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Cycles and Circumferences
The Tower of Gonbad-e Kāvus as a Time-measuring Monument

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Abstract The focus is on the tower of Qābūs ibn Wušmgīr, Ziyarid ruler of Gīlān between the tenth and the eleventh century CE. In spite of the archaeological evidence, the monument is still considered as a *mausoleum* by most scholars. However, the tower's geometrical and mathematical features can reveal the outstanding significance of the building as a time-measuring monument. A new interpretative key for the well-known tower of Gonbad-e Kāvus, based on the major time-reckoning cycles of Iranian world, is proposed. On this basis, it is possible to see how the building quite satisfies three needs at least: a need for dynastical propaganda, an administrative need in a fiscal equality perspective, and an Islamic orthodox need, as far as the accuracy of the daily prayer is concerned.

Keywords Gonbad-e Kāvus. Qābūs ibn Wušmgīr. Iranian calendar. Ziyarids.

به وقت هندسه عبرتنمایی
مجسطیدان و اقلیدسگشایی
(Niẓāmī, *Qiṣṣa-yi Farhād*)

The building under discussion here is located in the Caspian region, in the Iranian city now referred to officially as Gonbad-e Kāvus – the ancient Jurjān/Gurgān[1] – where the well-known tower of the amīr Qābūs ibn Wušmgīr[2] stands.

Scholars who have examined this building (figs. 1-3) and already referred to the singular star-shape of the plan and its conical roof, all agree about its probable astronomical-astrological meaning. However, no one has yet managed to identify any revealing element that could allow such an understanding of the monument.

1 On the history of the city, see Le Strange 1905, pp. 377-379, and Godard 1939, pp. 967-970. I take this chance to thank Emilio Secchi for his most precious advice and help in analysing the tower of Qābūs and elaborating figs. 4-5 and 7.

2 Ruled from 367/978 to 371/981 and from 387/997 to 402/1012 (371-387/981-997 Buwayhid occupation). See Bosworth 1996, pp. 166-167.

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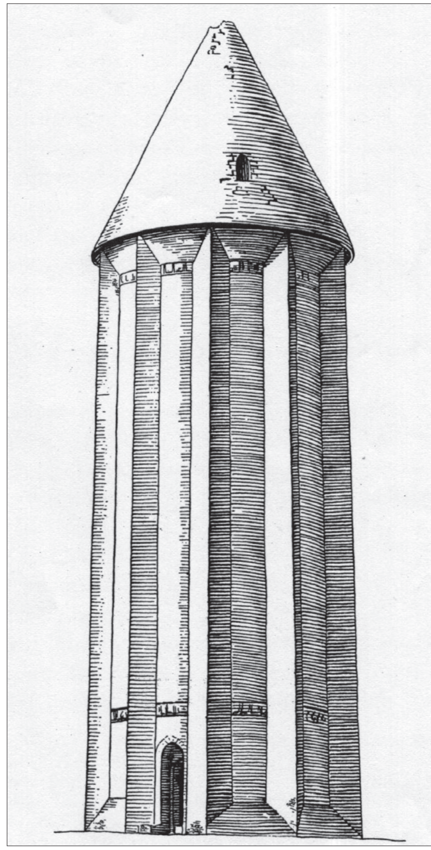

Figure 1. Front of the Gonbad-e Kāvus tower (Godard 1939, p. 974, fig. 336)

With regard to its patronage, it is easy to note that the *laqab* of the prince Qābūs ibn Wušmgīr, as well known titled *shams al-ma'ālī*, definitely alludes to a sort of vocation for a 'rise'; as Sheila Blair says: «the solar date» – which appears for the first time in a monumental inscription on this tower – «was an apt literary allusion to Qabus's title *shams al-ma'ālī* (sun of eminences)» (Blair 1992, p. 65). Can we only talk about a 'literary allusion', or, behind that first official inscription, is there something else?

The building is famous most of all for the awing, spectacular effect produced by its rocket-shape standing out from the flat land around with a height of 52.8 meters and based on a 10-meter-high embankment. Referring to the well-known ability of the Ziyarid ruler as an expert calligrapher[3] and

3 The *Nawrūznāma*, a *risāla* of miscellaneous contents composed about a century after the building of the tower hereby at hand, states: *Ba zamīn-i 'Irāq dawāzdah qalam-ast* [...] *wa har yak-ī rā ba buzurg-ī az ḵaṭṭāṭān bāz ḵwānand* [...] *yak-ī rā ṣifat kunīm wa ān qalam-i šamsī ast wa qalam-i Šams al-Ma'ālī* [...]. «On the 'Irāq land, they use twelve types of calam

Figure 2. View of the Gonbad-e Kāvus tower from south

Figure 3. The vertical 'rise' of the Gonbad-e Kāvus tower from north-east

a skilful astronomer, Blair states that «these interest and avocations clearly played a role in the design of the Gunbad-i Qabus» (Blair 1992, p. 65). But what sort of 'role'? I would like to focus mainly on these questions.

The building was excavated by a czarist military detachment under the command of I.G. Poslavskij at the end of nineteenth century, in order to establish the existence of an underlying burial chamber, but no tomb was discovered (Diez 1918, 1, p. 42).[4] Then, the prince was not buried there; he was not buried under the level of the tower internal floor either. Was he buried upstairs as al-Jannābī (sixteenth century) suggests? And how?

According to al-Jannābī, the body of the Ziyarid amir Qābūs ibn Wušmgīr was laid into a crystal coffin filled with aloe and suspended by means

[...] and each one of these takes the name from a famous calligrapher [...]. We now describe one and it is the *šamsī* calam. The calam of Šams al-Ma'ālī [...]» (MS Cod. Or. 8° nr. 2450, f. 96a SB Berlin; lacuna in the MS Add. 23568 BM London).

4 A French abridgement of the Poslavskij's Russian text by Ernst Diez is available in Diez 1918, 1, pp. 41-43; the Poslavskij's original, entitled *Iz poezdki na r. Atrek i Gjurgen*, was published in 1900 in the 5th volume of the *Protokol' turkestanskogo kružka ljubitelej archeologii*.

of chains from the vault of the tower he built as his own mausoleum.[5] This fascinating hypothesis given by such a late source is not trustful (Bartol'd 1966, p. 265 n. 22), because no evidence of any fixing points of the hanging chains has ever been found. The use of this topos[6] may have been suggested to al-Jannābī by the extraordinary height of the building and its singular star-shape; nevertheless, it could also be due just to the apparent absence of any sort of burial structures.

The archaeological evidence notwithstanding, most scholars still consider the building as a *mausoleum*.[7] However, as correctly observed by Bartol'd, the Arabic word corresponding to Persian *gunbad* (which, together with the prince's name allegedly buried there, obliterated the ancient city's name) is *qubba*, whereas the term which appears in the inscription is Arabic *qaṣr* (from Gr. *κάστρον*, Lat. *castrum*), meaning 'castle', 'palace', and never with the meaning 'mausoleum' or 'tomb' (1966, p. 265). In his article, where he provides a complete and comprehensive survey of all the literature on the subject which had appeared up to his time, Bartol'd discusses the burial function of the tower, referring also to O'Donovan's observations about the tower in Rādkān (*The Merv Oasis*, 2, pp. 22-24; *non vidi*); according to O'Donovan, this latter tower could be neither a tomb nor a place to live in because of the lack of architectural openings in the upper part of the building, as it also happens in other so-called 'mausoleums' in eastern Anatolia and in Kars. On this basis, Bartol'd notes that the very existence of an upper opening in Qābūs' tower excludes the possibility that it could be something different from a tomb. Despite Bartol'd's opinion, I think that the prospect of possible different functions of buildings similar to mausoleums is not necessarily questioned by the presence of a window in the tower, which can have a precise role underlining the importance of the east-west orientation of the building.

5 The statement by al-Jannābī is written in his *Badāyiʿ al-āṯār fī nawādir al-ḥikāyāt*. The text, in Bernhard Dorn's German translation, is in Diez 1918, 1, p. 40; many other sources on the monument are recorded there. In this regard, Francesco Noci states that, probably according to an ancient custom, the window on the eastern side of the roof may have been designed for the exposure of the prince's body to the first sunbeams (2002, p. 841).

