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Quis dubitet hominem coniungere caelo?

a cura di
Elio Antonello

INDICE

The astronomical origin of numbers' symbolism

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Abstract. We propose a quantitative method for measuring the cultural importance of numbers. It consists in measuring their occurrence in a specific cultural context and then normalizing the outcome for the Benford's law. We give a provisional estimate of the "numerological signature" for the Western culture as a whole and point out that it's possible to establish the numerological signature also for much more specific targets. We note that carrying out such a work for mythological or religious canons or single literary works from the past could guarantee a wealth of in-depth information about their origin and eventual mutual influences. We then show that the majority of the most important numbers in our culture have an astronomical derivation and we report our interpretation as to their origin: 7 from the number of the planets; 12 from the entire lunations in a solar year; 72 as 1/5 of 360, being 5 the difference between 365 and 360; 108 as the least common multiple between 12 and 27, capable to merge solar and lunar Zodiac. A note about frequent fortuitous coincidences in astronomical numerology and of a possible discovery of symbolic use of 72 and 108 in Dante's *Divina Commedia* is also provided.

1. Introduction

As anyone can easily verify, numbers are not used in an even way in our life and culture: some happen to be used more frequently than others. This evident fact is mainly due to two separate causes that we see in detail: 1) Benford's law, 2) cultural bias.

1) Benford's law[1] states that in many sets of numerical data the first digit is likely to be small. Populations of cities or lengths of rivers are more likely to start with a 1 than with a 9, and there are less with a higher figure than with a lower (see Figure 1). The Benford's law applies to any collection of random numbers that occur naturally[2], that is to say without

[1] Discovered in March 1938 by Frank Benford (Benford 1938).

[2] Apart from the usual examples of the length of the rivers (in any unit of measure) or the inhabitants of towns, also the Fibonacci numbers obey to the Benford's Law.

human intervention, and defines the distribution of the first digits in such collections (which results to be logarithmic). Benford's law, although just empirical and without a complete theoretical explanation, appears to be sound and reliable enough to be used to detect frauds (i.e. improper manipulation) in statistic data[3] and evidences based on Benford's law have been admitted as forensic proofs in criminal cases in the United States[4].

2) With *cultural bias* we basically mean "choice": when any number could go, one was chosen instead of others because of its cultural relevance[5]. Cultural bias is often the effect of the symbolism associated to the numbers: a number with a strong symbolic meaning was used preferably instead of less significant numbers.

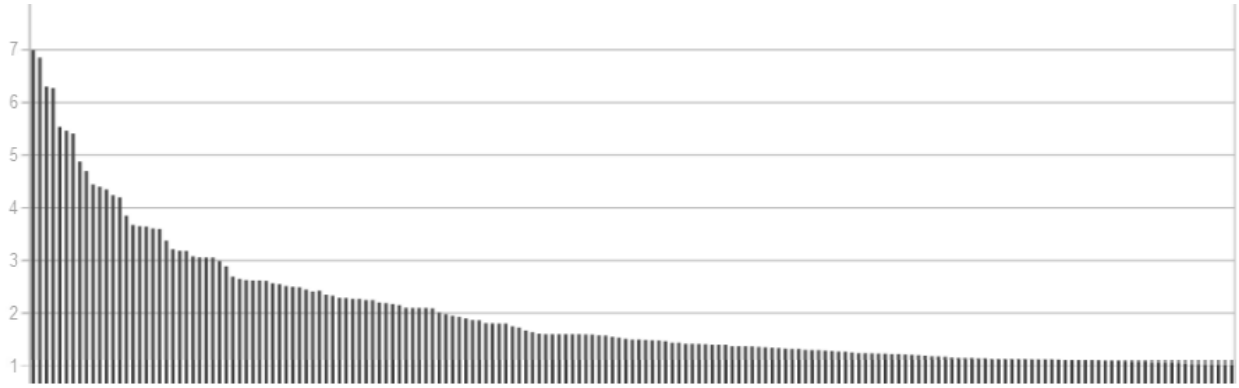

Fig. 1. The "Benford-like" behaviour is obvious in this bar chart: the height of the bars represents the length of the longest rivers in Mm (first on the left is the Amazon River). Shorter rivers are more numerous than longer ones just as smaller numbers are more frequent in our culture than bigger ones.

These two aspects mainly model the occurrence of numbers in our culture. Our aim is to spot the cultural selection among numbers (cultural bias) and analyse its possible causes with an emphasis on ancient cultural issues. In order to do so, we first identify usable data referring to the usage of numbers, then we apply Benford's law for normalization, and finally recognize and discuss those numbers that stand out from the mean distribution.

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[3] Nigrini (1999).

[4] Mark Nigrini and Darrell D. Dorrell, *From Benford to Erdös*. Radio Lab. Season 6 | Episode 5, 2009-10-09. http://www.radiolab.org/story/91699-from-benford-to-erdos/

[5] Here we assume that numbers can have a symbolic meaning associated with them. This is a safe assumption since numerology and number-related religions, cults and magic, all based on the different connotations of the numbers, exist since antiquity.

2. About the collection of numbers

As said, our first aim is to quantify the usage of the numbers in our culture. To do this we should be able to count how many times each number is used. Unfortunately this implies to read any newspaper, listen to any broadcast and to examine every book (past and present), waiting to come across a number and take note of it. As this is an impossible task, we have two possibilities: 1) to use subsets (and count numbers used only in specific circumstances) or 2) to take advantage of some "natural counters", anything that spontaneously reacts to the use of a number and can work as an indicator.

