CHAPTER 4

Who is who?

1. PRELIMINARY OBSERVATIONS

As we have seen, the dating of the Almagest by proper star movements might turn out erroneous if there was an error in identifying the fast stars used for dating as their Almagest equivalents. The problem of identifying the Almagest stars, or, more precisely, the Ptolemaic descriptions of stars, as real, or "modern" stars – the ones that we can observe today, that is, often turns out extremely complex. In some cases, there is no unambiguous solution at all. Obviously enough, we haven't been the first ones to address the problem of identifying the stars in the Almagest catalogue. This problem has been known to researchers for quite a while. However, it is of extraordinary importance to us, since no dating of the Almagest star catalogue by proper star motion rates is possible before the problem in question is solved.

Let us remind the reader that the Almagest catalogue contains 1025 stars. However, only twelve of them have names of their own in the Almagest catalogue, which use the formula "*vocatur*" (named). Those are Arcturus, Aquila (Altair), Antares, Previndemiatrix, Acelli, Procyon, Regulus, Spica, Vega = Lyra, Cappella, Canopus and Sirius (the latter is referred to as "The Hound"). No other stars but these twelve have proper names in the Almagest. They are simply described as "star at the middle of the neck", "star at the tip of the tail", "star at the end of the front leg", "the brighter of the two stars on the left knee" etc. Such descriptions are more often than not completely insufficient for a reliable identification of one Almagest star or another as its modern counterpart.

Numerous researchers of the Almagest have already performed an identification of the stars contained therein as the modern stars by comparing the Almagest star coordinates to those of the modern stars. The results of this identification can be found in the work of K. Peters and E. Knobel, for instance ([1339]). They cite a table where each Almagest star corresponds to a modern star. [1339] also contains the table of discrepancies between the identifications suggested by different researchers. However, it has to be emphasized that all prior identifications were made by astronomers who trusted the Scaligerian hypothesis, which notably affected the identification result in many cases.

Indeed, if the position of a dim and otherwise unremarkable star with a high proper motion velocity has altered notably over the period of time between the beginning of the new era and our days, it will identify as different Almagest stars in different epochs. It is pointless to date the catalogue by such stars, since the epoch of the catalogue's compilation will be chosen depending on the chosen identification. Multiple possible identifications will lead us to multiple datings of the catalogue's compilation.

Apart from that, in this situation it is altogether impossible to be certain that the "fast" star in question is in fact included in the Almagest. Most of the stars are dim and their order of magnitude is between 4 and 6. Many of these dim stars weren't included in the Almagest catalogue for the simple reason that there are more such stars than the catalogue contains, and so there are cases when a single Almagest star can be identified as several stars visible with the naked eye. All such cases need to be taken into account so as not to base the dating method on ambiguous scenarios.

However, in general, we did not doubt the fact that the star identifications of Peters and Knobel were made diligently and in good faith ([1339]). Our computations have proved this viewpoint correct. Possible errors result from nothing but the implied incorrect dating of the Almagest star catalogue – the Scaligerian early A.D. dating. In order to rule out the effects of the Scaligerian dating, we have performed the Almagest identification of fast stars anew.

2. FORMAL SEARCH OF THE FASTEST STARS IN THE ALMAGEST CATALOGUE

2.1. The star identification method

We are only concerned with the issue of identifying the notably mobile stars in the Almagest catalogue, which may be of use for dating purposes. The faster the star, the more precisely we can date the catalogue by its position – but only given that the star in question is reliably and unambiguously identified in the catalogue that we attempt to date. In the first stage we have chosen but 78 of the fastest stars from the bright star catalogue ([1197]) in order to identify them formally as Almagest stars. Double stars are counted as a single star. The stars that we have chosen have a minimal proper movement velocity of 0.5" per year by at least one of the coordinates in the equatorial system of the epoch of 1900 A.D. It has to be said that the majority of these stars are rather dim.

