214, when the observable crescent new moon was indeed closely synchronized to 1 January, 214.²⁷ For this table to schedule Pasch on 27 March, luna 17, in AD 354 it had to commence at AD 298 with epact 1, and this requirement provided the basis for the construction of the *Supputatio*. Thus the *Supputatio* was adapted from the secular table for the 84-year period AD 214–97 by reducing the interval between consecutive saltus from fourteen to twelve years, which made it explicit that this is an 84-year lunar cycle, while preserving the secular table's omission of the saltus at year 84. This construction, while ensuring that AD 354 commenced with the appropriate epact 21 to obtain Pasch on 27 March, luna 17, resulted in AD 29 = 365–4×48 commencing with epact 23, and hence Pasch in AD 29 inappropriately on 27 March, luna 19 (cf. Figure 8). It should also be noted that in this construction the compilers of the *Supputatio*, while achieving in AD 354 Hippolytus's Passion date of 25 March, chose to replace his Johannine Passion of luna 14 with the Synoptic luna 15. Schwartz's conclusion that the *Supputatio* had been instituted in the early fourth century is in accordance with this reconstruction. Thus I conclude that both the *Supputatio* and Sulpicius's table are two separate adaptations of an earlier secular 84-year period with a 14-year saltus.

²⁷ Mosshammer, *The Easter computus*, 206–07, the Ambrosian table; Espenak, *Six Millenium Catalog*, sa. 213, gives lunisolar conjunction at 16:40 on 29 December, AD 213. Sulpicius's table has epact 29 at AD 382, which implies that the secular 84-year period had the following sequence of initial epacts at 84-year intervals: AD 382–ep. 29, 298–ep. 30, 214–ep. 1, 130–ep. 2, 46–ep. 3.

The remarkable mathematical properties of the 84-year table with a 14-year saltus, whether a cycle or a period, derive from the interaction between the Julian calendar and the seven-day week, so its introduction must postdate these. In 46 BC Julius Caesar († 44 BC) reformed the Roman calendar, but following his murder the bissextiles were incorrectly inserted until AD 8 when Augustus († AD 14) corrected and stabilized these. While the Roman seven-day planetary week is attested in the last century BC, it is from Augustus's reign that these references increase in number and formality, appearing in inscriptions and in poetry.²⁸ Thus the properties of the solar cycle were likely known to those who corrected the insertion of the bissextiles for Augustus. For they could hardly have achieved the correction of the bissextiles without becoming aware of the solar cycle, and the advent of such knowledge would accord with the increased number of formal references to the planetary week from that time. In the early second century the design of the Pantheon in Rome, the present building constructed c. AD 126 by Hadrian († AD 138), is certainly suggestive of the solar cycle. The spectacular hemispherical dome, 43.3 metres in diameter, is supported and subdivided by twenty-eight equally spaced ribs, while at ground level seven substantial, architecturally framed niches are spaced evenly around the circumferential walls. These structural details and its name would all reconcile with the length of the solar cycle and the planetary week, and consequently suggest that the importance of the 84-year period for the Julian calendar was known in Rome by c. AD 126.²⁹

Long before Sulpicius's time christian mathematicians in Rome considering the scheduling of Pasch had sought simple, regular relationships between solar and lunar cycles. For example, the construction of the 112-year Paschal table for AD 222–333 inscribed on the plinth of a statue found in the mid-sixteenth century in Rome shows that its compiler had studied the relationship between the solar cycle and an 8-year lunar cycle very carefully. For the first column of this table is a 16-year sequence of Paschal luna 14 dates employing two successive cycles of the 8-year octaëteris commencing in AD 222. This column is followed by seven columns listing the feriae on which these sixteen luna 14 dates will fall, and, because in sixteen years the feria of any fixed Julian date must decrement by one modulo 7, then each row of these seven columns consists of the seven feria 1–7 in a decrementing series. For example, since the first luna 14 date is 13 April, which in

²⁸ Blackburn & Holford-Strevens, *Companion to the year*, 670–71, Augustus's correction of the Julian bissextiles; 566–67, Roman planetary week; Sacha Stern (ed), *Calendars in the making – the origins of calendars from the Roman Empire to the later Middle Ages* (Leiden & Boston 2021) 22–38, 'The Roman planetary week', with Ilaria Bultrighini; 23, 'The planetary week should be regarded as specifically "Roman" ... It is well attested in the city of Rome and in central-southern Italy in the Augustan period and the first century CE'.

²⁹ For the Pantheon details cf. https://en.wikipedia.org/wiki/Pantheon,_Rome.

