

# THE TOTAL ECLIPSE OF THE SUN OF JULY 29, AD1478, IN CONTEMPORARY SPANISH DOCUMENTS

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## ABSTRACT

The total solar eclipse on July 29, AD1478, went unnoticed by most of Europe. Although several scholars accurately predicted it, very few observations made by professional astronomers have survived, and these contain very little relevant information. In contrast, several observations, many of which unknown or unpublished, made by casual eyewitnesses have reached our days from the different kingdoms of the Iberian Peninsula in the 15th century. We present six such observations. These descriptions, collected in observations, chronicles, or diaries, although not professional, provide interesting information that, in some cases, lead us to obtain valid values for the  $\Delta T$  parameter.

**Keywords:** Astronomical Sources, History of Astronomy, Medieval Astronomy, Solar Eclipses.

## INTRODUCTION

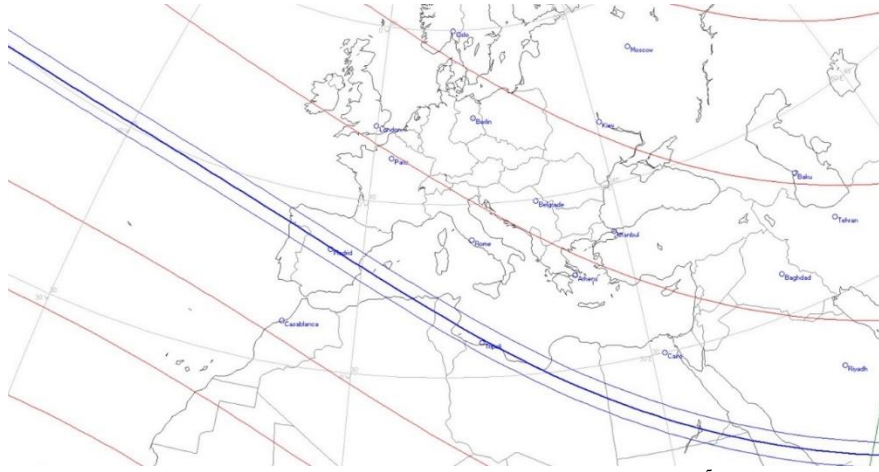
The search and study of ancient astronomical sources is one of the aims of the International Astronomical Union (IAU) and is included in the objectives of Division C: Educational Outreach and Heritage. Several academics have devoted themselves to this research, and after their extensive publications, it has become quite challenging to find new reports of astronomical events, even when studying relatively recent historical periods from which many written documents have been preserved, such as the late Middle Ages and the early Modern Period. In fact, when they are found, new primary sources are often found in local documents, which are sometimes written in vernacular languages, as in some of the cases that we will deal with in this paper.

An excellent introduction and summary of the history of the compilation and analysis of historical solar eclipse records can be seen in the paper by Stephenson<sup>1</sup>. In the compilations of historical eclipses carried out by different authors, there are no records of visual observations of the totality of the solar eclipse of July 29, AD1478, whose band of totality entered Europe through the NW of the Iberian Peninsula, affected the North of Portugal, and crossed all of Spain (at that time, divided into several kingdoms: Castile, Aragon, Navarra, and Granada). Later, it crossed part of North Africa, including Tunisia, Libya, and the South of Egypt. The Sun went dark in France or Italy by 75% and more than 50% in London or Istanbul (See Figure 1).

The absence of records from West Europe is curious since the Iberian Peninsula was at that time in a period of effervescence, both in the kingdom of Portugal under the reign of Alfonso V, and in the kingdoms of Castile and Aragon, at the beginning of the reign of the so-called Catholic Monarchs who were about to complete the conquest of al-Andalus<sup>2</sup>. Thus, there were plenty of chroniclers or scholars who could account for such an important phenomenon in such a significant period of history.

In this paper, we will ignore those chroniclers who, even referring to this eclipse, are not contemporary, as well as descriptions from later eclipse catalog listings<sup>3</sup>. Instead, the records we will see in this paper correspond mainly to casual observers who, according to Stephenson's conclusions<sup>4</sup>, were only aware of the phenomenon if the magnitude was greater than 0.98. However, an observer did see it from a smaller magnitude.

In the first place, we will comment on the precedents in the literature of the epoch since, although the observations collected are scarce, the eclipse was indeed predicted by some of the scholars of the time. Later, we will show the records we have found, providing the original source and the translation and obtaining, in its case, the  $\Delta T$  values that can be inferred from them.



**Figure 1:** Path of the July 29, AD1478 solar eclipse, using SkyMap Pro v.11<sup>5</sup>. The blue band corresponds to the zone of totality.

## PRECEDENTS: PREDICTIONS AND ASTRONOMICAL LITERATURE

The historical context to this phenomenon is provided by the long reign of the so-called "Catholic Monarchs", Queen Isabel I of Castile (1474-1504) and King Fernando II of Aragon (1479-1516), whose marriage and joint rule marked the "de facto" unification of Spain. The Monarchs soon understood that written chronicles could serve as an efficient means of propaganda, and to facilitate the extension of the project in society, Spanish (Castilian) soon gained ground over Latin in writing.

It will be in 15th-century Castile, under Juan II (1406-1454), when we find the appointment of a royal chronicler for the first time: Juan de Mena. The position of royal chronicler seems to have been for life, and Alfonso de Palencia replaced Juan de Mena after his death in 1456. Initially, there was only one chronicler per reign, although King Enrique IV of Castile (1425-1474) appointed two at least, and the Catholic Monarchs up to three. They would end up being trustworthy advisers and experts on matters of history, which would make them efficient diplomats and ambassadors. Of course, the chroniclers wanted to please those who paid them and tried to make their stories, chronicles, or memorials favorable to them<sup>6</sup>. Three of the records presented in this paper for the eclipse come from royal chroniclers.

Among the royal chroniclers of the Crown of Aragon and Castile in the 15th century and the beginning of the sixteenth century, some of the most recognized names are Alonso de Palencia and Juan de Flores. Joan Margarit, Diego de Valera (who was an advisor during the successive reigns of Juan II, Enrique IV, and the Catholic Monarchs), Hernando del Pulgar; Antonio de Nebrija, Gonzalo de Ayora, Andrés Bernaldez (the first to complete the chronicle of the Catholic Monarchs); Gonzalo García de Santa María and Lucio Marineo Siculo. All of them, to a greater or lesser extent, wrote documents in which political and historical events were recorded, commented on or embellished, always in a favorable manner to the reigning monarchs. After the arrival of Columbus in America, it would be the chroniclers of the Indies who would report on the geography and the indigenous way of life, highlighting Bartolomé de las Casas, Francisco Ximénez, Bernal Díaz del Castillo, Fray Bernardino de Sahagún, among others.

However, this eclipse is not mentioned in the "official chronicle" *Chronica de los muy altos y esclarecidos Reyes Catholicos Don Fernando y Doña Isabel*, written in vernacular by Fernando del Pulgar<sup>7</sup>, who was appointed royal chronicler by Queen Isabel I of Castile, replacing Alonso de Palencia in 1482. The *Chronica* was translated into Latin by Antonio de Nebrija, to whom it was wrongly attributed when it was first printed in 1565 in Valladolid.