A list of the fastest stars visible to the naked eye is contained in Table 4.1. This table contains the equatorial coordinates of stars for the epoch of 1900 A.D. (for the time moment of $t = 0$ in our system, and the proper motion components of star velocities rendered to the equator for the epoch of 1900 A.D. The first column of Table 4.1 contains the index of the star according to Bayer and Flamsteed. Some of the data contained in Table 4.1 were taken from the previous edition of the catalogue ([1197]). The discrepancies between the numeric values contained in both editions are minute and negligible in our case.

According to the data contained in this table, the formulae of transforming the equatorial coordinates into their ecliptic equivalents with proper star motion velocities taken into consideration (see Chapter 1) were used in order to determine the ecliptic coordinates $L_i(t)$ and $B_i(t)$ of star i on the celestial sphere ($1 \leq i \leq 78$) for epoch t.

We built an estimated ε-area for each of the above 78 fast stars – in other words, a circle whose radius equals ε around the calculated position of the star on the celestial sphere for each assumed dating t between 1100 A.D. and 1900 A.D. ($0 \leq t \leq 30$), see fig. 4.1. After that, we calculated the arc distance $\xi(A, i, t)$ between star A from the Almagest catalogue and the estimated position of fast modern star i, with estimated coordinates equalling $(L_i(t), B_i(t))$ in epoch t for each of the assumed dates (t).

If $\xi(A, i, t) < \varepsilon$, modern star i is likely to identify as star A from the Almagest catalogue in the moment of t. Otherwise, no such identification is likely. Thus, the identification (or "capture") only took place when area ε around the star i from the modern catalogue

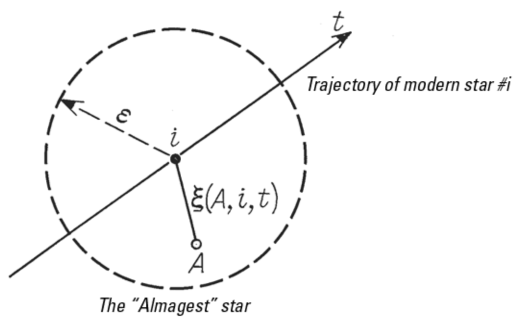

Fig. 4.1. The circular area around a modern star that moves across the celestial sphere together with the star.

Table 4.1 A list of the fastest stars in the catalogue ([1197]). We have chosen all the stars whose speed equals 0.5 sec/year minimum by at least one of the equatorial coordinates (α and δ) for the epoch of 1900.

Modern name of the star (where applicable)	Star number in the catalogue [1197]	α_{1900}			δ_{1900}		V_α measurement unit 0.001"/year	V_δ measurement unit 0.001"/year	Magnitude of the star in the catalogue [1197]
		h	m	s	°	′			
	6	00	01	08	49	38	560	-37	5,77
11 β Cas	21	00	03	50	58	36	527	-178	2,42
	77	00	14	52	65	28	1708	1163	4,34
	98	00	20	30	77	49	2223	326	2,90
	159	00	32	12	25	19	1383	-8	5,71
	173	00	35	31	24	21	640	-329	6,24
	176	00	35	44	60	01	886	451	5,79
24 η Cas	219	00	43	03	57	17	1101	-523	3,64
	222	00	43	08	4	46	752	-1142	5,82
μ Cas	321	01	01	37	54	26	3430	-1575	5,26
52 τ Cet	509	01	39	25	16	28	-1718	860	3,65
	637	02	06	19	51	19	2108	651	6,28
	660	02	10	57	33	46	1155	-240	5,07
	753	02	30	36	6	25	1807	1459	5,92
18 ι Per	937	03	01	51	49	14	1267	-81	4,17
	1006	03	15	36	62	57	1332	659	5,48
	1008	03	15	56	43	27	3056	744	4,30
	1010	03	16	02	62	53	1328	655	5,16
23 δ Eri	1136	03	38	27	10	06	-92	744	3,72
40 o^2 Eri	1325	04	10	40	-7	49	-2225	-3418	4,48
	1614	04	55	51	-5	52	557	-1089	6,50
15 λ Aur	1729	05	12	06	40	01	528	-659	4,85
	2083	05	51	44	50	24	74	568	5,00
	2102	05	53	20	63	07	135	540	4,53
9 α CMa	2491	06	40	45	16	35	-545	-1211	1,60
10 α CMi	2943	07	34	04	5	29	-706	-1030	0,48
78 β Gem	2990	07	39	12	28	16	-623	-52	1,21
	2998	07	39	51	44	55	-72	-563	5,22
	3018	07	41	51	39	59	-293	1663	5,39
	3384	08	28	57	31	11	-1119	757	6,36
	3951	09	55	15	32	25	-522	-436	5,60
	4098	10	21	54	49	19	81	-892	6,50
53 ξ UMa	4375	11	12	51	32	06	-431	-593	4,41
83 Leo	4414	11	21	42	3	33	-723	177	6,50
	4486	11	33	29	45	40	-594	18	6,39
	4523	11	41	45	39	57	-1538	393	5,04

