پژوهشگاه علوم انسانی و مطالعات فرهنگی
پرتال جامع علوم انسانی

the Latin European Science by means of the extensive translations of Arabic works into Latin, and to some extent Hebrew, undertaken in Spain, Italy and France during the 12th and 13th centuries.

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Fes = ASH, SHA	------
Ghamiq = BIR, SHA	------
Qulumriyya = SHA	=
Sijilmasa = ASH, SHA	=
Sus Alaqsa = ATH.FID, BIR, ASH, SHA	=
Tarjala = ASH, SHA	------
Udbula = BIR, ASH, SHA	------
Udghast = ASH, SHA	=
Zawila = SHA	------
Shantarin = ------	BIR

BIR = Al-Bīrunī's *al Qānûn al-Mas 'ûdi* (m. 11th c.)
ATH = *Kitāb al-atwāl wa-l- 'urûd li-l furs* (date unknown, but predating al-Tûsī
(m. 13th c.)
ATH-FID = ATH according to Abû 'l-Fidā' (m.14th c.)
ASH = *AshrajF* by Sayf al-Munajjim (b. 14th c.) and
SHA = *al-Zij al-jadīd* by Ibn al-Shātir (m. 14th c.)

However, as we have seen. Omar Khayam compatriot, Nasīr al-Dīn al-Tûsī, of the first half of 13th century, does uses the Andalusian Meridian of Water. As I showed in a communication in Tehran (1998), the relationship between the Castilian and the Eastern Islamic courts, proved by the different well known embassies, could have provided the interchange of knowledge. not just as far as geography is concerned but also in many other aspects specially astronomical. This was mainly due to the interest in this subject showed by the king Alfonso X and Ulugh Beg

This geographical development shows that Andalusi science, after using oriental materials, was able to develop new ideas and pass them back to orient as well as on to Europe.

Once more, the role played by Arabic mathematical geography in the development of this science in Europe should also be stressed in the face of the predominant opinion according to which the printing of Ptolemy's *Geography* had influenced the development of geography during the Renaissance.

Although mathematical geography was founded by the Greeks, and through them reached the Arabic world, there is no doubt that Arabic astronomers and geographers in Orient and Occident highly enriched this heritage. Afterwards they pass the torch on to a size for the Mediterranean Sea similar to that of al-Ma'mûn'a astronomers.

* The *Speculum astronomiae* by Albertus Magnus (1220). It uses the "meridian of water" for cities like Toledo but the Ma'munīī's Shore of Africa for oriental cities like Alexandria.

The list of works, although not exhaustive, is wide enough to show that the new Andalusian meridian of water was thoroughly used not only in al-Andalus, the North of Africa and Europe, but also in the Muslim East.

SNB SNH

We can now see that in the second half of the 11th century new and more correct geographical determinations were in use, at least in al-Andalus. Omar Khayyām, one of the greatest mathematicians of the Middle Ages, lived in the second part of the 11th century and the first part of the 12th's, but as far as we know he was not aware of the Andalusian improvements. In fact his, entitled *zij al-Zij al-Malikshāhī*, and supposedly dedicated to the Seljuk Sultan Malikshah, has been lost. However, we have different copies of *Al-Zij al-Sanjarī* by a student of Khayyām, Abû Mansûr Abû 'l-Fath 'Abd al-Rahmān al-Khāzinī al-Marwazī written c. 1120 at Merv and dedicated to the Seljuk Sultan Sanjar ibn Malikshah.[2] The Vatican copy has not a table of geographical coordinates. British Library MS Or. 6669, fols. 104v-106r, has a table of 162 localities (SNB) and Istanbul Hamidiye 859, fol. 29v, has another of 111 localities (SNH). Other copies however should be also studied as the one kept at Sipahsālār Mosque of Tehran, MS n. 681. The following table shows the western localities appearing in these sources.[3]

The few western localities appearing in these lists show no influence of the new Andalusian meridian.

SNB	SNH
Cordova = BIR	=

[2]. E.S. Kennedy offers an abstract of this: zij in his *A Survey of Islamic Astronomical Tables*. Transactions of the American Philosophical Society. Vol. 46, 2. (Philadelphia , May 1956).

[3]. See E.S. & M.H. Kennedy, *Geographical Coordinates of Localities from Islamic Sources*. Frankfurt, 1987.