6 The topos of the suspended coffin was already known to the Jewish traveller Benjamin of Tudela, who, in 1160, saw prophet Daniel's coffin suspended from the arch of the bridge in Susa (van Berchem 1918, p. 102 n. 2, who also points to two other cases). About the suspended (*muʿallaq*) coffin supposedly containing Aristotle's remains and located in a former church converted into a mosque described by Ibn Ḥawqal (end of the tenth century), see Vanoli 2008, pp. 247-253.

7 «Gonbad-e Qābus is a tall tower that marks the grave of the Ziyarid ruler Qābus b. Vošmgir» (Blair 2003, p. 129); see also Noci 2008. The monument is described as a tomb also in its inscription on the World Heritage List (see `http://whc.unesco.org/en/list/1398` [2015-12-30]).

In comparison to similar more or less coeval monuments, the tower is extraordinarily high. In its simplicity of lines and conception, no doubt it is the result of an attentive project work, as the system adopted for the joints between the flanges and the central body, and the bricks shape of the perfectly conic cupola (Godard 1939, pp. 972-973; for some corrections about the building measures, see Bulatov 1978, pp. 90-92), and the formal stylistic refinement of the inscriptions definitely testify (Blair 1965, p. 65). The imposing walls and the fine quality of the material clearly indicate that the tower was conceived that way to last over time, and, if it endured over nine centuries before restoration was needed of the eroded base, due to the breaking of some bricks because of the excessive weight from above, one can say that the patron's expectations have been certainly and largely satisfied.

Two encircling Kufic inscriptions on ten brick cartouches are located approximately two meters below the conic roof and eight meters above the ground. By starting from the east bands, the inscriptions underline the importance of the east-west orientation of the entire building marked by the window. The two inscriptions give the same text. Its translation is as follows:

> In the name of God, the Beneficent, the Merciful. This is the high palace by the prince Šams al-Maʿālī (Sun of the Eminences), the prince son of prince, Qābūs son of Wušmgīr. He ordered the construction of the building during his life, in the lunar year three hundred ninety seven [27 September 1006-16 September 1007] and the solar year three hundred seventy five [15 March 1006-14 March 1007].[8]

These inscriptions reveal the patent willingness to provide such type of information and nothing else. More than signs of ancient paganism counterfeited under apotropaic-dedicatory astrological intents – as assumed by Max van Berchem (quoted in Blair 1965, p. 106) – they recall instances of astronomical-calendrical type certainly connected with the ancient tradition as well.

The Ziyarid amir had a glorious ancestry ascending to Arġuš-i Farhādān,[9] lord of Gīlān at the time of Kay Ḵusraw, in which Saʿīd Nafīsī (1968, pp. 201-

8 The Arabic text is as follows: *Bismillāh al-raḥman al-raḥīm | haḏā al-qaṣr al-ʿālī | li-ʾl-amīr šams al-maʿālī | al-amīr ibn al-amīr | Qābūs ibn Wušmgīr | amara bi-bināʾi-hi fī ḥayāti-hi | sana sabaʿ wa tisʿīn | wa ṯalaṯamiʾa qamariyya | wa sana ḵams wa sabaʿīn | wa ṯalaṯamiʾa šamsiyya*.

9 Or Āġuš son of Wahādān, according to the *Qābūsnāma* by Kay Kāʾūs ibn Iskandar, nephew of Qābūs ibn Wušmgīr; see Kay Kāʾūs ibn Iskandar 1981, pp. 14-15. On the Ziyarid dynasty, see Justi 1895, p. 431; Rabino 1936, p. 416; Zambaur 1927, pp. 189, 211. A clear and well-traced genealogy of the Ziyarid lineage by Riccardo Zipoli is available in Kay Kāʾūs ibn Iskandar 1981, unnumbered page at the end of the book.

203) tries to identify Āraš, the mythical archer who established the Iranic *space*. Less legendary is Qābūs' paternal uncle, the well-known Mardāwīj ibn Ziyār (315-323/927-935), founder of the family fortunes.[10] Like a new Khosrow, he is credited by Ibn Miskawayh with the intention of restoring the Sasanian *īwān* in ancient Ctesiphon (al-Madāʾin), also known as Ṭāq-i Kisrā.[11] It should be remembered that the first historical information on a celebration of the Iranian Sada fire-festival occurs in the sources relating to the dramatic death of Mardāwīj (Cristoforetti 2002, pp. 118-126). Qābūs was the younger son of Māhān the Great (r. 323-357/935-967), best known to the scholars with his nickname Wušmgīr, the Quail-catcher,[12] who in the

10 Mardāwīj ibn Ziyār was a Jīlite soldier of fortune, who, during the rebellion of a Samanid general, took the opportunity to conquer most of northern Persia, and soon Iṣfahān and Hamadān. Under Wušmgīr ibn Ziyār (323-357/935-967) and his successor Bīsutūn (357-366/967-977), they acknowledged the sovereignty now of the Samanids, now of the latters' rivals the Buwayhids; but in the reign of Qābūs ibn Wušmgīr they lost Ṭabaristān and Gurgān to the Buwayhids, who remained in control of the region until 388/998; see Bosworth 1965 and 1996, p. 166; Madelung 1975, pp. 212-215.

11 See Ibn Miskawayh 1914, p. 317 (Arabic text); Ibn Miskawayh 1921, p. 359 (English trans.). The Arabic text preserves a note by al-Ṣūlī, who attributes to Mardāwīj the following statement: «I will bring back the power of the Persians and I will destroy the power of the Arabs» (Ibn Miskawayh 1914, p. 317 n. 1).

12 On the basis of *Nawrūznāma*, I can say, with some certainty, that Māhān the Great is the proper name of the Ziyārid ruler known as Wušmgīr. The author of *Nawrūznāma* ascribes to him the composition of a voluminous work on falconry written in *kūhī* language (probably the *ṭabarī* language). I transcribe here the relevant passage found in the Berlin MS (f. 98[b]; the chapter on falconry is missing in the London MS). It might prove useful because some parts of it were misunderstood by M. Mīnawī (*Nawrūznāma* A, p. 57), by the authors of the Russian translation (where Badr ibn Ḥasanūya's – or Ḥasanwayh's – name is not properly interpreted, and where it's not even considered that Māhān is the name of Wušmgīr; see *Nawrūznāma* B, p. 214), and by other Iranian scholars who edited this work as, for example, ʿA. Ḥaṣūrī, (see *Nawrūznāma* C, p. 68): *wa šinūdam az Bāzirkānī ki dar ayyām-i mā būdand ki hīč kas az Māhān-i Mih-i Wušmgīr bihtar našinaḵta andar-i iškira rā ki kār-i īšān sāl-ī dawāzdah māh šikār kardan būd wa ʿAlī-i Kāma ki sipāhsālār-i Badr-i Ḥasanū[ya] būd nīz nīkū šināḵtī walīkan hama muttafiq būdand ki hīč kas az Māhān-i Mih bih nadānistī wa ū rā ba-zabān-i kūhī kitāb-ī šikaranāma-st buzurg taṣnīf-i way.* «I have heard from our coeval Bāzirkānī [Kurds] that nobody could say more about falcons than Māhān the Great, the Quail-catcher, since he used to devote himself to hunting twelve months a year. ʿAlī son of Kāma, general of Badr, son of Ḥasanw[ayh], was an expert as well, even if everybody still agrees about Māhān the Great's hunting knowledge. He himself wrote in *kūhī* language a voluminous work with the title *The hunting falcon*». A few lines below, (f. 99[a]) the text adds: «It is said that Māhān was a great king, perfect and wise», from where we could infer that Māhān was the name of the famous Quail-catcher. Badr was governor (on behalf of Buwayhid ruler Fannā Ḵusraw) of a wide region, free reign of his father Ḥasanwayh (r. ca. 959-979), leader of the Bāzirkānī (or Bazirīnī) Kurdish tribe. His father played an important role in the military policies of the Azerbaijan and the western regions of the Iranian plateau in the second half of the tenth century. Badr (r. 979-1014) soon regained political independence and he was honoured by the caliph with the *laqab Nāṣir al-Dawla*.