Modern name of the star (where applicable)	*Star number in the catalogue [1197]*	α_{1900}			δ_{1900}		V_α *measurement unit 0.001"/year*	V_δ *measurement unit 0.001"/year*	*Magnitude of the star in the catalogue [1197]*
		h	*m*	*s*	°	′			
	4540	11	45	29	2	20	742	-277	3,80
5 β Vir	4550	11	47	13	38	26	3994	-5800	6,46
	4657	12	10	02	-9	44	31	-1024	6,12
	4710	12	17	51	67	05	-748	243	6,38
43 β Com	4983	13	07	12	28	23	-799	+876	4,32
	5019	13	13	10	17	45	-1075	-1076	4,80
	5072	13	23	32	14	19	-237	-583	5,16
	5183	13	42	00	6	51	-513	-114	6,32
	5189	13	43	10	35	12	-522	-178	6,47
	5209	13	45	50	23	53	-575	-310	6,48
	5568	14	51	37	20	58	1041	-1745	5,76
v^2 *Lup*	5699	15	15	03	47	57	-1621	-275	5,71
41 γ Ser	5933	15	21	50	15	59	307	-1292	3,86
15 ρ CorB	5968	15	57	13	33	36	-200	-774	5,43
	6014	16	04	16	6	40	235	-744	6,02
	6060	16	10	11	-8	06	227	-508	5,56
26 ε Sco	6241	16	43	41	34	07	-613	-256	2,36
36 Oph	6401/2	17	09	12	26	27	-464	-1146	5,33; 5,29
	6416	17	11	28	46	32	975	213	5,58
	6426	17	12	09	34	53	1167	-176	5,89
	6458	17	16	55	32	36	126	-1047	5,36
	6518	17	25	18	67	23	-529	0	6,31
	6573	17	33	57	61	57	253	-513	5,31
46 μ Herc	6623	17	42	33	27	47	-313	-748	3,48
	6752	18	00	24	2	31	256	-1097	4,07
58 η Ser	6869	18	16	08	-2	52	-554	-697	3,26
44 χ Dra	6927	18	22	52	72	41	521	-356	3,57
	7373	19	20	12	11	44	722	640	5,16
	7644	19	55	32	67	35	845	-680	6,07
	7703	20	04	38	36	21	449	-1568	5,32
	7722	20	09	03	27	20	1244	-178	5,73
	7875	20	31	46	50	53	309	-569	5,12
3 η Cep	7957	20	43	15	61	27	91	822	3,43
61 Cyg	8085/6	21	02	25	38	15	4135	3250	5,21; 6,03
	8148	21	13	59	26	46	-539	-352	6,56
	8387	21	55	43	57	12	3940	-2555	4,59
	8697	22	47	20	9	18	522	49	5,16
	8832	23	08	28	56	37	2073	299	5,56

contained star A from the Almagest catalogue on some a priori dating interval $[t_*, t^*]$ (a fragment of the historical interval $0 \leq i \leq 30$). Obviously, different Almagest catalogue stars could wind up in the same area ε of the modern star i, simultaneously as well as with different t values. In some cases, the region around a fast star didn't contain any Almagest stars, regardless of the t value under consideration.