AD 222 fell on feria 7, the first row is simply 7, 6, 5, 4, 3, 2, 1, and the subsequent rows merely rotate this sequence.³⁰ The ferial data in this table could have been written in half the space as seven columns of eight rows but then the sequence of the first row would become 7, 3, 6, 2, 5, 1, 4; clearly the regular decrementing sequence at 16-year intervals was preferred by its compiler, and these may be compared with the simple incrementing sequences of the k-1sd in Figure 3.

Conclusions

From the foregoing we may answer the four questions posed in the introduction. It is clear that for anyone who understood the valuable mathematical properties of an 84-year lunar cycle with a 14-year saltus, then a modest calculation was sufficient to establish that in order to precisely observe Anatolius's termini, luna 14–20 and 26 March–23 April, the solar cycle should commence with epacts 9/19/29. In c. AD 410 Sulpicius Severus performed this calculation and then discovered that the epacts of the resulting table not only synchronized closely with the real moon at that time, but when projected retrospectively to AD 29 it reproduced Hippolytus's date of 27 March for Jesus's Resurrection with luna 17, and hence the Synoptic luna 15 for Jesus's Passion. Moreover, at AD 354 it again reproduced Hippolytus's Resurrection date of 27 March and luna 16 for Pasch, and hence also his 25 March and Johannine luna 14 for the Passion. While Sulpicius's 9/19/29 solution is not unique, and it is the 7/17/27 solution that has the minimal range of 28 days, Sulpicius's solution is the only one that precisely accommodates Anatolius's termini. Further, when compared with other 84-year Paschal tables it is seen that Sulpicius achieved a Paschal schedule observing not only Anatolius's termini without any exceptions, but also the then prevailing beliefs regarding the chronology of Jesus's Passion and Resurrection.

It seems likely that it was the combination of the table's outstanding mathematical properties together with its conformation to Synoptic and Johannine Passion chronology, to Hippolytus's AD 29 Crucifixion date, and to Anatolius's termini that invited deep admiration and commitment to it. Sulpicius's Paschal table attracted the devotion of especially monastic christians in Gaul, Britain, and Ireland, where it arrived at about AD 425.³¹ Here it appears that its remarkable mathematical and chronological properties inspired the early Irish christian computists to study care-

³⁰ Mosshammer, *The Easter computus*, 116–21, the statue and its doubtful identification with Hippolytus; 121–25, the Paschal table. Blackburn & Holford-Strevens, *Companion to the year*, 805, feria relationship at 16-year intervals. Cf. Figure 3 k-feria at solar cycle 1–12 versus 17–28.

³¹ Daniel Mc Carthy, 'On the arrival of the *Latercus* in Ireland', in Immo Warntjes & Dáibhí Ó Cróinín (eds), *Proceedings of the Second International Conference on the Science of Computus* (Turnhout 2011) 48–75: 69, date of *latercus* arrival in Ireland.

fully its lunar and Paschal cycles, and then to compare them critically with Victorian and Dionysiac tables as these became available. This process is well-documented by Cummián's letter of circa AD 633, and the Irish computistical text-books of the later seventh and early eighth centuries, the *Munich Computus*, the *Computus Einsidlensis* and *De ratione computandi*.³² Notwithstanding the inexorable advance of its Paschal luna 14 relative to the real moon, the *latercus* continued in use by the Iona community to AD 716, and by some British communities to at least AD 768. Moreover, certain distinctive elements of Sulpicius's Paschal table continued in Irish monastic culture for many centuries. Their annals, for example, employed the 'KI' representing the kalends of January as the primary component of their chronological apparatus until their termination in AD 1590.³³ In the nineteenth century a verse learned orally by Canon Peter O'Leary in west Cork provided a formula with which to calculate the age of the moon based upon Anatolius's unique lunar year, maintained by Sulpicius.³⁴ In these various ways Sulpicius's achievement of reconciling Anatolius's termini and lunar year to the 84-year cycle with a 14-year saltus, left an enduring trace upon Ireland's monastic culture.

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³² Walsh & Ó Cróinín, *Cummian's Letter 'De controversia paschali'*, 55–97, Cummián's Letter; 115–213, *De ratione computandi*; Mc Carthy, 'The Paschal cycle of St Patrick', 100–04, the Paschal tables discussed by Cummián; Warntjes, *The Munich Computus*, 1–317, *Munich Computus*; the *Computus Einsidlensis*, is currently being edited and translated by Tobit Loevenich in Dublin.

³³ Daniel Mc Carthy, *The Irish annals: their genesis, evolution and history* (Dublin & Portland OR 2008) 352–53, Figures 54–55, ranges of annalistic chronological criteria; cf. idem, www.irish-annals.cs.tcd.ie/saa. 1–1590.

³⁴ Mc Carthy, 'Easter principles', 212–13, O'Leary's verse and analysis.