John Dee and the Magic Tables in the *Book of Soyga*[*]

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'Oh, my great and long desyre hath byn to be hable to read those tables of Soyga'.
— John Dee[1]

1. John Dee and the *Book of Soyga*

Until recently the *Book of Soyga* was known only by repute, through mention in the diaries of John Dee (1527–1608). Dee's association with the *Book of Soyga* is conveniently summarized by Christopher Whitby:[2] On 18 April 1583 Dee was unable to find his *Book of Soyga*: it has been mislaid. On 29 April 1583 Dee remembered a detail about the missing book: '...E[dward] K[elley] and I wer talking of my boke Soyga, or Aldaraia and I at length sayd that, (as far as I did remember) Zadzaczadlin, was Adam by the Alphabet therof...' On 19 November 1595 Dee recovered his *Book of Soyga*. Many years later Elias Ashmole (1617–1692) reported that 'the Duke of Lauderdale hath a folio MS. which was Dr. Dee's with the words on the first page: Aldaraia sive Soyga vocor'.

In addition to these unremarkable appearances of the *Book of Soyga* in Dee's *nachlaß* —unremarkable, for who does not sometimes mislay and later recover a valued book? — there is the singular exchange held between Dee and the angel Uriel on the occasion of their first conversation, at Mortlake on Saturday, 10 March 1581/1582, the very first scrying session mediated by Dee's most famous scryer, Edward Kelley (1555–1595?), also known as Kelly and Talbot.[3] In the following, Δ is Dee, VR is Uriel:

Δ— ys my boke, of Soyga, of any excellency?

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VR— Liber ille, erat Ada[m]e in Paradiso reuelatus, per Angelos Dei bonos. [That book was revealed to Adam in Paradise by God's good angels.]

Δ— Will you give me any instructions, how I may read those Tables of Soyga?

VR— I can—But solus Michaël illius libri est interpretator. [Only Michael is the interpreter of that book.]

Δ— I was told, that after I could read that boke, I shold liue but two yeres and a half.

VR— Thow shallt liue an Hundred and od yeres.

Δ— What may I, or must I do, to haue the sight, and presence, of Michael, that blessed Angel?

VR— Presentias n[ost]ras postulate et invocate, sinceritate et humilitate. Et Anchor, Anachor, et Anilos, non sunt in hunc lapidem invocandi. [Request and invoke our presence with sincerity and humility. Anchor, Anachor and Anilos are not to be called into this stone.]

Δ— Oh, my great and long desyre hath byn to be hable to read those tables of Soyga.

VR— Haec maximè respiciunt Michaëlem. Michaël est Angelus, qui illuminat gressus tuos. Et haec revelantur in virtute et veritate non vi. [These things are mostly to do with Michael. Michael is the angel who illuminates your steps. And these things are revealed in virtue and truth and not by force.]

Δ— Is there any speciall tyme, or howre to be observed, to deale for the enioying of Michael?

VR— Omnis hora, est hora nobis. [Every hour is ours.] ... [4]

To summarize: Uriel confirms Dee's high estimation of the *Book of Soyga*'s value. Dee wants angelic help in understanding his *Book of Soyga*, but only the angel Michael is cleared to talk about this topic. If, as some scholars believe, Kelley was a charlatan, then here we find him (in the voice of Uriel) being characteristically evasive. As a newcomer to Dee's household he does not want to commit himself to any more specific statements about the *Book of Soyga*, about which he knows very little beyond the fact that it fascinates Dee.[5]

There things rested for roughly four centuries. Dee prized his *Book of Soyga*, but since the book was lost, modern scholars could only guess about its contents and possible influence on Dee's magic system, especially for the version in his *Book of Enoch*.[6]

But then in 1994 Deborah Harkness — like the hero of Poe's 'The Purloined Letter' — located not one but two copies in the obvious places, in this case in two of England's greatest libraries. They had been catalogued under the title *Aldaraia* instead of *Soyga*.[7]

At last we can examine the *Book of Soyga*, and in particular its tables, and see for ourselves what it was that Dee prized so highly.

The *Book of Soyga* is an anonymous late-mediaeval or early modern Latin magical work extant in two sixteenth century manuscript copies: one in the Bodleian Library, which I refer to as Bodley 908, and the other in the British Library, which I refer to as Sloane 8.[8] Since there is as yet no edition or translation of either of the two manuscripts for me to refer to, nor even a synopsis of their contents, I offer the following brief description.[9]

The Sloane 8 copy (but not the Bodley 908 one) bears the title *Aldaraia sive Soyga vocor* at the head of the text and on the leaf preceding the text, both in the same hand as the text, fitting Ashmole's description. Sloane 8's preceding leaf also bears the description *Tractatus Astrologico Magicus*, written in a different hand. Both copies contain the equation of 'Adam' with 'Zadzaczadlin', so there can be no doubt that Harkness's *Book of Soyga* is closely related to Dee's *Book of Soyga*; on Ashmole's *Aldaraia sive Soyga vocor* evidence, and based on the arguments I present at the end of section 5, it is easy to guess that Sloane 8 was in fact Dee's copy of the *Book of Soyga*.[10]

The 197 leaves of Bodley 908 contain three named works, *Liber Aldaraia*, *Liber Radiorum*, and *Liber decimus septimus* (of 95, 65, and 2 leaves, respectively) as well as a number of shorter unnamed works totalling about 10 leaves. The final 18 leaves contain the tables that are the subject of this paper. Sloane 8 has 147 leaves, and seems largely identical with Bodley 908, except that the tables occupy 36 leaves and the *Liber Radiorum* is present only in a 2 leaf truncated 'executive summary' version.

A cursory inspection of the *Book of Soyga* shows it is concerned with astrology and demonology, with long lists of conjunctions, lunar mansions, names and genealogies of angels, and invocations, not much different from those found, say, in pseudo-Agrippa.[11] A single example, of a list of spirits of the air, is illustrative of the whole:

> Adracty, Adaci, Adai, Teroccot, Terocot, Tercot, Herm, Hermzm, Hermzisco, Cotzi, Cotzizi, Cotzizizin, Zinzicon, Ginzecohon, Ginchecon, Saradon, Sardon, Sardeon, Belzebuc, Belzscup, Belcupe, Saraduc, Sarcud, Carc, Sathanas, Satnas, Sacsan, Contion, Conoi, Conoison, Satnei, Sapnn, Sappi, Danarcas, Dancas, Dancasnar.[12]

Some of the spells or incantations have a vaguely Christian or alchemical air to them, as 'Petra Ouis Angelus Agnus Lapis Sponsus' and 'Diuinitas Christus Venturus Iustorum Humanitatis Vnitas',[13] but the

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overall impression is that it is no more an alchemical treatise than it is a devotional work.

Several features of the *Book of Soyga* seem worth particular mention, as being untypical of a standard late mediaeval or Renaissance magical work, or of the run-of-the-mill necromancy handbook.[14] In contrast to most mediaeval or Renaissance works, the text has extremely few references to known authors or personalities. There are no recognizable *auctores*. Other than the occasional mention of a few Old Testament names, and two references to *Libro Geber*, and a puzzling marginal gloss 'Steganographia' in the same hand as the text, which is presumably a reference to the work of Johannes Trithemius (1462–1516), there are no references to recognizable personalities.[15]

Instead, it makes numerous references to what are presumably mediaeval magical treatises, works such as *liber E*, *liber Os, liber dignus, liber Sipal, liber Munob,* and the like.

