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KNOWLEDGE OF THE MILKY WAY IN THE ARABIC CULTURAL REGION BETWEEN THE 8TH AND 15TH CENTURIES

Andreas Eckart* and Mesut Idriz**

Abstract: The Milky Way is the largest object in the astronomical sky, so it has always attracted the attention not only of past and present scientists but the public in general. Here, we summarise findings and opinions about the Milky Way that were widespread in the early Islamic period. We compare texts by several Arabic authors from the 8th to 15th centuries to explore the role of the Milky Way in the early Islamic civilisation. We refer to texts by Ibn al-Haytham, Ibn Rahiq, Ibn Majid and al-Marzouqi. First, we discuss the description of the Milky Way given by al-Marzouqi in the 21st chapter of his *Kitab al-Azminah wa al-Amkinah*. Al-Marzouqi also points out how the Milky Way can be used to determine the direction of prayer. Second, we discuss Ibn al-Haytham's finding that, in comparison with the Moon, the Milky Way has no measurable parallax and must belong to the realm of the stars. We compare the situation at Ibn al-Haytham's time to that of the Great Debate in 1920.

Keywords: *Milky Way, early Islamic civilisation, astronomy, Great Debate on the Milky Way*

INTRODUCTION

The attention of early explorers was drawn to the Milky Way because it appears as a extended, diffuse and cloud-like object in the night sky. The Arabian scientist Abū ʿAlī al-Ḥasan ibn al-Ḥasan ibn al-Ḥātim Haytham (c. 965–c. 1040), or Ibn al-Haytham (in Latin Alhazen or Alhacen), convincingly combined knowledge from the past with new observations to determine the nature and a lower limit to the distance of the Milky Way. Born in Basra, Ibn al-Haytham was active as a mathematician, astronomer and philosopher. His works include important contributions to the foundation of optics, mathematics, astronomy and meteorology.

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Science and mathematics historian Roshdi Rashed[1] emphasises that, although Ibn al-Haytham is well-known for his work in optics, the number of his astronomical treatises is twice as high as the number of his texts on optics. Ibn al-Haytham's treatise on the location of the Milky Way in the sky can probably be considered one of his early works in astronomy.[2] This treatise is passed down to us in at least three almost identical copies. Ibn al-Haytham died after 1040 CE in Cairo. His contribution must be seen as part of a long discussion on this topic.

Anaxagoras (500–428 BCE) and Democritus (460–370 BCE) suggested that the Milky Way consists of distant stars. Aristotle (384–322 BCE) suggested that the Milky Way is a phenomenon of the upper atmosphere.[3] Olympiodorus the Younger (c. 495–570) argued that the Milky Way must have a parallax if it is sub-lunar. Similarly sceptical were Philoponus (c. 490–575), Ibn al- Biṭrīq (d. c. 830) and Ḥunayn ibn Isḥāq (808–873). Ibn Sīnā (980–1037) may have assumed the Galaxy was a truly celestial object, which was also supported by Ibn al-Haytham (see below). This is suggested by the fact that Ibn Sīnā did not mention the Milky Way when he summarised meteorological aspects of Ptolemy's *Almagest*. Also, the discussion on the composition and position of the Milky Way continued. Astronomer Abū Rayḥān al-Bīrūnī (973–1048) suggested the Milky Way as "a collection of countless fragments of the nature of nebulous stars."[4] Philosopher and astronomer Ibn Bājja (from al-Andalus; 1058–1138) thought that the Milky Way consists of many stars, which almost touch each other. But he considered the Milky Way to be a phenomenon that belongs to the atmosphere and celestial sphere. Astronomer Naṣīr al-Dīn al Ṭūsī (1210–1274) wrote in his *Taḏkira*: "The Milky Way consists of a very large number of small, closely packed stars, which, due to their concentration, appear as cloudy patches."[5]

As the Milky Way is the largest object in the astronomical sky, it has always attracted the attention not only of scientists but the public in general. In this article, we compare texts by several Arabic authors from the 8th to the 15th centuries to explore the role of the Milky Way in the early Islamic civilisation until the 15th century. Among other works, we refer to texts by Ibn al-Haytham, Ibn Rahiq, Ibn Majid and al-Marzouqi. First, we discuss the description of the Milky Way given by al-Marzouqi in the 21st chapter of his *Kitab al-Azminah wa al-Amkinah*. Al-Marzouqi also points out how the Milky Way can be used to determine the direction of prayer. Second, we discuss Ibn al-Haytham's finding that, in comparison with the Moon, the

1 Roshdi Rashed, "The Celestial Kinematics of Ibn al-Hytham," *Arabic Sciences and Philosophy* 17, no. 1 (2007): 7, https://doi.org/10.1017/S0957423907000355.