Regarding European professional astronomers, from whom we already know a significant number of names in this century, we have a few observations of the AD1478 eclipse, and they are surprisingly brief and provide little astronomical data. For instance, in the case of Walther's brief comment<sup>8</sup> from Nuremberg, far from the zone of totality, he states:

*July 29. At about the first hour after midday, namely when the Sun's altitude was 54 ½ degrees, a solar eclipse began. Further, it ended when the altitude of the Sun reached 41 ½ degrees.*

From this report, we can obtain some information, summarized in Table 1, along with the actual eclipse data for Nuremberg.

Author	Contact	Sun altitude (°)			Universal Time (h)		
		Observed	Computed	Error	Observed	Computed	Error
Walther	1	54.5	55.96	1.46	12.43	12.03	-0.40
	4	41.5	41.25	-0.25	14.28	14.30	0.02

**Table 1:** Computed values and measurements from Walther.<sup>9</sup>

The zone of the eclipse's totality included Salamanca, which had become a prominent center of culture in the 15<sup>th</sup> century. Two of the most brilliant astronomers of the time are related to this city, Juan de Salaya (mid-15<sup>th</sup> century-16<sup>th</sup> century) and Abraham Zacut (1452–1515). Juan de Salaya held the Chair of Astrology at the University of Salamanca from 1464 to 1469, when he left it to assume that of Logic. He was the author of two commentaries on Aristotle's *Physics* and *De coelo*, as well as friend and collaborator of Abraham Zacut, whose main work, the *ha-Hibbur ha-gadol*<sup>10</sup> (or Great Treatise), translated from Hebrew into Spanish in 1481 (or 1482). Interestingly, neither Diego Ortiz de Calzadilla (1469-1476), Fernando de Fontiveros, who briefly held the chair of Astrology in Salamanca between 1476 and 1480, nor Diego de Torres<sup>11</sup>, between 1481 and 1495, make mention of the eclipse in any of their known works.

Juan de Salaya stated:

*Aconteció un horrible eclipse en el que se vieron todas las estrellas y del que se seguirán, entre otros grandes males, muertes de pontífices y de príncipes*<sup>12</sup>

*A horrible eclipse occurred in which all the stars were seen and from which will follow, among other great evils, the deaths of pontiffs and princes.*

On the other hand, Abraham Zacut does mention his observation of the eclipse in his *Sefer Yubasin* (book of genealogies), but just as a short note, without comment<sup>13</sup>. In addition, he also informs us that the eclipse had been predicted by another astronomer<sup>14</sup>, the Luso-Jewish Judah ben Verga (c. 1455-1480), who worked in Lisbon and was the author of some Astronomical Tables adjusted to the meridian of that city. Finally, we also have evidence of the criticisms that Moses Farissol Botarel, an Avignon astronomer from the late 15th century, made to some anonymous astronomers who wrongly predicted the totality of the eclipse in Avignon<sup>15</sup>.

As mentioned, Zacut's report is brief and states:

*En el año 5238, el miércoles 29 Av (20 de Julio de 1478) a mediodía en España, hubo un eclipse solar distinto a todo lo que se había visto, pues [el cielo se oscureció] como si fuese medianoche.*<sup>16</sup>

*In the year 5238, on Wednesday 29 Av (29th July 1478) at noon in Spain, there was a solar eclipse unlike anything that had been seen, because [the sky darkened] as if it were midnight.*

Until now, there were few records documentary evidence of the total eclipse<sup>17</sup>. The eclipse was not "scientifically" observed by astronomers at the time, which is quite surprising since, as previously mentioned, the eclipse was predicted and therefore expected. The prediction of solar and lunar eclipses was already common since ancient times. During the 13<sup>th</sup> and 14<sup>th</sup> centuries, many tables were compiled to help in the computation of the different astronomical phenomena<sup>18</sup>. Most of this material was compiled within the framework of the Parisian Alfonsine Tables, which was not challenged until the middle of the 16<sup>th</sup> century.

As the demand increased, lists of eclipses for a given locality which included the local most significant features for the events, appeared. See, for instance, the list of solar and lunar eclipses in the MS 5371 from the Vienna Nationalbibliothek or the list of lunar eclipses in MS 110 from the Biblioteca de la Catedral of Segovia<sup>19</sup>. This last manuscript contains one of the versions of Abraham Zacut's predictions for the eclipse of 1478. Chabás provides another prediction from Poblet's MS 150 and, in his comparison, shows that, although Bonjorm's Tables, based on the longitude of the city of Perpignan, were used in the compilation of MS150, no correction was made to adapt it to Poblet or Barcelona, while Zacut did correct it to adapt it to Salamanca<sup>20</sup>. We will return to these manuscripts in the following paragraphs.

L. Thorndike<sup>21</sup> collects another prediction of this eclipse from manuscript 868 of the Riccardian Library in Florence (L.II.I in the old catalog of Lami<sup>22</sup>), which is an anonymous document dated in the year 1510. Despite this, Thorndike believes that the date given is that of the copy of the manuscript and not that of the publication of the ephemeris. It includes various astronomical and medical treatises, some of them by known authors such as Andalò di Negro or Regiomontanus. For the year 1478, it reads:

*Eclipsis solis 29 1 59 Iulli dimidia duratio 0.56. Puncta novem.*

The month, day and hour of day (1:59) is accurately stated. Unfortunately, we do not know for sure the city for which this event was calculated. However, the Florentine doctor Mazzingo Mazzinghi (sec. XV-XVI) was, in part, the copyist and original owner of the manuscript. He worked for Marsilio Ficino and was a friend of Bernardo Machiavelli<sup>23</sup>, so Florence would be a reasonable assumption for the place of the prediction. As Thorndike points out, the eclipse time is given in hours and minutes, as it is the duration. The magnitude is expressed in puncta, a punctum being 1/12 of the diameter of the sun.

Place	Source	Author	Mean Duration	Mag	Time	Sun Position
Florence ?	ms868 Riccardian	Anonymous	0:56	9	1:59	--
Salamanca	ms110 Segovia	Abraham Zacut	0:55	12	0:51	--
Poblet	ms150 Poblet	Anonymous	1:18	10	--	4s 14:26

**Table 2:** Summary of the computed predictions for the AD1478 eclipse. Under "Place" we list the city for which the prediction was intended. Magnitude is expressed in puncta.

Place	Lat	Lon	Partial Eclipse Begins	Max. Eclipse	Sun alt. at max eclipse	Partial Eclipse Ends	Eclipse Mag.
Florençia	43.76956	11.25581	12:09	13:23	52.2°	14:32	0.795
Poblet	41.38032	1.08122	11:51	13:12	60.8°	14:27	0.960
Salamanca	40.96736	-5.66538	11:38	13:00	64.5°	14:19	1.027

**Table 3:** Main characteristics of the partial eclipse of 29 July AD1478. Magnitude refers to the magnitude of the eclipse. (UTC)<sup>24</sup>.  $\Delta T$  used 218.6s<sup>25</sup>. Positive longitudes indicate east of Greenwich meridian. In this table, Eclipse Magnitude is the fraction of the Sun's diameter occulted by the Moon

The Cathedral of Segovia preserves several manuscripts relevant to the history of astronomy in Spain. We are particularly interested in Segovia MS110, a Latin manuscript of about a hundred folios from the late 15th century that consists of astronomical tables and two brief texts. Although the name of Abraham Zacut does not appear in the manuscript, all these tables can now be identified as part of (or closely related to) his *ha-Hibbur ha-gadol*. We reproduce this version of Zacut's prediction from Chabás and Goldstein<sup>26</sup>. Misprints in this manuscript were corrected by these authors using Hebrew manuscripts. We refer readers to that same work and to Goldstein's paper<sup>27</sup> for a complete analysis and details.

