
REPORTS AND DRAWINGS OF CELESTIAL OBSERVATIONS
IN THE 8TH CENTURY SYRIAC *CHRONICLE OF ZUQNĪN*
(AURORAL AND METEORITIC PHENOMENA)



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THE *CHRONICLE OF ZUQNĪN*

The Syriac Chronicle of ZuqnĪn offers a world history starting with the presumable creation and ending at around the time of writing, A.D. 775/776. It survives in one manuscript of 173 folios located as Codex Zuqninensis at the Vatican Library (Vat. Syr. 162), and the remaining six folios are found in the British Library (Add. 14.665 folio 2-7); in Codex Zuqninensis, 129 folios are palimpsest, one even a double-palimpsest.¹ Some of the folios in the British Library which cover the last years are worm-eaten and, hence, very fragmentary. Its first and last folios are lost together with the name of the author.² The Chronicle is divided into four parts, all translated to English³ and French.⁴

Shortly after the manuscript was found and bought for the Vatican, it was considered to be written by the West Syrian patriarch Dionysius I of Tell-Mahrē, so that this

chronicle was long known as Chronicle of Dionysius of Tell-Mahrē.⁵ Dionysius did write a world chronicle, but lived later (died A.D. 845). Since this mistake was noticed, the chronicle has been called the Chronicle of Pseudo-Dionysius of Tell-Mahrē⁶ or, better, the Chronicle of ZuqnĪn,⁷ because the text mentions the monastery of ZuqnĪn as the living place of the author; ZuqnĪn was located near Amida, now Diyarbakır in Turkey near the border of Syria.

The single manuscript that exists is very likely the autograph.⁸ Its author was probably the stylite Joshua, monk of Amida;⁹ a stylite is an early Byzantine or Syrian Christian ascetic living and preaching on a pillar in the open air, so that many atmospheric and celestial observations can be expected in his work.

The Chronicle of ZuqnĪn is made of four parts: Part I runs from the creation to Emperor Constantine (A.D. 272-337), Part II from Constantine to Emperor Theodosius II (A.D. 401-450) plus a copy of the so-called Chronicle of Pseudo-Joshua the Sty-

lite (sometimes also called Chronicle of Edessa) which covers the years from A.D. 497 to 506/7, Part III from Theodosius to Emperor Justinian (A.D. 481-565), and Part IV to the time of writing, A.D. 775/776. The Chronicler used a variety of sources, some of them otherwise lost.¹⁰

The events reported in the text are dated using the Seleucid calendar; this era started on October 7, B.C. 312 (= Dios 1 = *Tishri* 1), the Macedonian start of the year B.C. 312/311, in which Seleucus I Nicator won the important battle of Gaza (afterwards, he returned to Babylon to rule his satrapy). There are several versions of the Seleucid calendar, including the Babylonian (Jewish), Macedonian, and West Syrian (Christian) ones. The author of our chronicle systematically used the latter version for reports during his lifetime – a solar calendar, in which the year ran from *Tishri*/October 1 to *Elul*/September 30, applied since at least the fifth century.¹¹

The Chronicle of Zuqnān reports about a variety of celestial phenomena, which can be classified as northern lights, possibly meteor showers, meteorites, a bolide, comets, a close Saturn-Mars conjunction, halo displays, a solar eclipse, and other (atmospheric) darkenings. The author's eyewitness reports start around folio 128 in A.D. 743.¹² Since the Chronicle ends in A.D. 775/6, probably shortly before the death of the author, much of the eyewitness material is reported from memory years to decades after the events. For an 8th century manuscript, the Chronicle of Zuqnān is exceptional, being an autograph, which offers detailed eyewitness records and even realistic drawings of celestial observations from the chronicler's life-time, including Halley's Comet in A.D. 760 (its study is in preparation by Neuhäuser et al.).

Historical observations of celestial phenomena are important for a variety of studies: observations of historical comets and

meteor showers may be used to refine their orbits and connections; credible observations of northern lights (aurora borealis) can be used to reconstruct past solar activity (including the 8-14 years long Schwabe cycles with variations in sunspots and auroral activity and decades-long Grand Minima of lower activity);¹³ accurate dates and locations of solar eclipses are used to study small changes in the Earth rotation period;¹⁴ solar (and lunar) halo displays are atmospheric effects,¹⁵ and were of strong interest in ancient and medieval times, partly as weather indicators.¹⁶

Here, we report on phenomena situated in the atmosphere: especially northern lights (aurora borealis) including some dubious cases which could be either meteor showers or auroral displays, also one bolide (bright meteor exploding in mid-air) and one case where meteorites were fallen onto the ground. Historically, such atmospheric (meteorological) phenomena were all called "meteors".

The Chronicler will be quoted in English translation¹⁷ including the interpretation and the drawing by the chronicler if available. Then, we present parallel transmissions (both Near Eastern and worldwide, sometimes with complementary information) including the sources of our Chronicler, if known. We reflect on his reception and use of sources. Then, we discuss the observational information in detail and try to identify the nature of the observed event by close reading; for an overview, see Table 1. To correctly classify an old observational record using partly different terminology (historical descriptions are "pheno-typical"), one has to discuss the original text and wording as well as the translation, which is always somehow an interpretation; we also consider the context and the Chronicle writer's ideological background and his sources (e.g. apocalyptic). Clear scientific criteria are important

for the classification of the phenomena. Furthermore, the exact dating is often important, e.g. the lunar phase for identifying celestial observations, the correct year for solar activity studies, or the offset between the Julian and Gregorian calendar for comparing a meteor shower observation with today's showers.

In most historical records, when neither day-time nor night-time is mentioned, it has to be assumed that the bright day is meant; this holds also for celestial observations, which typically include atmospheric meteorological phenomena, like halo displays. Hence, we normally require explicit or indirect mentioning of night-time in order to classify a record as e.g. an aurora borealis; terms like “star(s)” or “(half) moon” do not automatically indicate night-time, because, e.g., parhelia (sun dogs) can also be called that way. However, the Chronicle of Zuqnān several times did not mention night, so that other circumstantial evidence has to be considered: sometimes description together with drawing leave no doubt that a night-time phenomenon is meant, see for example in this article the last two Events (aurora borealis), or we have to rely on his sources or parallel transmissions for possibly additional evidence.

Typical criteria to identify a historical observation as mid- to low-latitude aurora borealis are as follows: (i) night-time (excluding twilight), (ii) direction: mostly northern, sometimes from East over North to West (but not low in the south), (iii) colour and form: red or fiery (sometimes also tinged green, yellow, or blue), like “a fire”, an arc with rays, in form of a curtain, etc., (iv) dynamics like pulsating brightenings or rays (but aurorae can also be stationary), and (v) duration and repetition within one to few nights; normally northern lights are restricted to polar latitudes, but strong display can be seen further south; around the

7th and 8th centuries the geo-magnetic pole was in the (northern) West-Asian quadrant, so that we may expect observations of the aurora borealis (even though as a rare phenomenon) in the Near East during this epoch.¹⁸

Typical criteria to identify historical observations such as meteor showers are as follows: (i) night-time including twilight, (ii) direction: common direction of motion and origin (radiant) on sky (e.g. Perseids from Perseus), (iii) colour and form: tens to thousands of streaks/tails of white light (depending on composition of meteoroid and gases in the ionization trail, the trail can show colours, but they are not detectable by the naked eye at night, because the eye needs longer than the meteor duration to adapt for noticing colours), (iv) dynamics: very fast motion (time-scale of seconds), (v) duration: peaking over one or a few nights (appearance on typical phases during the tropical year, e.g. the Alpha Aurigids meteor shower occurring August 28 to September 5).

Individual meteors as small solid objects (meteoroids) falling through the Earth's atmosphere, and heated by collisions with air molecules, can be seen (as meteors) anytime also outside of showers. A bolide (“fireball”) is a large, resolved, very bright, sometimes disintegrating meteor visible for time-scales of minutes, sometimes with sound and/or touching ground (meteorites). The term “meteor” in today's sense is restricted to these cases, but was much broader in history.

A close reading under consideration of the criteria should help to identify the likely true nature (in the modern sense) of the observed phenomena – the criteria are indicative (and partly discriminative), but one always has to consider whether the record is consistent with a certain interpretation and whether nothing speaks against it.

EVENT 1

At “night ... on the north side in the likeness of a blazing fire” on *Āb* 22, SE 813 (aurora borealis, August 22, A.D. 502)

The Chronicle of Zuqnān for SE 813 (=A.D. 501/502): Part III, folio 87v, with a drawing (Fig. 1); square brackets are added to the translation of the Syriac text:

The year eight hundred and thirteen: ... On the same night of the earthquake [in Acco, Tyre, and Sidon, as specified before] that occurred in the month of *Āb* (August), on the twenty-second, at the dawn [or: “eve of”] of Friday, a sign was seen on the north side (of the sky) in the likeness of a blazing fire.¹⁹

This event is also mentioned in *Chronicon Edessenum* (written in Syriac, ending in SE 850, i.e. A.D. 538/9): “An. 813, a great fire appeared on the side of the north, which blazed all night on the 22nd of *Āb* (August).”²⁰ The 12th century Syriac Chronicle of Michael the Syrian reports this event (“large fire in the north”).²¹

For these years, the Chronicle of Zuqnān is actually largely based on the Chronicle of Pseudo-Joshua from Edessa (A.D. 494/5 to 506/7), which is very accurate in dating;²² Pseudo-Joshua is quoted verbatim in Zuqnān’s Part II, although it is condensed and somewhat modified in Part III, a matter dealt with here. The original report from Pseudo-Joshua is found on folio 75r-v of Part II of the Chronicle of Zuqnān:

Now listen to the atrocities that were perpetrated in this year and to [f75v] the sign that was seen on the day when they occurred, because you required us (concerning it) too. On the twenty-second of *Āb* (August) of this year, on the night preceding Friday, a great fire was seen burning in the northern region during the whole night, such that we thought that the

entire earth was about to be wiped out by the conflagration of fire in that night. The mercy of our Lord protected us unscathed, but a letter was sent to us by some people of our acquaintances, who were travelling to Jerusalem, and the following was in it: In the same night in which that great burning fire appeared, the city of Ptolemais, which is Acre, was overturned, and nothing inside it remained standing; then after a few days, people from Tyre and Sidon came to us and told us that in the day the fire appeared and Ptolemais was overturned, in the same day half of their cities, that is part of Tyre and part of Sidon, collapsed ... [one sentence omitted] ... Now on the very day on which that fire appeared the king of the Persians, Kawad Son of Peroz, gathered the whole army of the Persians and, coming up by the northern (route), crossed the Roman border with the army of Huns which he had with him.”²³