Persian chronicle *Mujmal al-tawārīḵ* is described as «extremely Iranian».[13] It was a time of renewed hope for the return of the Iranian people to their ancient splendour. This is well testified by al-Bīrūnī, especially concerning the Buwayhids rulers of Baghdad.[14]

Qābūs has been widely recognized as a refined and well-taught intellectual in Arabic historiographical and biographical works. As Bosworth underlines: «In Qābūs b. Wushmgīr, the dynasty produced an outstanding figure of the florescence of Arabic learning in Ḵurāsān and the East, which his seventeen-year exile in Nīšābūr, while the Būyids occupied his lands, facilitated» (Bosworth 1996, p. 166). Indeed, he was forced to leave his dominions between 981 and 997. That happened because, in 979, Qābūs gave shelter to Faḵr al-Dawla (952 ca.-997), the Buwayhid ruler of Rayy, defeated by his brother Fannā Ḵusraw, best known as ʿAḍud al-Dawla (r. 949-982), the most powerful representative of the Buwayhid house. In retaliation, Fannā Ḵusraw sent another of his brothers, Muʾayyid al-Dawla (r. 976-983), to invade the lands of Qābūs, who fled to Nīšābūr, in Ḵurāsān, under the protection of the Samanid ruler Nuḥ II (r. 976-997). He would regain control of his dominions only eighteen years later.

The tower was planned after the prince had perfected his education, that, by the standards of the time, had to include both religious subjects and the «ancient sciences» (*al-ʿulūm al-qadīmiyya*), such as philosophy, medicine, astronomy, mathematics. About this latter, one of the most popular work on the matter between ninth and tenth century was the *Kitāb al-majisṭī*, only partially preserved, by the famous Iranian astronomer Abū ʾl-Wafāʾ al-Būzjānī (328-388/940-998).

Abū ʾl-Wafāʾ wrote also a treatise on those geometrical constructions which are necessary for a craftsman (*Kitāb fī mā yaḥtājū al-ṣāniʿ min al-ʿamal al-handasiyya*) for planning and construction of buildings, where he discusses, among other things, how to construct a regular decagon using

13 See *Mujmal al-tawārīḵ wa ʾl-qiṣaṣ*, p. 389: *Wušmgīr az jānib-i Gīlān ba-Rayy āmad wa sakht ʿajam-ī būd*. This chronicle was written in Seljuk times.

14 In his *Kitāb al-āṯār al-bāqiya* (see *Chronology*, p. 197), al-Bīrūnī reports a *vox populi* in this regard: «People say that the Sasanian rule existed during *fiery* conjunctions. Now, the rule over Dailam was seized by ʻAlî b. Buwaihi called ʻImâd-aldaula during fiery conjunctions. This is what people used to promise each other regarding the restoration of the rule to the Persians, although the doings of the Buwaihi family were not like those of the ancient kings. I do not know why they preferred the Dailamite dynasty, whilst the fact of the transitus into a *fiery Trigonon* is the most evident proof indicative of the Abbaside dynasty, who are a Khurâsânî, an eastern dynasty. Besides, both dynasties (Dailamites as well as Abbasides) are alike far from renewing the rule of the Persians and further still from restoring their ancient religion». However, as al-Bīrūnī states in the same work (see *Chronology*, p. 129), those were the times when the imperial title of Sasanian dynasty, *šāhinšhāh*, was resurrected.

compasses of fixed opening (Bellosta 2002, pp. 507-509).[15] One of his pupils, Abū Naṣr Manṣūr ibn ʿAlī ibn ʿIrāq (ca. 950-ca. 1018 to 1036), «who was himself an outstanding scholar and author of some twenty works on mathematics and astronomy, and an outstanding figure in the intellectual history of mediaeval Islam, was the mentor of Abū ʾl-Rayḥān al-Bīrūnī» (Fedorov 2000, p. 71). It is important to observe that al-Bīrūnī dedicated to Qābūs his *Kitāb al-āṯār al-bāqiya ʿan al-qurūn al-ḵāliya*, written during the period when the Khwarazmian scholar lived under his patronage. He finished this work in 1002 CE ca., just a few years before the building of the tower.

The amīr enjoyed the company and learning of several poets, as well as astronomers and mathematicians, such as Abū ʿAlī Ḥusayn ibn Sīnā, to mention the greatest among them. That is why we believe that the inscriptions on the tower, which proved to be source of obscure dilemmas for van Berchem, can, on the contrary, provide us with a self-evident clue that will drive us towards a correct interpretation of this 'mysterious' building.

The novelty of the Arabic inscriptions consists in featuring both an Islamic lunar date (year 397) and an Iranian solar one (year 375; Bartol'd 1966), both of them corresponding to 1006-1007 CE. The solar date clearly pertains to the well known Persian solar era, starting with the official rise to the throne of the last Sasanian sovereign Yazdegard III in 632 CE (16 June) and characterized by a one-day backward shift of all dates of the relative calendar every four years.[16]

In spite of the mobility of this kind of solar calendar and the continuous changing in the correspondence between Yazdgardī dates and fixed seasonal points, a relevant part of the Iranian tradition refers to an ideal coincidence between the first day of the first month of the year (i.e. 1st of Farwardīn) and the 1° of Aries, the first day of spring. The date in the tower inscriptions exactly marks such a coincidence. I have already suggested the possibility of a functional link between that solar date and the purpose of the tower in my introduction to the Festschrift for the 70th Sada of Gianroberto Scarcia (Cristoforetti 2004, pp. 10-12). Now, ten years later, I think it is possible to add some evidence in support of that hypothesis. I will state my case on the basis of considerations that are both general and subsequent to a geometrical and mathematical analysis of the building.

First of all, we must consider the following facts. A well-known feature of the regular decagon is that each of its sides is in *golden ratio* (φ) to the

15 For the Arabic edition of Abū ʾl-Wafāʾs work see ʿAlī 1979.

16 Such backward shift is notoriously due to lack – or non-application – of an intercalary mechanism in the Iranian calendar.

radius (R) of the circumscribed circumference.[17] This implies that, being the side of our decagon equal to AC_1, there is a decreasing progression between *R* and the segment AC_1 by the meaningful ratio (√5 – 1) / 2. Then, given $R = M_0 = 1$, we have $AC_1 = M_1 = 0.618$; $OC_1 = M_2 = 0.382$ and so on (see fig. 4). That is true for each φ derived segment of the radius. Therefore, AG, being the segment defining the extroflection of the flanges of the tower, is the fourth segment (M_4) of the above mentioned decreasing progression (see Bulatov 1978, p. 92).

By its geometrical definition the regular decagon is a polygon having all sides of equal length and each angle equal to 144° (fig. 5); therefore, the sum of its ten angles is equal to 1440°. This is of the utmost importance for our understanding of the tower structure, because it implies that the decagon revolution number is 4 (1440/360 = 4).

The plan of the tower is derived from the combination of two simple geometrical shapes: the circle and the decagon. The circle is well represented by the circumferences drawing the base and the internal room. The regular decagon is to be perceived by means of ten flanges, whose angles measure 90° each (fig. 5).[18] Then, the elevation of the tower is the vertical development of a star-shaped decagon inscribed in the circumference of the base.

The tower features several solar references. The shape of the Sun is evident in the plan. The external sides of the tower are thirty as the days are in the whole of the months of the Iranian solar calendar current at the time of building. The roof window is not aligned with the entrance (see fig. 1), a fact that is still unexplained: to our knowledge the only attempts made on this regard are mostly based on legendary tales. The window faces east exactly, this fact being a clear clue of its function because it let the window to identify the east-west axis.[19] It is important to notice here that the Arabic inscriptions start precisely from the eastern panels below the window. This combination leads us to consider the functional importance of the east-west axis in the project of the tower. From an astronomical point of view, such axis indicates the exact points of the sunrise and the sunset on two days of the year, that is the days of the equinoxes.

17 In a regular decagon each side subtends an angle of 36° at the centre (360° / 10) and a circumference angle of 18°. According to the chord theorem, each side *s* (AC_2, AC_3… in fig. 4) is $s = 2\ R \cdot sin\ 18°$. Given that $sin\ 18° = sin\ \pi / 20 = (1 + \sqrt{5}) / 4$, then, $s = R \cdot (1 + \sqrt{5}) / 2$, i.e. the side *s* is in *golden ratio* to the radius R of the circumscribed circumference.