The above identification method is, of course, rather rough. In particular, it makes sense to choose values of the "capture" radius that happen to be several times greater than the error margin value of the catalogue under study. It turned out that the actual identification hardly depended on the radius values (ε) at all, owing to the fact that the stars of the Almagest are distributed across the celestial sphere rather sparsely.

2.2. The result of identifying the "modern" stars as their counterparts from the Almagest catalogue

When we were giving a general description of the Almagest catalogue, we already mentioned that the catalogue precision level as declared by the compiler equals 10' (with latitude and longitude considered individually). Hence, the arc distance measurement precision as declared in the Almagest roughly equals 14', which is $\sqrt{2}$ times lower than the individual measurement precision for each coordinate. However, this declared precision happens to represent a record value of sorts, that is, such precision can only be attained for well-measured stars – such as the named basis ones. Real precision might well prove to be several times lower.

We shall consider the precision issues in more detail below (Chapters 5 and 6). For the meantime, we can safely leave the topic alone and choose such a value for the capture radius ε that will be several times greater than 14'. This is exactly what was done, namely, we chose the values for ε to equal (½)°, 1°, (1½)°, 2°. Table 4.2 contains the fast star identification results for the abovementioned time interval of $0 \leq t \leq 30$ – between 1100 B.C. and 1900 A.D., that is. The only fast stars that we find in this table are the ones whose environs "capture" at least one star from the Almagest catalogue with a minimum of one t for the indicated values of ε.

Each of the table's rows corresponds to a pair of identified stars – the "fast modern star" whose number is taken from the catalogue ([1197]), and the Almagest star which we shall mark as A. If the "fast modern star" isn't identified as the Almagest star A whatever the value of ε – that is to say, if the Almagest star A isn't captured by the ε circumference of the "fast modern star" in question, we put a dash into the respective position in the table. For instance, star 1325 from [1197] cannot be identified as Bailey's star #780 from the Almagest anywhere on the historical interval $0 \leq t \leq 30$ with $\varepsilon = 0.5°$.

If a star numbered i is just identified with a single star A from the Almagest catalogue, what we indicate in the respective row is Bailey's number of star A, as well as the time intervals for which the identification takes place with different values of ε. Star whose i value equals 21 (11 β Cas, that is) can thus be identified as the star $A = 189$ with $20 \leq t \leq 30$, if $\varepsilon = 0.5°$ and on the entire interval of $0 \leq t \leq 30$ if $\varepsilon \geq 1°$.

Should star i have several identification options, all of them are indicated in the corresponding row, and the time interval that we regard is the one for which the Almagest catalogue star under study is closer to star i than other stars that it may be identified as. The star with $i = 1325$, for instance, or 40 o^2 Eri, can be identified as different Almagest stars on different time intervals (numbers 778, 779 and 780 in Bailey's numeration). The column that corresponds to the value $\varepsilon = 1.5°$ tells us that while $0 \leq t \leq 10$, star $i = 1325$ is the closest to Almagest star $A = 780$ (in Bailey's numeration). Nevertheless, let us note that if $t = 10$, the distance between the stars $i = 1325$ and $A = 779$ is also less than 1.5°.

The reason for identifying the modern stat i as the Almagest star A for the moment t is as follows. If one is to assume that the Almagest catalogue was compiled in year t, the most fitting "candidate" for playing the part of A-numbered star from the catalogue is the i-numbered star from the modern catalogue ([1197]).