Last, the MS150 of Poblet<sup>28</sup>, a manuscript written in Catalan and dated shortly before 1475. Possibly, it is an extract from another more extensive work, now lost. In the end, it offers a list of predictions of solar and lunar eclipses in the form of a succession of sentences, among which the one in question is found. In the transcription published by Torné<sup>29</sup> it reads:

*Any MCCCCLXXVIII*

*Sol a XXVIII de juliol, a I<sup>a</sup> hora, XVIII menuts, a X dits e a IIII signes, XIII graus e XXVI menuts*

*Year 1478, sun on July 29, hour 1, 18 minutes. Magnitude 10, sign 4, 14 degrees and 26 min*

As can be seen, the year, day, and time of the eclipse are indicated, as well as the solar latitude. If the magnitude has been given in puncta, it would correspond to 83% of the hidden surface of the sun. It should be noted again that the Poblet manuscript contains data that was calculated for the Perpignan longitude, and the author made no correction to adapt them to the Poblet longitude<sup>30</sup>. The position of the sun in ecliptic longitude appears, expressed in signs, IIII signes meaning 120°<sup>31</sup>, providing  $\lambda = 134^\circ$ , the calculated apparent longitude for the instant of the eclipse is  $\lambda = 134.4^\circ = 134^\circ 24'$

In Table 2 are listed the summaries of the information provided by each of the mentioned manuscripts. Similarly, Table 3 shows the calculated circumstances of the eclipse for the cities and their geographical coordinates.

A last issue is some recent controversy<sup>32</sup> about the date of the eclipse that Diego de Valera (1412-1488) collects in his *Crónica de los Reyes Católicos*<sup>33</sup>, which seems to be related to the culmination of the conquest of the Canary Islands (See Table 5 for the coordinates of Gran Canaria), whose traditional date is April 29, AD1483, although the official incorporation to the crown occurred on January 20, AD1487. Some authors have recently suggested that this eclipse could be the one from 1478. The documents place the author in Puerto de Santa María (Cádiz, in the South of the Iberian Peninsula) at the beginning

of August of the year 1478, so in no case could he have witnessed the phenomenon that he narrates in chapter XXXVII, corresponding to an event during the conquest of Gran Canaria in the islands:

*(...)Y otro día siguiente el faycán<sup>34</sup> y los otros canarios salieron de la fortaleza, y los trajo consigo, y se tornaron cristianos, en el cuál día hizo el sol grande eclipse, y después llovió e hizo muy gran viento; y pasaron en aquella isla muchas aves que antes nunca habían visto, las cuáles fueron grullas y cigüeñas y golondrinas, y otras muchas aves que no saben los nombres<sup>35</sup>.*

*(...) And the next day the faycán and the other Canarians came out of the fort, and brought them, and became Christians, on which day the Sun made a great eclipse, and afterwards it rained and a great wind blew; and over that island flew many birds that they had never seen before, which were cranes and storks and swallows, and many other birds they do not know their names.*

It is doubtful that the mentioned eclipse is that of the year 1478. From an astronomical point of view, the magnitude of the eclipse in the Canary Islands was only 0.55, insufficient to be considered "a great eclipse." On the other hand, the events narrated take place after the arrival of Pedro de Vera on August 18, AD1480, in Gran Canaria appointed as governor, as the same chronicler indicates at the beginning of chapter XXXVII.

The eclipse occurred after the battle of Ajódar<sup>36</sup>, and shortly before the shipment on April 14, AD1483, of aborigines to the court in Seville<sup>37</sup>. No solar eclipse fits this temporal context, although three partial eclipses were visible in Gran Canaria in 1478-1490.

In our opinion, this fragment corresponds to the author's desire to give relevance to the events narrated by relating them to a spectacular astronomical phenomenon, and they describe the mixture of two eclipses: the description corresponds to the eclipse of May 28, AD1481, with a magnitude of 0.8. On the other hand, the meteorological conditions seem to describe a sirocco, *calima* or *southern weather* episode<sup>38</sup>, which in the Canary Islands can occur throughout the year but has its maximum in winter, including March, so the eclipse that really observed the chronicler could be that of March 16, AD1485.

## **ECLIPSE JULY 29, 1478. DOCUMENTS AND REPORTS**

In this section, we will discuss some observations of the eclipse of July 29, AD1478. All of them were made by non-professional observers and appear in chronicles, private diaries, or marginal notes in non-astronomical documents. Some were carried out in the zone of totality, but admiration for the phenomenon is detected in all of them, and, even exceptionally, they provide us with astronomically relevant data. In Table 4 we see, ordered from most to least interesting, the documents in which we have found mentions of the phenomena.

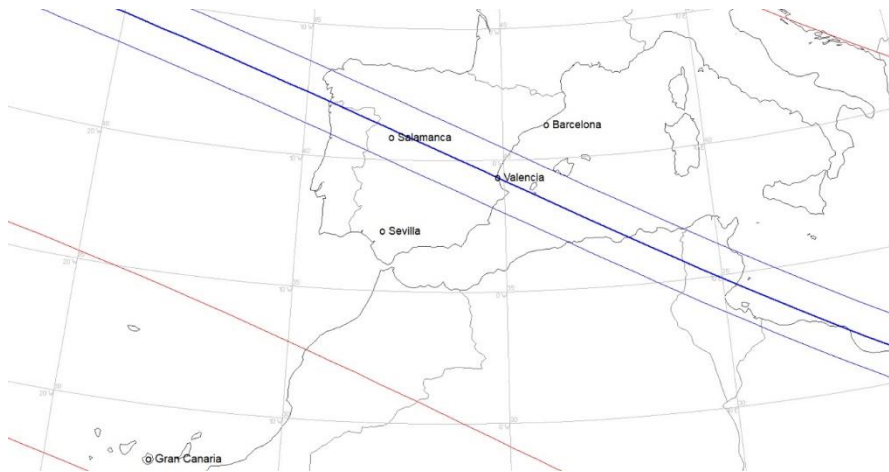
Author	Document	Place	Eclipse	$\Delta T$ range
Andrés Bernáldez	<i>Historia de los Reyes Católicos</i>	Salamanca	T	-750 +1125
Anonymous	<i>Anales Valencianos</i>	Valencia	T	-450 +1175
A(ntonius?) Cortés	ms- ç-IV-11	Salamanca (?)	T	
Martí de Viciana	<i>Senyals del cel</i>	---	P	
Jaume Safont	<i>Llibre de Jornades</i>	Barcelona	P	
Alonso de Palencia	<i>Decada cuarta</i>	Sevilla (?)	P	

**Table 4:** Documents, including the authors and the place where they were at the time of the eclipse (if this data can be determined). T and P indicate if the eclipse was total or partial. We have added a column that includes the  $\Delta T$  provided by the observation for those cases in which we can obtain a relevant value.