1. Iberian Peninsula
* Abû-l-Husayn al-Zayyāt (1058).
2. Rest
* Nasīr al-Dīn al-Tûsī (c. 1270).
* The *Kitāb kanz al yawāqīt*, probably by Nāsir b. Sim'ûn (d. 1337). It also uses the meridian of water and the Canary Islands prime meridian.
* The table of al-Wābaknawī (1330)
* The *zij*-i Khāqānī by al-Kāshī (1420). It also uses also the meridian of water for some localities.
* Ulugh Beg's *zij -i Sultānī* (c. 1440). (Similar to the former).
* Abû-l-Fadl ^{c}Allāmī (1580) (meridian of al-Zayyât together with the meridian of water for western localities)
* The table in the *Kitāb al-tahdhīb fī ma^{c}rifat al-qibla wa-nasb al-mahārīib* by Zayn al-Dīn al-Dimyātī (date unknown). It also uses the meridian of water for some localities.

C) Tables or texts which use the meridian of water wrongly.
* The 1483 edition of the *Alphonsine Tables* by Erhard Ratdolt (1483) (used only for some cities such as Toledo, Saragossa, Barcelona, etc but not for others like Cordova, Tangiers. etc). As we have seen. by using the meridian of water wrongly they return to al-Kwârizmi s value for the Mediterranean size.
* The *Commentarius astrologicus* of Diego de Torres (15th c.). The meridian of water is used for occidental localities while Ma'mûnī s values are used for oriental ones. This implies a hypercorrection of the value of the size of the Mediterranean (27:08° in this case).
* The *Almanach Perpetuum* and the *Ha-jibbur ha-gadol of* Abraham Zacut (end of 15th c.). They use exactly the same combination of meridians as Diego de Torres.
* A table found in a manuscript of the National Library in Vienna (Cod. 2332. f. 140v-141r), which should be dated after 1415 because there is stated in this table that Ceuta belongs to the Portuguese king. Only for some western localities such as Toledo and not for some others such as Sibta.
* The table by Conrad Von Dyffenbach (1426). In it the "meridian of water" is used for localities such as Cordova and Toledo, and the "meridian of water" plus some 10° is used for localities such as Sibta and Tangiers as well as for oriental localities. Reaching then

Raqqām's.

* A table found in a maghribi manuscript (Zawiyya Hamzawiyya, 80) by Abû Zayd ᶜAbd al-Rahman al-Lakhmī.

3. Eastern Islamic tables.

* The table in the *Kitāb al-tahdhīb fī maᶜrifat al-qibla wa-nasb al-mah_r_b* by Zayn al-Dīn al-Dimyātī (date unknown).
* The Anonymous ms. In Zāhiriyya (Damascus) (12th century).
* The *Tāj al-azyāj* of Yahyā b. Muhammad b. Abī 'l-Shukr al-Maghribī (1276), written in Damascus in 1257. There exist two copies of this *zij*, identical except for some tables, among them the geographical one. However, in both the Meridian of Water is used.
* The *Kitāb kanz al yawāqīt*, probably by Nāsir b. Sim'ûn (d. 1337). It also uses al-Zayyat's meridian and the Canary Islands prime meridian.
* The ones of the Persian group such as the *zij*-i *khāqānī* by al-Kāshī (1420), although he only uses this meridian for some western localities such as Marrakech and Malaga.
* And the *A'īn-i akbarī* by Abû-l-Fadl ᶜAllāmī (c. 1580). 4.

4. European Latin or Hebrew tables or astronomical works:

* The European *z ijes* derived from Maslama's version of al-Khwārizmī's *zij*: Robert of Chester (c. 1150).
* Latin versions of the *Toledan Tables*: Raymond of Marseilles (c. 1140) and Roger of Hereford (c. 1175).
* A table in Codex 2452 of the Vienna National Library (13th-14th centuries). It uses the meridian of water for al-Andalus and the North of Africa.
* A table found in a miscellaneous manuscript of the National Library in Vienna (N° 5311) copied probably in the 14th-15th centuries.
* A table found in a manuscript of the National Library in Vienna (Cod. 2332, f. 133r) 15th century. Only for some western localities such as Toledo and not for some others such as Sibta.
* The table in the *zij* by Josef b. Isak b. Moses for the longitude of Toledo and year radix 720/1320. The *zij* written in Arabic language but in Hebrew scripture, is strongly related to Ibn al-Kammād's.

B) Tables using a prime meridian 10 degrees less than the "Meridian of Water"

* The *Portuguese Almanac of Madrid* (1321), in which for the first time the words *da terra* or *d'agoa* identify the meridian employed. So that although different prime meridians are used. the reader knows to which meridian the longitude of each city refers to.

