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(*fl*. Syria, and later Marāgha, *ca*. 1260–1265)

*trigonometry, astronomy, astrology*.

Al-Maghribī was a Hispano-Muslim mathematician and astronomer, whose time and place of birth and death cannot be determined. Little is known about his life except that he was born in the Islamic West and flourished for a time in Syria and later in Marāgha, where he joined the astronomers of the Marāgha directed by Naṣir al-Dīn al-Ṭūsī. He made observations in 1264–1265. It has been said that he was a guest of Hūlāgū Khān (īl-khān of Persia, 1256–1265) and met Abu ’1 Faraj (Bar Hebraeus, 1226–1286).

Suter and Brockelmann ascribe quite a long list of writings to al-Maghribī.

Trigonometry

1. *Kitb̄ shakl al-qā̤’* (“Book on the Theorem of Menelaus”).

2.*Ma yanfari’u ’an shakl al-qā̤* (“Consequences Deduced From shakl al-qā̤’”).

3.Risl̄a fī kayfiyyat istikhrj̄ al-juyb̄ al-wq̄i’a fil̄-dī’ira (“Treatise on the Calculation of Sines”). Astronomy

4. Khuls̄at al-Majisṭ̄(“Essence of the *Almagest*”). It contains a new determination of the obliquity of the ecliptic made at Mar̄gha in 1264, 23; 30° (the real value in 1250 was 23; 32, 19°).

5. Maql̄a fī istikhrj̄ ta ’dīl al-nahr̄ wa sa ’at al-mashriq wa ’l-dr̄ir min al-falak (“Treatise on Finding the Meridian, Ortive Amplitude, and Revolution of the Sphere”).

6. Muqaddamt̄ tata’allaqu bḥ̄arakt̄ al-kawk̄ib (“Premises on the Motions of the Stars”).

7. Taṣ̄ al-ạurl̄b (“The Flattening of the Astrolabe”).

Editions of the Greek classics; they are called recensions (sing. *taḥrīir*).

8. Euclid’s *Elements*.

9. Apollonius’ *Conics*.

10. Theodosius’ *Spherics*.

11. Menelaus’ *Spherics*.

He also wrote more than six books on astrology and a memoir on chronology.

Al-Maghrib̄’s writings on trigonometry contain original developments. For example, two proofs are given of the sine theory for right-angled spherical triangles, and one of them is different from those given by N̄ir al-Dn̄ al-̣s̄ this theorem is generalized for other triangles. He also worked in several other branches of trigonometry.

Ptolemy (A.D 150) used an ingenious method of interpolation in the calculation of chord 1°. This is of course approximately equivalent to chord 1°. The same method was used for sines in Islam. To find the exact value, one must solve a cubic equation. This was done later by the Persian astronomer al-Kāshī (*d*. 1429/1430), Al-Maghribī, and before him Abu ’l-Wafā’ (940–997/998),tried to find the value of the sine of one-third of an arc. For that purpose Abu ’l-Wafā’ laid down a preliminary theorem that the differences of sines of arcs having the same origin and equal differences become smaller as the arcs become larger.

Using this preliminary theorem, al-Maghribī calculated sin 1° in the following way (see Fig. 1):

$VF = 1; 7, 30°$ and $\sin VF = FK = 1; 10, 40, 12, 34$p

$AV = 0; 45°$ and $\sin AV = AI = 0; 44, 8, 21, 8, 38^p$.

The arc $AF$ is divided into six equal parts and each part = 0; 3, 45° therefore,

arc $DV$ + arc $DH = 1°$ and $\sin HV(=1°) = HZ$.

The perpendiculars $AT$, $BY$, and $CK$ divide $DT$ into three unequal parts: $TY > YK > DK$; $TD/3 > HL$; $DQ + TD/3$ (=1; 2, 49, 43, 36, $9^p$) > $HZ$(=sin 1°). $FM$ is divided into three unequal parts: $MN > NS > SF$; $DQ + FM/3$ (=1; 2, 49, 42, 50, 40, $40^p$) $NK = HZ$ (=sin 1°). Then he found sin 1° =1; 2, 49, 43, 24, 55p.

Al-Maghribī calculated sin 1° by using another method of interpolation based on the ratio of arcs greater than the ratios of sines. He found sin 1° = 1; 2, 49, 42, 17, 15, 12p and said that the difference between two values of sines found by using different methods is 0; 0, 0, 0, 56p, which is correct to four places.

Using these methods, al-Maghribī calculated the ratio of the circumference to its diameter (that is, $\pi$).

$AC(=2AT)<$ are $ABC < RF$

$\sin AB(=3/4°) = AT = 0; 47, 7, 21, 7, 37$p

$\Delta RFH \sim \Delta AHC$, $RF/AC = BH/TH$.

$RF = 1; 34, 15, 11, 19, 25$p

arc $ABC$ = = 1; 34, 14, 16, 47, 19, 30p.

The circumference = 240. Arc $AB$ = 6; 16, 59, 47, 18p, the diameter being 2p. The diameter being lp, the circumference 3; 8, 29, 53, 34, 39p < $3R$ + 1/7, since 1/7 = 0; 8, 34, 17, 8, 34, 17p.

Al-Maghribī compared the latter and Archimedes' value, $3R$ + 1/7 < the circumference < $3R$ + 10/71, found by computing the lengths of inscribed and circumscribed regular polygons of ninety-six sides. Half of the difference between 10/71 and 10/70 is equal to 0; 8, 30, 40p.

Al-Maghribī determined two mean proportionals between two lines, that is, the duplication of the cube (the problem of Delos). In antiquity many solutions were produced for this problem. It was thought that in terms of solving this problem the mathematicians of Islam stood strangely apart from those of antiquity; but recently many examples have been discovered, thus altering this opinion. The following example of Al-Maghribī's is of interest in this respect. He finds two values (see Fig. 3):

$AB$ and $BC$ are given and $AB > BC$, and $AB \wedge BC$. $AC$ are joined. Triangle $ABC$ is circumscribed by a circle. The perpendicular $DH$ is drawn so that $DC$ must pass through point $R$.

$HR = AB$, $RH/DH = BA/DH$

$AH = BR$, $RH/HD = DH/HA$, Since angle $D = 90°$

$BA/DH = DH/HA$

But

$RH/DH = RB(=HA)/BC$

$BA/DH = DH/HA = HA/BC$.

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