The geographical coordinates for the different sites and cities mentioned are given in Table 5. Negative longitudes imply that the position is West of the Greenwich meridian and positive longitudes indicate East. See Figure 2 for the different positions of the observation sites in relation to the totality band of the eclipse.

	Longitude (°)	Latitude (°)	Altitude (m)
Barcelona	2,17634927	41,38424664	13
Gran Canaria (Las Palmas de GC)	-15,413368411	28,099378545	6
Salamanca	-5,66538084	40,96736822	798
Sevilla	-5,99251368	37,38620512	11
Valencia	-0,371565717	39,47534441	16

**Table 5:** Coordinates and altitude of the places named in the paper.<sup>39</sup>



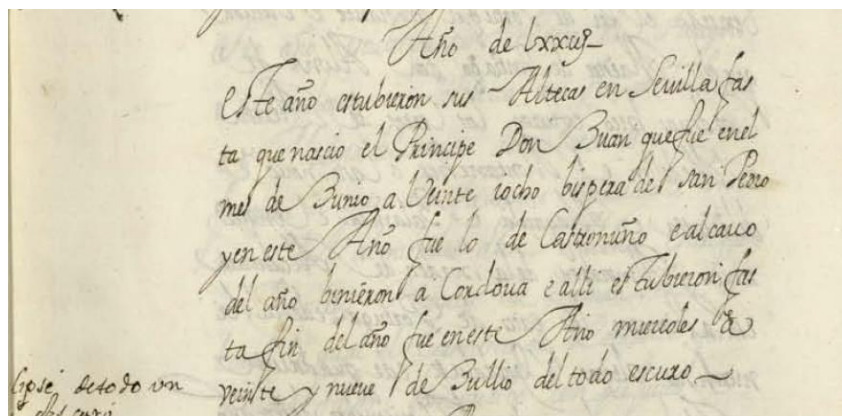
**Figure 2:** Observation sites in relation to the totality band of the eclipse, using SkyMap Pro v.11<sup>40</sup>. The blue band corresponds to the zone of totality, the red lines represent the limits of 0.75 and 0.5 magnitude.

The first observation of the eclipse appears in the XXXIV chapter of the *Historia de los Reyes Católicos*, written by Andrés Bernáldez, (c. 1450 - 1513), priest of Los Palacios. Although first published in 1856, the editor Rodrigo Caro pointed out that "it has always been handwritten", indicating that it was in circulation in manuscript form for a long time before. This chronicle covers a period between 1454 and 1513, being the author an eyewitness of many of the events. It is known that Andrés Bernáldez served as priest of the Villa de los Palacios, near Seville, from 1488 until his death. In the chronicle, he does not mention the geographical position where he witnessed the eclipse, but we know that he studied theology in Salamanca, graduated from high school, and was later ordained a priest ("received holy orders"). As the university was accessed after having studied grammar, which used to end around the age of 14 or 15, this would place him with some certainty in Salamanca in the year 1478.<sup>41</sup>

*El dicho año de mil é quatrocientos y setenta y ocho, á veinte y nueve dias del mes de julio dia de Santa Marta á medio dia, fizo el sol un eclipse el mas espantoso que nunca los que fasta allí eran nacidos vieron, que se cubrió el sol de todo é se paró negro é parecían las estrellas en el cielo como de noche; el cual duró así cubierto muy gran rato, fasta que poco á poco se fué descubriendo, é fué gran temor en las gentes, y fuian á las iglesias, y nunca de aquel ora tornó el sol en su color, ni el dia esclareció como los dias de antes solia estar, é así se puso muy calijinoso.<sup>42</sup>*

*That year of one thousand four hundred and seventy-eight, twenty-nine days of the month of July, Saint Martha's day at noon, the Sun went into an eclipse, the most frightening that ever those who were born until then saw, as the Sun was completely covered and it stood black and the stars appeared as it were at night; which lasted jammed that way for a very long while, until been uncovered little by little, and people were in great fear, and they fled into the churches, and never again did the Sun return to its color, nor the day made clear as the days before it used to be, and so it became very hazy.*

It should be noted that in this record, the author explicitly states that the sun disappeared completely. Hence there is no doubt about its totality, he also adds the usual note that stars appeared, which accompanies many of the descriptions of great eclipses. This is one of the scenarios in which a reliable range for the  $\Delta T$  value, defined as the difference between terrestrial time (TT) and universal time (UT), can be obtained<sup>43</sup>. The obtained interval for the  $\Delta T$  value is listed in Table 4. Table 6 shows the calculated data of the eclipse at Salamanca. Regarding the value obtained, we can see that it is compatible with the one recently calculated by Morrison et al<sup>44</sup>, who place it in the range  $-723 < \Delta T < 1095$ . Curiously, Hernando del Pulgar, the considered official chronicler of the time, does not mention it, although the eclipse took place an exact month after the especially expected event of the birth of the infant Juan, the only male child, and heir to kings, and he does mention a subsequent eclipse on March 16, AD1485.



**Figure 3:** Handwritten reference to the eclipse in the *Memorial de los Reyes Católicos*, which is a Copy of the one mentioned by Andrés Bernáldez. The author, born in Plasencia on the very edge of the zone of totality, could have been an eyewitness, albeit as a young child.

Likewise, this eclipse is also collected by Lorenzo Galíndez de Carvajal (1472-1527), author of the *Memorial o Registro Breve de los Reyes Católicos*<sup>45</sup>, in what seems to be a copy of the testimony of Andrés Bernáldez, as it appears in a handwritten note in a version of the work that includes critical notes by Rafael Floranes<sup>46</sup> (See Figure 3). However, this version does not provide new data.



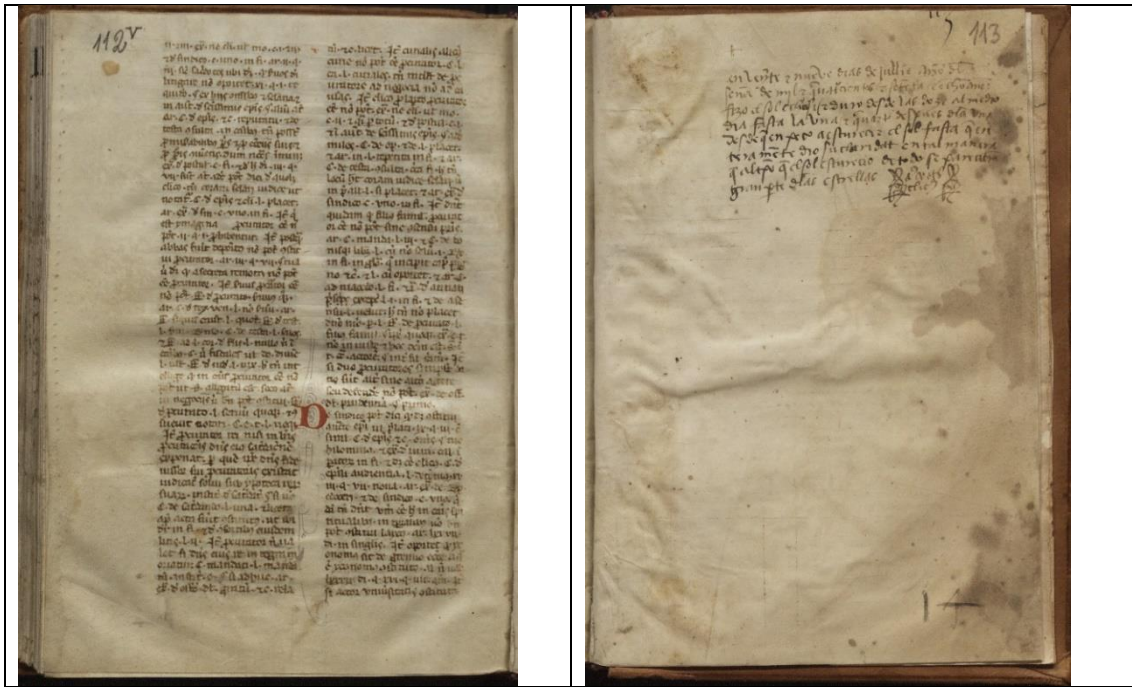
Another report of the eclipse is found in the *Anales Valencianos*<sup>47</sup>. It is an anonymous manuscript whose original was in the Library of Gregorio Mayans y Siscar<sup>48</sup>, and it was transcribed for the first time in 1750 from this same original. Apparently, the author of these *Anales* was already unknown at the time of the copy, but through reading, it has been established that he must have written them between 1455 and 1481 in Valencia since he knows the city, according to his topographical descriptions, and focuses all his attention on what happened there. The content is assorted, but we are interested in the last part, which focus on events in Valencia from 1348 to 1481.