We see these possibilities in detail:

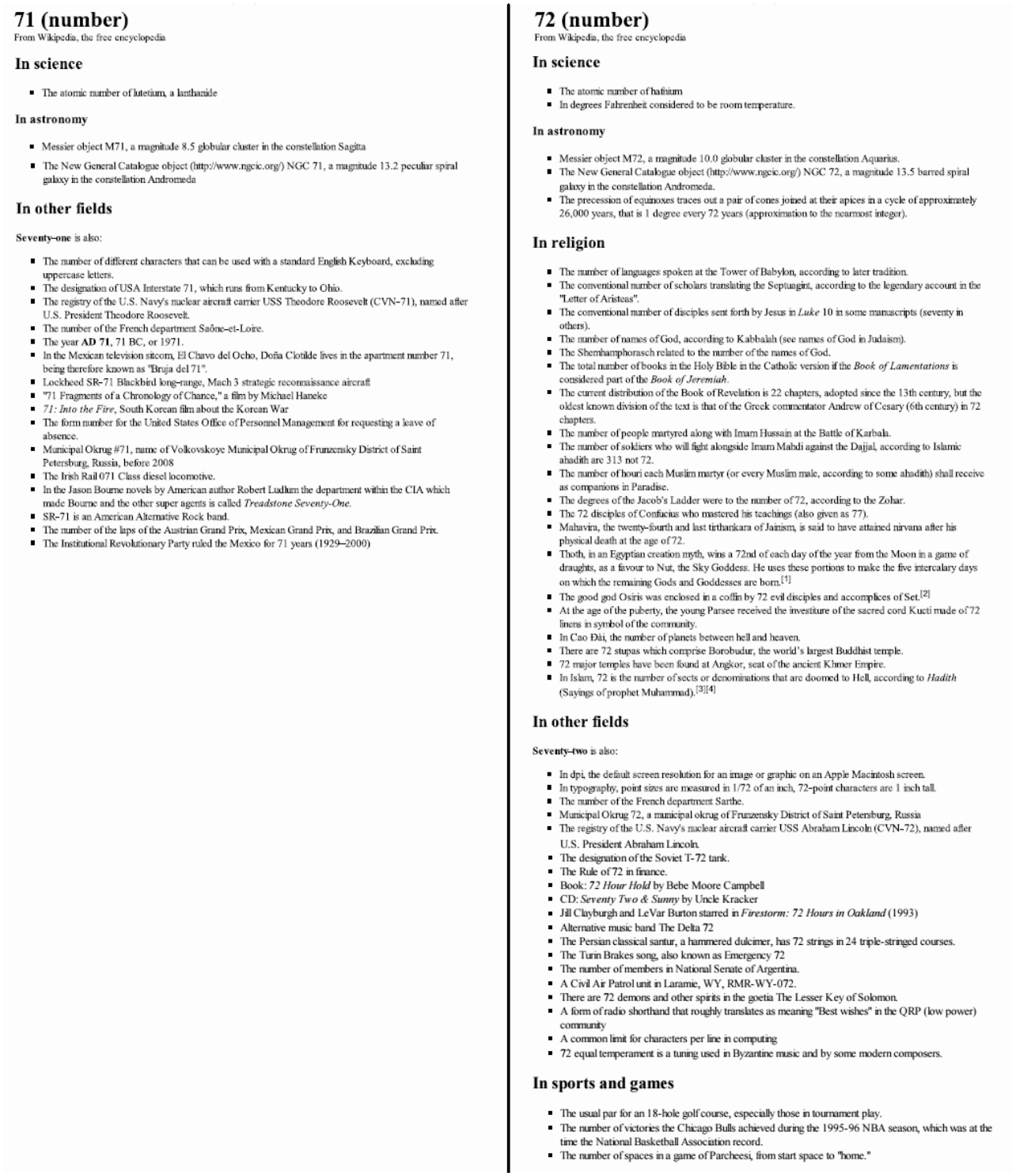
1) Defining subsets is an interesting possibility: we renounce to know the usage of numbers in a global sense and we concentrate to study it only in a definite region or period. We can also decide to limit our investigation to a semantic area (i.e. legal, scientific, religious, poetic...), epoch (archaic, Classical, Medieval…) or even to a single literary work (i.e. Bible, Veda, Homeric Poems, Kyrgyz Manas...). We didn't choose this option because we first needed to verify if the method itself worked, but it is clear that studying the distribution of numbers in single literary works is an extremely promising research and it will be undertook in the future. Its potential is shown in the final chapter of this paper.

2) Although we can't actually count all the numbers used in our culture, we can still conceive some shortcuts that allow us to have an estimate of the general usage of a number (and then of its importance). A good tool turned out to be Wikipedia, the well known "free online encyclopaedia". Each number is in fact an entry of this encyclopaedia and we noticed that the length of the page depends on the usage of the number. This is obvious: the more important is an encyclopaedia entry, the longer it will be. Other indicators could be, for example, the amount of pages found by Google containing each number. But, while Wikipedia already selects the use of a number in various cultural areas, Google queries are somewhat more noisy and requires a more elaborated processing.

About the choice of using Wikipedia as a brief indicator of cultural importance of the numbers, it is useful to note that: 1) the language of Wikipedia doesn't seem to greatly affect the results since pages are often similar copies from other languages (mainly English)[6], 2) the facts that

[6] Or, otherwise, the pages that we could access and treat are all written in Indo-European languages and then maybe for this reason show the same numerological signature.