* The *Tables of Barcelona.* by two Christian astronomers. Pere Gilbert and Dalmau Ses Planes and one Jewish, Jacob Corsino, all of them working for the King Peter, the Ceremonious (1360-1366). Closely related to the table by Ibn al-Kammād.

* The table for localities of al-Andalus and North of Africa interpolated into the al-Battānī's *zij* in the Latin translation kept in ms. Escorial 908.

2. Maghribi *zijes* and other astronomical works.

* The *zij* by Ibn Ishāq al-Tûnisī (c. 1203). Although this astronomer was born in Tunis, he worked in Morocco. Ibn Khaldûn says that his *zij* had been very popular during the fourteenth century in the Maghrib. The extant copy is a compilation which includes different materials from Azarquiel, Ibn al-Kammād, Ibn al-Hā'im, etc. There are no tables in this *zij* but the longitudes of Toledo and Tunis from the Meridian of Water are stated on every page.

* The *Kitāâb jāmi^c al-mabādi' wa-l-ghaya* by Abû-l-Hasan ^cAli al-Marrākushīi (1250). Closely related, as is usual, to Ibn al-Kammād's table. The very same author says that he followed the work of Azarquiel and Ibn al-Kammād.

* The *Minhāj al- Tālib li-ta^c dīl al-kawakib* of Ibn al-Bannā' al-Marrakushī (1256-1321). Ibn al-Bannā' himself says that he wrote this *zij* following Ibn Ishāq al-Tûnisī s method.

* The three *zijes* by Ibn al-Raqqām (1315): *al-Zij al-shāmil fi tahdīb al-Kāmil, al Zij al-qawīm fi funûn al-ta^cdīil wa-l-taqwīm* and *al-Zij al-mustawfī*. This astronomer, who probably was born in Murcia (al-Andalus) lived in Tunis and Bejaia and died in Granada. He is the one who uses the Meridian of Water in the most correct way.

* The versified *zij* by Abu'l-Hasan ^cAlī b.Abī ^cAlī al-Qusuntīnī, written in Fes around the middle of the fourteenth century.

* The *Zij al-muwīfiq*, written in Fez, probably by Ibn ^cAzzīz al-Qusuntinī (m. 1354), its geographical table is related to Ibn al-

We can find this improvement in a great number of sources and authors.

A) Tables or texts using the "Meridian of Water":

1. Iberian Peninsula

* The adaptation by Maslama (d. 1007-1008) of al-Khwārizmī's tables. The meridian of water is for the first time implicit in the text and eclipse tables.

* Ibn al-Saffār's *al-Zij al-mukhtasar* (d. 1035). (Canons).

* Ibn Mu^cād *Tabulae Jahen* (second half of the 11th c.). (Canons).

* *Toledan Tables* (c. 11th c.). (Canons). As far as the geographical tables are concerned, it only appears in some manuscripts and exclusively for the longitude of Toledo. However, from the lunation periods taken from the: " of al-Battānī. it can be easily determined that the difference between the longitude of Raqqa (73;30°) and Toledo is of 45°. That means that Toledo must be considered to be at 28;30° (73;30° - 45°) as stated in the canons, which implies the use of the Meridian of Water in the tables also.

* The *Zij al-muqtabas* by Ibn al-Kammād (c. 1116-1117). Although Ibn al-Kammād, probably a direct disciple of Azarquiel, wrote three *zijes*, only a Latin translation of *al-muqtabas*, a compilation of the two previous *zijes*. *al-Kawr ^calā-l-dawr* and *al-Amad ^calā-l-abad*, is still extant. For the first time this new meridian appears in the tables applied to all the localities of al-Andalus and the North of Africa implying the new and correct value for the Mediterranean size.

* *Sefer ha-^cIbbur* of Abraham Bar-Hiyya (d. 1136), using the meridian of water for all the cities in al-Andalus and closely related to the table of Ibn al-Kammād.

* The *Alphonsine Tables* in some mss. use the meridian of water for Toledo, as in most of the tables of the *Toledan Tables* (for instance Biblioteca Nacional de Madrid n. 4238). and other cities from al-Andalus but not for some others as Tangiers and Cordova.

* The *Tortosa Almanac* (1307). The same values for the Mediterranean size as the ones achieved by the al-Andalus astronomers.