The Zuqnān Chronicler omitted the positive sentence “The mercy of our Lord protected us unscathed” in his own version. Pseudo-Joshua uses the “fire ... in the northern region” on 22nd August to dramatically start a lengthy narration of the history of the war between the Persians under King Kawad, “coming up by the northern (route)”, and the Byzantine-Roman Empire, which is the main content of his report; peace did not return until the last (12th) year of the Chronicler’s report ending in November A.D. 506. This connection between a celestial sign and political events is also reflected in the first sentence from Pseudo-Joshua as quoted above: “Now listen to the atrocities that were perpetrated in this year and to the sign that was seen on the day when they occurred, because you required us (concerning it) too.” The person addressed as “you” could

be the possibly fictitious addressee of Pseudo-Joshua's letter, who presumably asked the author to compose his report: "Sergius ... I have received [your] letter ... in which you direct me to write you, as it were, the memorial of (the time) when the locusts came, the sun was dimmed, there was earthquake, famine, and plague, and the war of the [Byzantine-]Romans and the Persians".²⁴ Pseudo-Joshua considered the observation interpreted as aurora borealis as one of those signs, as part "of the Devine Economy".²⁵



Figure 1

Aurora borealis (northern light) reported for August 22, A.D. 502 on folios 75r-v and 87v with this drawing on 87v showing red lines (lower left, Event 1). The drawing by our Chronicler of coloured parallel lines (probably meant to be perpendicular to the horizon, here the edge of the folio) may not be based on the source, Pseudo-Joshua, who mentioned "the likeness of a blazing fire," but instead it is similar to the two cases of aurora borealis seen by our Chronicler himself as eyewitness (Events 8 and 9).

This report was interpreted as aurora borealis before, dated August 22, A.D. 502.²⁶ Several aurora borealis criteria²⁷ are fulfilled (see Introduction): night-time, northern direction, aurora-typical red col-

our ("fire"), and motion ("blazing") – duration of the "whole night", but no repetition in subsequent nights. Since Pseudo-Joshua used "we" and "us", he was an eyewitness (probably in Edessa). He also has information from several more independent eyewitnesses south of Edessa, towards Jerusalem, but it is unclear whether they also reported the aurora borealis, or whether Pseudo-Joshua connected their earthquake reports in the same night and on the same 24-hour-day with this aurora borealis; hence, the aurora borealis oval extended to Edessa, and possibly even further south.

In principle, the drawing in the Chronicle of Zuqnān (Fig. 1) with coloured parallel lines (similar as in Figs. 2 and 3 in the last two Events below) would be consistent with an aurora borealis, but here our Chronicler has drawn what he saw in his own lifetime – it does not look like "the likeness of a blazing fire" as reported by Pseudo-Joshua.

In the West-Syrian Christian calendar, the Seleucid month of *Āb* is identical to the Latin August. The "night preceding Friday" (Pseudo-Joshua) is the night we would designate as *Thursday/Friday night, August 22/23* – and indeed, August 22 (= 22 *Āb*) was a Thursday;²⁸ Pseudo-Joshua's dating to "22 *Āb*" and the "night preceding Friday" would then point to the start of the observed phenomenon during the first half of the night, August 22/23; Pseudo-Joshua then adds that it was "seen ... during the whole night." The "eve of Friday" in the Chronicle of Zuqnān also points to the first half of that night. The new moon occurred on August 18, so that it was dark most of the night of August 22/23.

In the years around A.D. 502, no other likely cases of true aurora borealis are found in aurora catalogues,²⁹ but there were two credible reports on naked-eye sunspot observations in China in February and March, A.D. 502, also in the three years

before.³⁰ Together with this relatively low-latitude aurora borealis in Edessa, they indicate strong solar activity.

In the last two Events below (Events 8 and 9), northern lights will be reported again for Fridays like here, and our Chronicler then adds that such signs were seen three times, always on a Friday.

EVENT 2

“Stars ... leaping in the sky” reported for SE 843 (meteor shower or auroral display, probably September, A.D. 532)

Chronicle of Zuqnān for SE 843 (=A.D. 531/532), Part III, folio 100r:

The year eight hundred and forty-three: Rufinus came and made peace between the Romans and the Persians. On the same day, the stars were seen shooting in the sky.³¹

The Syriac phrasing translated here as “stars ... shooting in the sky” literally means “leaping stars”; Witakowski translated: “On the same day stars appeared leaping in the sky.”³²

This sighting was reported in two contemporary chronicles; although *Chronicon Paschale*, written A.D. 628, is quite detailed for these years, it does not report this observation:

(a) Pseudo-Zacharias shortened and translated into Syriac the Chronicle of Zacharias of Mytilene around A.D. 569 in Amida (he is called Scholastikos or Rhetor, lived around A.D. 465 to after 536): “... this Rufinus ... made peace; and a written treaty was drawn up and ratified. And the stars [*kawkbē*] in the sky had appeared dancing [*dāyṣīn*] in a strange manner [lit.: in a new way], and it was the summer of the year eleven. And it lasted about six or seven years, until the year three”; the former “year eleven” being A.D. 532/3 and the latter “year three” (of the respective 15-year-long indiction) being A.D. 539/540.”³³

(b) John of Malalas (Byzantium, born A.D. 490, chronicle written A.D. 565): “72. In that year [A.D. 531/2 or 532/3] Rufinus set out for Persian territory with a sacred memoranda to make a peace treaty with the Persians. 73. ... 74. ... 75. In that year [A.D. 531/2 or 532/3] there occurred a great shower of stars from dusk to dawn, so that everyone was astounded and said, ‘We have never known anything like this to happen.’ 76. In that year Hermogenes and Rufinus returned from Persia, bringing with them a peace treaty between the two states of Rome and Persia.”³⁴

The Chronicle of Zuqnān probably used Pseudo-Zacharias as his source: he uses the same sequence that first Rufinus achieved peace, then the “leaping stars” like “stars ... dancing” – and he does not copy the quotation from within the Malalas chronicle, nor its given time span “from dusk to dawn” nor his “great shower of stars”; there is no evidence in the sources (a) and (b) that the reported “shooting stars” were observed on the “same day” as the peace treaty, but in the same year (Pseudo-Zacharias: in summer). When Pseudo-Zacharias reported “it lasted about six or seven years,” he means the span of peace between the (Byzantium) Romans and the Persians (Malalas also has new hostilities by A.D. 540).

The *Chronicon Edessenum* gives SE 843 September for the peace treaty between the Romans and Persians,³⁵ so that, if the celestial event was on the “same day” (Zuqnān), it would have been in September, A.D. 532; this is not inconsistent with “summer of the year 11” (Pseudo-Zacharias) as the 11th year of the current indiction started September 1, A.D. 532.

Let us consider a meteor shower: the report by our Chronicler meet up to two meteor criteria (see Introduction), namely maybe dynamics (“shooting/leaping”) and probably night-time (“stars”, but parhelia were also often called “stars”); Malalas’

parallel account clearly indicates night time by saying “from dusk to dawn”; however, the wording by Pseudo-Zacharias “appeared dancing in a new way” does not necessarily sound like a typical meteor shower. In modern catalogues of meteor showers, this event might be listed via the late transmission by Cedrenus (11th century Byzantine historian): “magnus fuit stellarum discursus” (“there was a large move of stars”) for A.D. 532.³⁶

In East Asia, it was reported that in August 28, A.D. 532 (Julian) “stars fell like rain” in Korea and/or China. This has been interpreted as describing a meteor shower;³⁷ however, in this time the wording “stars fell like rain” is not as uniquely used for meteor showers as later, sometimes it is related to thunder or lightning, e.g. A.D. 586.³⁸ If the date September, A.D. 532 and the interpretation as a meteor shower is correct, this could point to Alpha Aurigids shower August 28 to September 5, peaking September 1 (Gregorian); the offset between Julian and Gregorian was only 1.5 days by A.D. 532.

Meteor streams are relatively frequent, and known also to laymen, so that a wording like “We have never known anything like this to happen” (Malalas) is unusual for a meteor shower (and it was not mentioned that this one was particularly strong). Also the wording “dancing in a new way” in Pseudo-Zacharias could point to some rare phenomenon.

If not a meteor shower, one could consider an alternative interpretation: the report of our Chronicler fulfils one or two aurora criteria, probably night-time (“stars”) and dynamics (“shooting/leaping”). The additional information by Pseudo-Zacharias and Malalas (“dancing in a new way”, “never known anything like this to happen”) allow an auroral interpretation: the observed phenomenon could be a pulsating auroral display with moving brightenings during a

strong geomagnetic storm; aurora borealis can appear in various forms and strengths, e.g. (almost) stationary (“fire”, e.g. Event 1) or with ordered, coloured rays (see in this article the last two Events as seen by the author of the Chronicle of Zuqnān), or otherwise irregular forms with many changes of shape. There is a credible aurora report from China slightly later, in A.D. 536 and also one from A.D. 522,³⁹ i.e. one Schwabe cycle earlier.

However, in sum, there is not sufficient information to classify this observation reported for SE 843 (A.D. 532 September) with certainty: doubts remain about its interpretation as a meteor shower, but an auroral display is also not certain.

EVENT 3

“Stars of the sky fell ... shot like arrows towards the north” reported for SE 937 (meteor shower or auroral display, A.D. 625/6 or maybe a few years later)

Chronicle of Zuqnān for SE 937 (=A.D. 625/626), Part IV, folio 122v:

The year nine hundred and thirty-seven: The stars [*kawkbē*] of the sky fell [lit.: to drop (like tree leaves)] in such a way that they all shot like arrows towards the north. They provided the Romans with a terrible premonition of defeat and of the conquest of their territories by the Arabs. This was in fact what happened to them almost immediately afterwards.⁴⁰

The death of Muḥammad, the founder of Islam, is reported next for A.D. 626/627, but as he died in June, A.D. 632, the falling stars may also have happened some five years later than reported in the Chronicle of Zuqnān (or its source).