2 Andreas Eckart, "The Early Great Debate: A Comment on Ibn al-Haytham's Work on the Location of the Milky Way with Respect to the Earth," *Arabic Sciences and Philosophy* 28, no. 1 (2018), https://doi.org/10.1017/S0957423917000078.

3 For example, Paul Lettinck, *Aristotle's Meteorology and its Reception in the Arab World* (Leiden: Brill, 1999).

4 Al-Bīrūnī, *Kitāb al-Tafhīm li-awā'il ṣinā'at al-tanjīm* [The Book of Instruction in the Elements of the Art of Astrology], trans. Robert Ramsey Wright (London: Luzac & Co., 1934), 87.

5 Jamil Ragep, *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy (al-Tadhkira fī 'ilm al-hay'a)*, vol. 12 of *Sources in the History of Mathematics and Physical Sciences*, ed. Gerald J. Toomer (New York: Springer, 1993), vol. 1, 24-88.

Milky Way has no measurable parallax and must belong to the realm of the stars. We compare the situation at Ibn al-Haytham's time to that of the Great Debate in 1920.

We first summarise the general knowledge of the Milky Way in the 8th to 15th centuries in the next section. We then highlight four main aspects of that knowledge: an overview of different descriptions of the Milky Way in the sky; the various debates on the nature of the Milky Way that were carried out in the Arabic world around 1000 CE and in modern astronomy at the beginning of the last century; a translation and partial analysis of the 21st chapter of *al-Marzūqī's Kitāb al-Azminah wa al-Amkinah*; and some criticisms of the traditional descriptions of the Milky Way that were put forward in the 15th century. We conclude with a summary and acknowledgements.

GENERAL KNOWLEDGE OF THE MILKY WAY IN THE 8TH TO 15TH CENTURIES

Eckart presents a detailed analysis of various texts from the Arabic cultural area of the 10th to the 15th centuries.[6] The analysis comprises nine authors.[7] It is not complete but highlights some important aspects concerning knowledge of the Galaxy at that time. One of the earlier mentions of the Milky Way at the beginning of the Islamic period can be found in the work of the Dhū al-Rumma (c. 696–c. 735), who used the Milky Way for boasting, i.e. to show off his bravery in front of his audience. Dhū al-Rumma was a Bedouin poet who lived towards the end of the Umayyad Age (661–750). This time was strongly influenced by the pre-Islamic tribal society of the Bedouin Arabs.[8] Dhū al-Rumma probably stood at the end of a long poetic tradition of this way of life. Among other things, he is a representative of the so-called Fakhr poetry. He proudly reports that he is crossing the desert in summer when the Milky Way culminates at night. His work is impressively described by Nefeli Papoutsakis in *Desert Travel as a Form of Boasting: A Study of Dhū al-Rumma's Poetry*.[9]

From a text by the scholar Ibn Raḥīq, we learn about the role of the Milky Way in early Islamic society. In his book on astronomy for laypeople, Ibn Raḥīq summarises basic astronomical information, especially for pilgrims.[10] This work contains a section on the Milky Way and provides information on what was known about the Milky Way in the first centuries after the Hijra. He reports on a communication between a Byzantine emperor and Mu'āwiya,

6 Eckart, "The Early Great Debate"; Andreas Eckart, "Ibn Raḥīq's Text on the Milky Way: Perception of the Milky Way in the Early Islamic Society," *Arabic Sciences and Philosophy* 29, no. 2 (2019), https://doi.org/10.1017/S0957423919000055; Andreas Eckart, "Use of the Galaxy as a Tool for Spatial and Temporal Orientation during the Early Islamic Period and up to the 15th Century," *Arabic Sciences and Philosophy* 31, no. 1 (2021), https://doi.org/10.1017/S0957423920000077.