Kepler	43;00°

Distance between Toledo and Mecca:

Modem value	43:51°
Ptolemy	-------
Ma'mûnī	-------
Al-Zayyāt	49;00°
Ibn al-Raqqām	49;00°
Ibn Abī l-Shukr al-Maghribī	49;00°
Al-Marrākushī	49;12°
Kepler	58:00°

However, the distance that has been always used to assess the Mediterranean size is the distance between Tangiers and Alexandria. In the following table we can compare the values arrived at by different astronomers in different times.

Distance between Tangiers and Alexandria

	Value	Dif. with Modern
Ptolemy	54°	18;21°
Al-Ma'mûn	43;20°	7;41°
Al-Zayyāt	37;10°	1;31°
Ibn al-Raqqām	36;10°	0;31°
Kepler	[c.43°][1]	7;21°
Modern	35;39°	------

Ptolemy: Geography
Al-Ma'mûn: *Kitāb sûrat al-ʿard*
Al-Zavyât: *Dhikr- al-aqālīm*
Ibn al-Raqqâm: *al-zij al-qawīm* and *al-zij al-kāmil*
Kepler: The *Rudolphine Tables*

The Andalusian meridian of water implies, then, a new correction to the length of the Mediterranean sea, and made possible, for the first time, a surprisingly correct value which in some cases shows a difference of only 0;31° from the actual length, as in the case of Ibn al-Raqqām.

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1. Although Kepler has no coordinates for Tangiers, we must take into account that in all the tables the difference between Tangiers and Cordoba is of 1°, so we can calculate that the distance between Tangiers and Alexandria would de 1° less than between Cordoba and Alexandria.

Al-Marrākushī	36;00°
Kepler	4;45°

Distance between Cordova and Damascus:

Modem value	41:05°
Ptolemy	59:40°
Ma'mûnī	50:40°
Al-Zayyāt	43:00°
Ibn al-Raqqām	39:00°
Ibn Abī l-Shukr al-Maghribī	43:00°
Al-Marrākushī	43:12°
Kepler	53:00°

Distance between Cordova and Mecca:

Modem value	44:35°
Ptolemy	64:00°
Ma'mûnī	57:40°
Al-Zayyāt	50:00°
Ibn al-Raqqām	50;00°
Ibn Abī l-Shukr al-Maghribī	50;00°
Al-Marrākushī	50;00°
Kepler	55;00°

Distance between Toledo and Damascus:

Modem value	40:21°
Ptolemy	------
Ma'mûnī	------
Al-Zayyāt	42;00°
Ibn al-Raqqām	38;00°
Ibn Abī l-Shukr al-Maghribī	42;00°
Al-Marrākushī	42;12°
Kepler	53;00°

Distance between Toledo and Alexandria:

Modem value	33:57°
Ptolemy	-------
Ma'mûnī	-------
Al-Zayyāt	33;20°
Ibn al-Raqqām	33;20°
Ibn Abī l-Shukr al-Maghribī	34:00°
Al-Marrākushī	35:12°

determining longitudes has been attested by a great deal of authors all over the history. This paragraph is just intended to show some samples of Greek, Eastern and Western Arabic and European authors who use this method for finding the longitude of a given location. For instance. Ptolemy who seems to have been able to report the time difference between two localities by the observation of the lunar eclipse of 331 BC at Carthage and Irbil. In fact. though, Ptolemy does not seem to have achieved a good longitude difference because. according to the data which have reached us, he determined that the difference between the two cities was of 45;10°, while modern coordinates attribute a difference of 33:45°. In the chapter dealing with the longitudes of localities of the *al-Zij al-mukhtar* it is also stated that to know the longitudes the "method of the lunar eclipses" should be used. Ibn Ezra, in his *Book on the foundations of the astronomical tables,* states that the longitude of Cordova of 27 degrees has been proved in different times by means of lunar and solar eclipses and that Ptolemy was wrong to give to this city a longitude of 9 degrees. He also adds that he himself had used this method to calculate longitudes. Roger of Hereford (c. 1175) in his version of the *Toledan Tables* mentions a total solar eclipse (13th September 1178) which he observed and for which he noted the times according to the meridians of Arin, Toledo. Marseilles and Hereford to determine the difference in longitude between their meridians. The very same Kepler in his *Tabularum Rudolphi* talks about different determinations of longitude distances based on lunar eclipse observations and mentions explicitly the eclipse of 18th January 1497. References of this kind are to be found in a wealth of sources.