“Falling stars” are often interpreted as meteors. Here, up to three criteria may be fulfilled (see Introduction for the criteria): night-time (probably fulfilled by “stars”),

form (“like arrows”), and dynamics or motion (“shot”; but see below for “fell”). The specification regarding the direction (“towards the north”) is doubtful for the meteor interpretation, because true showers fall *from* a certain area on sky (radiant) and not towards a direction.

The wording “stars [*kawkbē*] of the sky fell” or very similar is also found in a few more records below, where there are doubts as to whether they are meteoritic phenomena; we point to the discussion of the Events of A.D. 745 and 765 below.

“Arrows towards the north” could indicate an aurora borealis corona with “arrows” like stripes along the magnetic fields lines and “*kawkbē*” as brightenings along them. The report in the Chronicle of Zuqnān fulfils two to three aurora criteria: night time (probably fulfilled, because stars are mentioned), northern direction, and dynamics (see Introduction for the criteria).

No other reports concerning meteor showers occurring around A.D. 625/6 or 632 are known (Europe, Near East, Far East).⁴¹ Also, no other record about any aurora borealis is known for around A.D. 625/6 or 632.⁴² Again, a final classification may not be possible here, e.g. a meteor shower or an aurora borealis; as mentioned, “arrows *towards* the north” may be inconsistent with a meteor shower, but are consistent with an aurora borealis.

EVENT 4

“Stars in the sky fell ... like fiery balls in all directions” reported for SE 1054 Latter *Kānūn* 1 (meteor shower or aurora borealis, probably January 1, A.D. 745)

Chronicle of Zuqnān for SE 1054 (=A.D. 742/743), Part IV, folio 131v:

The year one thousand and fifty-four:
The stars [*kawkbē*] in the sky fell [lit.: to drop (like tree leaves)], at the beginning of Latter *Kānūn* [January 1], on a Friday, and they were seen like fiery balls [Syriac *'aspīrō* from Greek

“sphere”] in all directions. They predicted the calamities, sword, and plague that were to occur in the land afterwards, as well as the advent of the Persians.⁴³

In A.D. 743, January 1 was not a Friday; one can usually trust the given weekday more than the date; the closest year with January 1 being a Friday was A.D. 745, meaning the night December 31 to January 1;⁴⁴ this is consistent with Michael the Syrian, who reports the same event for January 1, either A.D. 745 or 746. The Chronicle of Zuqnān does not mention explicitly whether it happened during day or night (“stars” could be parhelia, as mentioned in the previous two Events).

Michael the Syrian (born ca. A.D. 1126, later patriarch of the Syriac Orthodox Church from A.D. 1166 to his death in 1199, lived in Melitene, today Malatya in Eastern Turkey) wrote for SE 1056 or 1057 (A.D. 744/5 or 745/6):

At the beginning of *Kānūn* II [January 1], *zīqē* were seen shooting/flying in the air [lit.: in all the air, i.e. in the whole sky] like stars, everywhere, violently and angrily in the likeness of a battle/war. Also in the night in the middle of the sky, something like a great pillar/column of fire was seen and during the day [lit.: 24h-day (generic)] these *zīqē* began shooting/flying. Near the Milky Way, a star big in look, like the moon, was seen and it remained/lingered four days.⁴⁵

Only the *zīqē* phenomenon seems to resemble the observation reported in the Chronicle of Zuqnān. Michael's source here is probably Dionysius of Tell-Mahrē (Patriarch of Antiochia A.D. 818-845, whose chronicle is lost). The rare Syriac term *zīqē* is used by Michael the Syrian only twice; the other location is in SE 1019 (A.D. 708/9), also from Dionysius of Tell-Mahrē, square brackets from us:

In the year 1019, in the month of *Tammūz* [i.e. July 16, A.D. 709], the portent of *zīqē* appeared in the air, shooting, I mean flying. Some people call them shooting/falling stars. They were seen in the entire sphere of the sky during the whole night flying, intensely and quickly, from the south side toward the entire north. This is something never heard of since the generations of the world. On that account, holy doctors wrote concerning them [*zīqē*], particularly Jacob of Edessa and Moses son of Kipho. What would the naturalists say now? They pretend that they [*zīqē*] are thick air, I mean condensed air, which when it goes up, it comes in contact with fire above and it burns. If someone asks them wherefrom does this condensed air go up and where was it hidden? Because they are unable to respond with anything, let them be persuaded that the Lord does everything that he wishes [Daniel 4:35, Psalm 135:6]. The happening of this affair shows that these flying things [Syriac: *kešjē*] symbolize the Arabs who at this time invaded the lands of the north, destroying, burning down, and annihilating regions, along with their inhabitants.⁴⁶ (Terms like “thick air” and “condensed air” remind us of Aristotle’s meteorology.)

While in A.D. 709, the *zīqē* phenomenon clearly happened “during the whole night”, a close reading of the A.D. 745 text could point to the bright day: in Michael’s next sentence, “Also” is related to “was seen,” and not to “in the night,” so that the “great pillar/column of fire” was seen at night and the *zīqē* during the 24hr-day; if *zīqē* were seen at night, one would normally not write something like “during 24hr-day” (but “at night”). However, neither Michael nor his source, Dionysius of Tell-Mahrē, were an eyewitness, and the wording in Michael is somewhat unusual (“like stars ... in the night ... during the [24hr-

]day”), so that we consider both night-time and day-time as possible. Similarly, in A.D. 502 (Event 1, aurora borealis), Pseudo-Joshua reported “In the same night in which that great burning fire appeared ... that in the day the fire appeared ...”, indicating that the term “day” here was also used in a generic way for the 24hr-day including the night.

In Michael’s texts, Syriac *zīqē* was translated to French as “bolides,”⁴⁷ but it is plural and means literally *radiance* or *big fires*. While *zīqē* and “great pillar/column of fire” (A.D. 745) were related to each other by the source, and may have been seen in the same night. The “star big in look, like the moon” mentioned in the next sentence (“four days”) seems to be a different phenomenon, probably not starting on the very same 24hr-day (i.e. date), but somewhat close in time.⁴⁸ The Chronicle of Zuqnān does not mention “star big in look, like the moon,” its “fiery balls” are best compatible with the *zīqē* [lit.: big fires] in Michael.

The Chronicle of Zuqnān brings the same wording as at the start of the event discussed here again for SE 1076, i.e. A.D. 764/765 (see below): “The stars [*kawkbē*] of the sky fell ... during the whole night,” i.e. here clearly at night. For this event (A.D. 765), it is quite likely that the author of the Chronicle of Zuqnān (died slightly after A.D. 775/6) was an eyewitness, because he reports in very much detail.

Michael’s reports for A.D. 709 and 745 are compatible with the reports from the Chronicle of Zuqnān reports for A.D. 745 and 765, so that they could point to a similar phenomenon, possibly happening typically during the night.

For January 1, A.D. 745, one could first consider a meteor shower: it was probably at night time, Zuqnān mentions “stars [*kawkbē*] in the sky,” Michael “*zīqē* ... like stars.” The description “in all direc-

tions” is typical of a meteor shower to coming from some radiant point and then seemingly to fly to all other directions given the peculiar sighting projection. This sighting cannot be explained with the bright and strong Quadrantids, the only meteor shower known to peak early January, if the Quadrantids have formed much later in the Ching-yang event in March/April, AD 1490.⁴⁹ “Fiery balls” (Zuqnān) and *zīqē* as “big fires” (Michael) do not fulfil the colour criterion, because meteors in a shower seen by naked eye should be a colourless bright white (see Introduction). Also, “fell [i.e. to drop like tree leaves]” (Zuqnān) and “shooting/flying” (Michael) does not automatically point to the typical velocity of a meteor shower, as in A.D. 709, where Michael reports *zīqē* to “go up” and to be “flying”.

One could then consider an auroral display (probably night-time, fiery colour, and dynamics); the “pillar/column of fire” (Michael) was seen at night and could be auroral, it was seen “in the middle of the sky,” which could point to the celestial rotation axis, i.e. the celestial North Pole. Since A.D. 745 January 7 was a new moon, the “great pillar/column of fire” (January 1, Michael) cannot be a lunar halo phenomenon, because it was shortly before the new moon, instead it would have been dark enough for an aurora borealis.

The *zīqē* reported for A.D. 709 by Michael is even more consistent with an auroral display, because it was definitely at night and probably north: first “from the south side toward the entire north” (i.e. a phenomenon seen in the “entire north” coming “from the south”) and later that this sign would have portended problems with the Arabs “who at this time invaded the lands of the north, destroying, burning down”. Similarly, in A.D. 502 (Event 1), Pseudo-Joshua finished his report of an aurora observation with such a portentous

connection, a problem from the north: “now on the very day on which that fire appeared the king of the Persian king, Kawad son of Peroz, gathered the whole army of the Persians and, coming up by the northern (route), crossed the Roman border with the Hunnish army which he had with him.”

There are no meteor shower records from East Asia for A.D. 709 or 744/5.⁵⁰

A similar sighting was reported for northern England by Simeon of Durham (A.D. 1060-1130) in his *Historia Regum* for A.D. 745: “Anno DCC.xlv visi sunt in aere ictus ignei quales numquam ante mortales illius aevi viderunt; et ipsi pene per totam noctem visi sunt, kal. silicet Januarii,”⁵¹ i.e. A.D. 745, fiery strokes were beheld in the air, such as no men of that generation had ever seen before; and were visible throughout almost all the night of January 1.⁵² Up to A.D. 957 Simeon used old Durham annals as sources, which are not otherwise preserved). The Melrose Chronicle (A.D. 745-1140 from Melrose Abbey in Scotland, partly using Simeon of Durham) has for A.D. 745 the following: “Anno DCC.xlv visi sunt in aere ictus ignei, quasi stellae discurrentes, tota nocte kalendarum Januarii, quod omnibus intuitibus magno fuit monstro,”⁵³ “A.D. 745, fiery strokes were beheld in the air, like moving stars, the whole night of January 1; for all who looked at it, it was a large (wonderous) sign” (our translation).