7 Eckart, "Use of the Galaxy," 3, fig. 1.

8 Nefeli Papoutsakis, "Dhū al-Rumma," in *Encyclopaedia of Islam*, 3rd ed., ed. Kate Fleet et al. (Leiden: Brill Academic Publishers, 2012); Nefeli Papoutsakis, *Desert Travel as a Form of Boasting: A Study of Dhū al-Rumma's Poetry*, vol. 4 of *Arabische Studien* (Wiesbaden: Harrassowitz, 2009).

9 Papoutsakis, *Desert Travel*.

10 Petra G. Schmidl, *Volkstümliche Astronomie im Islamischen Mittelalter* [Popular Astronomy in the Islamic Middle Ages], vol. 68 of *Islamic Philosophy, Theology and Science. Texts and Studies*, ed. Emilie Savage-Smith, Hans Daiber and Anna Akasoy (Brill, 2007), https://doi.org/10.1163/ej.9789004153905.i-860.

then presents the knowledge of the Milky Way as a proof that one is well read in the revealed texts. He also points out the agricultural importance of the Galaxy that is suitable to indicate the time of the date harvest.

Through a comparison with data published in the *Almagest* by Ptolemy, Arabian astronomer Ibn al-Haytham made the first systematic attempt to understand the parallax[11] of the Milky Way but concluded it must be far from Earth and not part of the atmosphere. He did so by comparing the change of the positions of bright stars with respect to the edge of the Milky Way. As a reference, he used the distances of stars to the Milky Way as published by Ptolemy.[12] Even with the unaided eye (i.e. without a telescope), these measurement can be sufficiently reliable to lead to a lower limit on the distance of the Milky Way silhouette of at least five times the distance of the Moon.[13] Ibn al-Haytham was working under the premise put forward by Aristotle that the Milky Way is a phenomenon belonging to the Earth's atmosphere. By not finding a change of these distances and comparing it to the parallax of the Moon of at least half a degree, Ibn al-Haytham could conclude that the silhouette of the Milky Way is much further away than the Moon – placing the Galaxy away from the Earth and closer to the realm of the stars.

The treatise by al-Marzūqī and Ibn Qutayba (c. 696–735) makes it clear how the Milky Way can be used as a guide in space and time. They give a detailed description of the Milky Way based on the work of Abu Hanifah[14] (815–896). They also explain the geographical use of the Milky Way and – in part in poetic verses – summarise common knowledge on the Galaxy and its role in the heavens. The great navigator Ibn Mājid[15] (1421–c. 1500) emphasises in his work that the Milky Way is a valuable navigation aid in the "dark regions"; by this, he implied the provision for navigational support by the Galaxy in finding and validating stars useful for navigation also in the southern hemisphere, e.g. towards Madagascar.[16]

A criticism of the traditional description of the Milky Way can be found in the treatises of al-Marzūqī, al-Jurjani[17] and al-Iji.[18] Here, the fact the Milky Way shows a high density of stars

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11 A parallax is the angular displacement of an object with respect to a background, if seen from different locations. In astronomy, it is used to measure the distance to objects.

12 Gerald J. Toomer, *Ptolemy's Almagest* (London, Princeton University Press, 1998); Christian Peters and Edward Knobel, *Ptolemy's Catalogue of Stars, A Revision of the Almagest* (Washington: Carnegie Institution of Washington, 1915).

13 Eckart, "The Early Great Debate."

14 ʾAbū Ḥanīfa Aḥmad b. Dāʾūd al-Dīnawarī (815-896) was an astronomer, mathematician, geographer and historian. See Nicola Clarke, "Al-Dīnawarī," in *Oxford Dictionary of Late Antiquity*, ed. Oliver Nicholson (Oxford University Press, 2018), 484.

15 See Thomas Glick, Steven Livesey and Faith Wallis, ed., "Ibn Majid," in *Medieval Science, Technology, and Medicine: An Encyclopedia* (New York: Routledge, 2005), 252.

16 Gerald Randall Tibbetts, *Arab Navigation in the Indian Ocean before the Coming of the Portuguese: Being a Translation of Kitāb Al-Fawā'id Fī Uṣūl Al-baḥr Wa'l-qawā'id of Aḥmad B. Mājid Al-Najdī; Together with an Introduction on the History of Arab Navigation, Notes on the Navigational Techniques and on the Topography of the Indian Ocean and a Glossary of Navigational Terms* (London: Royal Asiatic Society of Great Britain and Ireland, 1972).