Wikipedia reports for each number refer to arithmetical properties, utilization in religion, myth or literature, and magic numerology, which are all information valid for a work oriented toward the study of the ancient roots of a culture.



71 (number)

From Wikipedia, the free encyclopedia

In science

- The atomic number of lutetium, a lanthanide

In astronomy

- Messier object M71, a magnitude 8.5 globular cluster in the constellation Sagitta
- The New General Catalogue object (http://www.ngcic.org/) NGC 71, a magnitude 13.2 peculiar spiral galaxy in the constellation Andromeda

In other fields

Seventy-one is also:

- The number of different characters that can be used with a standard English Keyboard, excluding uppercase letters.
- The designation of USA Interstate 71, which runs from Kentucky to Ohio.
- The registry of the U.S. Navy's nuclear aircraft carrier USS Theodore Roosevelt (CVN-71), named after U.S. President Theodore Roosevelt.
- The number of the French department Saône-et-Loire.
- The year **AD 71**, 71 BC, or 1971.
- In the Mexican television sitcom, El Chavo del Ocho, Doña Clotilde lives in the apartment number 71, being therefore known as "Bruja del 71".
- Lockheed SR-71 Blackbird long-range, Mach 3 strategic reconnaissance aircraft
- "71 Fragments of a Chronology of Chance," a film by Michael Haneke
- *71: Into the Fire*, South Korean film about the Korean War
- The form number for the United States Office of Personnel Management for requesting a leave of absence.
- Municipal Okrug #71, name of Volkovskoye Municipal Okrug of Frunzensky District of Saint Petersburg, Russia, before 2008
- The Irish Rail 071 Class diesel locomotive.
- In the Jason Bourne novels by American author Robert Ludlum the department within the CIA which made Bourne and the other super agents is called *Treadstone Seventy-One*.
- SR-71 is an American Alternative Rock band.
- The number of the laps of the Austrian Grand Prix, Mexican Grand Prix, and Brazilian Grand Prix.
- The Institutional Revolutionary Party ruled the Mexico for 71 years (1929–2000)

72 (number)

From Wikipedia, the free encyclopedia

In science

- The atomic number of hafnium
- In degrees Fahrenheit considered to be room temperature.

In astronomy

- Messier object M72, a magnitude 10.0 globular cluster in the constellation Aquarius.
- The New General Catalogue object (http://www.ngcic.org/) NGC 72, a magnitude 13.5 barred spiral galaxy in the constellation Andromeda.
- The precession of equinoxes traces out a pair of cones joined at their apices in a cycle of approximately 26,000 years, that is 1 degree every 72 years (approximation to the nearmost integer).

In religion

- The number of languages spoken at the Tower of Babylon, according to later tradition.
- The conventional number of scholars translating the Septuagint, according to the legendary account in the "Letter of Aristeas".
- The conventional number of disciples sent forth by Jesus in *Luke* 10 in some manuscripts (seventy in others).
- The number of names of God, according to Kabbalah (see names of God in Judaism).
- The Shemhamphorasch related to the number of the names of God.
- The total number of books in the Holy Bible in the Catholic version if the *Book of Lamentations* is considered part of the *Book of Jeremiah*.
- The current distribution of the Book of Revelation is 22 chapters, adopted since the 13th century, but the oldest known division of the text is that of the Greek commentator Andrew of Cesary (6th century) in 72 chapters.
- The number of people martyred along with Imam Hussain at the Battle of Karbala.
- The number of soldiers who will fight alongside Imam Mahdi against the Dajjal, according to Islamic ahadith are 313 not 72.
- The number of houri each Muslim martyr (or every Muslim male, according to some ahadith) shall receive as companions in Paradise.
- The degrees of the Jacob's Ladder were to the number of 72, according to the Zohar.
- The 72 disciples of Confucius who mastered his teachings (also given as 77).
- Mahavira, the twenty-fourth and last tirthankara of Jainism, is said to have attained nirvana after his physical death at the age of 72.
- Thoth, in an Egyptian creation myth, wins a 72nd of each day of the year from the Moon in a game of draughts, as a favour to Nut, the Sky Goddess. He uses these portions to make the five intercalary days on which the remaining Gods and Goddesses are born.[1]
- The good god Osiris was enclosed in a coffin by 72 evil disciples and accomplices of Set.[2]
- At the age of the puberty, the young Parsee received the investiture of the sacred cord Kucti made of 72 linens in symbol of the community.
- In Cao Đài, the number of planets between hell and heaven.
- There are 72 stupas which comprise Borobudur, the world's largest Buddhist temple.
- 72 major temples have been found at Angkor, seat of the ancient Khmer Empire.
- In Islam, 72 is the number of sects or denominations that are doomed to Hell, according to *Hadith* (Sayings of prophet Muhammad).[3][4]

In other fields

Seventy-two is also:

- In dpi, the default screen resolution for an image or graphic on an Apple Macintosh screen.
- In typography, point sizes are measured in 1/72 of an inch, 72-point characters are 1 inch tall.
- The number of the French department Sarthe.
- Municipal Okrug 72, a municipal okrug of Frunzensky District of Saint Petersburg, Russia
- The registry of the U.S. Navy's nuclear aircraft carrier USS Abraham Lincoln (CVN-72), named after U.S. President Abraham Lincoln.
- The designation of the Soviet T-72 tank.
- The Rule of 72 in finance.
- Book: *72 Hour Hold* by Bebe Moore Campbell
- CD: *Seventy Two & Sunny* by Uncle Kracker
- Jill Clayburgh and LeVar Burton starred in *Firestorm: 72 Hours in Oakland* (1993)
- Alternative music band The Delta 72
- The Persian classical santur, a hammered dulcimer, has 72 strings in 24 triple-stringed courses.
- The Turin Brakes song, also known as Emergency 72
- The number of members in National Senate of Argentina.
- A Civil Air Patrol unit in Laramie, WY, RMR-WY-072.
- There are 72 demons and other spirits in the goetia The Lesser Key of Solomon.
- A form of radio shorthand that roughly translates as meaning "Best wishes" in the QRP (low power) community
- A common limit for characters per line in computing
- 72 equal temperament is a tuning used in Byzantine music and by some modern composers.