This observation was interpreted before an aurora borealis, but based on a later source.⁵⁴ In particular the wording “such as no men of that generation had ever seen before” may be inconsistent with a meteor shower, one or several of which can be seen each year, while it would be well consistent with an aurora borealis sighting: after very low activity for several decades (Dark Age grand minimum until about A.D. 690), there was

again stronger solar activity around A.D. 745;⁵⁵ there were more sightings of an aurora borealis in June and September A.D. 743 in the Near East.⁵⁶ Also, for July A.D. 709, Michael's report that "this is something never heard of since the generations of the world" is more consistent with an auroral display than with a meteor shower; in (July) A.D. 707 and/or 708, aurorae were seen in China.⁵⁷

Even though the records in the Chronicle of Zuqnān and by Michael the Syrian first seem to sound like a meteor shower, there are several arguments pointing to an auroral display.

EVENT 5

"A large, terrible and dreadful star flew, broke through the sky and the air, and came down at sunset" reported for SE 1065 Latter *Tišri* 26 (bolide, probably November 26, A.D. 754)

Chronicle of Zuqnān for SE 1065 (=A.D. 753/754) Part IV, folio 136r, with our additions in square brackets:

The year one thousand and sixty-five: ... The battle was fought for several days and many fell on both side, and in the end °Abd-Allah, son of °Alī, was defeated before the Persian Abū-Muslim [Persian general, died A.D. 755]. He was put to flight and he fled and disappeared on the 26th of Latter *Tišri* (November), on Tuesday, when Wednesday was dawning. ... In the same evening of the defeat of the son of °Alī, God made a great miracle. A large, terrible and dreadful star [*kawkbō rabō zī'ō wa-dhīlō*] flew, broke through the sky and the air, and came down at sunset in the middle of the camp of the son of °Alī, in the likeness of a fiery ball. When the Arabs saw this thing, their hope was shattered and lost. Their eyes were blinded and they could not hold out anymore because they clearly knew that this thing came from the Lord,

and therefore they could not bear it any longer.⁵⁸

°Abd-Allah, the son of °Alī, was defeated on A.D. 754 Nov 26, so that this is obviously the date meant above, which was indeed a Tuesday⁵⁹ ending in the Muslim calendar at sunset, the start ("dawning") of Wednesday, "in the same evening" it "came down at sunset". Therefore, the Chronicle of Zuqnān is one year off.

Agapius (original Mahbūb son of Qūštānīn, a 10th century Christian-Arabic Melkite bishop of Hierapolis, died A.D. 940's, wrote a world chronicle in Arabic using Byzantine sources) reported a "spear/lance" for the time of the insurrection of °Abd-Allah: "A sign appeared in the sky in the likeness of a spear (*ḥarbā*) of fire extending from the east to the west, and it was expanding and then decreasing. During this time the war of °Abd-Allah son of °Alī was expanding."⁶⁰ Given that Agapius used a different wording for the bolide (spear, *ḥarbā*), he probably used a different source, neither the Chronicle of Zuqnān nor its source. The Chronicle of Zuqnān is a good source for this event; it happened in the lifetime of its author, even though he probably was not an eyewitness.

The wording "large, terrible and dreadful star flew, broke through the sky and the air ... in the likeness of a fiery ball" (Zuqnān) is best consistent with a bolide, in particular that something was flying for quite a distance through the air dissolving, if not exploding, as "fiery ball" seemingly coming down in the camp of °Alī (Arabs) – as seen from a distance by the winning Persians around Abū Ja'far. The narrative expression that the observers' "eyes were blinded" could be based on the experience of the large brightness in the moment of explosion. A bright bolide can be seen during day-time (as recently in Tscheljabinsk, Russia, on Feb 15, 2013), so that the night-time criterion does not need to be fulfilled.

The description as “likeness of a spear of fire extending from the east to the west” expanding and decreasing (Agapius) is also consistent with a bolide. That no other report from anywhere else like Europe or East Asia is known is consistent with the interpretation as bolide, because a bolide is a local phenomenon. (Cook, however, not considering the Chronicle of Zuqnān, interpreted this event from Agapius as comet and was then confused by the fact that it is not mentioned by the Chinese.⁶¹)

Our text with the bolide “coming down” may have been interpreted later as a heavenly confirmation of the defeat of the Arabs, or alternatively, it may have really broken the mood of the Arabs, as implied by the last sentences, e.g. “When the Arabs saw this thing, their hope was shattered and lost.” This defeat of the Arabs around ‘Alī against the Persians around Abū Ja‘far (2nd ‘Abbasid caliph, since A.D. 755) is part of the transition from the Umayyads to the ‘Abbasids. Interestingly, very close to the death of Caliph Abū Ja‘far Al-Manṣūr in A.D. 775, another bolide came down – observed by him and his party.⁶²

EVENT 6

“Two stars ... fighting ... all the stars fell in all directions ... the whole night” reported for SE 1076 Latter *Kānūn* 4 (meteor shower or aurora borealis, January 4, A.D. 765) Chronicle of Zuqnān for SE 1076 (=A.D. 764/765), Part IV, folio 137r:

The year one thousand and seventy-six: The stars [*kawkbē*] of the sky fell [lit.: to drop (like tree leaves)] in the month of Latter *Kānūn* (January), the fourth day in it – a Friday. When it started to become dark and the stars [*hšak*] began to rise, two stars [*kawkbē*] came out from the middle of the sky, fighting with each other, like people who fight or engage in a contest with each other. Thus they moved forward, while

fighting, and fell down toward the East. When they fell down and vanished, all the stars [*kawkbē*] in the sky began to fall [*le-mēppal*, lit.: to drop], shooting like fiery balls that fly in all directions. Thus they fell [like tree leaves] during the whole night, and the following statement of our Saviour was fulfilled ...⁶³ (then quotations from Mark 13:24, Acts 2:20, Matthew 24:6, 15).

The date given in Zuqnān, SE 1076 “Later *Kānūn* (January), the fourth day in it” (January 4, A.D. 765), was really a Friday,⁶⁴ as given, the night of January 3/4 is meant.

The observed phenomenon is clearly seen from astronomical twilight (“stars began to rise”) until the morning: “during the whole night.” For the observed “two stars” and “all the stars”, the general word “*kawkbē*” is used, which means “celestial objects” (used e.g. for stars, planets, brightenings etc.). Like in the Event of A.D. 745, the location (“middle of the sky”) should again be the area around the northern celestial pole (38° above horizon at Amida). The wording “fighting with each other” may describe dynamics; “like people” shows that the report includes narratives elements; a story of a fight between two phenomena with motion is not unusual for a celestial observation.⁶⁵ The duration appears to be longer than just a few seconds. The “two stars” then “fell down toward the East”, i.e. approaching the horizon. When “all stars” [*kawkbē*] are reported to “fall” or “drop” (downwards?), contradicts to “fly in all directions;” what is probably meant is that “stars” leave their position (“fly in all directions”) appearing like “fiery balls;” again, the author cannot mean “stars” in the modern sense, but again some celestial brightenings.

Let us check the meteor criteria: nighttime (“during the whole night”); direction (“fell down toward the East” could be con-

sistent with meteors, while “all the stars ... in all directions” would not be possible for a meteor shower); colour/form (“fiery balls,” a red colour, would not be consistent with meteors); dynamics and motion (“two stars ... fighting with each other” seems to be longer than a few seconds, to “drop (like tree leaves)” would be too slow for meteors).

Parts of the first sentence of the above citation from the Chronicle of Zuqnān citations were recently interpreted as illustrating a meteor shower: Uso & Castillo⁶⁶ list under the date A.D. 765 January 4 first a Latin citation from Assemani (*Bibliotheca Orientalis*, “*Stellae quasi e coelo cadere visae sunt*,” our ref. 5), which is a Latin translation of the Chronicle of Zuqnān, then a Latin citation from Simeon of Durham, which is dated A.D. 763 or 765 by Dall’Olmo (“probably a shower”),⁶⁷ see below for the Latin text. However, for the latter, neither month nor day is given, so that the date to January 4, A.D. 765 is unjustified. Furthermore, there are several mis duplications and dating problems around this time.

In early January, the only known meteor shower is the Quadrantids. However, several elements of the Zuqnān report appear to be inconsistent with this shower: the Quadrantids shower with its radiant in Bootes is very low on the horizon in the evening after sunset, so that the above report in the Chronicle of Zuqnān (“When it started to become dark and the stars began to rise ... two stars came out from the middle of the sky ... they fell during the whole night”) would hardly be consistent with this shower. In addition, this shower is considered to have formed much later in the Ching-yang event in March / April, A.D. 1490.⁶⁸

Let us also check the aurora criteria: night time (“during the whole night”); direction (“middle of the sky” may mean

around the northern pole); colour/form (“fiery balls”, a red colour); dynamics/motion (“fighting with each other,” and strong motion on large parts of the sky).

There are other reports from the Near East dated Hijra 147 (A.D. 764/5) without month or day:

(a) al-Azdī (historian of Mosul, Iraq, died in AH 334/A.D. 945): “In it [A.H. 147] the stars [*an-nujūm*] fell [*tanātharat*, lit.: to drop like tree leaves, to scatter, to disperse] as it is mentioned.”⁶⁹

(b) Ibn Taghrībirdī (Egyptian historian, A.D. 1411-1470): “In this [A.H. 147] year planets scattered from the beginning of the night until morning. People were afraid of what it might forebode”⁷⁰ (what is translated here as “planets” may well be *kawākib*, the plural of *kawkab*, which means “planets” in current Arabic, but which had a more general meaning of celestial brightenings including planets and stars in the past; we could not consult the original Arabic text).

(c) Nu‘aym ibn Ḥammād (died A.D. 843): [A.H. 147] “Then we saw a star, which did not glow, rising from the right [of the *qibla*, i.e. the west], the opposite side of Syria: its blazing fire spreading from the south to the north, to Armenia. I noted this to an elderly learned man from the people of the Sakasik [Yemenite tribe], and he said: This is not the expected star.”⁷¹

Regarding the first two texts, we find similarities in the Chronicle of Zuqnān: “from the beginning of the night until morning” (Ibn Taghrībirdī) is resonant of “during the whole night” (Zuqnān) and “the stars fell” (al-Azdī) is resonant of “the stars of the sky fell” (Zuqnān). Al-Azdī, writing in Arabic, used “*an-nujūm*” (“stars”). Although a word “*shihab*” (meteor) exists in Arabic (not found in Syriac), it is doubtful whether he meant meteors by using “*an-nujūm*” instead of “*shihab*”.