17 Hugh Chisholm, ed., "Jurjānī," in *Encyclopaedia Britannica*, 11th ed. (Cambridge University Press, 1911), vol. 15, 587.

18 Josef van Ess, "Al-Ījī, ʿAḍūd al-Dīn ʿAbd al-Raḥmān b. Aḥmad," in *Encyclopaedia of Islam*, 2nd ed., edited by Peri Bearman et al. (Leiden: Brill, 2012).

in the sky is valued higher that its apparent link to clouds, the weather and general properties of the sky.

FOUR MAIN ASPECTS CONCERNING KNOWLEDGE OF THE MILKY WAY

Knowledge of the Milky Way in the 8th to 15th centuries comprises four major aspects, which we will summarise in the next sections. There is a description of the Milky Way in the sky and various ways to explain how it is arranged with respect to the bright stars in the sky (or vice versa), how it changes in appearance across the year and how it can be used by the observer.

Then we have the more scientific analytical approach as followed by Ibn al-Haytham. In comparison to information put forward by Ptolemy, he determined in a systematic way a lower boundary on the distance to the Milky Way[19] and could reject the hypothesis by Aristotle that it is only a cloud, i.e. a phenomenon of the atmosphere.

Finally, we have the traditional and poetry approach of describing the Milky Way. This links it to natural phenomena and experiences – most of them with an agricultural background. This link became so strong that it spawned criticism to the traditional description of the Milky Way.

Description of the Milky Way in the Sky

As reported by al-Marzouqi in his *Kitāb al-Azminah wa al-Amkinah*, Abu Hanifah gives a more elaborate description of the appearance of the Milky Way in the sky. This description can also be found in a more condensed form in Ibn Majid's report.[20]

As a basis for our comparison, we take the description by Ptolemy as found in the *Almagest*. Ptolemy uses the constellations along the Milky Way and gives a record of the stars in or near it. He starts by describing the bifurcation of the bright milky appearance of the Milky Way that happens between the constellations of Ara in the south and Cygnus in the north. He then outlines the circle of the Milky Way in the southernmost region. He begins with the constellation of Centaurus and continues with the constellations Lupus, Scorpius, Sagittarius, Serpens, Ophiuchus and Aquila. He then turns to the west and north with the constellations Cygnus, Cepheus and Cassiopeia. Then further east and towards the south he lists Perseus, Auriga, Gemini, Canis Minor and Canis Major as well as Argo. He finally arrives again at the constellation Ara from which the milky band in the sky continues to the Centaurus region.

Abu Hanifah, on the other hand, uses for his description mostly well-known and bright stars rather than constellations. If he mentions them, he used Arabic constellations that are only partially consistent with the Greek/Roman constellations listed by Ptolemy. Abu Hanifah

[19] What is meant here is the distance to the conglomerate of stars that create the milky appearance of the Milky Way. These objects can have distances of several thousands of light years. Therefore, the distance is to the nearest or the bulk of the nearest members of that entity.

[20] Glick, Livesey and Wallis, "Ibn Majid"; Tibbetts, *Arab Navigation in the Indian Ocean*.

briefly mentions that the Galaxy is widest in the constellation of Scorpius.[21] He outlines that it mainly stretches out between the constellations of the two eagles, al-Nasrān, which are Aquila (al-Nasr al-ṭā'ir, the flying eagle) with Altair as its brightest star and Lyra (al-Nasr al-Wāqiʿa, the falling eagle) with Vega as its brightest star. He mainly uses the locations of bright stars in or close to the Galaxy to describe its path. He starts with the stars α Cygni (al-Ridf) and λ Scorpii (al-Shawla), continues to Taurus with the star cluster of the Pleiades (al-Thurayyā), the constellation the 'Stained Hand' (al-Kaff alKhaḍib, mostly Cassiopeia), α Aurigae (al-ʿAyyūq, the Goat), stars close to the constellations Orion, Gemini, Canis Minoris and Canis Majoris, the zodiac sign of Aries and again to λ Scorpii (Shawlat al 'Aqrab).