Throughout the book much importance is placed on writing words backwards. This can be seen in some of the titles mentioned above: *Sipal* backwards is *Lapis,* and *Munob* reversed is *Bonum.* Phrases such as 'Retap Retson' occur throughout. This principle is reflected in the form of the tables, as discussed below. The name of the work, *Soyga*, is itself explained to be 'Agyos, literis transvectis'.[16]

Throughout the book there is a preoccupation with letters and combinations of letters, assignments of numerical values to letters, assigning letters to planets and to elements, listing combinations of letters associated with houses of the moon, recombining letters and syllables in incantations to form new magic words, listing new names for the 23 letters of the Latin alphabet, sometimes taken in reversed Z through A order, listing new symbols for the 23 letters, and so on.

And, towards the end of the book there is the set of thirty-six large square tables, described in section 2 of this paper, filled with a seemingly random jumble of letters. (One of these is illustrated in my Plates I and II.) These tables do not appear to be like any illustrated in, say, Shumaker's survey of mediaeval and early modern magic works.[17]

The *Book of Soyga*'s preoccupation with letters, alphabet arithmetic, Hebrew-like backwards writing, and so on, is of course characteristic of the new Cabalistic magic which became popular in the sixteenth century, exemplified by the great compilation of Agrippa of Nettesheim (1486–1535), and borrowing authority both from the Renaissance humanist interest in the Kabbalah expressed by such figures as Pico and Reuchlin and from the supposed Biblical antiquity of the Kabbalah.[18] Although large square tables are not themselves a characteristic feature of the traditional Kabbalah, they had by Agrippa's time become an integral part of the Christian magical Cabala.[19]

Such a work must have appealed to Dee since it encompassed so many of the ingredients associated with early modern magical and Christian Cabalist texts; we know the tables in the *Book of Soyga* excited John Dee's interest, as seen in the dialogue with Uriel. They certainly also excited mine as a professional cryptologist. Were they, I wondered, filled with a random (and hence pointless) selection of letters, or were they a cryptogram (with a hidden 'plain text' meaning, which might at least in principle be recoverable by cryptanalysis), or was there some other structure or pattern to them? I approached the tables as I would any cryptographic problem, first transcribing the data and entering it into the computer, and then trying out what I knew of the bag of code-breakers' tricks. The results, which I describe in sections 3 through 6, were unexpectedly gratifying.

This paper, then, indirectly addresses the question of the *Book of Soyga*'s possible influence on Dee by examining and comparing the *form* (or method of construction) of the tables in the *Book of Soyga* and those found in other early modern magic tables (including Dee's and Agrippa's), rather than their *function* (i.e., purpose or method of use).

2. The Magic Tables of the *Book of Soyga*

The *Book of Soyga* contains thirty-six tables; each table is a square grid of 36 rows and columns; each grid cell contains a letter of the Latin alphabet.[20] These tables turn out to be formed by a completely deterministic calculation method, or algorithm, starting from an arbitrary 'code word' for each table. This construction algorithm is so intricate that it is unlikely that its presence would be detected on casual examination of the tables.

Each of the thirty-six tables is headed with a number and a label. I summarize these in my Table I. For convenience I will refer to them as T1, T2, and so on. T1 through T12 are labelled with the signs of the zodiac, Aries through Pisces; as are T13 through T24. T25 through T31 are labelled with the seven planet names, and T32 through T35 with the four element names. T36 is labelled with the word 'Magistri'. See my Plates I and II for the Bodley 908 and Sloane 8 versions of T1 'Aries'.

Eight of these tables also appear copied in Dee's notebook, the *Book of Enoch*, joined in pairs: 'The First Table' in the *Book of Enoch* is a 72-row table, filling both pages of an opening, the first 36 rows of which are Soyga's T1 and the last 36 rows of which are Soyga's T13, the two

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Table I. Soyga Tables.

Table	*label*	*code word*	*location in:* Bodley 908	Sloane 8	Sloane 3189
1	Aries	NISRAM	180r	102v/103r	58v
2	Taurus	ROELER	180v	103v/104r	60v
3	Gemini	IOMIOT	181r	104v/105r	62v
4	Cancer	ISIAPO	181v	105v/106r	64v
5	Leo	ORRASE	182r	106v/107r	
6	Virgo	OSACUE	182v	107v/108r	
7	Libra	XUAUIR	183r	108v/109r	
8	Scorpio	RAOSAC	183v	109v/110r	
9	Sagitarius	RSADUA	184r	110v/111r	
10	Capricornus	ATROGA	184v	111v/112r	
11	Aquarius	SDUOLO	185r	112v/113r	
12	Pisces	ARICAA	185v	113v/114r	
13	Aries	MARSIN	186r	114v/115r	59r
14	Taurus	RELEOR	186v	115v/116r	61r
15	Gemini	TOIMOI	187r	116v/117r	63r
16	Cancer	OPAISI	187v	117v/118r	65r
17	Leo	ESARRO	188r	118v/119r	
18	Virgo	EUCASO	188v	119v/120r	
19	Libra	RIUAUX	189r	120v/121r	
20	Scorpio	CASOAR	189v	121v/122r	
21	Sagitarius	AUDASR	190r	122v/123r	
22	Capricornus	AGORTA	190v	123v/124r	
23	Aquarius	OLOUDS	191r	124v/125r	
24	Pisces	AACIRA	191v	125v/126r	
25	Saturni	OSRESO	192r	126v/127r	
26	Jovis	NIEBOA	192v	127v/128r	
27	Martis	OIAIAE	193r	128v/129r	
28	Solis	ITIABA	193v	129v/130r	
29	Veneris	ADAMIS	194r	130v/131r	
30	Mercurii	REUELA	194v	131v/132r	
31	Lunae	UISEUA	195r	132v/133r	
32	Ignis	MERONF	195v	133v/134r	
33	Aeris	ILIOSU	196r	134v/135r	
34	Aquae	OYNIND	196v	135v/136r	
35	Terrai	IASULA	197r	136v/137r	
36	Magistri	MOYSES	197v	137v/138r	

'Aries' tables, and so on, as indicated in my Table I.[21] See my Plate III for the *Book of Enoch* version of T1 'Aries'.

The tables are written with italic letters, mostly lower case, written into a neatly pencilled regular grid. In Bodley 908 the grid cells measure approximately one quarter of an inch, so a complete table fits on one page. In Sloane 8 the grid cells are approximately one third of an inch in size, and each table occupies the two facing pages of an opening. In each book there is occasional use of the short s; much more common is the long s. The writing becomes more even after the first few tables, with greatly diminished use of upper case letters, as if the copyist became accustomed to what must have been an unusually irksome and tedious task of copying completely senseless data which offered no obvious contextual clues for correcting mistakes. In Bodley 908 upper case L is used exclusively, presumably to avoid confusion with long s. In Sloane 8 lower case l is used exclusively.

The handwriting in Bodley 908 is quite even, and pains seem to have been taken to make the letters clearly distinguishable. The handwriting in Sloane 8 is less clear, so that *n* and *u* are often hard to tell apart, as are the pairs *c/e* and *l/i*. Sloane 8 shows obvious signs of proofreading, with dots, double dots, and cup strokes marking errors or doubtful readings. Occasionally a cell contains, in addition to its main letter, a tiny *f* followed by another tiny letter; I surmise *f* means *falso* and the following letter is the suggested correction. Some corrections seem to have been made by erasure and overwriting; the handwriting also seems to change part way through.

The left hand margin in each table is special. Each table has a 'code word', e.g., T1 'Aries' has code word NISRAM. The left margin is composed entirely of the code word and the reversed code word, e.g., NISRAM MARSIN NISRAM MARSIN ... repeated until the margin is filled.