18 This specification is most due to the fact that, according to the plan of the building traced out by Diez (1918, p. 39) and uncritically reprinted in the *Encyclopædia Iranica* (Blair 2003, p. 129, fig. 1), the angles of the flanges measure 72° each; Also Bulatov accepted the same wrong measure (1978, p. 90, fig. 25).

19 It should be noticed that the road axis of nearby ancient Jurjān was oriented in the same way.

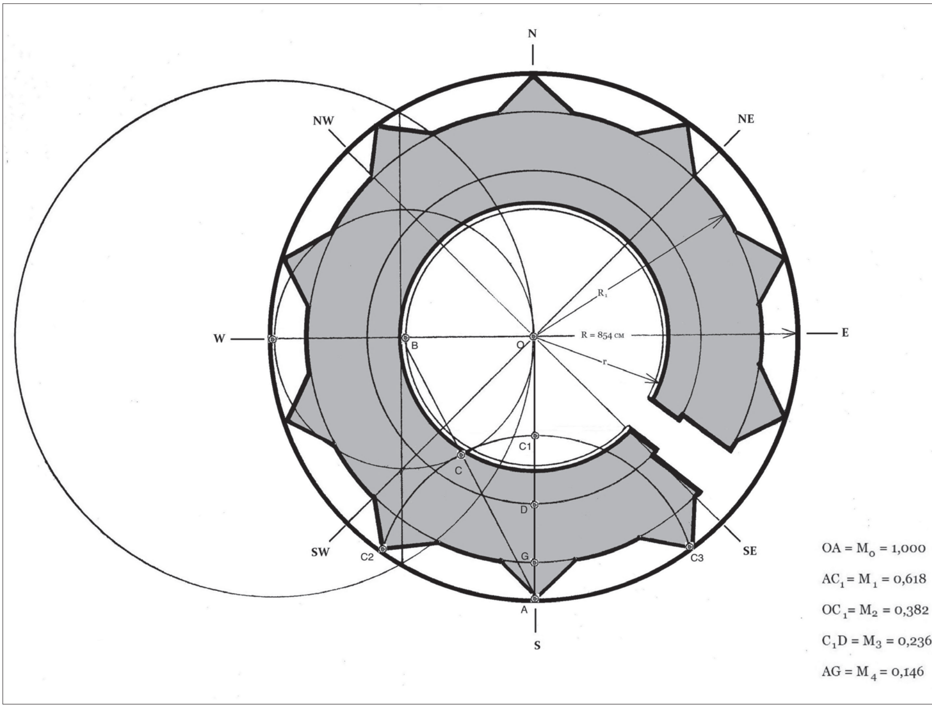

Figure 4. Oriented plan of the Gonbad-e Kāvus tower with indication of the parts (M_0, M_1 …), given R = 1

Of course, the geometrical evidence I brought up until now is not enough: the features of regular decagons, with their angular sum of 1440°, and the lasting of the Iranian Great Year measuring 1440 year, could be a mere coincidence. However, I got quite confident to support a calendrical interpretation of the plan only after considering the discrepancy between the window and the inscriptions on one side and the entrance on the other. This is highly unlikely to be merely casual,[20] the more so when we consider that the architect shifted the entrance on a different side of the tower than the window and inscriptions, managing to create two internal angles of 36° (E angle) and 144° (W angle) between the focus of the entrance and the east-west axis (fig. 5). This is obvious to any attentive observer, with no need for advanced knowledge of geometry; it is enough to count the

20 A further, even though not needed, confirmation of this, can be found in the miniature of the tower of Gunbad-i Kāvus located in the garden of the Iranian Art Museum (Tehran), where window and entrance are in line, thus unwillingly ‘correcting’ the ‘asymmetry’ of the original tower.

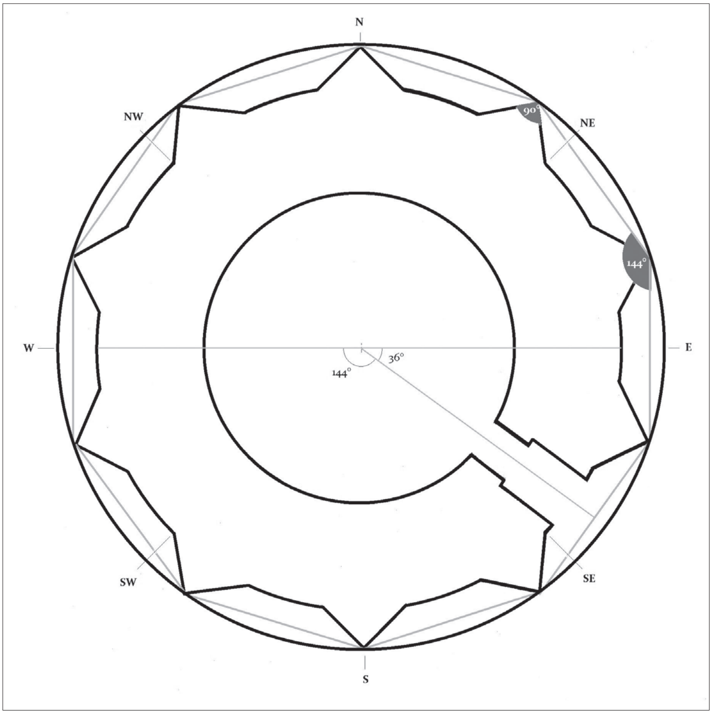

Figure 5. The regular decagon defining the star-shape plan of the Gonbad-e Kāvus tower

facades between the flanges: the entrance focus is placed at 1/10 of the circumference from the east radius and 4/10 from the western one. These are self evident measures. The only reason for this choice can be a precise will to place the entrance at 144° and 36° in a decagon shaped building oriented on east-west axis.[21] But why?

As already stated, each perimetric angle of the regular decagon measures 144°, summing up to 1440°, and all the vertex angles of the triangles formed with its sides as bases measure 36°. Needless to say, between 1440 and 360 and between 144 and 36 the ratio is the same, that is 4. The deliberate discrepancy quite harmonically points to the decagon revolution number (4). This is the number expressing the backward moving of the

21 The focus of the entrance does not have a meaningful orientation in regard to the cardinal points. Other meaningful points of entrance do not create internal angles with the coordinates of the building recalling the *golden ratio* of the structure. It should be noted that, observing the entrance from outside the building, the left edge is exactly SE from the centre of the tower (fig. 5).

Iranian year through the seasons (that is one day every four years). In addition, it does not seem far-fetched at all to say that the tower of Qābūs bears a reference to the so-called intercalary cycle (*dawr al-kabīsa*) of the Iranian calendar lasting 1440 years.[22] Indeed, though it is mathematically true that a solar year of 365.25^d, according to the average measure of the solar year considered at that time, entails a backward cycle through the solar seasons of exactly 1461 solar vague years (= 1460 solar Julian years),[23] we should keep in mind that coeval astronomical tradition – well attested in the works by Bīrūnī and Kūšyār ibn Labbān al-Jīlī – believed in the existence of an intercalary mechanism of the Iranian calendar, working in ancient (Sasanian) times in order to maintain the New Year Day (*nawrūz*) in acceptable correspondence with the beginning of the spring, and abandoned after the Muslim conquest. The Iranian intercalation (*kabīsa*) was believed to function by the insertion of an extra month every 120 years, marked by the shift of the five epagomenal days (*ḵamsa*