Also, there are a few reports on celestial observations from East-Asia dated to the

turn of the year A.D. 764/5, which may be relevant here: for December 30, A.D. 764 in China “stars fell like rain” (at night), “a multitude of stars fell”, “stars streamed like rain” (at night) were reported; for December 31, A.D. 764, in China “at night, stars streamed like rain”; and for January 7, A.D. 765, in Korea “there were meteors, some large, some small”.⁷² Interpreting this as a meteor shower is problematic: (i) the term “meteor” is not present in the original Korean text, but is an interpretation, nighttime also is not given in the Korean text; (ii) at this time, the wording “stars fell like rain” in the Chinese texts, is not uniquely used for meteor showers, as it is later, but sometimes relates to thunder or lightning, e.g. A.D. 586;⁷³ (iii) as mentioned, the only known meteor shower for early January, the Quadrantids, is thought to have formed much later.

For A.D. 765, Simeon of Durham (A.D. 1060-1130) reports a sighting in northern England in his *Historia Regum*: “Anno DCC.lxv ignei ictus in aere visi sunt, quales quonquam apparuerunt tempore nocturno kal. Januarii, ut superius praenotavimus.”⁷⁴ i.e. “[A.D. 765] fiery strokes were seen in the air, such as formerly appeared on the night of January 1, as we have already mentioned [A.D. 745],”⁷⁵ interpreted as aurora borealis or meteor shower.⁷⁶ The previous similar sighting in A.D. 745, as mentioned by Simeon of Durham, was discussed above (see Event 4) with its description in the Chronicle of Zuqnān, which we found to probably indicate an aurora borealis, actually two Schwabe cycles before the A.D. 765 sighting (consistent with aurorae). The two observations in England in January 1, A.D. 765 and in A.D. 745 are compared to each other, so that both might have been a similar atmospheric phenomenon – possibly, because of the explicit comparison, we could speculate that the second sighting

may have also been in early January, A.D. 765 may have been seen early January. Zuqnān gives Friday January 4, A.D. 765 and January 1, A.D. 745.

Considering all evidence, the classification of both the phenomena in January 1, A.D. 745 and January 4, 765 as aurora borealis is more probable than as meteor shower. After very low solar activity for almost a century (Dark Age grand minimum until about A.D. 690), there was increasing solar activity, as seen e.g. in dropping radiocarbon around A.D. 745 and 765.⁷⁷

In the last two events below, we will read about the aurora borealis cases seen in the years A.D. 772 and 773: “It was on Fridays that it used to appear during these three consecutive years.” Two of those are clearly narrated (Events 8 and 9), while a text about the third one is either missing or may possibly be identified with this report for A.D. 765, where the sighting was also on a Friday (but then, only two of them would have been “consecutive”).

EVENT 7

“Stones ... fell from the sky” reported for SE 1080 (meteorites around A.D. 768/769 or 760/761)

Chronicle of Zuqnān for SE 1080 (=A.D. 768/769), Part IV, folio 145r:

The year one thousand and eighty: ... Also in this year, stones—black stones – fell from the sky. Many people really saw them and touched them, and they are still standing to this day. Did they per chance ascend to the clouds or where could they have come from? God alone knows! But again, there are no black stones whatsoever in the region in which they fell! But believe, O reader, that God does in heaven and earth all that he wishes.⁷⁸

This report quite clearly refers to meteorites (“black stones”) newly found on the ground, even seen while falling down (the

night-time criterion does not need to be fulfilled). Our Chronicler may not have been an eyewitness himself, as he states “many people saw them and touched them,” and he also does not mention their exact location. When he asks whether “they per chance ascend to the clouds,” he may refer to the old theory that meteorites first somehow have to ascend to high altitude (“clouds”) before they can fall down, but he also looks and asks for an alternative (“or where could they have come from,”) because such black stones did not otherwise exist in this region. His wordings “God alone knows” and “God does in heaven and earth all that he wishes” allows for alternatives: the extra-terrestrial origin of meteorites was not explicitly assumed at that time.

For the same year (SE 1080, A.D. 768/9), the Chronicle of Zuqnān reports the transition from Bishop Zachariah of Edessa to Elijah of Qartmān, which was A.D. 760/1, so that the meteorites may have fallen in that year (mentioned at the end of the report for that year). The dating of the next report in the Chronicle of Zuqnān (at the start of the next year) differs by up to several years in other chronicles.⁷⁹

EVENT 8

“Northern side ... red sceptre ... moving”
reported for “harvest time [SE 1083]”
(aurora borealis, late spring or summer,
A.D. 772)

Chronicle of Zuqnān: Part IV, folio 150v
with drawing and headline:

Concerning another sign which was
also seen in the northern region dur-
ing this year: [headline]

Another sign appeared in the northern
side, and its appearance gave testi-
mony about the threat and menace of
God against us. It was seen at harvest
time, while occupying the entire
northern side, from the east end to the
west end. Its likeness was as follows:

a red sceptre, a green one, a black
one, and a yellow one. It was moving
up from below, while one sceptre was
vanishing and another one appearing.
When someone looked at it, it would
change into seventy shapes. For the
intelligent person the sign indicated
menace. Many people said many
things about it; some said it an-
nounced bloodshed, and others said
other things. But who knows the
deeds of the Lord? ‘I will give signs
in the heaven, and wonders on the
earth’ (Acts 2: 19).⁸⁰

Both the report and the drawing shown
on the right margin toward the bottom of
folio 150v (Fig. 2) are consistent with an
aurora borealis observation, fulfilling sev-
eral criteria: (i) north: the phenomenon was
widespread on “the entire northern side”
and “from the east end to the west end,” (ii)
colour/form: rays (“sceptre”) in different
colours red, green, yellow, and even black
– red is typical for mid-latitude aurorae
(geomagnetic latitude of 43-50° at that
time⁸¹); green/yellow indicates a stronger
geomagnetic storm, it is indeed possible to
describe parts of an aurora borealis as
black as lines without colour and bright-
ness in between brightly coloured lines and
areas can appear black or dark (this de-
scription is found in other historical exam-
ples); (iii) dynamics: descriptions like
“moving up from below ... one sceptre was
vanishing and another one appearing ... it
would change into seventy shapes” indicate
a strong geomagnetic storm. Even though it
is not explicitly mentioned that it was at
night, the whole text would hardly be con-
sistent with anything other than an aurora
borealis and the drawing strongly supports
this interpretation.

The original drawing (Fig. 2) on the
more than 1200 year old autograph (com-
pleted in A.D. 775/6) still shows different
colours including red and green/yellow.
The coloured lines (“sceptre;” Fig. 2) show

aurora borealis rays, which follow the textual description: “moving up from below, while one sceptre was vanishing and another one appearing.”



Figure 2

The aurora borealis rays reported for corn harvest time (late spring to summer) of A.D. 772 from folio 150v with red and yellow/green lines.

When looking at the folio, the lines appear horizontal, but they are meant to be perpendicular to the folio edge (the horizon): as seen in Fig. 2, one word is written next to the drawing (and also one unrelated word written further below on the bottom margin toward the right). The word directly beside the red lines is the Syriac word *saggiyē* meaning “many” (see above: “Many people said *many* things about it”); it is an insertion that was forgotten in the text and written perpendicular to the main body of the text (landscape format).

The aurora borealis recorded in this paragraph of the Chronicle of Zuqnān is found after a section with several more celestial observations; the words “which was also seen” in the headline relate to those previous phenomena, and not to the “northern region” mentioned next.

We have discussed the dating before (ref. 13): between SE 1078 (A.D. 766/7) and SE 1084 (A.D. 772/3) the author does not report in a strict chronological order. After the formal heading for SE 1078 (A.D. 766/7), several headings are found

without explicit dates, but some are datable, e.g. shortly before the aurora borealis the text states that the Caliph rebuilt the Dome of the Rock Mosque in Jerusalem, which was in A.D. 771.⁸² After several paragraphs, the next year – the first of “three years of affliction” – is given explicitly: for SE 1084 (A.D. 772/3), an additional aurora borealis event is reported (see next Event); since that later description also mentions the “sign that was seen a year ago in the northern region,” we can conclude that the earlier aurora borealis was clearly seen in A.D. 771/2.⁸³

The time of the year is given here as *harvest time*, where *corn harvest* is meant, as the Syriac word for *harvest* means *corn harvest*, if not otherwise specified, i.e. in A.D. 772 in late spring to summer (on a Friday as specified in the next Event).⁸⁴

EVENT 9

“Northern ... change into many shapes ... red ray” reported for SE 1084 *Hazīrān* (aurora borealis, June, A.D. 773)

Chronicle of Zuqnān: Part IV, folio 155v with drawing and headline:

Concerning the previous sign which was seen in the northern region; it was also seen in this year: [headline] ... Signs appeared to us in the sky, threatening disobedient people, and their mere appearance testified to the intelligent ones about the magnitude of our evil and about the wrath with which justice is menacing us. The sign which was seen a year ago in the northern region was seen again in this year, in the month of *Hazīrān* (June), on a Friday. It was on Fridays that it used to appear during these three consecutive (lit.: “three years one after another”) years, stretching itself out from the eastern side to the western side. When seen by someone, it would change into many shapes, in such a way that as soon as a

red ray vanished, a green one would appear, and as soon as the green one vanished, a yellow one would appear, and as soon as this one vanished, a black one would appear. It announced that the land would not merely suffer one affliction but several, as in fact happened to us. The shape of this sign is as drawn above.⁸⁵

Red and yellow/green lines are drawn again on the right margin of folio 155v (Fig. 3): here explicitly connected with the text. As in the previous Event, the lines are meant to be vertical, so that the drawing as well as the report are consistent with aurora borealis rays. The report again fulfils three aurora borealis criteria: northern direction, colour, and dynamics.⁸⁶ As in the previous Event, the night-time criterion is not fulfilled, but text and drawing are hardly consistent with anything other than aurora borealis.

Given that the description of this Event is quite similar (but shorter) than in the previous text (Event 8), it is possible that part of the description was copied from the former report, and that the latter aurora borealis was not as strong as the earlier one; also in the drawing, the later event has less stripes (“rays”) than the earlier one.