In sports and games

- The usual par for an 18-hole golf course, especially those in tournament play.
- The number of victories the Chicago Bulls achieved during the 1995-96 NBA season, which was at the time the National Basketball Association record.
- The number of spaces in a game of Parcheesi, from start space to "home."

Fig. 2. Wikipedia entries for numbers 71 and 72. The length of the latter mostly depends on the wide use of this number in religion.

3. Data processing

We started downloading 150[7] pages of Wikipedia (one for each number between 1 and 150), then we used their digital weight (KB) to code the length of text used for each number. As expected for the Benford's law, the smaller numbers showed to have longer pages in the encyclopaedia according to their greater use, resulting in higher bars in Figure 3.

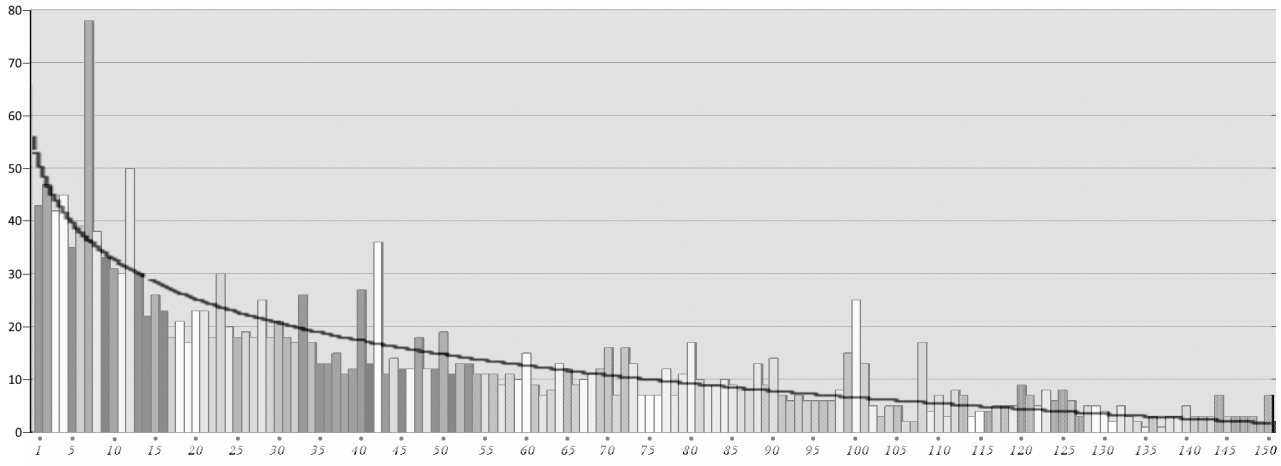


Fig. 3. The histogram with the raw data shows its "Benford-like" behaviour. Columns represent the weight of the Wikipedia page for each number in KB.

Some numbers do peak above the overall trend (for example numbers 7 and 12): in order to determine their actual importance we normalized the data set with the Benford's law.

The now "flat" histogram clearly shows which numbers deserved more space in the encyclopaedia, revealing their cultural importance (Figure 4). Bars don't have errors because they derive from given digital quantities, but the result in general counts on the reliability of Wikipedia itself in assessing the utilization and cultural relevance of a number. Basically, this work has been possible because "the richer is the cultural role of a number, the bigger is the encyclopaedia's page that refers to it". We, for ourselves, assumed a +/-10% as an indicative value of uncertainty in case of a quantitative treatment of the data, but it's clear that a mostly qualitative use of this histogram is quite enough for the interest of this study.

[7] It's just a practical limit: nothing would have changed with a wider set of pages. Moreover most of the numbers known to have a cultural relevance are lower than 150, so such a set is ideal for testing our method. The data were taken from the Italian version in early 2015.