The text referring to the eclipse is found immediately after the news of the birth of Prince Juan in Seville. In the rest of the document, no reference is made to any other type of astronomical phenomenon:

*Dimecres a XXVIII<sup>o</sup>. de joliol dit any entre XII hores e una de mig jorn, fon tan gran eclipci en lo sol com james fos vist; de que tot lo sol se escurri, es mostraren les esteles e dura mes de una hora*

*Wednesday the XXVIII<sup>o</sup>. of July of that year between twelve o'clock and one in the afternoon, there was as great an eclipse in the sun as had ever been seen; all the sun was darkened, the stars appeared and it lasted more than an hour.*

Analogously to the previous case, there is an explicit reference to the totality and the appearance of stars. Again, we can obtain a possible interval for the  $\Delta T$  (see Table 4). The eclipse totality is still collected in another manuscript pointed out by Chabás<sup>49</sup> from the Escorial Monastery with the signature ms-ç-IV-11. The manuscript is dated in the 12<sup>th</sup> century<sup>50</sup>; it consists of 113 parchment pages with varied Latin content, including texts by Palladio and *opuscula iuridica*. The curious thing about this case is that on the last page and without any relation to the previous content, we find the astronomical reference by a different hand and contemporary to the eclipse (see figure 4). It is possible that this record was written by a reader who was consulting the document at the time of the eclipse and decided to report it. Although the annotation is signed by an unknown A. (Antonius?) Cortés, clericus<sup>51</sup>, the specific place where the phenomenon was observed does not appear, and the name of the writer is common enough so that the observer cannot be identified nor located with certainty.



**Figure 4:** Pages 112v (left) and 113r (right) of the manuscript ms-ç-IV-11. Notice the difference between the Gothic letter that appears in the *opuscula iuridica* written in Latin on the left (13th century) and the contemporary note referring to the eclipse, in Castilian, on the right. Reproduction authorized by Patrimonio Nacional.

The tracking of the document does not provide us with more information about the author or the place of the annotation. It seems that before the Escorial Library, the manuscript belonged to Antonio Agustín Albanell<sup>52</sup> (Zaragoza, 1517 – Tarragona, 1586), known as Augustinus, a Spanish ecclesiastic who stood out as a humanist, polygraph, and precursor of the historical study of Law. He received his doctorate in civil law in Salamanca in 1534, so it could be that it was at this time that he got the manuscript, which provides a possible location for the observation. The text, in Castilian, says:

*En veinte e nueve días de jullio año del señor de mil e quatrocientos e setenta e ocho años fizo el sol eclipsi e duró desde las doze de medio dia fasta la una e quart después dela una empeçó a escurecer el sol fasta que enteramente dio su claridad en tal manera que al tiempo que el sol escureció de todo se parecieran gran parte delas estrellas.*

*On the twenty-ninth day of July, in the year of the Lord one thousand four hundred and seventy-eight years, the sun was eclipsed and it lasted from twelve noon until one quarter after one o'clock the sun began to darken until it completely gave its light in such a way that at the time that the sun totally darkened a large part of the stars appeared.*

Once again, it is important to highlight that the author explicitly says that the sun was darkened entirely, the reference to the appearance of stars at the moment of their maximum occultation being already classic. The fact that we do not know with certainty the situation in which the observation was made does not allow us to determine an interval for the  $\Delta T$ , although, if it were Salamanca, it would coincide with the one obtained for the first record.

The remaining reports correspond to witnesses of the phenomenon that were not within the band of totality. The following text does not identify the eclipse as total but asserts that three-quarters of the sun was covered. It corresponds to Martí de Viciano (?- 1492), called “el Vell” (the “old man”, in Valencian, his vernacular language) to differentiate from his grandson, the well-known historian Rafael Martí de Viciano (1502-1582). He was a politician and humanist, and also the author of at least two translations and commentaries on Aristotle and Seneca, and numerous opuscles. It is in one of these opuscles where we find the reference. In particular, in the transcription of folio 116r of the manuscript ms. d-III-2 from the Escorial Library. This document was already mentioned by Chabás<sup>53</sup>, but without actually identifying its author. It is very short and is written in the Valencian of the 15th century. In our case, we use the transcription corresponding to the study by Iborra<sup>54</sup>. It is entitled "Senyals del cel" (signs from heaven), and the author himself states in the introduction that he wrote it with the intention of recording the many astronomical events that he witnessed in person throughout his life: *L'any mil CCCXXXVIII tro a l'any MCCCCLXXVIII se són seguits e vists per mi los senals següents (Between the year 1448 and 1478 the following signs were followed and seen by me)*

*A xxviii de juliol, en l'any MCCCCLXXVIII, fonch un eclipsi de sol tant gran que quatre parts del sol s'escoriren les tres; e més, fonch lo món escur, que no és la prima nit, tant que no avia qui conegués un diner de quina moneda era; en lo qual any foren morts per tot lo món generals.*

*On xxviii of July, in the year MCCCCLXXVIII, there was an eclipse of the sun so great that three of the four parts of the sun eclipsed; and what's more, the darkness was like that of the first hour of the night, so that no one could distinguish the type of coin; in this year generals were killed all over the world.*

In this case, there is a curious circumstance: Martí de Viciano was appointed Commander of the Order of Calatrava of Borriana in 1476 and governor of La Plana from 1477 and 1492<sup>55</sup>, the year of his death. In this period, he lived in the towns of Borriana or Castelló de la Plana (separated only 12 km, with coordinates Longitude: -0.08472°, Latitude: 39.889°), which should place him exactly inside the band of totality. However, from his description, it is clear that the sun was only  $\frac{3}{4}$  darkened, indicating that he was not in his usual residence. Although it is known that in 1485 he was "conseller e coper" of King Fernando, in 1478 Martí de Viciano was still a servant of the King of Aragon Juan II, father of Fernando, who had been in Barcelona since September 20, 1477<sup>56</sup>, this being a possible location of Martí de Viciano, even when the estimated sun occultation in this city is 0.95, higher than the 0.75 indicated.