Ibn Majid gives a more concise and compact description of the Milky Way in his *Kitāb al-Fawā'id fī Uṣūl ʿIlm al-baḥr wa-al-qawā'id*. He highlights that the Milky Way is enclosed by the two eagles. His brief description of the Galaxy in the sky starts and stops with a comment motivated by the navigational use of the stars and Milky Way silhouette. At the beginning, he mentions that the Milky Way mainly reaches from the constellation Camel (al-Nāqa, mostly Cassiopeia) to α and β Centauri (al-Ḥimārān). He then names bright stars and lunar houses in the constellations Centaurus, Sagittarius and Canis Minoris. He ends with a probably navigationally motivated comment that the constellation Crux (al-Murabbaʿāt) in the south and the bright star Vega (al-Nasr al-Wq̄´a in Lyra) in the north lie in the Milky Way. Al-Nāqa and al-Nasr al-Wq̄´a in the north and al-Murabbaʿāt and al-Ḥimārān in the south belonged to the most important navigational references and – if up – could be seen throughout the Indian Ocean. They highlight the two end points of the visible section of the Milky Way that was an important reference for finding or validating stars suitable for navigational purposes.

Finally, Ibn Raḥīq gives a short yet precise description of the Milky Way. He does not mention stars or constellations but restricts himself to a general description of the Milky Way as it evolves throughout the year.[22] He highlights that it is close to the horizon in spring, culminates at midnight in the sky in summer and rapidly changes position in fall (autumn).

Except for Ibn Raḥīq's explanations, all descriptions have in common that they start in the south and west, go to the north then continue to the south and east. Taking the constellation of Centaurus as a starting point appears to be obvious since it culminates in early summer followed by the bright, main body of the Milky Way. The descriptions by Abu Hanifah and Ibn Majid mostly regard the bright stars rather than the constellations the Galaxy passes through. Also, they refer mainly to Arabic constellations. With the *Almagest*, they have in common that they initiate the description by making a statement on the shape, i.e. the location of the widest section of the Milky Way. Other than that, they are genuine descriptions tailored to the use of the Milky Way as a geographical or navigational phenomenon. Ibn Raḥīq gives a seasonal description focused on the agricultural use of the Milky Way and al-Marzouqi outlines the Galaxy as a tool to find the Qibla in summer. Ibn Majid highlights the use of the Milky Way to localise bright stars useful for navigation.

21 Eckart, "Use of the Galaxy."
22 Eckart, "Ibn Ra ḥ īq's Text on the Milky Way."

Debates on the Nature of the Milky Way

The situation around 1000 CE bears similarities to that in 1920. In both epochs the nature of the Milky Way was discussed based on scientific observations. While the matter was initially not fully resolved or accepted in both cases, the discussion was started or at least highlighted by corresponding publications.

The Great Debate: In 1920, the so-called "Great Debate" between Harlow Shapley and Heber Curtis[23] showed that the Milky Way can be considered a stellar system similar to many galaxies. In fact, since the debate took place in 1920 and the corresponding paper was published in 1921, we are celebrating a centennial anniversary of this event. At this time, Shapley had determined the approximate size of the Milky Way, measuring the distribution of globular stellar clusters around it. Shapley first followed the idea that the spiral nebulae are part of the Milky Way. However, the Great Debate was preceded by the determination of Doppler shifts for some of the brightest spiral nebulae by Vesto Slipher in 1912[24] and the detection of novae in spiral nebulae by Heber Curtis in 1917.[25] The combinations of the redshift and distance measurements then lead to the famous Lemaitré-Hubble law, showing that the universe expands at a high rate. These results implied, similar to the distant spiral galaxies, the Milky Way is most likely a stellar island as proposed by German philosopher Immanuel Kant in 1770. However, the debate around 1920 only seems to have become "great" in retrospect; see Virginia Trimble's article in from 1995, which notes that very few people made comments on it at the time.[26]

The Early Great Debate: Ibn al-Haytham's work on the Milky Way was first translated into German by the physicist Eilhard Wiedemann in 1906,[27] about one and a half decades before the Great Debate took place. Unfortunately, Wiedemann could not value Ibn al-Haytham's work in full extent, since the discussion on the Milky Way's nature had not yet become relevant.

While Ibn al-Haytham could show that the Milky Way is at a large distance and not part of the upper atmosphere, the first galaxies other than the Milky Way were observed by astronomer

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23 Harlow Shapley, "On the Existence of External Galaxies," *Royal Astronomical Society of Canada* 13 (1919): 438; Harlow Shapley and Heber Curtis, "The Scale of the Universe," *Bulletin of the National Research Council* 2, no. 3 (1921); Harlow Shapley, "Globular Clusters and the Structure of the Galactic System," *Publications of the Astronomical Society of the Pacific* 30, no. 173 (1918); Heber Curtis, "Novae in the Spiral Nebulae and the Island Universe Theory," *Publications of the Astronomical Society of the Pacific* 29, no. 171 (1917).