Only in connection with the weekday, the author mentions that the same phenomenon was observed for three years: “it was on Fridays that it used to appear during these three consecutive years.” The Chronicler is now strictly chronological calling the year SE 1084 (A.D. 772/773) the “first year of affliction;”⁸⁷ after some other matter is narrated for that year, also the above headline (“seen in this year”) means that we are still in SE 1084 (A.D. 772/773); after this aurora borealis, the next mention of a year then says “concerning the second year of affliction which is the year [SE] 1085”⁸⁸ (A.D. 773/774); see also note 1 in ref. (1), p.

253. Therefore, this second observation can clearly be dated to SE 1084 (A.D. 772/3), a Friday in June.⁸⁹ Since it is mentioned that another similar event “was seen a year ago,” the previous event was in SE 1083 (A.D. 771/2) harvest time, i.e. A.D. 772 late spring or summer (Event 8).

If “three years” is not an error for “two years” and is meant in a strict consecutive sense, one could consider A.D. 771 or 774 for the third event; however, the manuscript is largely incomplete for the next year SE 1085 (A.D. 773/4) and thereafter. The Chronicle’s wording “to appear during these three consecutive years,” as found in the report for June, A.D. 773, more likely means A.D. 771, 772 and 773, since our author makes recourses to the past (like on these pages and in this very paragraph). But neither in A.D. 771, nor in the remains of A.D. 774, is a report about an aurora found. Alternatively, the author may mean the aurora borealis A.D. 502 Aug 22/23, which was also on a Friday and for which he presented a similar drawing (Fig. 1). His criteria to identify the signs as being from the same type might have been night-time, northern direction, red/fiery, motion (rays going up and down, or “blazing”), and may be Fridays. All three cases of aurora borealis (Events 1, 8, and 9) are similarly drawn (Figs. 1, 2, 3), as coloured vertical lines next to each other. Alternatively, the third event could be the January 4, A.D. 765 observation (see above), also on a Friday, because the writer was probably an eyewitness. However, that event is described with different wording, so that it was of a different type of aurora borealis (if auroral at all), and therefore possibly not identified by the author as one of those three similar signs; this (and other, similar additional ones like in A.D. 745) also were not drawn.



Fig. 3

The aurora rays reported for a Friday in A.D. 773 June from folio 155v with red and yellow/green lines.

The author, even though apocalyptic in tone, does not equate the “three years of affliction” exactly with the three consecutive years (“three years one after another”) with aurora borealis observations. This shows that his dates are credible. When describing the first case (A.D. 772 harvest), he mentions that people considered it to be a portent (“menace”) for some “bloodshed and ... other things,” but he does not specifically mention which unfortunate events followed. The next aurora borealis (A.D. 773 June) is then considered as portent for further affliction (“It announced that the land would not merely suffer one affliction but several, as in fact happened to us”), obviously his second and third year of affliction are meant. This indicates that this part was written later. In retrospect, he considers the first aurora borealis (Event 8, A.D. 771/2) as a portent for the first affliction year (A.D. 772/3). If a third aurora borealis would have happened in A.D. 773/4, he would have used it as a portent for the third year of affliction, but this is not the case as his wording shows.

Since we could confirm the weekdays to fit to the given dates in several cases, we can trust the author that both (or even all three) aurora borealis events were on Fridays. As a negative portent, this may have reminded our Christian author of the Friday crucifixion of Jesus of Nazareth.

SOME ASTRONOMICAL CONCLUSIONS FROM THE AURORAL AND METEORITIC OBSERVATIONS IN THE CHRONICLE OF ZUQNĀN

The celestial observations in the Chronicle of Zuqnān are credible. Here, we concentrated on auroral and meteoritic observations only. We suggest clear criteria for the identification of meteor showers and auroral displays in historical records. Literal translation and close reading are necessary for a correct understanding and classification of an historical observation. Other sources and also parallel observations from other locations should be considered. In some cases, doubts may remain regarding the classification, so that newly found records may resolve such cases in the future.

In some Events (2, 3, 4, 6) the Chronicle of Zuqnān reports on what may be either a meteor shower or an auroral display. We have argued that wordings like “stars fell” do not automatically point to a meteor shower: there may be information in the records (Zuqnān or others), which can be contradictory. However, if Events 4 and/or Event 6 were a meteor shower early January, then the claim that the Quadrantids, which peak early January, would have formed much later in the Ching-yang event in March/April, AD 1490⁹⁰ would be in doubt, when a planetoid formed the dust cloud (now producing the meteor shower). If the phenomena in A.D. 745 and 765 were meteor showers, this would support the alternative suggestion that the Quadrantids were created by comet 96P/Machholz some 2000 years ago, when a parent comet had a close Jupiter fly-by and a partial break-up.⁹¹ It would be necessary to revisit all presumably eighth-century A.D. meteoritic observations in history, which are dated to the end of December and the beginning of January (even though we con-

sider an auroral interpretation for A.D. 745 and 765 as more likely).

The drawings and reports of auroral displays on a Friday in A.D. 772 harvest and 773 June are exceptional: the reports and drawings are from an eyewitness, found in an autograph; texts and drawings are consistent and complement each other. In Event 9 (June A.D. 773), the author pointed in the text to his drawing: “the shape of the sign is as drawn above”; while the drawings visualize the main impression of the features in one depiction, the texts underline the changes and evolutions of the shapes. The drawing for August 21/22, A.D. 502 (Event 1) aurora borealis by our Chronicler is just modeled by those he saw, even though that particular earlier aurora borealis may have looked differently.

The two mid-latitude aurorae in A.D. 772 and 773 as observed in Amida, Turkey, indicate relatively strong solar activity at that time. Indeed, after the Dark Age grand minimum of lower than normal activity ending around A.D. 690, the Sun slowly became more active for eight Schwabe cycles with more and more aurorae per cycle until about mid A.D. 773, but then activity dropped for a few decades (the first new aurora after A.D. 773 occurs in A.D. 786, then normal to higher activity after about A.D. 800, e.g. a naked-eye sunspot observation, the first in more than 200 years in A.D. 807, is witnessed from Aachen,

Germany). This scenario is consistent with the radiocarbon data measured in tree rings: the stronger the solar activity, the stronger the solar wind blowing through the solar system, the less cosmic rays that can enter the solar system and, hence, less radiocarbon is created in the Earth’s atmosphere by such cosmic rays. After high radiocarbon in the Dark Age, it decreased slowly until its minimum around A.D. 773, when it suddenly increased strongly for some four years, to stay high (low solar activity) for a few decades. This scenario can explain the strong radiocarbon variation around A.D. 774/5, for which a nearby supernova, a Galactic gamma-ray burst, a cometary impact, and a super-strong solar flare are also to be considered. The two aurorae observed, described, and drawn by the author of the Chronicle of Zuqnān for A.D. 772 and 773 would be too early to constitute a strong solar flare as a cause for the radiocarbon variation after A.D. 774, but instead these descriptions are an important clue for showing the long- and short-term solar activity variation in the 8th century with the activity drop since about A.D. 773.⁹²

ACKNOWLEDGMENTS

We would like to thank the Vatican Library for providing the manuscript with its drawings in digital form and for allowing us to show the drawings here.

Table 1. Auroral and Meteoritic Phenomena as Reported in Parts II, III, and IV

Date given SE	Prob. A.D.	Page Date	Page (Harrak*)	Part / Folio	Phenomenon	Event + Figure	Source(s)
813 <i>Āb</i> 22, Friday	501/2 Aug 22	502 H17/400	H99/40	III/87v II/75r-v	aurora borealis	1 Fig.1 (87v)	Pseudo-Joshua (Chro. Edess.?)
Zuqnān Part III: 4 aurora criteria: “night”, “on the north side”, colour (“fire”), dynamics (“blazing”)							
Zuqnān Part II: 4 aurora criteria: “night”, “northern region”, colour (“fire”), dynamics (“burning”)							
843	531/2 September	532	H99/74	III/100r	meteor shower or aurora bor.	2	Pseudo-Zacharias or John Malalas
Zuqnān: 0-2 meteor shower criteria: night-time (“stars”)?, dynamics (“shooting/leaping”)?							
Zuqnān: 1-2 aurora criteria: night-time (“stars”)?, dynamics (“shooting/leaping”)							
Malalas/Ps-Zacharias: 2 aurora criteria: night-time “dusk to dawn”, dynamics (“dancing in a new way”)							
937	625/6 -630/1	625/6	H99/ 142	IV/122v	meteor shower or aurora bor.	3	
1-3 meteor shower criteria: night-time (“stars/ <i>kawkbē</i> ”)?, form (“like arrows”), dynamics (“shot”, “fell”)?							
2-3 aurora criteria: night-time (“stars/ <i>kawkbē</i> ”)?, direction (“towards north”), dynamics (“drop/shot”)							
1054 <i>Kānūn</i> II, 1, Fri	742/3 Jan 1	745	H99/ 180	IV/131v	meteor shower or aurora bor.	4	
1-3 meteor shower criteria: night-time (“stars/ <i>kawkbē</i> ”)?, direction (“in all directions”), dynamics (“fell/drop”)?							
2-3 aurora criteria: night-time (“stars/ <i>kawkbē</i> ”)?, colour (“fiery”), dynamics (“fell/drop”)							
1065 <i>Tišri</i> II, 26, Tue	753/4 Nov 26	754	H99/ 196/7	IV/136r	bolide “large, terrible, dreadful star flew, broke...came down”	5	
1076 <i>Kānūn</i> II, 4, Fri	764/5 Jan 4	765	H99/ 201/2	IV/137r	aurora borealis ?	6	Ibn Taghrībirdī (?) Zuq. Eyewitness (?)
1-3 meteor shower criteria: “whole night”, direction?, dynamics (“shooting”, “fell”)?							
3-4 aurora criteria: “whole night”, direction (“middle of sky”)?, colour (“fiery”), dynamics (“fighting”)							
1080	768/9	768/9?	H99/ 223	IV/145r	meteorites “black stones fell from sky”	7	?
1083 Harvest, Friday	771/2 772	mid 243/4	H99/ 243/4	IV/150v	aurora borealis	8 Fig. 2 (150v)	Zuq. eyewitness
3 aurora criteria: “northern side”, colour (“red sceptre, green, yellow”), motion (“moving up, change, 70 shapes”)							
1084 <i>Ḥazīrān</i> Friday	772/3 June	773	H99/ 262	IV/155v	aurora borealis	9 Fig. 3 (155v)	Zuq. eyewitness
3 aurora criteria: “northern region”, colour (“red ray, green, yellow”), motion (“change into many shapes”)							
(*) H99 = Harrak, <i>Chronicle of Zuqnān Parts III and IV</i> ; H17 = Harrak, <i>Chronicle of Zuqnān Parts I and II</i> .							
NB: Regarding whether and which criteria are fulfilled, please see texts for full discussion; for the classification of the observation, the whole texts (plus the drawing and other sources, if available) are to be considered.							