Table 4.2 demonstrates that the choice of the ε value hardly affects the identification results at all. This choice is arbitrary in many respects, and is only dictated by the following informal considerations. Firstly, the radius of ε must be comparable to the actual catalogue precision level. Secondly, it has to be sufficiently big for the identified pair list to contain

Table 4.2. Time intervals of possible identifications of the fastest stars as their Almagest counterparts for varying inclusion range values of ε. Alleged dating parameter t *has values that fluctuate between 0 and 30, which correspond to the changing alleged Almagest catalogue creation dating interval beginning with 1900 A.D. and stretching backwards in time with a step of 100 years. The value of* t = 0 *corresponds to 1900 A.D.;* t = 30 *corresponds to 1100 B.C.*

Number of the star in the star catalogue [1197]	*Number of the star in the Almagest star catalogue*	*Time intervals of fast star identification for varying inclusion range values of ε. We indicate intervals applicable to the alleged dating parameter* t*, which fluctuates between 0 and 30*			
		ε = *0.5°*	ε = *1.0°*	ε = *1.5°*	ε = *2.0°*
21	189	[20.30]	[0.30]	[0.30]	[0.30]
219	180	–	[0.30]	[0.30]	[0.30]
321	185	–	[6.27]	[0.30]	[0.30]
509	723	[4.30]	[0.30]	[0.30]	[0.30]
660	360	[8.30]	[8.30]	[8.30]	[8.30]
–//–	361	[0.7]	[0.7]	[0.7]	[0.7]
753	716	–	[10.30]	[2.30]	[0.30]
937	196	[27.30]	[0.30]	[0.30]	[0.30]
1136	783	[0.13]	[0.30]	[0.30]	[0.30]
1325	778	[29.30]	[29.30]	[29.30]	[29.30]
–//–	779	[19.25]	[14.28]	[12.28]	[12.28]
–//–	780	–	[0.8]	[0.11]	[0.11]
1614	775	–	–	[0.30]	[0.30]
1943	848	[0.17]	[0.30]	[0.30]	[0.30]
2491	818	[8.30]	[0.30]	[0.30]	[0.30]
2990	425	[0.30]	[0.30]	[0.30]	[0.30]
2998	882	[0.30]	[0.30]	[0.30]	[0.30]
4375	32	[0.3]	[0.30]	[0.30]	[0.30]
4414	486	[0.30]	[0.30]	[0.30]	[0.30]
4540	501	–	[14.30]	[0.30]	[0.30]
4657	732	–	–	[0.30]	[0.30]
5019	527	[8.30]	[0.30]	[0.30]	[0.30]
5188	935	–	–	[0.30]	[0.30]
5288	940	–	[0.21]	[0.30]	[0.30]
5340	110	[5.13]	[0.25]	[0.30]	[0.30]
5460	969	–	–	–	[0.30]
5699	979	[0.25]	[0.30]	[0.30]	[0.30]
5933	265	–	[8.30]	[0.30]	[0.30]
6241	557	[0.30]	[0.30]	[0.30]	[0.30]
6401	247	[17.30]	[0.30]	[0.30]	[0.30]
6623	125	–	[0.30]	[0.30]	[0.30]
6752	261	–	[4.30]	[0.30]	[0.30]
6869	279	[0.28]	[0.30]	[0.30]	[0.30]
7957	79	–	[0.22]	[0.30]	[0.30]
8085	169	–	–	[22.30]	[20.30]
8697	327	–	–	[0.7]	[0.7]
–//–	328	[28.30]	[8.30]	[8.30]	[8.30]

something in the first place; end result should not be affected by the possible aberrations contained in the catalogue. Thirdly, the value of ε should not be excessive to keep the identification result definite.