The code words are listed in the third column of my Table I. All thirty-six of them are exactly 6 letters long. The treatise in the *Book of Soyga* which discusses the tables, 'Liber Radiorum', has a series of paragraphs mentioning the code words for twenty-three of the tables, together with number sequences which stand in unknown relation to the words.[22]

Note that the code words for T13–T24 are the reverses of those of the corresponding T1–T12. Thus, T1 'Aries' has code word NISRAM and T13, also 'Aries', has code word MARSIN.

In Bodley 908, T36 'Magistri' has a blank 13th line—the first line after the first complete MOYSES/SESYOM cycle on the left. The Sloane 8 version the table has the same 35 non-blank lines, but they have 'closed ranks' so it is the last line of 36 which is blank.

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In general, the first four or five rows of the tables appear very repetitious. Often the first row or two consist entirely of endless repetitions of a given two letter 'motif', followed by two or three rows of repetitions of a 4 letter motif, with maybe another row or so consisting of repetitions of a 12 letter pattern. But these repetitions do not start until one has gone some distance into the row; with each successive row, one has to go further.

This may be seen in T1 'Aries', shown in Plates I and II, where the first three lines soon fall into repetitions of the 4 letter motifs `dizb`, `lytr`, and `xiba`, respectively, and the next two rows into repetitions of the 12 letter motifs `qsrnylfdfzly` and `ohqtauiducis`, respectively. Many of these motifs are found in several of the tables.

A few tables (like T5 'Leo') have a vast triangular area of repeats of `yoyo`:

```
oyoyoyoyoyoyoyoyoyoyoyoyoyoyoyoyoyoy
rkfaqtyoyoyoyoyoyoyoyoyoyoyoyoyoyoyo
rxxqnkoyoyoyoyoyoyoyoyoyoyoyoyoyoyoy
azzsxbqtyoyoyoyoyoyoyoyoyoyoyoyoyoyo
sheimasddtguoyoyoyoyoyoyoyoyoyoyoyoy
eyuaoiismspkfaqtyoyoyoyoyoyoyoyoyoyo
enlxflfudzrxxqnkoyoyoyoyoyoyoyoyoyoy
sxcahqczfbtfzsxbqtyoyoyoyoyoyoyoyoyo
azepxhheurgmyknqnkoyoyoyoyoyoyoyoyoy
rlbriyzycuyddpotxbqtyoyoyoyoyoyoyoyo
ryrezabirhdiszeknqnkoyoyoyoyoyoyoyoy
ogzgfceztqalpntsxhssyoyoyoyoyoyoyoyo
opnxxsnodxqhuekknykkoyoyoyoyoyoyoyoy
rcqsfueesfsqrqgqrossyoyoyoyoyoyoyoyo
roauxmdkkxkhyhmpzqphdtgtguoyoyoyoyoy
aqxmudiamubkoqifbszktdmspkfaqtyoyoyo
sazoesrmlrnaqnzhgabmsmlpeahfsddtguoy
...
```

Various other less pronounced repetitious structures can also be seen in the tables.

3. Analysis of Tables

Because Bodley 908's tables seemed more legible, I transcribed them first. The transcribed text was entered into the computer with many measures taken to prevent or detect copying errors. Once it was entered, repetitions in the text could be sought, patterns counted, and proof sheets printed.

In the course of this work it was noticed that in the vast majority of cases where a pair of adjacent `m`'s appeared, the letter above the second `m` was usually an `n`. That is, the pattern $\begin{array}{|cc|}\hline & \texttt{?} \\ \texttt{m} & \texttt{m} \\ \hline\end{array}$ was almost always actually $\begin{array}{|cc|}\hline & \texttt{n} \\ \texttt{m} & \texttt{m} \\ \hline\end{array}$. This led to a tabulation of all triplets of letters occurring in a $\begin{array}{|cc|}\hline & N \\ W & X \\ \hline\end{array}$ configuration, and it was found that in a large majority of cases the letter occupying the X position was predictable from the letters in the N and W positions. (The names of these variables are meant to represent the letter at the spot marked by X, the letter to its *North*, and the letter to its *West*.)

This led to discovery of an equation of form

$$X = N + f(W)$$

where $f(W)$ is a function of W and the addition is taken *modulo* 23. Here the letters are assigned numerical values according to their positions in the 23 letter Latin alphabet: `a` = 1, `b` = 2, ... , `u` = 20, `x` = 21, `y` = 22, `z` = 23, so that `z` + 2 = `b`, etc. The final ingredient in this formula, the auxiliary function f, is known to us only by a table of values determined empirically.

Table II. Auxiliary function values.

W	$f(W)$	W	$f(W)$	W	$f(W)$	W	$f(W)$
a	2	g	6	n	14	t	8
b	2	h	5	o	8	u	15
c	3	i	14	p	13	x	15
d	5	k	15	q	20	y	15
e	14	l	20	r	11	z	2
f	2	m	22	s	8		

Expressed another way: a letter is obtained by counting a certain number of letters after the letter immediately above (i.e., north of) it in the table. The number of letters to count is determined by the letter standing to the immediate left (i.e., west). If the letter to the left is an `f`, for instance, we are to count two letters past the letter above.

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So, continuing the example, if the letter above is an `l`, then the letter in question must be `n`, which is 2 letters past `l`: $\left|\begin{array}{cc} & \mathtt{l} \\ \mathtt{f} & \mathtt{n} \end{array}\right|$. If the end of the alphabet is reached in this letter counting one starts over at the beginning, treating `a` as the letter after `z`, and so on.

For letters in the top row of a *Soyga* table, for which there is no N letter, the following formula holds:

$$X = W + f(W)$$

where the addition is again performed modulo 23. That is, for letters in the top row one applies the rule for letters in the interior of the table, acting as if the letter appearing to the left also appears above.

4. Directions for Creating the Tables

This, then, is a recipe for recreating the tables, although almost certainly not expressed in the same terms the *Soyga* author would have used. Starting with a code word, such as NISRAM, and an empty grid of 36 rows and columns:

4.1. Left Column:

Write the code word followed by its reverse into the cells of the left hand column, starting at the top and working downwards, repeating the process until the column is full.

4.2. Top Row:

Fill in the remaining 35 cells of the top line, working from left to right, repeatedly applying the formula $X = W + f(W)$.

In our example, the first application of this formula yields $\mathtt{n} + f(\mathtt{n})$, that is, the letter $f(\mathtt{n}) = 14$ places after `n` in the 23 letter alphabet, which is `d`. (Thus: `n` is the 13th letter; $13 + 14 = 27$; reduced modulo 23, 27 is 4, which is `d`.) Write the letter `d` in the second cell in the top row, just to the right of the `n` of NISRAM.

The second application yields $\mathtt{d} + f(\mathtt{d})$. Since $f(\mathtt{d}) = 5$, this gives us `i`, the fifth letter after `d`. Write an `i` in the third cell of the top row.

The third application yields $\mathtt{i} + f(\mathtt{i})$. Since $f(\mathtt{i}) = 14$, this gives us `z`, the 14th letter after `i`. Write a `z` in the fourth cell of the top row.

The fourth application yields $\mathtt{z} + f(\mathtt{z}) = 23 + 2 = 25 = 2 = \mathtt{b}$; put a `b` in the fifth cell.

The fifth application yields b + f(b)= 2 + 2 = 4 = d; put a d in the sixth cell. At this point we have fallen into a cycle: the next application yields d + f(d) which we have already seen before is i, and the rest of the first row will continue to repeat dizb dizb...