22 Explicit mentions of the intercalary cycle (*dawr al-kabīsa*) of the Iranian calendar lasting 1440 years are in *Muntahā al-idrāk fī taqāsim al-aflāk* (MS Or. 110 of the Biblioteca Medicea Laurenziana in Florence: ff. 92^b-93^a) by ʿAbd al-Jabbār b. Muḥammad al-Ṯābitī al-Kharaqī (d. ca. 500/1106-7), and *al-Tuḥfat al-shāhiyya fī-'l-hay'a* (London, BL, MS Add. 23393, ff. 151^b-152^a; Paris, BN, Fond Arabe 2516, f. 98^b) by Quṭb al-Dīn Maḥmūd al-Shīrāzī (d. between 710/1310 and 716/1316). I believe that other possible evidence of the Iranian 1440-yearly cycle could be found in the *Dastūr al-ʿamal wa taṣḥīḥ al-jadwal*, the commentary to Uluġ Bīg's *Zīj* written in 904 (1498-1499) by the Ottoman astronomer and mathematician Mīrīm Çelebī (d. 931/1525), grandson of the teacher of Uluġ Bīg, Ṣalāḥ al-Dīn Mūsā ibn Muḥammad ibn Maḥmūd Qāḍīzāda al-Rūmī (see Taqizadeh 1937-1938, p. 170 n. 335; Italian ed.: p. 298). As it was customary for any astronomer writing after the reform introduced by Malikšāh al-Saljūqī in 1076-1079, Mīrīm Çelebī comments the intercalary cycle of the Jalalian calendar, that entails 4- and 5-year periods for the leap years. To find the order and alternation of the 5- and 4-year intercalary periods requires the harmonisation of the length of the solar tropical year with the length of the calendrical solar year (an exercise fit for a consummate astronomer only!). Unlike several other astronomers, who elaborated intercalary cycles of 220, 268, and 300 years, Çelebī elaborated a much longer cycle lasting 1440 years, with 349 leap years. Taqizadeh notes: «It is unknown why Çelebī assumed as a basis for his measure of the fraction of the solar year the astronomical observations from the *Zīj-i īlḵānī*, disregarding the observations from Samarqand, even though he himself did comment the *Zīj-i īlḵānī* by Uluġ Bīg, and his grandfather collaborated with that sovereign» (Taqizadeh 1937-1938, p. 173 n. 335; Italian ed.: p. 301). In my opinion all of this is a clue of how the idea of a 1440-year cycle connected to the Iranian calendar may have influenced the Ottoman scholar.

23 The *Nawrūznāma* speaks *apertis verbis* of a «Great Cycle» (*dawr-i buzurg*) lasting 1461 years (MS Add. 23568, f. 86^b BM London; the two passages are full of lacunae in MS Cod. Or. 8° nr. 2450, ff. 78^b and 79^b SB Berlin): «The *nawrūz* was instituted because the Sun has two cycles, the first fixed by his return to the 1° of Aries every 365 and ¼ days – that time is called *nawrūz* and *nawsāl* – and the other fixed by his return every 1461 years to the same degree at the very same moment and day when it started to move [...]. Then [Gayūmarṯ] subdivided the great cycle into four parts, every part of 365 and ¼ years, just as, we know it by reason, the year lasts 365 and ¼ days, and called it Great Year. Each time the four parts of this Great Year pass away, it is the Great Nawrūz and the renovation of the world». Then, according to this text, the Great Cycle lasts 1461 years ($365.25 \cdot 4 = 1461$).

al-mustaraqa) from the end of a given month to the end of the next month. Then, mathematically we have {12 · [(365 · 120) + 30]} / 365.25 = 1440 years, that is the amount of years taken for the five epagomenal days to regain their ideal position at the end of the year (after the twelfth month of Isfandārmaḏ), immediately before the spring equinox and the New Year Day.[24] The aforementioned cycles are two: that of the backward motion of Nawrūz during 1461 years, if we assume that the calendar was not intercalated, and that lasting 1440 years characterized by the 120-yearly shift of the epagomenal days from month to month, if we assume that the calendar was indeed intercalated. In both cases, these cycles have their pivotal point in the momentous return of the New Year Day (*nawrūz*) to its ideal position on the spring equinox in the first day of the first month (Farwardīn) of the Iranian calendar. That moment was felt as the proper and 'right' seat of Nawrūz. The closing and simultaneous beginning of a new calendrical cycle, marked by the dates mentioned in the inscriptions encircling the tower, well explain the shift of the five epagomenal days from their traditional position (in Islamic times) after the eighth month to the end of the year – shift that occurred at the beginning of the eleventh century CE. This is a pivotal question, as will be shown later.

At Qābūs' time, the approximation of the tropic solar year to 365.25^{d} (the same one determining the 4-year intercalary cycle in the Julian calendar) was well-known. It was normally used in calendrical sections of astronomical works to ease calculations for converting dates from one calendar to another.[25] That was a basilar notion for any astronomer, who needed to convert cycles of different lengths, as the solar or lunar year, to the same reference system, i.e. the 360° circumference. Their work aimed to convert dates of the year (day, hour, minute etc.) into degrees of Zodiacal months, each equal to 30°, sometimes operating the same conversion the way back. The link between the geometrical refinement of the tower and its astronomical connection to the solar year is nothing less

24 This idea is frequently maintained in Arabic and Persian sources; according to François de Blois (1996, p. 50), it may have appeared in the Iranian milieu of the astronomical studies of the first Islamic age. On this matter see also Panaino 1996, pp. 298-301; 2010, p. 161; 2014, p. 87 n. 2, and p. 93. At any rate, it should be noted that ancient authors do not discuss the loss of 60 days that occur over an entire intercalary cycle and which is due to the shift of the *andargāh* from a month to the next month; in order to avoid such a loss of 60 days during the intercalary operations, it would be necessary not to shift the *andargāh*, but keep it in its position and insert another *andargāh* (relative to the following intercalary turn) after the first month on the first intercalation, after the second month on the second intercalation (120 years after) and so on.

25 Al-Bīrūnī justifies the use of this approximated measure of solar tropic year in his *al-Qānūn al-mas'ūdī* (written in 1030), stating that, in the end, «it would not cause a divergence bigger than 1/10 days»; according to the great astronomer, in the case of the solar year, 1° is equal to 1 day + 7 / 480 day, i.e. $1^{d}\ 0^{h}\ 21^{m}$; see *al-Qānūn*, p. 130.

than evident if we consider the fact that it exists a mathematical ratio 1/10 between the segment M_4 (posed R = 1)[26] and the average daily increase in 1° (calculated on the basis of an average solar revolution of 365.25^d).[27] Then, M_4 plays a pivotal role in the project, as it directly relates the geometrical development of the building to its astronomical meaning. On the matter, it should be noticed that M_4 is the measure of the extroflection of each one of the ten flanges.

The arched entrance is 162 cm wide on the outside and 132 cm wide inside (measures given by Bulatov 1978, p. 90, fig. 25. Noci 2008, p. 840, gives 160 and 132 cm respectively), because there is a bottleneck in the entrance marked by vertical slips (fig. 6). The arch of entrance is everted in his upper part, creating small steps. Apart from the inscriptions, the only other decoration is placed on both sides over the vertical slips. This decoration is formed by two trilobated niches in stucco (Schroeder 1939, p. 1003, fig. 344). The vertical slips are structural elements of great importance. They clarify the function of the tower as a solar watch, explaining why the entrance is not aligned to east-west axis. In fact, on the equinox days, at sunrise, the north-east corner of the entrance projects its shadow exactly into the south-west vertical slip in the entrance (fig. 7). On 23

