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ANCIENT AND MEDIEVAL STAR CATALOGUES

GEORGE ABRAHAM*

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An estimate is made of the accuracy of four star catalogues, one each from Babylonia, Greece, India and the Middle East.

Key Words : *Star Catalogues.*

INTRODUCTION

From BC 500 to AD 1500 the main centres of astronomy have been Babylonia, Greece, India and the Middle East. I have selected four star catalogues, one from each of these countries, and compared their star coordinates with modern values, to assess their accuracy.

BABYLONIA

A fragment of a Babylonian star catalogue[1] gives the longitudes of six stars in Leo, Virgo and Libra. The longitudes are rounded to integer degrees, and the latitudes are omitted. Neugebauer compares these longitudes, λ, with modern longitudes, λ^0 calculated for the year BC 300, as in Table1.

		λ	λ_0	λ-λ_0
θ	LEO	140^0	131.5^0	8.5^0
β	VIRGO	151^0	144.5^0	6.5^0
ν	VIRGO	166^0	158.5^0	7.5^0
α	VIRGO	178^0	172^0	6^0
α	LIBRA	200^0	193^0	7^0
β	LIBRA	205^0	197^0	8^0

TABLE 1

*Plot 1520, 12th Main Road, Annanagar, Madras 600 040.

The mean difference of λ-λ_0 is 7°15′ and the standard deviation is 51′, which is a rough estimate of the accuracy of the Babylonian catalogue, from the available fragment. The mean difference shows that the origin of the Babylonian longitudes is about 7° to the left of the vernal equinox of BC 300.

PTOLEMY

Ptolemy's *Almagest*[2] devotes two chapters to the fixed stars. The total number of the stars listed in his catalogue is 1022. The most important of these are the 14 fundamental reference stars[3]. I use these to get an estimate of the accuracy of Ptolemy's star positions, as shown in Table 2, where λ are the Ptolemy longitudes and λ_0 are those obtained by Pedersen from modern tables for AD 100.

		λ		λ_0		λ_0-λ
α	TAURUS	42°;	40	43°;	20	- 40′
β	TAURUS	55°;	40	56°;	9	+ 29′
β	AURIGA	62°;	50	63°;	31	+ 41′
α	GEMINI	83°;	20	83°;	52	+ 32′
β	GEMINI	86°;	40	87°;	5	+ 25′
α	LEO	122°;	30	123°;	31	+ 61′
γ	VIRGO	163°;	10	163°;	59	+ 49′
α	VIRGO	176°;	40	177°;	26	+ 46′
α	LIBRA	198°;	0	198°;	41	+ 41′
β	SCORPIO	216°;	20	216°;	46	+ 26′
α	SCORPIO	222°;	40	223°;	20	+ 40′
α	CAPRICORN	277°;	20	277°;	23	+ 3′
β	CAPRICORN	277°;	20	277°;	37	+ 17′
δ	CAPRICORN	297°;	20	297°;	1	+ 41′

TABLE 2

The mean of λ_0-λ is 35′ and the standard deviation 14′. The date of observation is therefore about AD 60.

India

From Brahmagupta's list of 30 stars[4], I have chosen 16 bright stars near the ecliptic. In Table 3 their longitudes are compared with modern longitudes[5].

		λ	λ_0	λ_0-λ-21°
Asvinī	(β Aries)	12°	33° 4′	- 44′
Rohini	(α Taurus)	48° 14′	69° 33′	- 19′
Ārdrā	(α Orion)	65° 8′	88° 31′	- 143′
Punarvasu	(β Gemini)	92° 51′	112° 59′	- 52′
Pusya	(δ Cancer)	106°	128° 29′	- 89′
Maghā	(α Leo)	129°	149° 36′	- 24′
P-Phalguni	(δ Leo)	142° 48′	161° 4′	- 164′
U-Phalguni	(β Leo)	150° 30′	171° 23′	- 7′
Citrā	(α Virgo)	183° 41′	203° 36′	- 65′
Anurādhā	(δ Scorpio)	224° 36′	242° 20′	- 196′
Jyesthā	(α Scorpio)	230° 6′	249° 31′	- 95′
Mula	(λ Scorpio)	244° 2′	264° 21′	- 41′
P-Āsādhā	(δ Sagittarius)	255° 4′	274° 21′	- 103′
U-Āsādhā	(σ Sagittarius)	260° 23′	282° 8′	- 45′
Satabhisaj	(λ Aquarius)	319° 52′	341° 20′	- 28′
Revatī	(ζ Pisces)	359° 50′	19° 38′	- 72′

TABLE 3

For the indentification of Indian star names with the modern nomenclature, I have followed Burgess[6]. I find the mean difference of the longitudes to be 20° 32′, and their standard deviation to be 87′. Therefore the date of the observation is about AD 500.