At this point the top few rows of the partially filled in table will look like this:

```
ndizbdizbdizbdizbdizbdizbdizbdizbdiz
i...................................
s...................................
r...................................
```

4.3. Interior of Table:

Now, starting with the second row and working left to right within rows, fill in the interior cells as follows. With each blank cell encountered, if the work has progressed in normal European page-reading order, the cell just above the blank cell and the cell to the left have both been filled in. Call the letters appearing in those cells N and W, respectively, and use the formula $N + f(W)$ to determine what to write into the blank cell under consideration.

For example, the first blank cell in row 2 is the second cell. It has a d above it and an i to its left. So the letter d + f(i) = 4 + 14 = 18 = s is written in that blank cell.

The next cell, cell 3, in row 2 has an i above it and an s to its left (the s which we just wrote). So we put i + f(s) = 9 + 8 = 17 = r in cell 3 of row 2. The next cell gets z + f(r) = 23 + 11 = 11 =l, and so on. The top few rows now look like this:

```
ndizbdizbdizbdizbdizbdizbdizbdizbdiz
isrl................................
s...................................
```

This process, carried out row by row, left to right, will eventually fill the table.

Alternatively, instead of working row by row, left to right in each row, as described here, one could equivalently work column by column, working downwards within each column. The final results would be the same.

Of course I make no claim that the *Soyga* author intentionally used my $X = N + f(W)$ formula. Whatever means were actually used to construct the tables clearly had this formula's mathematical structure implicitly 'built in', but we can only guess at its implementation. The

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arithmetic modulo 23, for instance, could have been effected equally well by paper-and-pencil computations, by consultation of charts, by letter counting on finger tips, or by the use of Lullian wheels.

5. Error Analysis and Genealogy

In fact the tables found in the two extant manuscripts of the *Book of Soyga* are not identical with those I produced by a computer programmed to carry out the above rules, starting with the same code words as in the manuscripts. This is for two reasons:

1. The law of formation for the tables is sufficiently intricate that the *Soyga* author occasionally made mistakes in working out the original tables.
2. The copyists made new mistakes when transcribing so much apparently unpatterned text.

Fortunately for us, these two kinds of errors have radically different consequences. If a cell in the original is miscalculated, the mistake spoils the calculation of the cells to its right and below it, resulting in an avalanche of error with an easily recognizable rectangular shape. A mere copying error, however, will not have a cumulative effect, and will be classifiable into one of several familiar types: transposition, deletion, eye skip, and replacement.

In short, the constraints placed on the tables by the $X = N + f(W)$ formula allow an aggressive form of textual emendation of the received tables in Bodley 908 and Sloane 8. A similar technique has been used to trace copying of logarithm tables by Charles Babbage (1792–1871), but is of course not generally applicable.[23] Only texts with a well-defined mathematical structure are amenable to this method of detecting and correcting errors of generation and transcription.

5.1. Principles of Error Diagnosis: An Artificial Example

This can all be seen in an artificial example, concocted so as to display every kind of pathology in the first few lines of the table. Suppose the code word is SARTON. Ideally, the first few lines of the table would be

```
scfhndizbdizbdizbdizbdizbdizbdizbdiz
aeuzprupprupprupprupprupprupprupprup
rqrlmqrcsbygxilmobygxilmobygxilmobyg
tattuhyscenxnzncrnnxnzncrnnxnzncrnnx
oiklrtgaetxndedhyedcqueredsfpndhyedc
```

```
nzmkikyqbxnditmgetmbsetbgkkxgtmgetmb
noublgeghcqalqixuliqpsdgnamuylixuliq
oymanxuyzeggrdofycmpeispcdrhdqfzycmp
tgsidczabgnxisyxolifgphusmqesahenrzr
rscmcfbcexemhzazqhoopeymrzsnipxueheh
...
```

Call this the *ideal original table*. Suppose, however, that in working this out a mistake was made: an `e` was put down instead of a `p` in the fifth cell of the second line. This mistaken letter will cause mistaken values to be calculated for the sixth cell of the second line and for the fifth cell of the third line, and those mistakes will beget others. The resulting *actual original table* will be (with the erroneous `e` capitalized)

```
scfhndizbdizbdizbdizbdizbdizbdizbdiz
aeuzEsrlytrlytrlytrlytrlytrlytrlytrl
rqrlbuibaxibaxibaxibaxibaxibaxibaxib
tattkmhggdokqsrnplfdfzlyqsrnplfdfzly
oiklgsqdmcrxhztxgrrpthqtauiducisohqt
nzmkykhicftfkpimftbrgoaxqruterukfkha
noubamgpqcyxbrudlqyixfcasbylbteahpxq
oymacpugysgdgzyttaalsolxkrkcekuqefzs
tgsirczinixtpnnklxqhzqhcnhpqbmtagmyk
rscmqzblkazxgtxbnmpxpfksxzrdgsdficbm
...
```

Finally, suppose we receive this table, derived from the original but with a variety of copying errors:

```
scfhudizbdizbdhzbdizbdizbdkzbdizbdiz
aeuzefrlytrlyutlyttlyrtlyttlytrlytrl
rqrlbnibaxibaxibaxibxibaxibaxiibaxib
rattkmhggdokqstnplfdfzlyqfrnplfdfzly
oikglsqdmcrxhztxgrrpthqranidueisohqt
nzmkykhicstfkpimstyixfeafbylbtcahpxq
uoubamgpqpyxbiudlqalsolxkrkcckuqefzf
oymacpugyfgdgzyrtaqhzqhcnhpqbmtagmek
tgfirczinixtpnnzlxqhzqhcnhpqbmtagmyk
rfcmqzblkazxgtxbnmpxpsksxztdgsdsicbm
...
```

Our task is to recover the ideal original and actual original and diagnose the copying errors.

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First we inspect the left margin, where we see SARRON UOTR... etc, which is a damaged version of SARTON NOTRAS etc.; the code word is SARTON. (The left margin contains in all six copies — forward and reversed — of the code word, so in practice there is no doubt about what the code word is.)

From this we work out the ideal original table, and examine those positions where the received table differs from it. This diagram displays places where the received table agrees with the ideal original with a dot and places where they disagree with the value seen in the received table:

```
....u.........h...........k.........
....efrlytrlyutlyttly.tlyttlytrlytrl
....bnibaxibaxibaxib..baxiba..ibaxib
r...kmhggdokqstnplfdf.lyqfrnplfdfzly
...glsqdmcrxhztxgrrpthq.anidueisohqt
....y.hicstfkpims.yixfeafbylb.cahpxq
u...amgpqpyxbiudlqalsolxkrkcckuqefzf
....cp.gyf.dgzyrtaqhzqhcnhpqbmtagmek
..f.r..inixtpnnzlxqhzq.cnhpqbmtagmyk
.f..qz.lkazxgtxbnmpx.sksx.tdgsdsicbm
...
```

Here we see an essentially solid rectangular region of disagreement, starting in the fifth cell of row 2, with the value `e`, which is due to an error in the original. The 'pepper and salt' pattern of sporadic disagreements elsewhere is characteristic of copying errors. So we conclude that an `e` was put down by mistake in row 2, cell 5 in the original.

Now we work out the corresponding putative original, and display the disagreements between it and the received copy:

```
....u.........h...........k.........
.....f.......ut...t..rt...t.........
.....n..............xibaxibaxi......
r.............t..........f..........
...gl..................r.n...e......
.........s......s.yixfeafbylbtcahpxq
u........p...i....alsolxkrkcckuqefzf
.........f.....r..qhzqhcnhpqbmtagmek
..f............z....................
...
```

Since the remaining rectangular regions of disagreement do not reach to the bottom of the table, we conclude that they are not due to errors in the original. (Further examination will show they are due to eye skip.) No further errors seem to have been made in the original, so our putative original table is finished.