24 Vesto Slipher, "The Radial Velocity of the Andromeda Nebula," *Lowell Observatory Bulletin* 2, no. 8 (1913).

25 Curtis, "Novae in the Spiral Nebulae."

26 Virginia Trimble, Virginia, "The 1920 Shapley-Curtis Discussion: Background, Issues, and Aftermath," *Publications of the Astronomical Society of the Pacific* 107, no. 718 (1995): 1133, https://doi.org/10.1086/133671.1995.

27 Eilhard Wiedemann, "Über die Milchstraße bei den Arabern" [About the Milky Way among the Arabs], in *Beiträge zur Geschichte der Naturwissenschaftenn*, LXXIV, ed. Oskar Schulz (Erlangen: Kommissionsverlag von Max Mencke, 1928); Eilhard Wiedemann, "Über die Lage der Milchstraße nach Ibn al Haiṯam" [About the Location of the Milky Way according to Ibn al Haiṯam], *Sirius* 39, no. 5 (1906), https://wellcomecollection.org/works/hjwrb8m6.

Abd al-Rahman al-Sufi[28] (903−986). He gave the first records on the Andromeda Galaxy as a "small cloud." He also reported on the Large Magellanic Cloud (LMC) since it is visible from Yemen. The LMC was not found by Europeans until Magellan's voyage to South America in the 16th century. Of course, al-Sufi did not know what he had found, since essential pieces of information were still missing at that time: the distances to the stars and the fuzzy nebula like the Andromeda Galaxy and LMC.

With his work on the distance to the Milky Way, establishing the Galaxy as an extraterrestrial body and the widely supported hypothesis that the Milky Way consists of densely packed stars, Ibn al-Haytham was at the peak of the unaided-eye era of astronomy and the investigation of the Milky Way. Following 1920s nomenclature, one may refer to that era as the "Early Great Debate" on the nature of the Milky Way. Hence, Ibn al-Haytham's work represents a brilliant combination of passed down knowledge and personal observations one can still verify by the naked eye today. Since Ibn al-Haytham wrote his treatise on the Milky Way around 1028 (most likely as one of his earlier works in astronomy[29]), we are almost celebrating a millennium since this event and the Early Great Debate that took place in those days.

The 21st Chapter of Kitāb al-Azminah wa al-Amkinah

The section on the Milky Way in al-Marzūqī's *Kitāb al-Azminah wa al-Amkinah*[30] is the third of three sections that comprise Chapter 21, titled "On the Names of the Sky, the Planets, the Stars, and the Zodiac." The first section is titled "Explaining the Meaning of Heaven" and the second section is "Explaining the Meaning of the Firmament."

While a detailed description of the Milky Way is given in the third section of the 21st chapter "Controversy over the Milky Way," this contains text by Abu Hanifah and al-Marzouqi's representing a summary of traditional knowledge of the Milky Way.[31]

There is no strong or obvious relationship between the second and third sections, except the rotation of the stars with the sky, as highlighted in the first sentence:

الفلك أصله الدّوران

Translation: The firmament – its origin is the rotation.

Here, it is probably implied that the apparent rotation of the celestial bodies with the sky is a dominant feature of the firmament as it reveals itself. The topic is picked up again later in the text of the second section. It reoccurs in the third section on the Milky Way.

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28 Abd al-Rahman al-Sufi named many astronomical objects and published catalogues of stars. He is best known for his book *Ṣuwar al-kawākib* [Pictures of Stars]. See, for example, Ibn-ʿUmar Abd-ar-Raḥmān aṣ-Ṣūfī, "Ṣuwar al kawākib" [Pictures of Stars], in *Description des Étoiles Fixes* [Description of Fixed Stars], trans. Hans C. F. C. Schiellerup (Saint Petersburg: Eggers, 1874).

29 Eckart, "The Early Great Debate."

30 al-Marzūqī, *Kitāb al-ʾazmina wa-al-ʾamkina* [Book of Times and Places] (Beirut*:* Dār al-Kutub al-ʿIlmiyya, 1996), 260-62.