In particular, table 4.2 shows us that 36 out of the 78 stars under study could be identified. These identifications do not contradict the ones indicated in [1339]. Moreover, the overwhelming majority of them coincides with the previously known identifications. The visible exception is the star whose *i* number equals 1325, or o^2 Eri. The work of Peters and Knobel points out the dubiety of this star's identification. Our research demonstrates that it can be identified as different stars of the Almagest on different time intervals. Bearing in mind its rather low luminosity, the identification of the Almagest stars *A* = 778, 779 and 780 as real celestial objects is highly dubious. Therefore we have to exclude these three stars from further consideration, which we have already done.

Table 4.2 contains an example of the opposite as well. For instance, the Almagest catalogue star *A* = 169 in Bailey's numeration became identified as two modern stars simultaneously (#8085 and #8086 in the modern catalogue – [1197]).

The results presented in table 4.2 tell us that new identifications of stars are an exception and not the rule. This is explained by the low mobility of the overwhelming majority of the stars as well as the fact that the stars from the Almagest catalogue are at a significant distance from each other on the celestial sphere. The stars that we shall base our research upon were not re-identified; we shall therefore use their corresponding numbers in Bailey's numeration without quoting the numbers of [1197]. The star will be named should such a necessity arise.

The table that we cite might lead one to the question of whether one can use the resultant time intervals for fast star identification in the Almagest in order to date the latter. It appears that no reliable dating can be calculated in this manner. The reasons are discussed above in great detail (see Chapter 3).

We feel we should sum up with the general observation that if one were to exclude the ambiguously identified stars from the list and make ε equal some minimal value which would make all the identification intervals intersect with each other, this ε value could serve the ends of evaluating the real fast star measurement precision, the intersection point being the approximate date of the catalogue's creation. However, table 4.2 demonstrates that the value of ε that we get in such a manner is too great. It will take several millennia for this distance to be covered – even by the fastest of stars. However, in this case the date in question will be determined very unreliably, with a possible millenarian aberration. In particular, a dating like this shall be largely dependent on the stellar contingent under study. Adding or subtracting a single star, for instance, can significantly affect the dating. This is exactly why we describe the stage of classifying stars by the precision of their measurement separately in Chapter 3 for – it is a necessary procedure required for a reliable dating.

2.3. Corollaries

Corollary 1. Most of the stars in the Almagest catalogue were identified correctly by the researchers that preceded us.

Corollary 2. Out of the 78 fastest stars borrowed from a modern bright star catalogue ([1197]) and visible to the naked eye, 36 stars can be reliably identified as Almagest stars (see table 4.2).

Corollary 3. Only the following fast stars from table 4.2 are identified ambiguously with ε = 1.5°.

a) Star o^2 from the constellation of Eridanus = 40 o^2 Eri, numbered 1325 in [1197] can be identified as the following Almagest stars (in Bailey's numeration, for different alleged epochs).

Almagest star 778 for the interval of 1100 B.C. – 800 B.C.;

Almagest star 779 for the interval of 700 B.C. – 800 A.D.;

Almagest star 780 for the interval between 900 A.D. and the present epoch.

b) Star 660 from [1197] can be identified as the following Almagest stars:

Almagest star 360 for the interval of 1800-1900 A.D.;

Almagest star 361 before 1800 A.D.

c) Star 8697 from [1197] can be identified as two Almagest stars in different epochs:

Almagest star 327 for the interval of 1200 A.D. – 1900 A.D.;

Almagest star 328 before 1200 A.D.

3. THE SEARCH OF ALL THE FAST STARS RELIABLY IDENTIFIABLE IN THE ALMAGEST CATALOGUE

In the previous section we were looking for possible identifications of fast stars seen with the naked eye as the Almagest stars. This would allow us to instantly reject the stars which are a priori useless for a proper movement dating of the Almagest due to the fact that the possible identification of these stars as their counterparts from the Almagest is largely dependent on the alleged dating.