On the other hand, a comparison of the difference in longitude between some of the most important cities of the time will show us the great accuracy achieved by the astronomers using the "Meridian of Water" for western localities:

Distance between Cordova and Alexandria:

Modern value	34:41°
Ptolemy	51;10°
Ma'mûnī	42:00°
Al-Zavvât	34:20°
Ibn al-Raqqām	34;20°
Ibn Abī l-Shukr al-Maghribī	35;00°

Islands. They also stated that the "true occident" is located 17;30° to the west of the inhabited occident. Although the tables themselves seem not to use the "meridian of water", the above mentioned statements imply that somehow they are aware of the use of this meridian. Its incorrect use takes them back to al-Ma'mûn astronomers' error for the size of the Mediterranean.

The new value for occidental longitudes was probably arrived at by means of the old method of observing a lunar eclipse.

As is well known, the precise calculation of latitudes. which depends on the obliquity of the ecliptic, was known since the classical times and could be carried out by the observation of the altitudes of a star or the sun. The latitudes result from a development of the ancient notion of the seven geographical climates defined in terms of the length of the longest daylight and offered no specifically problems.

However, the determination of longitudes was more difficult. Until the arrival of chronometers it could be achieved by means of the simultaneous observation of a lunar eclipse in two different places which would supply the time-difference between these two places, and hence the longitude difference. Another way of determining geographical longitudes could be achieved after al-Bīrûnī's time (11th c.), through the so-called trigonometrical revolution developed by al-Bīrûnī's teachers at the end of the 10th century. It consists on the discovery of the sine theorem Al-Biruni put the new achievements in spherical trigonometry to the service of mathematical geography by relating the four quantities common to two localities: their latitudes. their longitude difference and the distance between them. Then. using trigonometry he was able to determine longitude differences.

In al-Andalus, in Maslama's time, the new achievements arrived at in Orient were not yet known. So the only tool they had for determining distances in longitude was the typical method of observation of lunar eclipses, as it is stated by Ibn al-Saffār's in the canons of his *al-Zij al-mukhtasar*. Maslama determines that the time difference between Cordova and Arin was 4 hours 12 minutes, that is to say 63 degrees, which implies that the prime meridian should be shifted 17;30° to the west of the Canary Islands to achieve a difference between the prime meridian and Arin of 90°. Using this difference of time we obtain a size of the Mediterranean extremely correct.

Apart from Ibn al-Saffār's statement, the use of lunar eclipses for

The second step is to be found in the *Kitāb sûrat al-ard* attributed to al-Khwārizmī but probably the result of al-Ma'mûn's astronomers work, in which a real correction of the size of the Mediterranean appears, which reduced the length of the Mediterranean from the Ptolemaic 54 degrees to 43:20°. This was achieved by using a prime meridian for the oriental localities placed 10 degrees to the east of the Canary Islands (the meridian employed by Ptolemy). The new meridian was theoretically located somewhere on the Atlantic shore of Africa.

The third, and last, step was taken by the astronomers of al-Andalus. They were motivated by the same reasons that urged Baghdad astronomers to develop precise geographical coordinates, that is to say, the need to adapt *zijes* prepared for other localities. Maslama, the first astronomer to determine a distance between Arin and Cordova which implies a shift of the zero western meridian to 17;30° to the west of the Fortunate Isles and a definitive correction of the size of the Mediterranean, was adapting al-Khwārizmī's tables drawn for the meridian of Arin to the meridian of Cordova.

This improvement in the calculation of the size of the Mediterranean Sea was, then, a very fortunate. albeit unintended, by-product of the earliest astronomical activities in al-Andalus. It is important therefore not to confuse the result with the cause. The result, evidently. was the improvement in the determination of the size of the Mediterranean. The motivating cause was the need to know the difference in longitude between Arin and Cordova in order to be able to adapt al-Khwârizmi *zijes* - calculated for the meridian of the former city - to the meridian of the latter.

The coordinates of localities of al-Andalus and North Africa in several other tables present an interesting feature. Their longitudes are 10° less than those reckoned from the meridian of water, that is to say, 7;30° more than the ones calculated from the Canary Islands. This is explained by the fact that the astronomers who used this first meridian also used the Ma'mûnī's meridian of the Atlantic Shore of Africa (10 degrees less than Ptolemy's) for oriental localities. The first time this displacement appears is in the table of the Andalusian geographer Abû-l-Husayn al-Zayyāt (1058).

However, some authors placed Arin at a longitude of 72;30° from what they called the inhabited occident, that is to say the Canary used as the starting point for reckoning longitudes.