31 Ibid.; Eckart, "Use of the Galaxy"; Clarke, "Al-Dīnawarī."

However, the first section on the meaning of the heaven (i.e. sky) is thematically closer to the Milky Way topic. We find several terms are discussed in this section then reoccur in the third section on the Galaxy. Here, we concentrate on details of the first section of the 21st chapter. We summarise the important points concerning the Milky Way in sequence as they occur in al-Marzūqī's first part of the 21st chapter of his book.

The colour of the sky is an important topic and al-Marzūqī states:

... فإنه أراد بجلد السّماء الخضرة التي تظهر، فشبّه صفاء الماء بصفائه

Translation: For he wanted the skin of the sky to have the green that [it] appears [in], so he likened the purity of water to its (the skins) clarity…

This is followed by:

... كأنّ لون مائه لون جلد السّماء.

Translation: …as if the colour of its water is the colour of the skin of the sky.

The "skin of the sky" is most likely referring to the smooth appearance of the celestial sphere. The colour of the sky is an important topic and al-Marzūqī links the clarity of the greenish (i.e. blue) colour of the sky with the purity of water. The (mostly) blue colour of the water is compared to the colour of the sky; hence, the colour blue is seen as part of the classical spectral segment called al-Ḫuḍra. Here, we refer to Hoeppe,[32] who presents a colour circle based on the colour theory presented in classical Arabic literature.

In the following, aAl-Marzūqī then gives an early reference to the verse with the goats and southern wind:

وخوت جربة السّماء فما ... لشرب أروية بمري الجنوب

Translation: The fields of the sky are exhausted…then what there is to drink for the goats is drawn from the southern winds.

This verse then reoccurs in the context of the description of the Galaxy within the sky in the third section of the 21st chapter. There, the expression *jirbat al-samāʾ* [sky fields] in the section on the heaven is replaced by *jirbat al-nujūm* [star fields] in the section on the Milky Way – underlining that the latter can be taken as a synonymous expression for the Galaxy.

In the first section, as part of the description of the sky, al-Marzūqī explains the term *al-jirbāʿ*:

وقال الهذلي ...:

أرته من الجرباء في كلّ منظر ... طبابا فمثواه النّهار المراكد

[32] Götz Hoeppe, *Why the Sky is Blue: Discovering the Color of Life*, trans. John Stewart (Princeton University Press, 2007).

Translation: …and al-Huḏalī said: They showed to him the star field from every direction of sight…a narrow, elongated streak of the sky and his grazing land of the day is the resting place.

The terms *ṯibāb*, a streak or narrow, elongated track of the sky, *maṯwa*, a place where one remains and rests, and *marākid*, places in which a person or other thing remains motionless, can be found in Lane.[33] This quotation is based on a work by ʾOsāma bin Ḥabīb al-Haḏalī,[34] who tells the story of a donkey expelled by horses. Taking refuge in the narrow canyons of the mountains, the donkey observes the sky. A possible interpretation of this verse is that the view of the sky, limited from within a narrow canyon, highlights the elongated appearance of the Milky Way in the sky showing itself as a single or several elongated streaks or bands. Al-Marzūqī also explains the comparison between the agricultural understanding of a field and the star field in the night sky:

ويقال في الجربة ما زرع من الأرض، وكأنّها إنما سميت جرباء لما فيها من آثار المجرة كأنّها الجرب

Translation: The field is called the part of the soil that is sown. In the same manner, the star field is called a field because in it there are the traces of the Milky Way as if it was a field sown in.

Finally, in the first section of the 21st chapter, al-Marzūqī differentiates between the names given to the sky according to the presence or absence of stars:

إنما سمّيت بالصّفات على حسب أحوالها، فإذا اشتبكت نجومها فهي الجرباء، وإذا غابت النّجوم فهي الملساء

Translation: It was called by the attributes according to their conditions. If its stars are entangled (and involved [i.e. it is packed with stars]), it is the fields, and if the stars are absent, it is smoothness.

This may imply that, if the stars fade away during the day, what remains is the smooth celestial sphere.

In summary, we find that all essential topics that are discussed in the second part of the (third) section on the Galaxy,[35] have also been addressed in the two previous sections of the 21st chapter. Hence, it appears the final sentences in the final section on the Galaxy can be considered a conclusion or summary of the entire 21st chapter regarding the properties of the sky and the Milky Way in it.