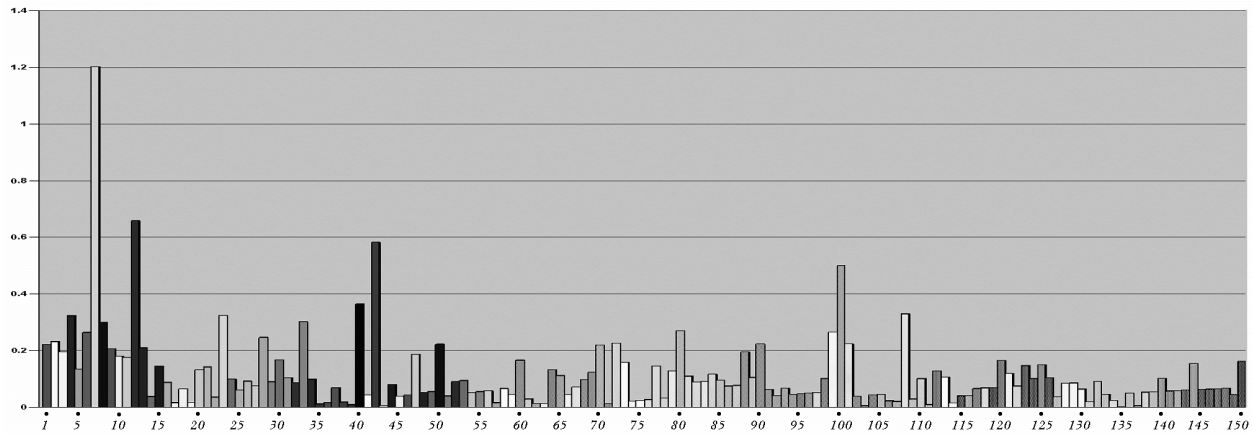


Fig. 4. The same bar chart of Fig. 3 net of the effects of the Benford's Law. Now the trend is flat and it's easier to evaluate the cultural relevance of each number.

4. Evaluating the histogram

The first time the histogram appeared to us, we eagerly went to see how certain well known numbers behaved, also in order to see if the response was reasonable. All the numbers that we expected to peak stood out of the lower crowd of "anonymous" numbers, showing that the work was reliable. We see the result in detail. Among the 24 numbers[8] that score highest in the graph, 7 are smaller than 10, and 7 more are related to "tens" (i.e. 40, 50, 70, 80, 99, 100, 101[9]). The only *small* number that seems reasonable to keep for further discussion is 7, which scores highest in the histogram and far above neighbouring digits. We'll also ignore those related to tens since their importance is probably just due to their being round numbers[10]. The nine numbers that clearly requires an explanation after this skimming are: 7, 12, 13, 23, 28, 33, 42, 72, 108[11]. All of them notoriously have a story to tell (often related to astronomy), confirming that the recognition process is effective[12].

[8] These are the numbers whose bar crosses the first horizontal line in the histogram, which has no a particular meaning apart from being helpful in spotting the highest results, the most interesting for our purposes.

[9] "100" is so important and peculiar that it brings above the line both 99 and 101.

[10] This doesn't mean that a round number can't have a story for itself (number 40, for example, is interesting), but we'll focus on those that have no evident reason to stand fiercely above the average.

[11] In "order of importance" (height of their bars) the numbers are: 7, 12, 42, 108, 23, 33, 28, 72, 13.

[12] There could exist interesting numbers that yet don't stand out in the histogram? It is possible and it would mean that their importance is subtle enough to have deceived Wikipedia's process. Such hairsplitting entries can be identified by a more precise,

5. Discussing the numbers and their meanings

We now leave aside the foregoing discourse about data collection and turn to investigate the possible origin of the importance of each number.

A closer look at those nine numbers shows that for some of them their "fame" is recent. The Free Encyclopaedia is in fact well updated about modern themes which are popular in the web and this aspect obviously emerges in our results.

23. The obliquity of Ecliptic is the most probable astronomical meaning of *twenty-three*, but, totalling 20 billion web pages, two mainstream movies and several musical clip with billions of visualizations, number 23 is so widespread that enters our statistics anyway, regardless of its astronomical valence. A better comprehension of this number and its possible but uncertain relation with astronomy could come from studying the occurrence of numbers in more ancient sources.

33. Besides being the age of Jesus, *thirty-three* has various uses that incline to mysticism, both in the Masonry and in numerology. This number seems to be unrelated to any astronomical meaning; it's fortune could well originate from the Gospels.

42. *Forty-two* got a longer entry in Wikipedia mostly because it is "the answer to the ultimate question of life, the universe and everything" in Douglas Adams' book "The Hitchhiker's Guide to the Galaxy". It's great fortune[13] in contemporary popular culture, with quotations in games and TV series[14], makes number 42 peak in the histogram regardless of any possible astronomical or ancient origin, that, if exists, should be thus investigated purposely.

6. Important numbers of astronomical origin

Six of the nine numbers that display a peculiar cultural relevance borrow their fortune from astronomy.

7. *Seven,* the number with the highest bar, is undoubtedly the most popular number with a specific symbolic meaning. Things listed in groups

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direct application of our method as proposed in paragraph 2.2 and suggested in the last chapter.

[13] Googling "42" will plainly testify it. Also, just starting typing the query "The answer..." in Google, the phrase will be automatically completed.

[14] As Elon Musk himself confirmed, a copy of this book is kept in the glove box of his *Tesla*, the car launched toward Mars by the most powerful roket Falcon Heavy of the SpaceX Corporation on 2018 Feb 6th. On the LCD display of the car is shown "don't panic" and a towel is also kept in the car: two more quotations from the book.

of seven are countless. The importance of this number is exquisitely astronomical and derives from the number of the "planets"[15]. Some relate 7 to the days of the week, that's to say to a quarter of a lunar cycle, but, at least for its primary meaning, the planetary interpretation is more convincing. There exist in fact all over the world ancient tales about seven doors, or ladders with seven steps or trees with seven branches that lead to the sky[16]. Such ladders or doors or branches can hardly be the days of the week, while are easy to identify with the classical seven "skies", one for each planet, that link the Earth to the upper world[17].

The importance of 7 is usually said to come from early planetary observations in Mesopotamia[18] but it's impossible to exclude that its origin could precede even by far Mesopotamian astronomy. Actually this possibility would better explain the wide spread of the motif.