We are now in a position to diagnose the copying errors. The mistakes in cells 21 through 30 of line 3 are easily seen to be due to elision of an `a` from one of the repeating `baxi` groups; the pattern ends on the right foot again in cell 31 by the insertion of an extra `i`. We might term this a *horizontal eye skip* error. The errors in cells 19 through 36 in lines 6, 7, and 8 are seen to result from a *vertical eye skip* error, as follows. The rightmost 18 cells of lines 6, 7, 8, and 9 of the original are

```
brgoaxqruterukfkha
yixfcasbylbteahpxq
alsolxkrkcekuqefzs
qhzqhcnhpqbmtagmyk
```

and of the received copy are

```
yixfeafbylbtcahpxq
alsolxkrkcckuqefzf
qhzqhcnhpqbmtagmek
qhzqhcnhpqbmtagmyk
```

so we see that the copyist deleted the right half of line 6 and duplicated the right half of line 9. There is a transposition error in row 5, cells 4 and 5: the original has `lg` and the copy has `gl`. The remaining errors are simple replacements of one letter by another.

5.2. Summary of Actual Errors

In fact all of the types of errors illustrated above occur in both the Sloane 8 and Bodley 908 versions of the tables. There seems to have been one set of original tables which I call A. Our extant versions, Bodley 908 and Sloane 8, seem to have been derived independently from a flawed intermediate version which I call C.

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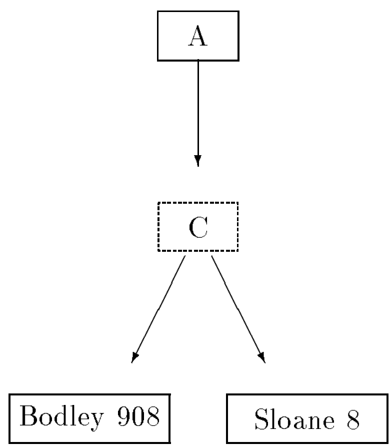
Table III. Errors in Originals.

Table	*Row/Col.*	*Err.*	*Row/Col.*	*Err.*	*Row/Col.*	*Err.*
T5	15 / 24	t				
T8	28 / 25	r				
T10	18 / 11	t				
T12	15 / 9	y				
T13	18 / 2	t				
T19	19 / 29	e	20 / 28	g		
T29	18 / 11	m	17 / 16	h		
T32	6 / 25	l	7 / 24	e	34 / 27	k
T35	19 / 23	d				



The originals A were constructed with the code words as listed in my Table I, by application of the $N+f(W)$ formula; the errors in applying the formula are listed in my Table III. Since errors in applying the $N+f(W)$ formula propagate and spoil everything below and to the right of the error locus, we can be sure that this is the complete list of errors in A. Out of the 46,656 cells in the complete set of tables, only 13 errors were made in applying the formula.

The alternative, that Bodley 908 and Sloane 8 did not share a common original, would require us to believe that exactly these same particular errors (and no others) were committed in working out the originals for both Bodley 908 and for Sloane 8. This is so unlikely under any reasonable model for errors that I reject this alternative in favour of a single shared common original A.

Table IV. Transposition Errors.

Table	*Row*	*Col.*	*Is*	*Ought*		
T3	22	29	`kq`	`qk`	Bodley 908	
T12	6	8	`cp`	`pc`		Sloane 8
T25	14	34	`ms`	`sm`	Bodley 908	
T30	33	28	`nm`	`mn`	Bodley 908	Sloane 8
T31	35	16	`lf`	`fl`	.	Sloane 8
T35	22	21	`nh`	`hn`	Bodley 908	Sloane 8
T35	27	34	`rs`	`sr`	Bodley 908	Sloane 8

Table V. Summary of cell reading disagreements.

Type of Disagreement	*Raw*	*Censored*
A, Bodley 908, and Sloane 8 all differ	10	6
A and Bodley 908 same; Sloane 8 different	266	115
A and Sloane 8 same; Bodley 908 different	144	75
Bodley 908 and Sloane 8 same; A different	394	223
A, Bodley 908, and Sloane 8 all agree	45541	45936

A number of gross eye skip errors were committed in the descent of Bodley 908 and Sloane 8 from A. In Bodley 908's version of T2, row 3, cells 20–35 read `axibaxibaxibaxib` instead of `xibaxibaxibaxiba`; that is, an `a` was inserted at cell 20. In both Bodley 908's and Sloane 8's versions of T24, the right hand half of row 35 was elided and the right hand half of row 34 was duplicated. In both Bodley 908's and Sloane 8's versions of T36, row 3, cells 30–36 read `baxibax` instead of A's `ibaxiba`, and row 12 is elided.

I detected seven transposition errors, some unique to Bodley 908 and to Sloane 8, and some shared, as listed in my Table IV.

A tabulation was made of all corresponding places where Sloane 8, Bodley 908, or A were all legible but failed to give unanimous readings of cell entries, except for those involved in the gross eye skips noted above. The tabulation was made again, where all differences explainable by mere confusion of *i/l*, *u/n*, *f/s*, *e/c*, or *t/r* were censored, in an attempt to compensate for possible transcription errors on my part (especially in reading Sloane 8).

The results, in my Table V, again show Bodley 908 and Sloane 8 each have a large number of unique errors in addition to a larger number of shared errors. If either of Sloane 8 or Bodley 908 were copied from the other, the errors unique to the ancestor would have had to have been corrected in the child. Because the text is incoherent, there is no

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natural 'self repair' mechanism analogous to a scribe's knowledge of orthography or grammar allowing emendation of errors, at least in the large areas of the tables lacking repeating motifs. If both Bodley 908 and Sloane 8 were independently derived from the original A, the 394 (or 223) shared errors would all be the result of accidental occurrence of precisely the same mistakes, independently committed in copying Bodley 908 from A and in copying Sloane 8 from A. This is very unlikely under any reasonable model of copying errors. So we conclude instead that both Bodley 908 and Sloane 8 were derived from a common flawed copy, which I call C, of the originals. Because Bodley 908 seems to have fewer disagreements with A than Sloane 8 does, we conclude that Bodley 908 is a more accurate copy of C than Sloane 8 is. Overall, there seems to be a 3/4% copying error rate in going from A to C, a 1/2% error rate in going from C to Sloane 8, and a 1/3% error rate in going from C to Bodley 908.

The same techniques can be used to see what relation Dee's copy of the eight *Soyga* tables appearing in Sloane 3189, the *Book of Enoch*, has to Bodley 908 and Sloane 8.

In the first place, the T13 of Sloane 3189 shows the same mistake in applying the $N + f(W)$ formula (in row 18, column 2) present in the T13 of A. Hence even if not copied directly from Bodley 908 or Sloane 8, the Soyga tables in Sloane 3189 are, like those of Bodley 908 and Sloane 8, ultimately derived from A. *A fortiori*, they are copies of the *Soyga* tables, rather than simply creations inspired by, or in the same style as, the *Soyga* tables.

Secondly, the T2 of Sloane 3189 lacks the gross eye skip error found in row 3 of T3 of Bodley 908. This suggests Sloane 3189 was not copied from Bodley 908, but not strongly so: the eye skip error occurs in the repeating `baxibaxi` area and could have been corrected by a naive but alert copyist.

Third, looking only at locations where all four of A, Bodley 908, Sloane 8 and Sloane 3189 supply legible values, I found the results in my Table VI. The agree-disagree counts seem to make Sloane 3189 slightly but insignificantly closer to Bodley 908 than to Sloane 8.