Let us now ask an altogether different question – which ones of the relatively fast modern stars can be identified in the Almagest catalogue with absolute precision? The search of these stars is the necessary preliminary work that has to be done before we can date the catalogue by proper star movements. This formulation of the problem differs from the one offered in the previous section. Before we have used a rough formal method for the rejection of the stars which obviously cannot be identified as the Almagest stars reliably. As a result, many of the "poorly qualified" stars were not excluded from our research. However, we shall be needing a meticulously verified list of fast stars which can be reliably identified in the Almagest. This task requires some additional work from our part, and we'll get right to it.

In order to solve the problem, we have taken the modern electronic version of the catalogue BS5 which contains all the stars visible to a naked eye – about nine thousand of them altogether. Catalogue BS5 is a more precise version of the bright star catalogue BS4 ([1197]). We have checked the electronic version of BS5 for misprints having compared it to the printed edition of BS4 ([1197]). All the misprints were corrected.

Step 1. Selecting the stars for speed.

We have picked out all the stars from the catalogue BS5 whose annual proper movement speed equals 0.1 sec (by one of the coordinates in the equatorial system for the epoch of 1900). These speeds were taken from the printed catalogue BS4 ([1197]), since in the catalogue BS5 the speeds are given in equatorial coordinates for the epoch of 1900 A.D. Let us remind the reader that the coordinate system choice of one epoch or another by no means implies that the star positions were calculated for the same epoch. These phenomena are not related in any way at all.

Step 2. Selecting the stars that have either Bayer's or Flamsteed's indications.

Further one, we have picked out just those stars whose indication either included a "Bayer's letter" or a "Flamsteed's number", or both. We have already mentioned our motivation for doing this above. The reason is that the systems of Bayer and Flamsteed are the XVII-XVIII century heirs of Ptolemy's stellar position description method which would describe the star's relative position in a given constellation verbally. It would be natural to assume that when these astronomers introduced a new system of indicating stellar positions, they studied the Almagest very pedantically, ascribing their new indication to a star whose identification would leave no place for doubt. Had we kept back the stars which neither have Bayer's letter nor Flamsteed's number in their name, it would mean that we're keeping back the stars that Bayer and Flamsteed were doubtful about. And what we seek to evade first and foremost is the effect of the "suspicious stars" that can lead us to erroneous datings based upon false identifications.

Why have we chosen Bayer and Flamsteed in particular – from the great multitude of later astronomers of the XVII-XX century who studied the Almagest? This was primarily caused by the fact that they were the ones to introduce the new indications of stars which reflected the old tradition that they were based upon. The generations of astronomers that followed them were already using the new indication for their studies, and the old tradition had soon been forgotten as obsolete. Metaphorically speaking, the astronomy teacher of Bayer could point out the stars on the sky (and then the respective places in the Almagest describing said stars) with his finger, quoting their names as given by Ptolemy – "the star on Virgo's shoulder", "the star on the hoof of Pegasus" etc. The following generations of young astronomers would already learn the names of these stars as "the Delta of Virgo", "the Epsilon of Pegasus" and so on. The Almagest catalogue terminology became completely obsolete.

Step 3. The selection of stars which have old names of their own.

The catalogue BS4 ([1197]) contains the complete list of "Star names found in old and more recent texts" on pages 461-468. The texts in question date back to the "antiquity" and the Middle Ages. We cite this entire list in tables P1.2(a) and P1.2(b) in Annex 1. We have picked out those of the stars we ended up with in the previous stage which can be found in this list of old stars possessing names of their own.

The reasons for such a selection are as follows. We want to exclude all possible errors in our identification of the stars which shall be used for the dating of the Almagest. It is obvious that if a star has a mediaeval name of its own, it makes its identification more reliable. Named stars have clearly been of special interest for the old astronomers, hence the very fact of their having names. Since old astronomy was based on the Almagest to a great extent, one is to expect that these stars could be identified in the Almagest more reliably than others.