It should be stated that the ancients considered the terrestrial hemisphere - which extended 90° to the east and to the west of a point on the equator called the "Cupola of the Earth", that is to say the mythical city of Ujjain or Arin - as the inhabited part of the world.

Of course, distances can be measured either in linear or angular units. To convert one to another, it is necessary to know the number of linear units per degree, or the radius of the Earth. In fact some of the angular measures were taken from linear distances. mainly in Ptolemy's *Geography*, which is at the very basis of Arabic mathematical geography.

Although the works of Ptolemy's predecessors in geography have not come down to us, by the early part of the ninth century both his *Geography* and his *Handy Tables* were available to the scientists of the Abbasid Empire. There is no doubt that Ptolemy represents the top moment of Greek science. but at the same time, his work is a synthesis of the work of his predecessors.

From Ptolemy's table (2nd c.), containing about 8000 localities to al-Ma'mûn's time (9th c.) there were no substantial developments in mathematical geography.

It is said that al-Kindī prepared a rather poor version of the *Geography,* which was later improved by Thābit b. Qurra. Tradition says that under the caliph al-Ma'mûn a group of seventy experts drew a series of maps.

In effect, the aim of mathematical geography was not only to supply geographical coordinates for astronomical, astrological and religious purposes. but also to depict the portrayal of the inhabited world by means of longitudes and latitudes ascertained by astronomical observations.

The Mediterranean Sea played a very important role in this portrayal from the Islamic point of view, because most of the Islamic countries were located around it.

Ptolemy attributed to the Mediterranean sea a longitude of 54 degrees, while the actual figure is of 3;39 degrees. The first step towards the correction of Ptolemy's error was made by al-Ma'mûn's astronomers. It was an indirect step, consisting in measuring the circumference of the equator and giving the Earth almost its real size.

common in Arabic (*zijes)* and *gibla* texts, while they are rarely found in the wealth of descriptive geographical literature preserved, which tends to present distances in linear measures.

However, sometimes we can find in this kind of books the coordinates of the cities placed between the name of a city and its description. For example in Ibn Sa'id's *Kitāb bast al-ard* or Abu'l Fidā 's *Taqwīm al-buldān* or al-Zayyāt in his *Dhikr al-aqālīm.* Another source of information at that respect are the maps, specially those provided with a grid of coordinates which allows its lecture.

Indeed, until now, the available data concerning geographical coordinates have been taken mainly from the :Ties, although medieval instruments offer an equally important historical source that has not as yet been fully exploited. In addition, geographical coordinates in Latin and Hebrew European sources must also be taken into account because they often. if not always, show a strong influence of the Arabic sources.

In short, to study Arabic mathematical geography any accessible medieval work including a reasonably large number of coordinates of localities should be used. I take advantage of the situation to say that I would be very grateful if someone could suggest me new or unknown sources or manuscripts offering this kind of data that could be included in the new version of the Book (geographical coordinates of localities from Islamic sources).

It must be said that no two sources are identical, even allowing for errors of transcription. but at the same time nor are any two sources completely independent of each other. The authors often use coordinates from more than one source without undertaking a systematic study of the underlying meridians and the geographical data.

The geographical coordinates are the longitudinal and latitudinal measurements of a locality taken in two circles of reference: the terrestrial equator. from which latitudes are universally measured, and a conventional. and to some extent arbitrary, zero meridian

Mathematical Geography in the Lifetime of Omar Khayam

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The aim of this communication is to present the panorama of the geographical knowledge in the lifetime of Omar Khayam. I will devote this paper especially to mathematical geography. And will analyse the role played by al-Andalus' astronomers in this field. Mainly in the determination of the new "Meridian of Water", the correction it implies on the length of the Mediterranean Sea and the influence that this improvement had in Orient, Persian and Arabic sources, and in Occident, Latin and Hebrew's.

As is well known. in the earliest phase of Arabic Astronomy astronomical handbooks consisting of canons and tables (*zijes*) drawn up for meridians such as Alexandria or Arin were brought to Baghdad, where a huge translation movement had begun. As it was necessary to recalculate the tables for new places. astronomers felt the need to assess the difference in longitude between the meridian used in the tables and the new locality. This required the determination of accurate geographical coordinates.

The problem of determining the *gibla*. that is to say the direction of prayer or the azimuth of Mecca from an arbitrary location also involves the need of precise geographical coordinates.

It is for these reasons that lists of geographical coordinates are so

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