Fourth, and more tellingly, the transposition error in T3 of Bodley 908, where there is a `kq` instead of the correct `qk` in row 22, is not present in the T3 of Sloane 3189. Unlike the T2 eye skip error, this error is well outside the area of repeating motifs, and so uncorrectable by a naive copyist.

On balance, then, it seems that the *Soyga* tables in Dee's *Book of Enoch*, Sloane 3189, are closer in manuscript transmission to Sloane 8 than to Bodley 908.

Table VI. Summary of cell differences between Sloane 3189 and A, Bodley 908 and Sloane 8.

Sloane 3189	*Raw*		*Censored*	
compared with	*Disagree*	*Agree*	*Disagree*	*Agree*
A	288	9877	209	9956
Bodley 908	203	9962	149	10016
Sloane 8	208	9957	155	10010

Assuming that the Sloane 3189 *Soyga* tables were copied from Sloane 8, the most common copying error was replacing `z` by `x`: out of the 477 occurrences of the letter `z` in the Sloane 8 tables which have corresponding Sloane 3189 versions, it was rendered correctly 441 times, rendered as an `x` 34 times, and as a `q` and an `r` each once. There are 9 instances where an `i` was written instead of a `y`. Overall, there is a 1.5% copying error rate from Sloane 8.

Regardless of which particular manuscript the *Book of Enoch* got its *Soyga* table copies from, the questions of *why* they were copied and what relation they have to the Enochian system are central to furthering our understanding of Dee's relation to the *Book of Soyga*. On the one hand it is possible that Dee deliberately copied them (or had them copied) into his notebook (in rearranged sequence: T1, T13, T2, T14, and so on, so both 'Aries' tables were visible on an opening, both 'Taurus' tables visible on the next, etc.) for ready reference, possibly with motives similar to mine in section 3 of this paper, or possibly in order to use them in magical operations. This might have happened some time before 1582, that is, before his 'Enochian' period, in which case their appearance with the Enochian material in Sloane 3189 would be the accidental result of reuse of a largely blank notebook. On the other hand, they might have a more direct connection with the Sloane 3189 Enochian material: they might have been revealed the same way the rest of the *Book of Enoch* material was (in which case the copying errors could be attributed either laudably to angelic emendation or deplorably to mundane data-entry-clerk error), or they might have been accorded a semi-privileged status, not themselves revealed but worthy of inclusion as an appendix to the *Book of Enoch* by a principle of virtue-by-association. Even though I see no way to use the methods of this paper to distinguish between these possibilities, I do not hesitate to speculate in the next section about one possible stylistic connection between the *Soyga* tables and the rest of the *Book of Enoch*.

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6. Comparison with other tables

Large square tabular arrays of letters are quite common in early modern magic works, exhibiting a variety of forms as yet unsurveyed in the scholarly literature. Here I present a brief taxonomy of magic tables according to their internal structure.

The more usual point of view, represented by Yates, pays primary attention to the authors' theories of magic and scant attention to the actual form of the tables:

> ... in Agrippa's Third Book [on Occult Philosophy] there are elaborate numerical and alphabetical tables for angel-summoning *of the type* [my emphasis] which Dee and Kelley used in their operations...
>
> These can be seen in Dee's manuscript 'Book of Enoch', British Museum, Sloane MSS. 3189. Cf. the 'Ziruph Tables' in Agrippa's *De occult. phil.*, III, 24. Agrippa was not Dee's and Kelley's only source for practical Cabala, but their minds run on these things within the Agrippan framework.[24]

In fact Dee's tables and Agrippa's have completely different forms (as can be seen by glancing at my Plates IV and V), so Yates must be using 'of the type' to refer to the authors' intentions and not to their tables' actual appearance or formation.[25]

My tentative taxonomy begins by crudely dividing all square magic tables into two classes, the small and the large, according to whether they have, say, fewer than fifteen rows and columns or more. Among the small tables are those with letters forming words when read either vertically or horizontally, as in the famous square found at Herculaneum,

S	A	T	O	R
A	R	E	P	O
T	E	N	E	T
O	P	E	R	A
R	O	T	A	S

which are nowadays known as 'word squares'. Word square charms have been in continuous use from Roman times to the present. Many such squares appear in Abraham ben Simeon's *Cabala Mystica*, which Patai concludes — based in part on an analysis of the text in the squares themselves — was written around 1400.[26]

Small numerical tables like

11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15

nowadays known as 'magic squares', have also been used since the late middle ages in Europe and in Asia for far longer as charms or arithmetical amusements.[27] (The numbers in each of the rows, columns, and two main diagonals all add up to the same sum, in this case 65.) Such a small numerical square appears in the 1514 print *Melencolia I* of Albrecht Dürer (1471–1528); many others are to be found in Agrippa's Book II, where each planet is assigned its own magic square, each square being presented in both Arabic and equivalent Hebrew numerals.[28]

As far as I know, all large magic tables in mediaeval or early modern sources are alphabetic. We may divide them into unpatterned and patterned; the latter are subdivided into those in which the form of the pattern is obvious and those in which the pattern is hidden.

Most of Dee's tables in the *Book of Enoch* are unpatterned: squares and lozenge shaped arrays with 49 rows and columns filled with text in the 'Enochian' language described by Laycock and Whitby.[29] One of these is illustrated in my Plate IV. The text is inscribed in the tables line by line, left to right, one letter per cell, with no space between words. The eight *Soyga* tables appearing in the same book are of course patterned, but with a hidden pattern; it is tempting to believe that Dee's favourite table size, 49, was inspired by the size of the *Soyga* tables, 36, since $49 = 7 \cdot 7$ is the next perfect square after $36 = 6 \cdot 6$. Similarly there are 36 *Soyga* tables and, as Kelley informed Dee on 24 March 1582/1583, there are to be 49 Enochian tables.[30]

There are many large patterned tables in one of Agrippa's Cabalistic chapters.[31] They include: an angel chart of no interest to us, a 'right table of commutation', an 'averse table of commutation', an 'irrational averse table of commutation', a 'table of Ziruph', and a 'rational table of Ziruph'.

The three tables of commutation are examples of what are nowadays known as 'Latin squares', N by N tabular arrays of symbols from an N symbol alphabet — in this case the $N = 22$ letter Hebrew alphabet — arranged in such a way that each letter appears just once in each row and in each column.[32]

It is possible that Agrippa received the idea of the 'tabula commutationum recta' from Trithemius. Book 5 of Trithemius's *Polygraphia*

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(written in 1508 but printed in 1518) contains a 'recta transpositionis tabula' and a 'tabula transpositionis aversa' of exactly the same form as Agrippa's but based on a hybrid 24 letter alphabet formed by adjoining 'w' to the end of the standard 23 letter Latin alphabet.[33] These Latin squares are of a particularly simple type, where each row is a shift of its predecessor, giving the table an overall barber-pole pattern of diagonal stripes.

Agrippa's third table of commutation, the 'tabula aversa dicat irrationalis' is a more complex Latin square. The top row and right-hand vertical margin contain the alphabet in its usual order; the bottom row and the left-hand vertical margin contain the alphabet in reversed order. The interior of the table is partially patterned. Most rows contain blocks of letters in consecutive alphabetical order. Because most of these blocks are shifted by one square from corresponding blocks in neighbouring rows, much of the area of the table has a diagonally striped pattern. But there does not seem to be a simple rule specifying the overall conformation of the table. It seems to be the result of an attempt to construct a Latin square as diagonally striped as possible, consistent with the given normal and reversed alphabets appearing in the margins.