The next account comes from Barcelona, from a private diary authored by a well-known character in Barcelona at the end of the 15th century. This is Jaume Safont (c. 1420-1487), the *escrivà major of the Generalitat*<sup>57</sup>, who was in charge of compiling the *Dietaris*<sup>58</sup> of the *Generalitat de Catalunya*<sup>59</sup> (*Dietaris* henceforth) between 1454-1472, although his influence continued until his death.

Initially, the *Dietaris* had an administrative character because it was used to register the designation of the institution's officials, together with their travels or absences, to pay them their corresponding salaries, traveling expenses, or reductions in their salaries, but they were also diaries where social, political, economic, or religious events were annotated, including every remarkable phenomenon. As previously stated, for the first volume of the *Dietari*, Safont is a crucial figure, as he either was the writer or was at least

closely involved in the redaction of the entries. It is, therefore, very fortunate that we have another manuscript by the same author, namely the *Dietari o llibre de Jornades 1411/1484*<sup>60</sup> de Jaume Safont (*Llibre* henceforth). This *Llibre* is a private document and complements the *Dietaris* in some senses. The writer seems freer to express himself in his private recordings, so some additional astronomical reports were added. Generally, these reports are linked to political events and provide clues about Safont's political sympathies. Regarding the eclipse, the *Llibre* states:

*Dimecres, a XXVIII de juliol MCCCCLXXVIII, fonch fet eclipse de sol, qui durà entorn a una hora e mige, ço és, que començà entre XII e una e durà fins a II hores après migjorn; tornà lo sol molt groch e enfosquí la terra, no pas tant com la gent deyen ans que fons fet; dien los stròlechs que aquest eclipsi de sol, segons lo signe en lo qual s'es eclipsat, demostré gran morts de reys e de prínceps e destrucció de magnats. Déus ne gart mon señor lo rey en Johan, muy benebenturadament regnant, qui.ns faria gran fretura si moria.*<sup>61</sup>

*Wednesday, 29 July 1478, there was a solar eclipse, which lasted about one hour and a half, this is, it began between 12 and 1 and lasted until 2 after midday; the Sun became very yellow and the land got dark not so much that the people said that it had not happened in years; the astrologers say that this eclipse of the Sun, according to the sign where it has been eclipsed, shows many deaths of kings and princes and magnates' destruction. God keeps my lord king Juan, who is reigning; he would cause us a great loss if he died.*

At this time, Catalonia was part of the kingdom of Aragon, although keeping its own institutions. Socially, the end of the Middle Age and the beginning of the Modern Age was very turbulent, characterized by endless fights against the royal power, including the Catalonia civil war (1462-1472), and the Second rebellion of the *remences* (1485-1486) so that King Juan II did not enjoy the sympathies of all his subjects.

Safont seems to follow the mentality of his epoch when he sees a sign of death in the eclipse. However, as he was not a supporter of King Juan II, whom he considers guilty of a civil war whose consequences were catastrophic for the population, his wishes for good health for the king are cynical, to say the least. The prophecy was accomplished with the death of the king the following January.

The eclipse was nearly total in Barcelona, and the time of the beginning of the partiality is accurately recorded (see Table 6).

Place	Eclipse Type	Partial Eclipse Begins	Total Eclipse Begins	Max. Eclipse	Sun alt. at max eclipse	Total Eclipse Ends	Partial Eclipse Ends	Eclipse Mag.	Total Eclipse Duration
Barcelona	P	11:53	-	13:13	60.1°	-	14:28	0.949	-
Las Palmas	P	11:30	-	12:50	77.8°	-	14:09	0.552	-
Salamanca	T	11:38	12:57	13:00	64.5°	13:03	14:19	1.031	5m16s
Sevilla	P	11:39	-	13:03	67.8°	-	14:23	0.925	-
Valencia	T	11:49	13:09	13:11	63.0°	13:14	14:28	1.027	5m06s

**Table 6:** Main characteristics of the eclipse of July 29, AD1478. Magnitude refers to the magnitude of the eclipse. (UTC)<sup>62</sup>.  $\Delta T = 218.6s$

The last record corresponds to the one collected by Alfonso Fernández de Palencia (1424-1492); he was a royal chronicler, historian, lexicographer, and humanist of the Pre-Renaissance Castile. The main work of Alfonso de Palencia is the monumental *Gesta*

*Hispaniensi ex annalibus suorum diebus colligentis*<sup>63</sup>, usually called *Decadas*, because it is divided into decades following the style of Tito Livio. This chronicle covers the events from the end of the reign of Juan II of Castille until 1481, including the reign of Enrique IV, his confrontation with the supporters of his half-brother Alfonso, the conflict over the succession of Enrique IV, the ensuing civil war and the consolidation of the Catholic Monarchs on the throne after the signing of peace.

The fourth decade, whose existence went unnoticed for a long time by most historians, was not published until 1970 by José López de Toro<sup>64</sup> in the original Latin and translated into Spanish by the same author.

*(...) el día 29 de julio del mismo año de la Natividad del Redentor de 1478, el sol eclipsado durante una hora dejó casi a oscuras la tierra, hasta después del mediodía. A este eclipse precedieron augurios de los astrólogos con amenazas para muchos príncipes especialmente para la nación de Portugal y sus cómplices.*

*(...) On July 29 of the same year 1478 after the Nativity of the Redeemer, the eclipsed sun for an hour left the earth almost in darkness, until after noon. This eclipse was preceded by predictions from astrologers with threats to many princes, especially to the nation of Portugal and its accomplices.*

The reference to Portugal is explained in the context of the war of the Castilian succession: after the battle of Toro (March 1, AD1476), the succession in Castile was practically resolved in favor of Isabel against Juana, who was supported by her husband, the King of Portugal. However, the end of the conflict was only concluded with the Treaty of Alcaçobas (September 4, AD1479), with remaining hostilities with France and Portugal until that date.

The chronicles place Fernández de Palencia in Seville in the year 1478<sup>65</sup>, where a huge but no total eclipse happened (See Table 6). He was preparing the conquest of the Canary Islands together with his assistant, Diego de Merlo.

## CONCLUSIONS

We have presented several unknown records of the total eclipse of the sun on July 29, AD1478, all of them carried out by contemporaneous eyewitnesses from the Iberian Peninsula. These records are of great importance for astronomical literature since no notes on the totality of said eclipse had been found, despite having been predicted by scholars of the time. In addition, the descriptions, although not professional, provide interesting information that, in some cases, have led us to obtain valid values for the  $\Delta T$  parameter. Considering the values obtained for the different places of observation, we have obtained an interval of  $\Delta T$  for the epoch between -450 and +1125s, and, taking into account the result obtained by Morrison et al<sup>66</sup>, the interval would be reduced to  $-450 < \Delta T < +1075s$

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## NOTES:

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<sup>1</sup> Stephenson F.R. "Investigation of Medieval European Records of Solar eclipses". *Journal for the History of Astronomy*. 41. (2010) 95-104.

<sup>2</sup> The conquest of al-Andalus is the period of the history of the Iberian Peninsula of approximately 780 years between the Umayyad conquest of Hispania in 711 and the fall of the Nasrid kingdom of Granada in 1492.