26 The idea of associating numbers to an arbitrary measure (see fig. 4, where R = 1 = M_0) was all but new at the beginning of the eleventh century (cf. Ben Miled 2002, p. 353). On a practical level, this allows to mathematically derive, in an easy and precise way, all the measures of the geometrical elements composing the project: in our case it suffices to multiply a part (M_0, M_1 ...) by the measure of length attributed to the radius (R). The measures of length can thus be calculated in relation to different systems of measure. It should be noted, on this regard, that the *gaz* could be subdivided in 120 *fuls* or in 24 *angušt*; see *sub voce gaz* in Dihḵudā 1957, p. 280. So operating, having a measure of R_1 equal to R – M_4 (1 – 0.146 = 0.854), given R = 9 *gaz-i šāhī*, the measure of R_1 is equal to 0.854 · 9 = 7.686 *gaz-i šāhī*, that is 0.854 · (9 · 120) = 922.32 *fuls*; that is 0.854 · (9 · 24) = 184.464 *angušt*. When adopting the decagon as the shape of choice, it is not surprising that all of the harmonic parts in the plan (M_0, M_1 ...) are expressed by irrational numbers. For example, even in the half of the 9th century, the famous algebraist ʿAbū ʿAbdallāh Muḥammad ibn ʿĪsā al-Māhānī (who worked in ʿIrāq around 860 ca., d. 880) analysed irrational numbers in his commentary to the *10th Book* of Euclid's' *Elements* (*Tafsīr al-maqāla al-ʿāšira min kitāb Uqlīdis*), calling them «mute quantities» (i.e., non-expressible, if not by radicals; the first edition of this work, along with an analysis of the text and a French translation, is available in Ben Miled 1999). For a practical solution to the problem of transferring in measures of actual length those measures expressed by radicals, Bulatov (1978, p. 124) demonstrates that to define the equivalent of √3 (= 1.732...), one preferred to approximate to 1.75 over 1.73. As for the measure of the extroflection of the flanges in the tower of Gonbad-e Kāvus (AG = M_4) Bulatov (1978, p. 92) finds an approximation of -2.6 cm, resulting from the calculus (0.146 · 854 = 124.6). In my opinion this case shows a down rounding to 1 + 18/60 *gaz*. Indeed, given *R* = 9 *gaz-i šāhī*, we obtain a measure of the *gaz-i šāhī* equal to 94.8 cm, that is an intermediate measure between those proposed by Fryer and Chardin, which are 94.745 cm and 95.15 cm respectively; see Hinz 1955, p. 62.

27 On the basis of al-Bīrūnī's statement (*al-Qānūn al-masʿūdī*, p. 130), 1° = 365.25^d / 360° = 1.014583 ≈ 1.0146^d, i.e. 1^d 0^h 21.024^m. Consequently, the average daily increase in 1° is equal to 0.0146^d, and this measure is equal to 1/10 M_4.

September 2014 I was able to ascertain the phenomenon *de visu*, thanks to the kind collaboration of the superintendent of the Research Center for Iranian Cultural Heritage in Gonbad-e Kāvus, Dr. Jebrael Nokandeh, and the Iranian scholar Dr. Farid Ghassemlou.[28] This fact clearly shows the functional usage of the building as a solar watch indicating the seasonal points. In fact, that day at sunrise the shadow of the north-east corner of the entrance moves inwards reaching its extreme internal projection in the winter solstice day. Later it moves backwards and returns into the south-west vertical slip in the entrance on the vernal equinox. Then, the shadow moves outwards along the wall day by day to reach its extreme external projection on the summer solstice. One could even dare to assume that the tower was meant to function as the gnomon of a solar watch. Regrettably, to my knowledge, a study on this subject is still to be done.

The absence of a fully developed study on this matter notwithstanding, we can assume that to the trained eye of a geometer, of an astronomer, or of a person gifted with geometrical-mathematical sensitivity and with a sound sense of proportions – as it is the case of a refined calligrapher – the features of this building clearly indicate the flowing of time, marked by its traditional calendrical subdivisions. The 'Great Year' is evoked by the 1440° of the decagon, the solar year by the moving of the shadow of the north-east corner of the entrance at sunrise, and the solar month of the Iranian calendar of that time by the thirty sides of the building. Such a refined scholar, not unlike the common visitor, will indulge in strolling around the tower, following the inscription that runs all around it. He will proceed from the east, just as the Sun does, setting in motion the mechanism of the Iranian Time embodied by the tower of Qābūs. He will meet the end of the circle going past the vertices of ten flanges, implicitly tracing two shapes out: the fundamental circle and the decagon, geometrically combined to create the harmonic measures structuring and raising the building.

Last but not least, the tower has another fundamental and typical Islamic feature, unnoticed till now. Since solar rays penetrate directly into the building at floor level only in some of the morning hours between the end of autumn and the beginning of winter, the entrance walls project a fixed shadow on the internal floor. This fixed shadow reaches a point of the internal circumference located at south-west from the centre of the building. On the spot given by the geographic coordinates of Gonbad-e Kāvus, the *qibla* direction is south-west (fig. 8).[29]

In my opinion, considering all of these elements as a whole is the only way to adequately comprehend the building – its celebrative function of

28 In Gonbad-e Kāvus the autumnal equinox was 23 September 2014 at 4:59 am (local time), the sunrise being at 5:41 am (local time).

29 The *qibla* direction for Gonbad-e Kāvus is 224° 27' from the true north.

Figure 6. Arched entrance of the tower of Gonbad-e Kāvus with one of the two stucco niches

a truly meaningful calendrical cycle for Iranian sensitivity and its close relation to an astronomical phenomenon of the utmost importance as the apparent motion of the Sun in its various expressions. The ruler aimed at celebrating the end and renewal of the great cycle of the Iranian year (a sort of Jubilee of Gayūmarṯ and Jamšīd, so to say), and, for the future, marking the clear relation between the traditional solar calendar and the vernal equinox – taking for granted the immutability of the calendar, of course. Sure enough, the tower was meant to function as a solar date setter, allowing an accurate determination of the date of the opening of the fiscal year and a basis for fixing payment deadlines for land taxes.

It seems to me that the building quite satisfies three needs at least, justifying such an enterprise: a need for dynastical propaganda (Qābūs as the ruler of the New Age just as a new Gayūmarṯ and a new Jamšīd), an administrative need in a fiscal equality perspective, aligned to the most ancient tradition (Qābūs as a new Anūšīrwān-i ʿādil, the dispenser of justice, that is the dispenser of the right measures, as the ancient king Jamshīd

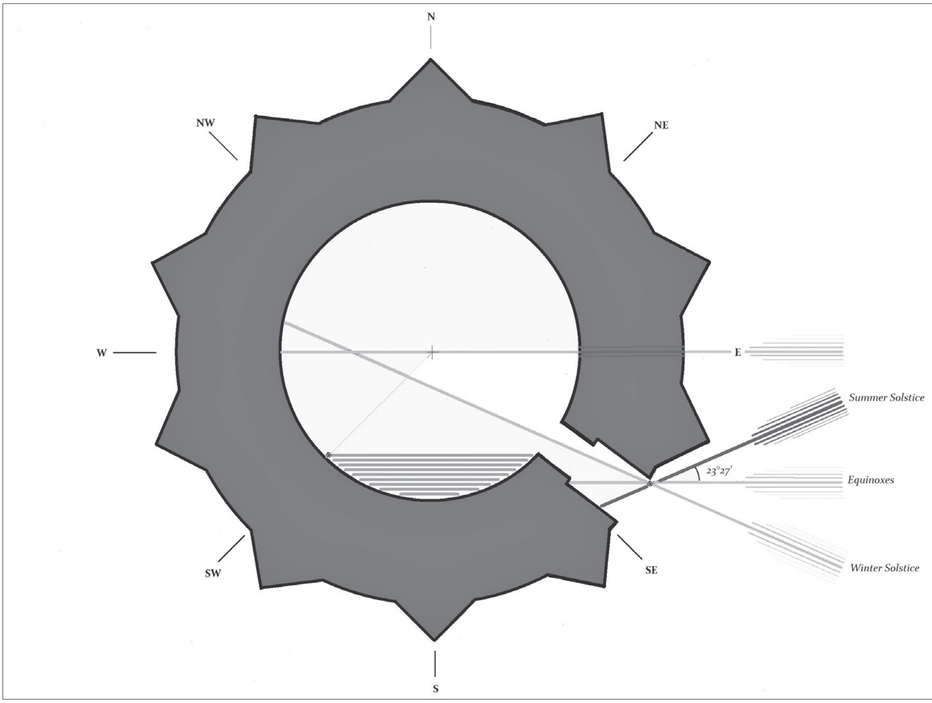

Figure 7. Projection of the sunbeams at sunrise at equinoxes and solstices through the entrance of the Gonbad-e Kāvus tower

Figure 8. Floor level inside the tower: the arrow in the figure indicates the qibla direction and the dashed line shows the fix shadow of the entrance walls

did at *nawrūz*),[30] and an Islamic orthodox need (Qābūs as the ruler seeing to the accuracy of the daily prayer). Of course other possible functions are not to be excluded, such as to point out the way to travellers, as it has been often suggested.

One could easily argue that, admitting such purposes for the building of the tower, we may find difficult to explain why the Arabic inscriptions do not bear any clear reference to those, restraining the matter to the allusive domain of geometry. In short: why don't the inscriptions cry out loud what the tower whispers as a whole?