Criticism of the Traditional Description of the Milky Way

Intense discussions about the nature of the Milky Way were held by scholars (including judges, linguists, encyclopedists and theologians) in the 15th century.[36] One can name here al-

33 Edward William Lane, *Arabic-English Lexicon* (Beirut, Lebanon: Librairie du Liban, 1968).
34 See Ismāʿīl b. Ḥammād al-Ǧawharī, *al-Ṣiḥāḥ*, 4th ed. (Beirut: Dar Al-Ilm Lil-Malayin, 1987), vol. 2, 477.
35 Eckart, "Use of the Galaxy"; Clarke, "Al-Dīnawarī."
36 Eckart, "The Early Great Debate"; Eckart, "Ibn Raḥīq's Text on the Milky Way."

Amidi (1156–1233), al-Iji (1281–1355), al-Jurjānī (1389–1413) or al-Hanbalī (d. 1475). Sirāj al-Dīn ʻUmar al-Ḥanbalī wrote in *al-Lubāb fī‘ ulūm al-kitāb*:

> And some interpreters said that in heaven the gates really do open and water runs out of them. The crowd of commentators said this was a metaphor and an analogy because rain is as common as doors (as if it was pouring out of doors).[37]

So, al-Ḥanbalī turns against the connection between heavy rain and the Milky Way. Likewise, al-Iji, for example, was critical of the traditional description of the Milky Way, in which it is related to weather phenomena. This was recorded in a Kalām text by al-Sherif al-Jurjānī.[38] He concluded from the discussion that sound knowledge of the Milky Way, proximity to Qur'ān knowledge and distancing oneself from uncertain explanations amount to a test of good faith. Translated to the present day, this means to stick to what is secure and refrain from "fake news."

SUMMARY AND CONCLUSION

Concerning al-Marzūqī's work, we find that all essential topics that are discussed in the final part of the third section of the 21st chapter of his *Kitab al-Azminah wa al-Amkinah* on the Galaxy have been addressed in previous sections. The outstanding feature of the section on the Galaxy is the detailed astronomical description of the Milky Way that al-Marzūqī took from the astronomer Abū Ḥanīfah. However, the fact the Milky Way is mentioned so often in the first section in describing the heaven suggests al-Marzūqī understood the Galaxy more as an integral part of the sky rather than a separate phenomenon. Hence, it appears the final sentences in the last section on the Galaxy can be considered to be a conclusion or summary of the entire chapter regarding the properties of the sky and the Milky Way in it.

Analysis of the work by Ibn al-Haytham on the Milky Way shows that we are currently celebrating a simultaneous centenary and millennium anniversaries of the discovery of the Milky Way as a truly celestial object that is not only much further away than the Moon but also a world island like the many galaxies in the sky. We find that knowledge about the Milky Way was widespread in the Arab culture of the 8th to 15th centuries. A distinction must be made between popular and scientifically based knowledge. The text by Ibn Raḥīq makes it clear on the traditional side that knowledge of the Milky Way was, in a way, a test of faith. Knowledge of this heavenly phenomenon proves reading in the traditional or holy scriptures. In these sources (e.g. *al-Adab al-Mufrad*[39] by al-Bukhārī), the Milky Way is clearly associated with heavy rain, as it occurs in the monsoon season. Presumably it is the position of the Milky Way in the sky in July/August that brought about the connection with the weather. Obviously, this link has been taken too figuratively, so critical texts have been written (e.g. by al-Iji or al-

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37 ʿUmar b. ʿAlī b. ʿĀdil al-Dimašqī al-Ḥanbalī, *Al-lubāb fī ʿulūm al-kitāb* [The Quintessence in the Sciences of the Book], ed. ʿādil Aḥmad ʿAbd al-Mawǧūd and ʿAlī Muḥammad Muʿawwaḍ (Beirut: Dār al-Kutub al-ʿilmiyya, 1998), vol. 18, 246.

38 See Eckart "Ibn Raḥīq's Text on the Milky Way," Appendix A.

39 al-Bukhārī, *Al-Adab al-Mufrad* [Individual Literature Sources], trans. Maulana Khalid Khan Garhi and Rafiq Abdur Rahman (Beirut, Lebanon: Dar al-Kotob al-Ilmiyah, 1971).

Ḥanbalī) that misrepresent this strong connection between weather phenomena and the appearance of the Milky Way.

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