A theme funded on the number seven that appear to us directly related to the planets is that of the "seven sages", attested in many cultures: the "original" seven sages, to which the human ones are inspired, could well be the seven planets, seen as superior intelligent beings, holders of the fate[19].

12. *Twelve* is the second most important number in our culture and it originates from the number of months (i.e. lunations or lunar cycles) that fit in a year. This number is sometimes depicted as a circle of stars. Each of such star represents a full moon along the Ecliptic (see the European flag). As a symbol, it has two meanings: 12 companions of the Sun (seen as an important man or god) and of the reaching of unity (one entire year) from multiplicity. We called this ancient symbol *dodecasterion* and discussed its meaning in a previous work[20].

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[15] Here we of course use "planet" with its ancient meaning of "wandering star", so that the "planets" are seven and were known since the most ancient times.

[16] The theme is renowned and widely studied. In a word: "Climbing the Tree of Life is referred to symbolically in stories that tell of ascending seven layers into the sky and climbing stairs with seven steps or ladders with seven rungs. For example, the Turko-Mongol birch post is carved with seven notches and set standing symbolically at the center of the world" (Pratt 2007).

[17] Later mystic ascensions to the heavens explicitly develop through the "skies" of the seven planets, as in Ibn 'Arabi's *al-Futūāt al-Makkiyya* or in Dante's *Divina Commedia*.

[18] See Eliade (1987).

[19] In India the Seven Sages (*Saptarishi*) are identified with the seven stars of the Big Dipper. It is possibly a later identification. See note 44 in chap. 8.

[20] Colona (2014a); see also Colona (2014b).

13. Modern triskaidekaphobia, which is the first reason why *thirteen* is high in our histogram, can be related to the interesting astronomical significance of this number, which also refers to the thirteenth Babylonian leap month (represented by a crow, a sign of misfortune) according to *Knaurs Lexicon der Symbole*.

28. *Twenty-eight* is not necessarily an "astronomical" number. 28 days are in fact the mean duration of the female cycle, and this could be enough for making 28 important. Yet the lunar cycle is very similar: the sidereal month is of 27.3 days while the synodic month is of 29.5 days, and their average equals the fertility cycle[21]. Actually, 28 can have been used as a lunar number in many cases throughout history. Among them we are inclined to count the division in 28 sectors of the dome of the Pantheon in Rome. From the length of the lunar cycle and of the year come the importance of the numbers 12 (months in a year) and 30 (days in a month).

7. Two crucial astronomical numbers

72. Symbolic use of *seventy-two* dates back to Egyptians and Babylonians and is well attested in many traditions[22]. The symbology of this number, often seen as the number of disciples or mates of some important figure, suggests a precise way for it to gain its importance, in analogy with number 12. It simply seems to be a further subdivision of the Zodiac by dividing each month in 6 sections of 5 days, that's to say half of a Decan[23], and the entire year into 72 steps[24]. Secondly, its importance may derive from being 1/5 of 360, where 5 is the difference between 360 (convenient partition of the Ecliptic) and 365 (the duration of a year), an essential evidence found after the first determination of the length of the year. The

[21] It's one of the reasons why the lunar symbol is close to the female figure in our culture.

[22] Just few examples: 72 were the conspirators that helped Seth-Typhon to kill Osiris; the mates Odysseus lost in the land of the Ciconians; the sages who translated the Bible from Hebrew into Greek; the disciples Jesus sent to spread the Gospel; the steps of the Jacob's ladder according to the Zohar; the virgins that awaits Islam martyrs in heaven; the sacred sites of Chinese Taoism, and the disciples of Confucius.

[23] Used in Egypt since the end of III millennium BC, Decans are a division of the rotating celestial sphere in 36 subsequent parts, each of which put in relation to the Zodiac.

[24] The connection between 5 and 72 to build up an entire year is also well known far from ancient Egypt. The traditional Japanese calendar includes 72 seasons of 5 days (called *Shichijūni Kō*) to keep in touch with the subtle and constant seasonal changes all through the year.

process must have been the following: the handy round digit closest to the actual duration of the year is 360 (upon this, the sexagesimal numeral system was developed by ancient astronomers and used in Mesopotamia[25]). If we consider a year of 360 days, 5 days will miss to the count, that's to say *one per each 72 days of the year*. Ancient astronomers got this notion. It is confirmed by the Egyptian myth[26] of the creation of the five "extra days", obtained by the god Thoth that gambled with the Moon for 1/72 of her light (360/72 = 5) and won[27,].

The importance of number 72 may then have flourished around II millennium b.C. or earlier depending on when a 365 days year was recognized and when the computing needs suggested the use of the round digit 360 to streamline calculations.

It is worth to spend a word about the relation between 72 and the precession of the equinoxes[28], that many scholars suppose was known in ancient times before Hipparchus[29]. We also believe that it's not correct to exclude that the notion of some effects of the precession could have been known far before Hipparchus. Though, following Hipparchus (as we know it from Ptolemy), the precession rate is said to be "less than one degree every 100 years" and not explicitly 72. Therefore the number 72 is ruled out. Under these circumstances, unless we find proof that the rate of the precession was known with its correct value in very ancient times, we must hold that the importance of number 72 is not linked to precession[30].

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[25] The choice was highly encouraged by practical reasons "for a magnitude of 60 units can be subdivided easily into halves, thirds, fourths, fifths, sixths, tenths, twelfths, fifteenths and thirtieths, thus affording ten possible subdivisions." Boyer B. C., Merzbach C. U. (2010) *A History of Mathematics*.