Apart from the fact that allusiveness is the main mark of the whole of Persian aesthetical production, I think that the chosen means of communication were very much respondent to the political and cultural climate of the time. Could an open statement of continuity with the ancient Iranian kings' traditions be interpreted and blamed as a prelude to a come-back of the religion of the Magi?

This danger was real, as well shown by the *vox populi* reported by al-Bīrūnī about the Buwahids, and was to be avoided even more in relation to the firm Sunnite politics of that dynasty and of Qābūs himself in particular.[31] Moreover, the wide diffusion of Avicenna's neoplatonised Aristotelianism and of a scientific thought that never failed to seek close relations between different levels of reality, in esoteric terms too – as the coeval production of the encyclopaedic work entitled *Rasā'il iḵwān al-ṣafā'* well testifies – can help in understanding how allusiveness was one of the several ways of communication and expression used at the time.

The politics of equilibrium between traditional heritage and institutional Islamic demands carried out by the Ziyarid prince is well recognizable in an anecdote about him to be found in the *Nawrūznāma* (A, pp. 32-33.) The passage goes as follows: Qābūs is requested to judge the damage inflicted on a field of barley by a stallion in springtime; his position is complicated by need to mediate between law – requiring a full amend for the damage caused by the horse – and tradition – requiring to let the stallions pasture

30 See al-Bīrūnī, *Chronology of Ancient Nations*, p. 203: «On the same day (i.e. *nawrūz*) Jam brought forward all kinds of measures; therefore, the kings considered his way of counting as of good omen».

31 In the *Nawrūznāma* Qābūs is showed as a very pious Muslim possessing a deep knowledge of the *Quran*. As a matter of facts (*Nawrūznāma* A, p. 48) this work contains an anecdote on a historical episode. The passage tells us about the epistolary exchange between ʿAḍud al-Dawla and his rebel brother Faḵr al-Dawla, who, having just received answer from his brother, showed the letter to Qābūs. The words of ʿAḍud al-Dawla saddened Qābūs, who lamented their shared misfortune by writing below ʿAḍud's epistle a gloss (preserved in the Arabic version of the text): *qad aflaḥa man tazakkā wa qad ḵāba man kaḏḏaba wa tawallā*. That gloss was skilfully composed by combining phrases that occur several times in the *Quran*; just to cite a couple of examples, the first half can be found in *Quran* 87,14 and the second in *Quran* 96,13.

on new barley at *nawrūz*. Needless to say the prince judged fairly, imposing the amend, but exhorting the land owner to a greater flexibility towards horse-breeding traditions.

The conclusions that follow the analysis I just laid out directly involve an important question concerning the history of the Iranian calendar[32] and it is necessary to briefly linger over them.

The renewed, epochal synchronisms between the *nawrūz* of 1st of *farwardīn* of the solar vague calendar and its ideal position at the 1° of Aries occurred after more than one thousand years and had happened together with another phenomenon related to the structure of the calendar hereby in question. I am referring to the already mentioned shift of the five epagomenal days from the end of the eighth month – that is their position as was set in the late Sasanian age and where they stayed during the first Islamic age – to the end of the year, after the twelfth month. This moment, from an Iranian perspective, signs the return to a condition of ideal primeval order. The oldest mention on this matter is a rather short text from the *Zīj al-jāmiʿ*, written in Arabic in the second half of the fourth century of Hegira (beginning of eleventh century CE) by Iranian astronomer Kūšyār ibn Labbān al-Jīlī.[33] This text lacks any reference to the responsible for the shifting:

> In the time of Kisrā ibn Qubād Anūšīrwān the Sun entered Aries in *āḏar-māh* [ninth month] and the five [epagomenal] days seated at the end of *ābān* [eighth month]. When, one hundred and twenty years later, the dynasty of the Persians fell and they got subdued by the Arabs, […] the five [epagomenal] days stayed at the end of *ābān-māh* [eighth month], till the year three hundred and seventy five[34] of the Yazdajird era, when the Sun entered Aries on the first day of *farwardīn-māh* [first month]

32 I prefer to call it Iranian calendar rather than Zoroastrian calendar, as it is customary in the scholarly tradition, because the latter definition seems to me to be reductive of an historical phenomenon of such a great socio-cultural relevance, and also because it is a better match for the definitions found in the sole ancient sources that speak extensively about it, i.e. the astronomical works of the Islamic age. In those texts the expression adopted is usually «the calendar of the Persians» rather than «of the Magi», even though Persian Magi did use that same calendar and this fact was well known.

33 This work was probably finished in 389 H (1020-1021 CE; Bagheri 2008, p. 69). A complete edition is still lacking. For some important considerations – substantially different from those given by Bagheri – on the dating of this work, see de Blois 1996, p. 52 n. 37 and n. 38.

34 There is complete correspondence between this date and the solar date in the tower's inscriptions. In chronological tables this year corresponds to the third year of a 4-year period in the Julian calendar (1004-1007); see Mayr/Spuler 1961, p. 38. The astronomers in their calendrical calculations referred to 4-year periods, indicating the backward shift of the *nawrūz*. It is possible that those periods were 'out of phase' by two years from the intercalary periods in the Julian calendar; were such the case, the first year of reign of Yazdgard III would be the third of a 4-year period of that type. On the matter see Cristoforetti 2014.

> and the five days were placed at the end of *isfandārmaḏ-māh* [twelfth month].[35]

If, on the one hand, the text does not allow us to assume a one-man venture, it does not fail, on the other, to testify a remarkable sensitivity to the matter. Several scholars tried to identify the mind behind this operation as one of the many prominent political men of that time: first, the hypothesis of Hasan Taqizadeh, who favoured Bahāʾ al-Dawla – likely, but not certainly, in virtue of his military and political prominence of the Buwayhid (Taqizadeh 1937-1939, pp. 917-918); secondly, the deliberate and completely unexplained assumption of Ḏabīḥ Bihrūz, pointing to the Saffarid Khalaf ibn Aḥmad (Bihrūz 1952-1953, p. 56); lastly, we can mention S.J. Bulsara, who saw in Qābūs ibn Wušmgīr the eluding policy-maker, but his position is flawed by too generic arguments, focusing on alleged Qābūs' Sasanian ancestry (Bulsara 1953, p. 191).[36] The scholar states: «It was not improbable that the Zarathushtrian intercalation was implemented under the patronage of the great Iranian monarch Kabus Vashmgir [*sic*] of Tabaristan, as his house was a branch of the imperial house of Sassan and had apparently preserved Zarathushtrian practice in a very great measure». By «Zarathushtrian intercalation» we should understand the simple shift of the five epagomenal days from the end of the eighth month to the end of the year.[37] I see no reason why Zoroastrian practices need to be alive to let a Muslim ruler regulate the calendar in use in his dominions and current among their rural population for administrative purposes.

A much relevant, coeval (dated 1008-1009 CE), Zoroastrian source is the first of three questions asked by some Khurasanian Zoroastrians to a chief priest, which immediately follow the *Riwāyat* of Āḏurfarrah-i Farruḵzāḏān in the MS TD2 edited and printed in Bombay (K.L. Bhargava & Co., 1969) by Behramgore Tehmurasp Anklesaria (de Blois 2003, p. 139). It identifies a government official named *ʾbwmswl* as one of the persons responsible for the shift. The editor of the text, B.T. Anklesaria, emends the name to

35 This work is still unpublished. I translate this passage from the German translation available in Ideler 1825-1826, p. 547 and p. 625. Another reference to the shift of the epagomenal days is to be found in al-Bīrūnī's *al-Qānūn al-masʿūdī*, p. 129.

36 See also Bulsara 1953, p. 188 n. 3: «This era [i.e. 1006 AD] was remarkable for revival of Iranism in Iran and surrounding areas. Shah Kavous Vashmgir [*sic*] (976-1012 AD), the patron of the celebrated writer Al-Biruni, was the ruler in Tabaristan, and belonged to a branch of the Sasanian imperial house; and it was not improbable that the above intercalation was made under his direction and patronage».