NOTES

¹ A. Harrak, *The Chronicle of Zuqnān Parts III and IV A.D. 488-775* (Toronto: Pontifical Institute of Medieval Studies, 1999).

² Ibid.

³ Harrak, *The Chronicle of Zuqnān*; A. Harrak, *The Chronicle of Zuqnān Parts I and II from the Creation to the Year A.D. 506/7* (Piscataway, NJ: Gorgias Press, 2017); Harrak, *Chronicle of Zuqnān Parts III and IV*.

⁴ J.B. Chabot, *Chronique de Denys de Tell Mahré* (Paris, 1895).

⁵ J. S. Assemani, *Bibliotheca Orientalis*, Vols. I-III, 1, 2 (Rome, 1719-28).

⁶ R. Abramowski, "Dionysius von Tellmahre, jakobinischer Patriarch von 818-845," *Abhandlungen zur Geschichte für die Kunde des Morgenlandes* 25 (1940) 2.

⁷ Chabot, *Chronique de Denys de Tell Mahré*.

⁸ Harrak, *The Chronicle of Zuqnān*, 9-17.

⁹ Ibid, 9-17.

¹⁰ Ibid, 20-21.

¹¹ W. H. Hatch, *Dated Syriac Manuscripts* (Boston: American Academy of Arts and Sciences, 1946), Plate I.

¹² Harrak, *The Chronicle of Zuqnān*, 30-31.

¹³ R. Neuhäuser & D. L. Neuhäuser, "Solar Activity around AD 775 from Aurorae and Radiocarbon," *Astronomical Notes* 336 (2015) 225.

¹⁴ R.R. Newton, *Medieval chronicles and the rotation of the Earth* (Baltimore: Johns Hopkins University Press, 1972); F. R. Stephenson, *Historical eclipses and Earth's rotation* (Cambridge: Cambridge University Press, 1997); F. R. Stephenson, L. V. Morrison, C. Y. Hohenkerk, "Measurement of the Earth's Rotation: 720 BC to AD 2015," *Proceedings of the Royal Society A*, vol. 472, issue 2196 (2016).

¹⁵ M. G. J. Minnaert, *Light and Color in the Outdoors* (New York: Springer, 1993).

¹⁶ D. L. Neuhäuser & R. Neuhäuser, *Halo-Code und Halo-Vergessenheit*, in: Wolf-schmidt, G. (Ed.) *Proc. 'Der Himmel über Tübingen'*, *Nuncius Hamburgensis* 28, 470-518 (Hamburg: tredition, 2014); D. L. Neuhäuser & R. Neuhäuser, "A red Cross Appeared in the Sky and Other Celestial Signs: Presumable Eu-

ropean Aurorae in the Mid AD 770s were Halo Displays," *Astronomical Notes* 336 (2015) 913.

¹⁷ Harrak, *The Chronicle of Zuqnān*.

¹⁸ Neuhäuser-Neuhäuser, "Solar Activity around AD 775 from Aurorae and Radiocarbon."

¹⁹ Harrak, *Chronicle of Zuqnān*, 40.

²⁰ I. Guido, *Chronicon Edessenum*, (in) *Chronica minora I* (Paris, 1903), p. 8 (Latin translation); English translation available on www.tertullian.org/fathers/chronicle_of_edessa.htm (R. Pearse), interpreting it as aurora borealis.

²¹ G. Y. Ibrahim (ed.), *The Edessa-Aleppo Syriac Codex of the Chronicle of Michael the Syrian* (Piscataway, NJ: Gorgias Press, 2009), 260.

²² F. R. Trombley & J. W. Watt, *The Chronicle of Pseudo-Joshua the Stylite* (Liverpool: Liverpool University Press, 2000), liv.

²³ A. Harrak, *The Chronicle of Zuqnān Parts I-II*, 400; see also Trombley-Watt, *The Chronicle of Pseudo-Joshua the Stylite*, 49.

²⁴ Trombley-Watt, *The Chronicle of Pseudo-Joshua the Stylite*, 1.

²⁵ Ibid, 3.

²⁶ J. J. de Mairan, *Traité physique et historique de l'aurore boréale* (Paris: De L'Imprimerie Royale, 1733); H. Fritz, *Verzeichnis beobachteter Polarlichter* (Wien: Gerold, 1873), 15 (quoting the *Chronicon Edessenum*).

²⁷ Neuhäuser-Neuhäuser, "Solar Activity around AD 775 from Aurorae and Radiocarbon."

²⁸ H. Grotfend, *Zeitrechnung des deutschen Mittelalters und der Neuzeit* (Hahn: Hannover, 1891).

²⁹ H. Fritz, *Verzeichnis beobachteter Polarlichter* (Wien: Gerold, 1873), 15 (for Europe), he cites the 17th century Hevelius (Poland) for the time before and after A.D. 502, but without source nor details; Z. Xu, D.W. Pankenier, Y. Jiang, *East Asian archaeoastronomy* (Amsterdam: Gordon and Breach, 2000), none for East Asia.

³⁰ A. Wittmann & Z. T. Xu, "A catalogue of sunspot observations from 165 BC to AD 1684," *Astronomy and Astrophysics Supplement Series* 70 (1987) 83.

³¹ Harrak, *Chronicle of Zuqnān*, 74.

- ³² W. Witakowski, *Pseudo-Dionysius of Tell-Mahre, Chronicle, Part III* (Liverpool: Liverpool University Press, 1996), 49.
- ³³ R. Pearse (ed.), *The Syriac Chronicle of Zacharias Rhetor in Early Church Fathers – Additional Texts* (1899); the source is available in www.tertullian.org/fathers/zachariah09.htm, book 9, chapter 7.
- ³⁴ E. Jeffreys, M. Jeffries, R. Scott et al., *The Chronicle of John Malalas: A Translation* (Melbourne: Australian Association for Byzantine Studies, 1986), 282 (text), 275 and 284 (for dating).
- ³⁵ Guido, *Chronicon Edessenum*, p. 11.
- ³⁶ U. Dall’Olmo, “Meteors, Meteor Showers and Meteorites in the Middle Ages: From European and Medieval Sources,” *Journal for the History of Astronomy* 9 (1978) 123, giving A.D. 531 citing Theophanes, but not found by us; M. J. M. Uso & F. J. M. Castillo, “A review of Dall’Olmo Survey of Meteors, Meteor Showers and Meteorites in the Middle Ages: From European and Medieval Sources,” *Journal for the History of Astronomy* 48 (2017) 62-120, correcting Dall’Olmo to A.D. 532.
- ³⁷ S. Imoto & I. Hasegawa, “Historical Records of Meteor Showers in China, Korea, and Japan,” *Smithsonian Contributions to Astrophysics* 2 (1958) 131; Z. Tian-shan, “Ancient Chinese Records of Meteor Showers,” *Acta Astr. Sinica* 14 (1966) 37; D.W. Pankenier, Z. Xu, Y. Jiang, *Archeoastronomy in East Asia* (Amhert: New York, 2008), 312; S. H. Ahn, “Catalog of Meteor showers and Storms in Korean History,” *Journal of Astronomy and Space Sciences* 21 (2004) 39-72, revising Imoto & Hasegawa.
- ³⁸ D. W. Pankenier, Z. Xu, Y. Jiang, *Archeoastronomy in East Asia* (Amhert: New York, 2008), 313.
- ³⁹ Z. Xu, D. W. Pankenier, Y. Jiang, 2000, *East Asian archaeoastronomy* (Amsterdam: Gordon and Breach 2000), 196; R.R. Newton, *Medieval Chronicles and the Rotation of the Earth* (Baltimore: Johns Hopkins University Press, 1972), none for Europe.
- ⁴⁰ Harrak, *Chronicle of Zuqnān*, 142.
- ⁴¹ Imoto-Hasegawa, “Historical Records of Meteor Showers in China, Korea, and Japan;” Tian-shan, “Ancient Chinese Records of Meteor Showers;” Pankenier-Xu-Jiang, *Archeoastronomy in East Asia*; Ahn, “Catalog of Meteor showers and Storms in Korean History,” 39-72 (revising Imoto & Hasegawa); Newton, *Medieval Chronicles and the Rotation of the Earth*.
- ⁴² Xu-Pankenier-Jiang, *East Asian archaeoastronomy*, 196.
- ⁴³ Harrak, *Chronicle of Zuqnān*, 180.
- ⁴⁴ Grotefend *Zeitrechnung des deutschen Mittelalters und der Neuzeit*, tables II and III.
- ⁴⁵ Ibrahim (ed.), *The Edessa-Aleppo Syriac Codex of the Chronicle of Michael the Syrian*, 464; translated by Amir Harrak.
- ⁴⁶ Ibrahim (ed.), *The Edessa-Aleppo Syriac Codex of the Chronicle of Michael the Syrian*; translated by Amir Harrak.
- ⁴⁷ Chabot, *Chronique de Denys de Tell Mahré*.
- ⁴⁸ In his world chronicle written around A.D. 942 in Arabic, Agapius also mentioned this observation (“The same year, in the month Kanoun II (January), there appeared another sign in the shape of the moon”) without any reference to the *zīqē*; see A. Vasiliev, *Kitāb al-‘Unwān: Histoire Universelle érite par Agapius (Mahboub) de Menbidj*, seconde partie, PO 7, 536 (1911); English translation is available at www.tertullian.org/fathers/agapius_history_02_part2.htm.
- ⁴⁹ P. Jenniskens, “2003 EH1 Is the Quadrantid Shower Parent Comet,” *Astronomical Journal* 127 (2004) 3018.
- ⁵⁰ Imoto-Hasegawa, “Historical Records of Meteor Showers in China, Korea, and Japan;” Pankenier-Xu-Jiang, *Archeoastronomy in East Asia*; Ahn, “Catalog of Meteor showers and Storms in Korean History,” p. 39-72, revising Imoto & Hasegawa, Newton 1972.
- ⁵¹ J. H. Hinde (ed.), *Symeonis Dunelmensis Opera et Collectanea*, Publications of the Surtees Society Vol. 51 (Durham: Surtees Society Andrews, 1868), 18.
- ⁵² Neuhäuser-Neuhäuser, “Solar Activity around AD 775 from Aurorae and Radiocarbon.”
- ⁵³ J. Stephenson, *Chronica Mailros, e Codice Unico, ed. 1270* (Edinburgh: The Bannatyne Club, 1835), 4.
- ⁵⁴ F. Link, *Geofysikalni Sbornik* 10 (1962), 316, citing the later Roger de Hoveden (died 1201) with the same text as above from Simeon of Durham; the same report is dated A.D. 743 January 1 in the Matthaëus Westmonasteriensis

(Matthew Paris, died 1259) Chronicle, but that is misdated; U. Dall'Olmo, 123, interpreted it as meteor shower and noticed the duplication, but thought that A.D. 743 would be the true year; Uso-Castillo, "A review of Dall'Olmo Survey of Meteors, Meteor Showers and Meteorites in the Middle Ages: From European and Medieval Sources," 62-120, present both as meteor shower, but do not mention the duplication.