Agrippa's table of Ziruph, illustrated in my Plate V, is possibly copied from Johann Reuchlin (1455–1522), who in turn owes much to the thirteenth century Kabbalist Abraham Abulafia (1240–1292).[34] It consists of 22 rows, each with 11 cells per row. In each cell is a pair of Hebrew letters, placed in such a way that each letter appears exactly once in each row. Each row represents a reciprocal substitution alphabet: the letters in each of the 11 pairs are to be substituted for each other. One of these rows gives the 'Atbash' alphabet according to which the first and last letters of the Hebrew alphabet (*aleph* and *taw*) are interchanged, the second and second from last (*beth* and *shin*), and so on.[35] Successive rows are obtained by alternately shifting all the left hand elements of the pairs to the pair to the left or all the right hand elements to the pair to the right (with a provision for reversing direction when the end is reached) in a kind of *contredanse*.[36]

Such substitution alphabets are used in the branch of the practical Cabala known as *temurah* (permutation) in connection with the operation of *tseruf* (combination). The intent is to enlarge the scope of Cabalistic correspondences between words and phrases: two words are related not only if they have the same numerical sum, as in usual *gematria*, but also if the one is equal to the Atbash-transformed version of the other, and so on. The 'rational table of Ziruph' is possibly Agrippa's invention. The size, shape, and general appearance of this table is the same as the Ziruph table, but the pattern by which the letters shift from row to row is slightly different.

Not all large patterned tables appearing in the early modern period are magical, however. For instance, a manuscript of Thomas Harriot (1560–1621) contains letter squares intended to illustrate a combinatorial calculation.[37] These tables, like the Soyga tables, are derived from a key word or phrase, but unlike the Soyga tables, the pattern is completely obvious. Harriot used the key phrases HENRICVS PRINCEPS FECIT and SILO PRINCEPS FECIT to form squares of 21 and 17 rows respectively. The following artificial example based on the key word VERITAS illustrates the pattern. (The key phrase starts at the centre and emanates in concentric lozenges towards the corners.)

S	A	T	I	T	A	S
A	T	I	R	I	T	A
T	I	R	E	R	I	T
I	R	E	V	E	R	I
T	I	R	E	R	I	T
A	T	I	R	I	T	A
S	A	T	I	T	A	S

Each of these tables is accompanied by a numerical calculation, which turns out to give the number of ways the given key phrase can be spelled out in the square, following a path of vertical and horizontal moves to adjacent cells, starting in the centre and finishing in a corner. (The present VERITAS specimen has 80 such paths; the general formula is 4 times the binomial coefficient $\binom{2n}{n}$, when the key phrase has $2n+1$ letters.)

And finally we have the tables in the *Book of Soyga* as our sole examples of large patterned tables whose pattern is hidden. None of the other tables, intricate as they are, have so complex an underlying pattern as that given by the $N + f(W)$ formula used in the *Book of Soyga*. It is no wonder that Dee found them perplexing.

Notes

[1] British Library, MS Sloane 3188, fol. 9ʳ.

[2] All of these examples: Christopher Whitby, *John Dee's Actions With Spirits*, 2 vols (New York: Garland, 1988), I, pp. 146–147.

[3] Scrying, a cooperative magical operation during which privileged visual and aural information — in this case from angels — is conveyed to the participants, was much used by Dee. Three differing views of what 'really went on' are presented

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in Meric Casaubon, *A True and Faithful Relation* (London, 1659) (which I have not seen), in Whitby, *Actions with Spirits*, I, and in D. E. Harkness, 'Shows in the Showstone: A Theater of Alchemy and Apocalypse in the Angel Conversations of John Dee (1527–1608/9)', *Renaissance Quarterly*, 49 (1996), 707–737.

4 John Dee, *Spiritual Diaries*, Sloane 3188, fol. 9^{r}, transcribed in Whitby, *Actions with Spirits*, II, pp. 17–18 and translated in Whitby, *Actions with Spirits*, I, pp. 211–212.

5 A marginal note on Sloane 3188, fol. 9^{r}, transcribed in Whitby, *Actions with Spirits*, II, p. 18, seems to say Kelley and Dee had met for the first time two days previous to this: 'Note: he had two dayes before made the like demaunde and request vnto me: but he went away vnsatisfied. For, his coming was to entrap me, yf I had any dealing with Wicked spirits as he confessed often tymes after...' See my note 16 for evidence of Kelley's continued ignorance of basic facts about the *Book of Soyga* a month later.

6 Whitby, *Actions with Spirits*, I, pp. 146–147; Deborah Elizabeth Harkness, 'The Scientific Reformation: John Dee and the Restitution of Nature' (unpublished Ph.D. dissertation, University of California at Davis, 1994), pp. 317–318, 415. Both guess the *Book of Soyga* might well have influenced Dee or Kelley. Harkness, p. 415, suggests that the *Book of Soyga's* Adamic association — in particular its use of an Adamic language, discussed by Uriel and Il, in Sloane 3188, fols. 9^{r} and 89^{v}— would have especially appealed to Dee. Whitby, *Actions with Spirits*, I, p. 147, cites I. R. F. Calder as conjecturing that the *Book of Soyga* is the Voynich manuscript (Yale University, Beinecke Rare Book & Manuscript Library, MS 408), the notorious cipher manuscript described by J. M. Manly, 'Roger Bacon and the Voynich MS', *Speculum*, 6 (1931), 345–391; if true, this would be a case of solving one mystery by replacing it with a greater. I see no connection between the two books, other than their probable ownership by Dee. The *Book of Enoch*, also called *Liber Logaeth* and *Liber mysteriorum sextus et sanctus*, British Library, MS Sloane 3189, was in effect Dee's lab notebook, written concurrently with the *Spiritual Diaries*, Sloane 3188. Whitby, *Actions with Spirits*, I, p. 143, gives a description of its contents.

7 Deborah Harkness, personal communication, 1996, and 'The Nexus of Angelology, Eschatology, and Natural Philosophy in John Dee's Angel Conversations and Library', in this volume.

8 Oxford, Bodleian Library, MS Bodley 908; British Library, MS Sloane 8.

9 This description is based on examination of microfilm copies, not on the manuscripts themselves.

10 'Zadzaczadlin': Bodley 908, fol. 69^{v} and Sloane 8, fol. 70^{v}.

11 Robert Turner, *Henry Cornelius Agrippa His Fourth Book of Occult Philosophy* (London, 1655; reprinted London: Askin, 1978).

12 Bodley 908, fol. 51^{v}.

13 Both in Bodley 908, fol. 42^{r}.

14 As described by, say, Richard Kieckhefer, *Magic in the Middle Ages* (Cambridge: Cambridge University Press, 1989).

15 'Geber': Bodley 908, fols. 116^{v} and 126^{r}; 'Steganographia': Bodley 908 fol. 123^{v}.

16 Bodley 908, fol. 4^{r}; Sloane 8, fol. 6^{r}. But this directly contradicts what the spirit 'Il' said during a scrying session with Edward Kelley and John Dee on Thursday 18 April 1583, as recorded in Dee's *Spiritual Diaries*, Sloane 3188, fol. 89^{v}, transcribed in Whitby, *Actions with Spirits*, II, p. 332: 'Soyga signifieth not Agyos. *Soyga alca miketh.*' (Dee's—or Il's—emphasis.) One might take this as evidence of Kelley's unfamiliarity with the *Book of Soyga* at this early stage in his residence in Dee's household.

17 Wayne Shumaker, *The Occult Sciences in the Renaissance: A Study in Intellectual Patterns* (Berkeley, California: University of California Press, 1972).