<sup>3</sup> Such as Ginzels work, although the eclipse of 1478 does not appear in this work. F.K. Ginzels, *Astronomische Untersuchungen über Finsternisse*. II. Abhandlung (Leipzig, 1883) pp. 629–755

<sup>4</sup> See Stephenson, *op cit.* (ref 1)

<sup>5</sup> Chris Marriott. SkyMap Pro v11.0.3

<sup>6</sup> See, for instance Pedro Hernández Martínez. *La memoria de la historia oficial: Crónicas y cronistas en la España de los Reyes Católicos*. REVISTA EPCCM. 15 (2013). pp. 235-268  
<https://franciscojaviertostado.com/2016/11/28/cronistas-de-la-historia/>

<sup>7</sup> The authorship was corrected in the second edition: Fernando del Pulgar, *Chronica de los muy altos, y esclarecidos Reyes Catholicos Don Hernando y Doña Ysabel* (Zaragoza, 1567)

<sup>8</sup> Steele J.M., Stephenson F.R. "Eclipse Observations made by Regiomontanus and Walther". *Journal for the History of Astronomy*. 29. (1998) 331-344. Regiomontanus did not have occasion to observe the phenomenon since he died in 1476.

<sup>9</sup> Solar eclipse predictions were made using the VSOP87/ELP2000-82 (<https://eclipse.gsfc.nasa.gov/SEpath/ve82-predictions.html>) solar and lunar ephemerides.

<sup>10</sup> Chabás J., Goldstein B.R. *Abraham Zacut (1452-1515) y la Astronomía en la Península Iberica*. (Salamanca: Ed. De la Universidad de Salamanca, 2009)

<sup>11</sup> Diego de Torres wrote a medical-astrological treatise to the eclipse of March 16, AD1485, which was partial in Salamanca. See Amasuno Sárraga, Marcelino V. *Un texto médico-astroológico del siglo XV «eclipse del sol» del licenciado Diego de Torres*. (Salamanca: Universidad de Salamanca-Ediciones del Instituto de Historia de la Medicina Española, 1972).

<sup>12</sup> Carabias Torres, A.M. *Salamanca y la medida del tiempo*. (Salamanca: Ed. De la Universidad de Salamanca, 2012) p. 102

<sup>13</sup> See Chabás J. "Predicción y Observación de eclipses en Cataluña a finales de la Edad Media" in *Actes de la VI trobada d'història de la ciència i de la tècnica* (Barcelona, SCHCT, 2002) pp. 287-293 and a complete study in Goldstein B.R. "Abraham Zacut and the Medieval Hebrew Astronomical tradition". *Journal for the History of Astronomy*. 29. (1998). 177-186

<sup>14</sup> Goldslein B.R. "The Astronomical Tables of Judah ben Verga". *Suhayl. International Journal for the History of the Exact and Natural Sciences in Islamic Civilisation*, 2, (2001). 227-289

<sup>15</sup> See appendix of Goldstein B.R. and Chabás J., "The Astronomical Tables of Moses Farissol Botarel", *Suhayl. International Journal for the History of the Exact and Natural Sciences in Islamic Civilisation*. 15. (2016-2017) p. 63

<sup>16</sup> This report appears in A. Zacut, *Sefer Yuhasin*, ed. By Abraham Hayyim [=Alfred] Freinmann (Frankfurt a. M. 1924), 226a

<sup>17</sup> No record of this eclipse appears in Stephenson's exhaustive collection in *Historical Eclipses and Earths Rotation* (Cambridge: Cambridge University Press, 1997). Other searches carried out by the authors in more recent astronomical publications have returned a calculation for the  $\Delta T$  in Morrison L.V., Stephenson F.R.,

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Hohenkerk C.Y., Zawilski M. Addendum 2020 to ‘Measurement of the Earth’s rotation: 720 BC to AD 2015’. *Proc.R.Soc.A* 477 :20200776, <https://doi.org/10.1098/rspa.2020.0776>. A mention of a report of the partiality was also given in Martínez MJ and Marco FJ. “New Astronomical References in Two Catalan Late Medieval Documents”. *Early Science and Medicine* 19(2). 2014. 174-185. DOI: 10.1163/15733823-00192p03

<sup>18</sup> Chabás J., Goldstein B.R. *A Survey of European Astronomical Tables in the Late Middle Ages*. In Time, Astronomy, and Calendars. Texts and Studies. V. 2 Eds: Charles Burnett, Sacha Stern (Brill:Leiden, Boston, 2012)

<sup>19</sup> See Chabás J., Goldstein B.R. *Op. cit.* (ref 18) p. 181 and p. 183 for Vienna and Segovia manuscripts respectively.

<sup>20</sup> See Chabás *op cit.* (ref 13)

<sup>21</sup> Thorndike L. “A record of eclipses for the years 1478 to 1507”. *Isis*, 43, 4 (Dec., 1952), pp. 252-256

<sup>22</sup> <https://www.mirabileweb.it/manuscript/firenze-biblioteca-riccardiana-868-manuscript/38643>

<sup>23</sup> See Robert Black. “A pupil of Marcello Virgilio Adriani at the Florentine Studio “in UMANESIMO E UNIVERSITÀ IN TOSCANA (1300-1600) Atti del Convegno Internazionale di Studi (Firenze: Ed. Stefano U. Baldassarri, Fabrizio Ricciardelli, Enrico Spagnesi. Casa Editrice Le Lettere, 2012). p 16.

<sup>24</sup> <https://eclipse.gsfc.nasa.gov/JSEX/JSEX-index.html>

<sup>25</sup> [http://xjubier.free.fr/en/site\\_pages/solar\\_eclipses/5MCSE/xSE\\_2\\_Five\\_Millennium\\_Canon.html](http://xjubier.free.fr/en/site_pages/solar_eclipses/5MCSE/xSE_2_Five_Millennium_Canon.html)

<sup>26</sup> *op cit.* (Ref 10)

<sup>27</sup> Goldstein, B.R. “The Hebrew astronomical tradition: New sources”. *Isis*. 72. 1981. 237-251

<sup>28</sup> See Chabás *op cit.* (Note 13)

<sup>29</sup> Torné Cubells J. Un quadern medieval de notes d’astrologia al monestir de Poblet. In Álvarez Ed. (Tarragona, Estació de recerca Bibliogràfica i documental “Margalló del Balcó”, 1998) p. 67-82

<sup>30</sup> See Chabás *op cit.* (Note 13)

<sup>31</sup> Chabás J., Goldstein B.R. *Op. cit.* (ref 18)

<sup>32</sup> [https://proyectotarha.org/en\\_GB/2016/11/27/el-eclipse-solar-de-1478/](https://proyectotarha.org/en_GB/2016/11/27/el-eclipse-solar-de-1478/) (in English) and Jiménez González, J. J. “Las sociedades canarias prehistóricas en el momento del contacto con los europeos: el tiempo, los astros y las gentes del mar”, *X Coloquio de Historia Canario-Americana*, vol. 1, (Las Palmas de Gran Canaria: Cabildo de Gran Canaria, 1992), pp. 76-98

<sup>33</sup> Diego de Valera. *Crónica de los Reyes católicos. Edición y estudio por Juan de Carriazo*. (Madrid: José Molina Impresor, 1929).