MIDDLE EAST

The most important catalogue of Islamic astronomy is that of Ulugh Beg, in the early fifteenth century. My source is G.R. Kaye's book[7] on Jai Singh. From the list of 1018 stars, I have chosen 15 bright stars and compared their longitudes[5] λ with the modern longitudes λ_0 in the Indian Astronomical Ephemeris 1983, in Table 4. In Kaye's book, $4^0\ 8'$ has been added to Ulugh Beg's longitudes. The mean of λ_0-λ is $3^0\ 4'$ and the standard deviation is 19′, the former confirming the date of the early fifteenth century.

	λ	λ_0	λ_0-λ
α TAURUS	66⁰ 39′	69⁰ 33′	2⁰ 54′
β ORION	73⁰ 33′	76⁰ 35′	3⁰ 2′
α ORION	85⁰ 21′	88⁰ 31′	3⁰ 10′
α CANIS MAJOR	100⁰ 27′	103⁰ 51′	3⁰ 24′
α GEMINI	106⁰ 51′	110⁰ 0′	3⁰ 9′
β GEMINI	110⁰ 3′	112⁰ 59′	2⁰ 56′
α CANIS MINOR	112⁰ 30′	115⁰ 33′	3⁰ 3′
α URSA MAJOR	131⁰ 33′	134⁰ 57′	3⁰ 24′
α LEO	146⁰ 21′	149⁰ 36′	3⁰ 15′
α VIRGO	200⁰ 18′	203⁰ 36′	3⁰ 18′
α BOOTES	200⁰ 39′	204⁰ 0′	3⁰ 21′
α SCORPIO	246⁰ 24′	249⁰ 31′	3⁰ 7′
α LYRA	282⁰ 27′	285⁰ 5′	2⁰ 38′
α AGUILA	298⁰ 18′	301⁰ 32′	3⁰ 14′
α CYGNUS	332⁰ 54′	335⁰ 6′	2⁰ 12′

TABLE 4

Comments

In the small samples studied in this paper, the standard deviations are as follows:

BABYLONIAN	GREEK	INDIAN	ARABIC
51′	14′	87′	19′

This shows that the Greek and Arabic astronomers devoted more attention to the determination of accurate star positions.

In Babylonia and India, planetary theory was based more on conjunctions with the sun and moon than on conjunctions with the stars, so that acurate positions of the latter were not so important. P.C. Sengupta, in his Introduction to Burgess's Translation of the *Sūryasiddhānta*[8], quotes from Āryabhaṭa:

"The day-maker has been determined from the conjunction of the earth and sun; and the moon from her conjunctions with the sun. In the same way star planets have been determined from the conjunctions with the moon".

In Ptolemy's *Almagest*[2] the order of presentation is first the theories of the sun and moon, then the star catalogue and finally planetary theory. This explains his emphasis on the star catalogue, a procedure followed later by Ulugh Beg.

In this study I have, following Pedersen[3], taken only a small sample of stars, restricted to bright stars near the ecliptic, which would have been important for fixing the planetary orbits.

References

1. Neugebauer,O. *History of Ancient Mathematical Astronomy,* New York (1975), p 546.
2. Toomer, G.J. Ptolemy's *Almagest,* London (1984)
3. Pedersen, O. *Survey of the Almagest,* Odense University Press (1974), p 252.
4. Pingree, D. *History of Mathematical Astronomy in India, Dictionary of Scientific Biography,* New York (1978), pp 565, 578.
5. *Indian Astronomical Ephemeris,* Calcutta (1983)
6. Burgess, E. Translation of the *Sūryasiddhānta,* Varanasi (1977), p 243.
7. Kaye, G.R. *Astronomical Observations of Jai Singh, Delhi* (1973), pp 98 - 114.
8. Reference 6, p xiv.