Step 4. The selection of stars that fall into the "well-measured celestial areas" of the Almagest.

We proceeded to exclude the stars which wound up in celestial areas *C* and *D* of the Almagest catalogue. We shall explain the reason for that in Chapter 6. These are the areas for which we can neither calculate nor compensate the systematic error of the Almagest compiler. Apart from that, our analysis of Ptolemy's measurement precision for different areas of the sky (see Chapter 2) demonstrates areas *C* and *D* to be the "worst-measured" in the Almagest. The implication is that even if the position of a star is measured well enough but falls into one of these areas, the error in its coordinates can substantially affect the proper movement dating, making it extremely imprecise.

Having performed the selection described above, we ended up with a total of 76 stars.

Step 5. Selecting the stars by the local star chart image.

In the final stage we have chosen only those stars which can be unequivocally located on the sky by Ptolemy's coordinates, even if one is to allow for the gigantic errors of 2-3 degrees. We have meticulously verified the correctness of luminosity as stated in the Almagest, as well as the veracity of Ptolemy's description. If any discrepancies were found, the star would be rejected at once.

As a result, the only stars that we decided to keep in our list were the ones which can be isolated among the stars of comparable luminosity and also correspond to the coordinates of a single star in the Almagest that cannot be identified as any other star even if we are to allow for an aberration of several degrees. We have used the star atlas ([293]), as well as the simple and convenient software package called Turbo-Sky which can display a detailed map of any given celestial area accounting for stellar luminosity. This program also includes a "telescope" feature giving a 25x zoom.

During this last selection stage 8 stars of 76 were rejected, which leaves us with 68 stars. The rejected 8 stars are listed in table 4.3.

Table 4.3. Eight stars rejected in the final stage of "filtration" of the 76-star list.

1	2	3	4	5	6	7	8
BS5	*Name*	*?*	M_{BS5}	$\nu_{\alpha 1900}$	$\nu_{\delta 1900}$	*Bailey's number*	M_A
921	25ρ Per		3.39	+0.130	–0.102	204	4
2484	31ξ Gem		3.36	–0.115	–0.194	441	4
4057	41γ^1 Leo		2.61	+0.307	–0.151	467	2
6913	22λ Sgr		2.81	–0.043	–0.185	573	3
8610	63κ Aqr		5.03	–0.070	–0.114	651	4
321	30μ Cas	D	5.17	+3.423	–1.575	185	4
343	33θ Cas	D	4.33	+0.229	–0.017	185?	5
7348	α Sgr	D	3.97	+0.030	–0.121	593	2-3

The first column of table 4.3 contains the star's number according to the bright star catalogue BS5. The second column contains the name of the star. In the third column we find the letter *D* which stands for "disagreement" (referring to different researcher versions) which we borrowed from the electronic version of the Almagest. The corresponding explanatory materials tell us that the discrepancies between the opinions of various astronomers are quoted according to [1478]. The book also accounts for the discrepancies pointed out by Peters and Knobel ([1339]). The fourth column contains Bailey's numeration, or the Almagest number given to the suggested doppelganger of the star in question. The eighth column contains the luminosity value according to Ptolemy.

We must emphasize that the previous list of 76 stars contained a total of three dubiously-identifiable stars according to [1478]. The stars we are referring to are marked *D* (for dubiously-identifiable). All three stars were discarded in the final "filtering" of our list.

To size up, we could say that we got a list of stars which can be identified as their Almagest counterparts reliably and whose proper movement is visible from celestial areas *A*, *Zod A*, *B*, *Zod B* and *M*. The list contains a total of 68 stars; it can be seen in table 4.4 from Annex 1 at the end of the book.

Let us emphasize that the resultant list contains the complete "kernel" of the eight named Almagest stars which we already mentioned above. These eight stars are collected in the very beginning of the list and marked with block letters. This is the primary list we shall use in our final dating of the Almagest catalogue by proper star movements.