<sup>34</sup> According to the Diccionario Básico de Canarismos (<https://www.academicanarialengua.org/diccionario/>), this word refers to the supreme priest and highest authority after the Guanarteme (highest political and military authority) among the aborigines of Gran Canaria,.

<sup>35</sup> Diego de Valera. *Op. Cit.* (ref 33)

<sup>36</sup> According to the archeologist Julio Cuenca, in charge of the research, this battle happened during the winter of 1482, or early 1483. See [https://www.eldiario.es/canariasahora/sociedad/mesa-junquillo-fortaleza-perdida-ajodar\\_130\\_7939225.html](https://www.eldiario.es/canariasahora/sociedad/mesa-junquillo-fortaleza-perdida-ajodar_130_7939225.html)

<sup>37</sup> Alfredo Mederos Martín. “Un enfrentamiento desigual. Baja demografía y difícil resistencia en la conquista de las islas Canarias”. *Anuario de Estudios Atlánticos*, vol. AEA, núm. 65, (2019) 1-32

<sup>38</sup> See *Op cit.* (ref 32)

<sup>39</sup> Source: Instituto Geográfico Nacional. (<https://www.ign.es/web/ign/portal/inicio>)

<sup>40</sup> Chris Marriott. SkyMap Pro v11.0.3

<sup>41</sup> <https://literaturayotrosmundos.wordpress.com/2018/03/17/duracion-de-higher-degree-studies-in-the-16th-century-university-careers-of-today-2-university-degrees-at-the-university-of-salamanca-in-1538/>

<sup>42</sup> Bernáldez, A. *Historia de Los Reyes Católicos D. Fernando y Doña Isabel*. Tomo 1. (Sevilla: 1870) p 98.

<sup>43</sup> See F. R. Stephenson, *Historical Eclipses and Earth's Rotation* (Cambridge: Cambridge University Press, 1997) for a complete explanation of the methods to obtain the values from eclipses and other astronomical phenomena and Morrison, L. and Stephenson, F. R., “Historical Values of the Earth's Clock Error  $\Delta T$  and the Calculation of Eclipses”. *Journal for the History of Astronomy*. 35, (2004), pp 327-336 for an update on the subject. See also <https://eclipse.gsfc.nasa.gov/SEcat5/deltatpoly.html> for the current values adopted.

<sup>44</sup> Morrison L.V. *et al.* *op cit.* (ref 17).

<sup>45</sup> Lorenzo Galíndez de Carvajal. *Anales de la historia de los Reyes Católicos: con los testamentos de los mismos y lo que después de su muerte sucedió hasta las Comunidades escrita por el doctor Lorenzo Galíndez de Carvajal*. Mss/7084 of the Biblioteca Nacional. p. 12r.

<http://bdh.bne.es/bnesearch/detalle/bdh0000009859>

<sup>46</sup> <http://bdh.bne.es/bnesearch/detalle/bdh0000191525>

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- <sup>47</sup> Cabanes Catalá M.L. *Anales Valencianos*. Textos Medievales, 61. (Zaragoza: Anubar), 1983.
- <sup>48</sup> Gregorio Mayans y Siscar (Oliva, Valencia, May 9, 1699-Valencia, December 21, 1781) was a Royal Librarian and a Spanish scholar, and the greatest representative, along with Benito Jerónimo Feijoo, of the first Spanish Enlightenment. See <https://dbe.rah.es/biografias/12423/gregorio-mayans-y-siscar>
- <sup>49</sup> See Chabás *op cit.* (ref 13)
- <sup>50</sup> <https://rbmecat.patrimonionacional.es/bib/384>
- <sup>51</sup> M<sup>a</sup> Luz Mandingorra, personal communication.
- <sup>52</sup> See Juan F. Alcina Rovira , Carmen Gallardo Mediavilla and Salvadó Recasens, Joan *Los manuscritos latinos clásicos de El Escorial procedentes de la biblioteca de Antonio Agustín*, (Barcelona: URV. Universidad Rovira I Virgili, 2021),. The authors also speculate on the possibility that the owner of the manuscript was King Felipe II.
- <sup>53</sup> See Chabás *op cit.* (ref 13)
- <sup>54</sup> Iborra, J. *Crònica i Memòria. Textos històrics de Martí de Viciana el Vell*. Fonts Històriques Valencianes, 69 (Valencia: Ed. de la Universitat de València, 2018)
- <sup>55</sup> González Arce J.D. 2016. La Casa y Corte del príncipe don Juan (1478- 1497). Economía y etiqueta en el palacio del hijo de los Reyes Católicos, Sevilla, Monografías de la Sociedad Española de Estudios Medievales, nº7. ISBN: 978-84-944621-1-5
- <sup>56</sup> Sans i Travé J.M.(Dir.) *Dietaris de la Generalitat de Catalunya*. (Barcelona: Generalitat de Catalunya, 1994). Vol. 1. p.229.
- <sup>57</sup> A sort of main notary of the ancient Generalitat, precursor of the homonymous modern institution
- <sup>58</sup> The Catalan word “Dietari” refers to a historiographical genre that provides news with a higher frequency and volume than annals and chronicles .
- <sup>59</sup> The *Dietaris* consisted initially of 109 manuscript volumes. Regretfully, the last one, corresponding to the year 1714, was destroyed after Barcelona’s conquest and occupation of the city by the Napoleonic army in 1808-1814. The remaining manuscript volumes are considered one of the main primary sources for the study of late medieval and modern Catalunya, as they contain most military, political, religious and social events that took place in Catalonia from 1411 to 1714. These remaining documents were published by Sans i Travé *Op cit.* (ref 56)
- <sup>60</sup> The *Llibre de Jornades 1411/1484 de Jaume Safont*, also published in 1992 by the *Fundació Noguera* under the direction of Josep María Sans i Travé (1992) is a particular document that complements the first tome of the *Dietaris*. They both are mostly written by the same author, who expresses himself with more freedom in the *Llibre* and so provides some clues to understand why he reports some astronomical events and not others.
- <sup>61</sup> Jaume Safont. *Llibre de Jornades*. Volume I. p. 106. See further comments in in Martínez MJ and Marco FJ. New Astronomical References in Two Catalan Late Medieval Documents. 2014. *Early Science and Medicine* 19(2): 174-185. DOI: 10.1163/15733823-00192p03
- <sup>62</sup> <https://eclipse.gsfc.nasa.gov/JSEX/JSEX-index.html>
- <sup>63</sup> Alfonso de Palencia. *Gesta Hispaniensi ex annalibus suorum dierum collecta*. Real Academia de la Historia, 2 vols, (Madrid : Eds. R. B. Tate & J. Lawrance, , 1998). Latin text and Spanish translation of the first two Decades of Palencia
- <sup>64</sup> Alfonso de Palencia. *Cuarta Década de Alonso de Palencia*. 2 Vols. Ed. J. López de Toro. Archivo Documental Español, nº 24 (Madrid: Real Academia de la Historia, 1970-1974).
- <sup>65</sup> Alvarez Delgado, J.. “Alonso de Palencia (1423-1492) y la historia de Canarias”. *Anuario de Estudios atlánticos*. 9. (1963) 51 79.
- <sup>66</sup> See Morrison et al. *op cit.* (ref 17)