⁵⁵ Neuhäuser-Neuhäuser, "Solar Activity around AD 775 from Aurorae and Radiocarbon."

⁵⁶ Ibid.

⁵⁷ K. Yau, F.R. Stephenson, D. Willis, *A catalogue of auroral observations from China, Korea, and Japan (193 BC - AD 1770)*, Technical report (London: Rutherford Appleton Lab, 1995).

⁵⁸ Harrak, *Chronicle of Zuqnān*, 196-197.

⁵⁹ Grotefend, *Zeitrechnung des deutschen Mittelalters und der Neuzeit*, tables II and III.

⁶⁰ Vasiliev, *Kitāb al-'Unwān*; this quotation from Agapius was translated slightly differently by D. Cook, "A survey of Muslim material on comets and meteors," *Journal for the History of Astronomy* 30, 131 (1999) 136, in particular "and this persisted as long as the war ... persisted" (which sounds like a long-term event) instead of "During this time, the war ..." (which is consistent with a short-term event like a bolide).

⁶¹ Cook, "A survey of Muslim material on comets and meteors," 136.

⁶² R. Neuhäuser & P. Kunitzsch, "A transient event in AD 775 reported by al-Tabarī: A bolide – not a nova, supernova, or kilonova," *Astronomical Notes* 335 (2014) 968-980.

⁶³ Harrak, *Chronicle of Zuqnān*, 201-202.

⁶⁴ Grotefend, *Zeitrechnung des deutschen Mittelalters und der Neuzeit*, tables II and III.

⁶⁵ Yau, F.R. Stephenson, D. Willis, *A Catalogue of Auroral Observations from China, Korea, and Japan (193 BC - AD 1770)*, for AD 858 July 16, i.e. just one day after new moon: "Tonight ... it appeared as if there were two cocks fighting each other in the sky north of Kitamo [Japan], above the Inari shrine. Their color looked scarlet and while they were fighting their feather scattered and fell. Although far away, they appeared as if before

one's eyes. After a long while they stopped" (from Montoku jitsuroku), interpreted as aurora borealis.

⁶⁶ Uso-Castillo, "A review of Dall'Olmo Survey of Meteors, Meteor Showers and Meteorites in the Middle Ages: From European and Medieval Sources," 62-120.

⁶⁷ Dall'Olmo, "Meteors, Meteor Showers and Meteorites in the Middle Ages: From European and medieval sources," 126.

⁶⁸ Op. Cit. (ref. 49) Jenniskens 2004.

⁶⁹ 'Ali Hubayqa (ed.), *Yazīd ibn Muḥammad ibn Zakariyya al-Azdī: Tārīkh al-Mawṣil* (Cairo, 1967), 200.

⁷⁰ W. S. Rada & F. R. Stephenson, "A catalogue of Meteor Showers in Medieval and Arab Chronicles," *Quarterly Journal of the Royal Astronomical Society*, 33 (1992) 11, translation to English from Arabic in Ibn Taghrībirdī, *Al-nujūm al-zāhira*, vol. II, p. 7.

⁷¹ Cook, "A survey of Muslim material on comets and meteors," 137, translation to English from Arabic in Nu'aym b. Hammad, *Kitāb al-fitan* (Beirut 1993) 132-3.

⁷² Op. Cit. (ref. 38) Pankenier-Xu-Yiang, *Archeoastronomy in East Asia*; Ahn, "Catalog of Meteor Showers and Sorms in Korean History."

⁷³ Pankenier-Xu-Yiang, *Archeoastronomy in East Asia*, 313.

⁷⁴ Hinde (ed.), *Symeonis Dunelmensis Opera et Collectanea*, 18.

⁷⁵ Neuhäuser-Neuhäuser, "Solar Activity around AD 775 from Aurorae and Radiocarbon."

⁷⁶ F. Link, *Geofysikalni Sbornik* 10 (1962), p. 316, citing the later Roger de Hoveden (died 1201) with the same text as above from Simeon of Durham, and Neuhäuser & Neuhäuser (ref. 13) interpreted it as aurora borealis; Dall'Olmo (ref. 67) interpreted it as meteor shower and noticed the duplication, but thought that A.D. 743 would be the true year; M.J.M. Uso & F.J.M. Castillo (ref. 66) present both as meteor shower, but do not mention the misduplication.

⁷⁷ Neuhäuser-Neuhäuser, "Solar Activity around AD 775 from Aurorae and Radiocarbon."

⁷⁸ Harrak, *Chronicle of Zuqnān*, 223.

⁷⁹ Ibid, 223, notes 2 and 3.

⁸⁰ Ibid, 243-244.

⁸¹ Neuhäuser-Neuhäuser, “Solar Activity around AD 775 from Aurorae and Radiocarbon.”

⁸² Harrak, *The Chronicle of Zuqnān*, 240 and note 4.

⁸³ This aurora borealis event was previously considered to have happened in A.D. 766, the last formal headline with a year, by D. J. Schove, *Chronology of eclipses and comets AD 1-1000* (Bury St. Edmunds: Boydell, 1984), 324; and U. Dall’Olmo, “An additional List of Auroras from European Sources from 450 to 1466 A.D.,” *Journal Geophysical Research*, 84 (1979) 1525.

⁸⁴ H. Hayakawa, Y. Mitsuma, Y. Fujiwara et al. “The Earliest Drawings of Datable Auroras and a Two-Tail Comet from the Syriac Chronicle of Zuqnān,” *Publications of the Astronomical Society of Japan* 69 (2017) 17, follow Neuhäuser-Neuhäuser, “Solar Activity around AD 775 from Aurorae and Radiocarbon,” in the interpretation as aurora borealis and in the dating (SE 1083 = A.D. 771/2) without mentioning it. They do not discuss the different dating in Schove and Dall’Olmo (see note 83); then, they argue that “harvest time” could also refer to some winter crops, but as we mentioned above, if only “harvest” is given, Syriac means “corn harvest”—the Syriac term for “harvest” is only for summer crops, and specifically “barley” and “wheat”, grains that are harvested in late spring to summer. Also, Pseudo-Joshua reported for SE 812: “In June and July, after the harvest ... the wheat of the new harvest” (ref. 22, p. 46). Hayakawa et al. also misinterpreted the record of comet Halley in May A.D. 760 with its detailed drawing in the Chronicle of Zuqnān as indicating a “two-tailed comet”, while the text and the drawing (see cover page of Harrak, *The Chronicle of Zuqnān*) clearly present a normal comet with one tail (to the upper right), the plasma tail blown by solar wind directed away from the Sun (the Sun is located to the lower left below the horizon). We are currently reconstructing dated positions of comet Halley from the *Chronicle of Zuqnān* (plus a few more from Chinese records for A.D. 760 and 837) in order to improve the orbital solution (presented first

in D. L. Neuhäuser, R. Neuhäuser, A. Harrak, M. Mugrauer as poster paper on “Celestial signs in the 8th century Syriac Chronicle of Zuqnān – their cultural and scientific relevance,” at Focus Meeting 5 of the General Assembly of the International Astronomical Union, August 2018 Vienna, Austria, soon to be published in detail elsewhere, and later also here together with the other Halley observations in the Chronicle of Zuqnān. For detailed critique on Hayakawa et al. papers, see D. L. Neuhäuser, R. Neuhäuser, J. Chapman, “New Sunspots and Aurorae in the Historical Chinese Text Corpus? Comments on Uncritical Digital Search Applications,” *Astronomical Notes* 339 (2018) 10-29, and also J. W. McAlister, “Scientists’ Reuse of Old Empirical Data: Epistemological Aspects,” in: *Conf. Proc. ‘Data in time: the epistemology of historical data’*, 25th biennial meeting, Philosophy of Science Association, DOI: 10.1086/699695 (2018).

⁸⁵ Harrak, *Chronicle of Zuqnān*, 262.

⁸⁶ Neuhäuser-Neuhäuser, “Solar Activity around AD 775 from Aurorae and Radiocarbon.”

⁸⁷ Harrak, *The Chronicle of Zuqnān*, p. 253.

⁸⁸ Ibid.

⁸⁹ The second event (dated here to A.D. 773 June) was previously considered to have happened in A.D. 770 by Schove, *Chronology of eclipses and comets AD 1-1000*, 324, and A.D. 770-772 by Dall’Olmo, “An additional List of Auroras from European Sources from 450 to 1466 A.D.”

⁹⁰ Jenniskens, “2003 EH1 Is the Quadrantid Shower Parent Comet.”

⁹¹ B. A. McIntosh, “Comet P/Machholz and the Quadrantid Meteor Stream,” *Icarus* 86, (1990) 299; L. Neslusan, Z. Kanuchova, D. Tomko, “The Meteor Shower complex 96P/Machholz revisited,” *Astronomy & Astrophysics* 551 (2013) 87.

⁹² Neuhäuser-Neuhäuser, “Solar Activity around AD 775 from Aurorae and Radiocarbon.” R. Neuhäuser & D. L. Neuhäuser, “Variations of 14-C around AD 775 and AD 1795 – due to solar activity,” *Astronomical Notes* 336 (2015) 930-954; and references therein.