[26] Plutarch, *De Iside et Osiride*, section 12. See also Graves R. (1948), *La Dea Bianca*, Faber & Faber Ltd, London, 2010, p. 449.

[27] Thank to these 5 brand new days conquered or created by Thoth, Nut could give birth to her 5 sons and daughters: Horus, Osiris, Set, Isis, and Nepthys. This is the mythic institution of the year of 365 days instead of 365. The five extra days are called *epagomenal days* and Egyptians considered them the birthdays of the five gods.

[28] The equinoxes go through one degree of Ecliptic every 72 years due to precession.

[29] Among them maybe the most famous is Giorgio De Santillana with his essay *Hamlet's Mill*.

[30] Assuming that the spread itself of number 72 is a proof that the precession rate was well known already in second millennium is surely a suggestive theory but alas it requires independent (and strong) proofs currently missing. (Instead, that the ancients knew that 72 is a fifth of 360 doesn't require any particular support).

(And, if it is, the importance of 72 must have occurred after the conventional division of the circle in 360°, this is a firm chronological constrain).[31] Of great interest is the relation between 70 and 72, since there was a convergence in their qualitative, symbolic meaning. It was due to their closeness and to the importance 70 had on its own for being ten times seven[32]. 70 and 72 are then sometimes used equivalently, with 70 approximating 72 and borrowing or sharing its connotation. For example Plutarch himself states that Thoth won one seventieth (εβδομηκοστός) of the year[33], and the so called *Septuagint* (namely "the Bible of the Seventy") was actually drafted by *seventy two* translators.

108. *One hundred and eight* is the number with the greatest cultural relevance in Southern and Eastern Asia. Oriental religion, philosophy, mysticism and even martial arts hold this number as the most significant and sacred. It is commonly found in Hinduism, Jainism, Buddhism and Chinese astrology. Its fortune seems to start in India, presumably during second millennium b.C. or before[34]. The reason of the fortune of 108 is to be found in the Moon, that encompasses the entire Zodiac in *circa* 27 days. Ancient Indian astrology divided the Ecliptic into 27 lunar mansions called *nakshatra*, and each *nakshatra* was purposely subdivided into four portions called *pada* (*step*) obtaining a total of *108* sections of the Zodiac. An alternative very suggestive hypothesis that we held true but later had to discharge is that this number became important when the discovery was made that it corresponds to the *relative distance* of the Sun[35]. In the past years the Author attempted several times to measure the relative distance of the Sun in order to see if such a measurement was accessible to ancient

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[31] This hypothesis is also contrasted by the wrong figure (100 years per degree) given by Ptolemy: how could very ancient civilizations know the exact rate of the precession when the much later astronomers Hipparchus and Ptolemy missed it?

[32] Number seventy appears some 50 times in the Bible (about ten more than number fourty), with this strong symbolism. In our bar chart 72 scores just slightly higher than 70.

[33] If not used instead of 72, it would be a paradox since 360 is divisible by 72, but not by 70.

[34] The number 108 is structural in the Vedic literature and is pervasive in any expression of ancient Indian culture. (And modern too. We can mention *en passant* that 108 is an Indian toll free emergency telephone number).

[35] The *relative distance* of an object is measured by means of its size. The Sun is 108 solar diameters away from the Earth, so 108 is its relative distance. Similarly, a ball will look the same apparent size of the Sun if placed at 108 times its diameter from the observer.

observers, and succeeded within an error of very few percents using totally trivial tools such as strings and wooden sticks. This reassured us that skilled ancient astronomers could well determine the *relative distance* of the Sun. We independently discovered this relation without knowing that it was first published by professor Subhash Kak in 1993[36]. We had to abandon this interpretation because of the following reasons. The symbolic meaning usually given to the number 108 in several Oriental religions and disciplines: it is often considered as the number of steps or difficulties to overcome in order to reach the spiritual goal of perfection and fulfilment[37]. Then the underlying concept appears to be that there are "108 times" a solar size to pass before reaching the real Sun[38]. This seems to support the interpretation of 108 as the relative distance of the Sun. Yet, if the Zodiac is divided in 108 steps, it's easy to conceive the year as a continuous struggle toward perfection, and the yearly solar path divided in 108 sections will still fit the symbolic meaning of 108 obstacles to overcome. The Mala itself, the Buddhist Rosary, compound of 108 grains, is a crown, a circuit, just like the Ecliptic. And the 108 bell tolls in the Japanese Buddhist ceremony for the new year can well be an omen for seizing the 108 opportunities brought by the new year (the next orbit of the Sun along the Zodiac) to improve oneself.

It is very remarkable that 108, with the same connotation (number of difficulties to outmatch) appears in Homeric Odyssey, quantifying the suitors of Penelope, the rivals that Odysseus had to kill before he could reveal himself to his wife and complete his *nostos*: the *Proci* were 108. In this case, though, interpreting 108 as the divisions of the Zodiac also holds since the numbers referring to the divisions of the Zodiac are always expressed in the myths as the mates of an important figure (12 Apostles, 72 Disciples and so on). Then, there could properly be 108 suitors at Penelope's court if this number is seen as a division of the Zodiac. Lastly, one could still argue that there must have been a reason for dividing in *four* sections the 27 nakshatras, and conclude that the reason could be that it was symbolically attractive to obtain the same number expressing the

[36] Subhash Kak, *Astronomy and its Role in Vedic Culture*, in *Vistas in Astronomy*, Volume 36, Part 1.