[18] D. P. Walker, *Spiritual and Demonic Magic from Ficino to Campanella*, (London: Warburg Institute, 1958) and Frances A. Yates, *Giordano Bruno and the Hermetic Tradition* (London: Routledge and Kegan Paul, 1964). It is certain that Hermeticism and Cabalism were important formative influences on early modern magic, even if Yates's claims about their influence on early modern science are rejected.

[19] Karen de Leon-Jones, personal communication, 1998. I have not found a single table or chart or discussion of such anywhere in the works I have seen of the two great modern historians of the Kabbalah, Gershom Scholem and Moshe Idel.

[20] In Bodley 908, at fols. 180–197; in Sloane 8, at fols. 102–138; see my Table I.

[21] *Book of Enoch*, Sloane 3189, in four openings of the book, between fols. 58–65, as shown in my Table I.

[22] In Bodley 908, fols. 167^{r}–168^{v}; in Sloane 8, fols. 138^{v}–140^{v}. The Bodley 908 version seems to contain many mistakes.

[23] Charles Babbage, 'Notice respecting some Errors common to many Tables of Logarithms', *Memoirs of the Astronomical Society*, 3 (1827), 65–67, which I have only seen reprinted in Charles Babbage, *The works of Charles Babbage*, edited by Martin Campbell-Kelly, 11 vols (London: W. Pickering, 1987), II, pp. 67–71. Summarized in Dr Dionysius Lardner, 'Babbage's Calculating Engine', *Edinburgh Review*, July 1834, no. 120; which I have only seen as reprinted in *Charles Babbage and his Calculating Engines, Selected Writings by Charles Babbage and Others*, edited by Philip Morrison and Emily Morrison (New York: Dover, 1961), pp. 163–224; the discussion of errors in logarithm tables appears on pp. 177–183.

[24] Yates, *Giordano Bruno*, p. 149 and note. The tables are in Agrippa, *De Occulta Philosophia*, III, 25, not III, 24.

[25] That is, Yates did not care to pay attention to the differences between the tables, possibly because she did not know how to. It is also possible that for Yates, magic tables — unlike texts or images — are not subject to the processes of copying, emulation, improvement, and confusion; that is, they are neither vehicles for ideas nor potential sources of evidence in intellectual or cultural history.

[26] Raphael Patai, *The Jewish Alchemists* (Princeton: Princeton University Press, 1994), pp. 277–288.

[27] Menso Folkerts, 'Zur Frühgeschichte der magischen Quadrate in Westeuropa', *Sudhoffs Archiv*, 65 (1981), 313–338 gives a detailed survey of the genre. Vladimír Karpenko, 'Between Magic and Science: Numerical Magic Squares', *Ambix*, 40 (1993), 121–128, surveys alchemical magic squares; in this connection, also see Patai, *The Jewish Alchemists*, chapter 26.

[28] Heinrich Cornelius Agrippa of Nettesheim, *De Occulta Philosophia libri tres* (Cologne, 1533). I rely on the edition of V. Perrone Compagni (Leiden: Brill, 1992). In a supercilious scholium, Shumaker, *The Occult Sciences in the Renaissance*, p.139, takes Agrippa to task for a mistake in one of his magic squares. However the mistake is clearly a typographic error present only in the Arabic numeral form of the square, and only in the particular edition Shumaker looked at. (Shumaker, p. 158, note 70, seems to say he relies on 'Henricus Agrippa ab Nettesheym, *Opera* (Lugduni, c. 1650?)', which he understands to be printed in London instead of Lyons!) For a discussion of Agrippa's magic squares, see K. A. Nowotny, 'The construction of certain seals and characters in the work of Agrippa of Nettesheim', *Journal of the Warburg and Courtauld Institutes*, 11 (1949), 46–57 and I. R. F. Calder, 'A note on magic squares in the philosophy of Agrippa of Nettesheim', *Journal of the Warburg and Courtauld Institutes*, 11 (1949), 196–199.

[29] Donald C. Laycock, *The Complete Enochian Dictionary: A Dictionary of the Angelic Language as Revealed to Dr. John Dee and Edward Kelley*, revised edition (York Beach, Maine: Samuel Weiser, 1994); Whitby, *Actions with Spirits*, I, pp. 144–146.

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[30] Sloane 3189, fol. 62$^{\mathrm{v}}$, transcribed in Whitby, *Actions with Spirits*, II, p. 227. Apparently one of the tables is not to be written, leaving only 48 to be put in the *Book of Enoch*. It is tempting to compare this with the *Book of Soyga*'s T36 'Magistri', which has a missing row.

[31] Agrippa, *De Occulta Philosophia*, III, 25, sigs. yii$^{\mathrm{r}}$–yiiii$^{\mathrm{r}}$. These tables are surveyed in a modern reissue of the J[ohn] F[rench] translation (London, 1651) of Agrippa: *Three Books of Occult Philosophy*, edited by Donald Tyson (St. Paul, Minnesota: Llewellyn Publications, 1993), appendix VII, pp. 762–767.

[32] J. Dénes and A. D. Keedwell, *Latin Squares and their Applications* (New York: Academic Press, 1974).

[33] Johannes Trithemius, *Polygraphiae libri sex* (Oppenheim, 1518), V, sigs. oij$^{\mathrm{r}}$ and oij$^{\mathrm{v}}$. It is barely possible that Trithemius received the idea of such tables from Agrippa, possibly when they met in the winter of 1509/1510. In 1510 Agrippa sent Trithemius a draft of his *De occulta philosophia* which, according to Compagni (p. 58), lacked the chapter containing the Ziruph tables and tables of commutation. Trithemius's use of the tabula recta is purely cryptographic, and most printed works on cryptography ever since include such diagrams, often under the name of 'Vigenère table'. Since Agrippa's text does not discuss his tables of commutation it seems more likely, absent any further direct evidence, that Agrippa copied from Trithemius.

[34] Johann Reuchlin, *De Arte Cabalistica* (Hagenau, 1517), Book III, sig. Nvi$^{\mathrm{r}}$; I rely on the parallel-text translation of M. Goodman and S. Goodman, of 1983, reissued with introduction by Moshe Idel (Lincoln, Nebraska: University of Nebraska Press, 1993). For gematria and the Reuchlin-Abulafia connection: Gershom Scholem, 'Gematria' in *Encyclopaedia Judaica* (Jerusalem: Macmillan, 1971) and Gershom Scholem, *Major Trends in Jewish Mysticism*, second edition, reissued (New York: Schocken, 1995), p. 127.

[35] A somewhat similar table of reciprocal substitution alphabets occurs in Giovanni-Battista della Porta, *De Occultis Literarum Notis* (Naples, 1563) II, 16; I rely on a facsimile (Zaragoza: Cátedra de Criptografía del Centro Politécnico Superior de la Universidad de Zaragoza, 1996) of the 1593 Montbéliard edition. This is a cryptographic work, and Porta tables are almost as much a fixture in cryptographic literature as Vigenère tables. Porta's table is based on a 22 letter Latin alphabet with the letter K omitted. In Porta's table but not in the Ziruph table letters from the first half of the alphabet are paired only with letters from the last half.

[36] There appears to be one deviation from this pattern. In the seventeenth row of both Reuchlin's and Agrippa's tables the letters *sade* and *resh* are paired, as are *tet* and *taw*. The rule used to produce the rest of the table would pair *taw* with *sade* and pair *tet* with *resh*.

[37] British Library, Additional MS 6782, fols. 27, 28, with associated calculation on fol. 57. These are briefly described in John W. Shirley, *Thomas Harriot: a Biography* (Oxford: Oxford University Press, 1983), pp. 419–420, who apparently did not understand the calculation on fol. 57. I intend to address these Harriot tables in a subsequent paper.