37 I fully agree with what de Blois says about the term *wihēzag*: «a word which is sometimes used for the intercalations allegedly carried out by the ancient Persian kings, but which also means simply 'moving'» (de Blois 2003, p. 139). On the question of the Iranian calendar see de Blois 1996; on the meaning of *kabīsa* – too many times translated as «intercalation» with excessive ease – as resulting from the sources, see Cristoforetti 2009.

Abū Manṣūr. This reading is followed by J. de Menasce, who, keeping in mind that the text speaks of this person as a government official, states that he «was obviously a Muslim» (de Menasce 1975, p. 553).

As shown by François de Blois – who identifies the man as «a Zoroastrian in the service of the Muslim government» –, the full name found in the text has to be read Abū Miswar Yazdān-paδ son of Marzbān. In his article the scholar completes the discussion of the accounts on the shift of the five epagomenal days given by two Muslim astronomers, Kūšyār ibn Labbān al-Jīlī and Abū ʾl-Rayḥān al-Bīrūnī (see de Blois 1996), and concludes: «The letter indicates that it [i.e. the reform] was instituted by the *mōbaδ* (who evidently resided in Fārs), that the *mōbaδ*'s instructions were communicated to the believers in Khurasan by a Zoroastrian dignitary residing in Baghdad, evidently a middle-ranking official in the service of the Buyids, and that some of the 'Magians of Khurasan' did indeed reject the reform» (2003, p. 143). In his study, de Blois focuses very much on the climate of the time regarding the problems of the Iranian calendar. Indeed, as he concludes, «the difference between the Muslim astronomers and the Zoroastrian author of the questions is that the former describe this as essentially a matter of calendrical calculations, while the latter is concerned mainly with the correct performance of the ritual». However, Zoroastrian priests and Muslim astronomers were not the only ones who were keen on the subject. If, reading the Zoroastrian text according to de Blois, it is to understand that the reform «was initiated by the *mōbaδ* himself and was not 'enforced' by Muslim officials» (p. 140), I can add that it is far from being deniable that Muslim rulers too may have operated on their own administrative calendar, that was just the same in use among the Zoroastrians.

Surely, for Muslim rulers, connecting the date of the opening of the fiscal year directly to *nawrūz* held the greatest importance, as shown by sources regarding the several reforms of the Iranian calendar implemented by Muslim rulers of Iranian origins for fiscal purposes in the second half of the tenth century. Among them we must mention the reform of 959 by the *ḵwārazmšāh* Abū Saʿīd of the line of Banū ʿIrāq[38] in Transoxiana, the reform of 984 under the vizierate of Ismāʿīl ibn ʿAbbād in the lands under Buwayhid suzerainty and that of uncertain dating performed by the Saffarid ruler Ḵalaf ibn Aḥmad (r. 352-393/963-1001-2) in Sīstān (see Cristoforetti 2003, pp. 141-156). All these reforms related on various levels to the opening date of the fiscal year, i.e. *nawrūz*. Such adjustments could

38 The first cousin of Abū Saʿīd Aḥmad ibn Muḥammad ibn ʿIrāq (not later than 952-not earlier than 977) was Abū Naṣr Manṣūr ibn ʿAlī ibn ʿIrāq, the aforementioned mentor of al-Bīrūnī.

be brought out by different means;[39] anyway, they had well known models in similar reforms ordered by the Abbasid caliphs.[40]

All these measures point to a true reformer tradition, either through a forced modification of the calendars structure or a shift of a meaningful date. In about seventy years after the building of the tower of Gunbad-e Kāvus, this trend of calendrical management was fulfilled by the famous reform of Malikšāh, who took the Iranian calendar to its ideal structure, the very same it had at the time of Qābūs, 'freezing' it by inserting the Jalalian intercalary mechanism. Hence the calendar of Malikšāh, needless to say, became a solar fixed one, ceasing to be vague, and featuring its five epagomenal days after the twelfth month. That means that – in a calendar where *nawrūz* coincides with the vernal equinox (that is the case at the time of Qābūs) – it was obvious and natural that the five epagomenal days were to be found in that position, at the end of the year. As demonstrated by de Blois in his study, this fact met opposition in the Zoroastrian side alone, due to the strong conservatism of some among them in liturgical matters.

I am confident to say that my interpretation of the tower is relevant to this subject. We can assume that the building is a representation of the solar cycle of the Iranian calendar, otherwise we should revert ourselves to seek an ever-eluding grave. Qābūs planned a building whose elements refer to a 1440-yearly cycle. This fact implies that at the moment of the epochal return of the 1st *farwardīn*, or *nawrūz*, to the 1° of Aries, the five epagomenal days were to be counted at the end of the year and not at the end of one of the precedent months. This is true because a 1440-yearly cycle can be considered *only* implying that the shift of the five epagomenal days was a connatural mechanism to the Iranian calendar. The Arabic sources do not give us a name to be held responsible for this shift, as if such operation were only *natural* in that calendrical system, and not to be attributed to any official or ruler. Moreover, the orientation of the entrance of the building allows to individuate the equinoxes and, subsequently, to know when to operate the shift of the five days, if needed.[41]

39 It could be the stabilization of the *nawrūz* on a fixed seasonal position, or the shift of the *nawrūz* from the start of the month of *farwardīn* to the start of another month of the Iranian calendar; both with or without the adoption of the Julian intercalary system.

40 We have knowledge of attempts to reform the Iranian solar calendar by al-Maʾmūn, al-Mutawakkil, al-Muʿtaḍid et al.; see Cristoforetti 2003, pp. 122-140.

41 Sources from the Islamic age and popular festive customs testify of this. On this regard there is a passage of extreme clarity in the discourse on chronology in the *Muntahā al-idrāk fī taqāsīm al-aflāk* by Abū Bakr Muḥammad ibn Aḥmad al-Ṯābitī al-Ḵaraqī. Concerning the year 500 Yazdgardī (beginning 12 February 1131, ending 11 February 1132), the author writes: «The Saturday, 12th of the month of *rabīʿ* the 2nd in the year [52]5, the year 500 in the era of Yazdajird, the turn of the *kabīsa* returned to the month of *urdībihišt* and therefore we held *kabīsa* in the month of *farwardīn*, and we added the five epagomenal days to its last

As I already observed, the most evident elements of the Arabic inscriptions of the tower of Qābūs are the year of the building – that is, up until today, the most important date of the Iranian *Heidentum* retained through the Islamic era – and the name of its magnificent patron. In other words the tower of Qābūs is an architectural evidence of the Iranian calendrical sensitivity of that time – the time of the momentous return of the *nawrūz* on the vernal equinox and the renewal of the Great Year of the Persians, holding relevant meanings at symbolical and propagandistic level.[42] Oddly enough, a century of scholarly research on the possible astronomical and/or astrological meanings of the building, has not taken into account such a clear indication.

There is no doubt that the time expressed and measured through the structure of the tower of Gunbad-e Kāvus is the Time of the Iranian heritage, embodied by the building both in its solar yearly cycle and calendrical 1440-year cycle. The tower is a 'jewel' of a Grand Watch representing, and therefore cyclically defining, the solar time in the Iranian world.

To interpret this building from perspectives that are different from the standard esthetical and architectural ones, opens new ways of analysis, aiming to the development of categories of thought that go beyond the scholarly tradition of pure technical and architectural description. Further research may find more examples of building in need of a broader approach, but a case as strong as the one just presented here is nonetheless sufficient.

days and so its days numbered thirty-five» (MS Or. 110 of the Biblioteca Medicea Laurenziana in Florence: f. 93[b]). I discussed this passage and other material on the matter of the shift of the five epagomenal days in the Iranian calendar in Cristoforetti 2007, pp. 47-54.

42 As far as other possible symbolic and propagandistic levels are concerned, it is noteworthy that the date of construction of the tower matches the 'middle conjunction' of Jupiter and Saturn indicating the passage from the firey to the earthly triplicity (that conjunction started in Leo and ended in Virgin). The astrology of conjunctions believes those moments to be important for the change of dynasties (the previous middle conjunction, in 749 CE, signed the upcoming of the Abbasid dynasty; see *Chronology*, p. 197). However, this coincidence of dates is the only evidence in this direction that I found and no other element was found to relate the geometry of the building with this astronomical phenomenon.

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