[37] The defilements of Buddhism are 108; conventional Buddhist mala (Rosary) has 108 beads, each remembering the mortal desires of mankind.

[38] For example, in Japan, at the end of the year, a bell is chimed 108 times in Buddhist temples to welcome the new year. Each ring represents one of 108 earthly temptations a person must overcome in order to achieve nirvana.

relative distance of the Sun. But two problems arise here: 1) we have no archaeological or historical evidence that independently indicate that such a measurement was actually obtained in ancient times; 2) there is a far more compelling reason for doing so: 108 is the Least Common Multiple between 12 and 27, that's to say 108 is the number that links the Lunar Zodiac (27 days/nakshara) with the Solar one (12 months/signs). 108 is then important for itself regardless of the knowledge of the relative distance of the Sun.

108 and its meaning must have been very popular in the region of origin and eventually spread along with Indian culture and religion. Starting from the second half of the first millennium b.C. Buddhist monks mainly conveyed in other regions and cultures (China, Japan and far East) the symbolism of 108 that also passed to Islamic nations in later centuries[39]. It is interesting to note that the fortune of 108 seems to have leaked also into Christian culture. The Rosary, in its canonical form, has 54 beads. This must be compared to the Buddhist use of making the Rosary (called Mala) of 108 beads or of a divisor of 108[40].

8. Dante, numerology and fortuity

We are trying to bring quantitative analysis into a field usually left to speculation and suggestion. To our surprise, the difficulty was not only that in ancient times it wasn't usual to write why a number was important, or that the explanations given today are often assumptive. Our biggest issue actually was with *fortuity*. This study definitively demonstrates that coincidences and flukes do exist. As the reader may have noticed, in fact, three of the four most important astronomical numbers (12, 72, 108) are mutual multiple or divisors. It is so strong the enticement of arithmetic that, once it's established that 12 is a very important number for obvious reasons, one could conclude that its multiples (12 x 6 and 12 x 9, i.e. 72 and 108) are important just because of it[41]. Worst, one could be tempted by

[39] Giorgio De Santillana downright grasped the importance of 108 but couldn't determine its origin. Along with 72 he unfortunately related 108 to the precession of the equinoxes due to arithmetic relations between the two numbers.

[40] Number 108 sometimes also appear in architectonic decorations of Western churches as it does for example in the magnificent façade of the cathedral of Ferrara, embellished with 54 *couples* of columns.

[41] If it was true, then also 48 (12 x 4) and 84 (12 x 7) should be as much common numbers in ancient literature. But this doesn't happen: the assumption is wrong.

easy numerology and notice that the first powers of the very first numbers (2^2 x 3^1, 2^3 x 3^2 and 2^2 x 3^3) give us precisely our figures: 12, 72, 108.

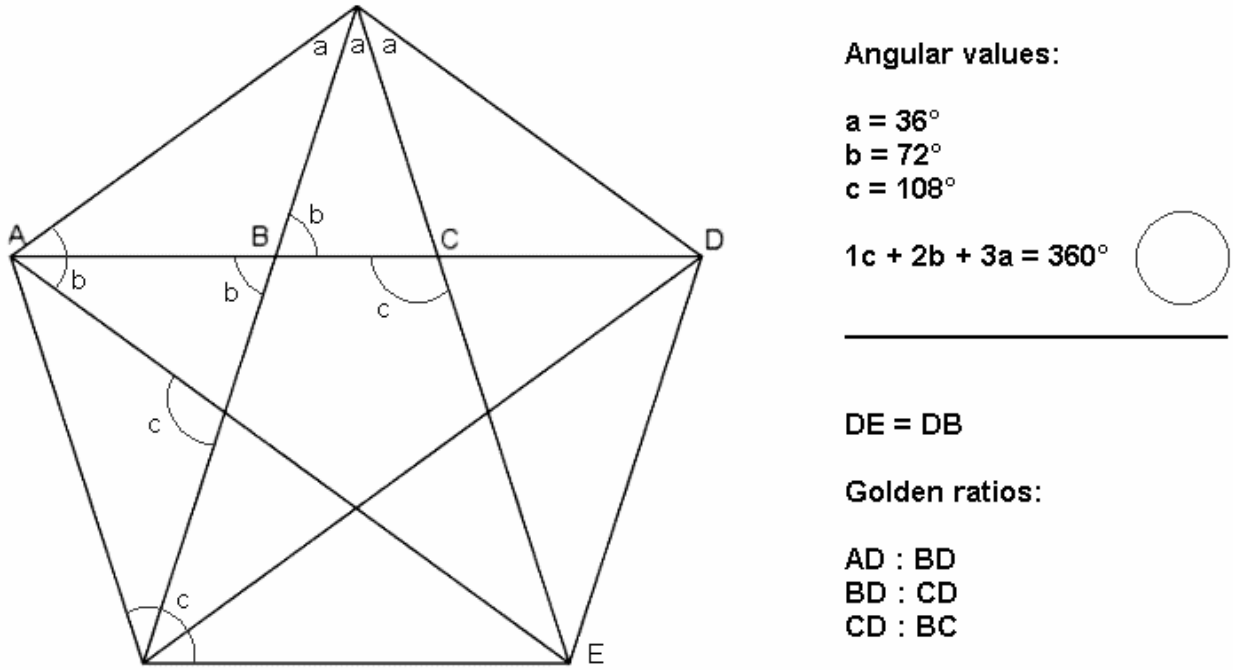

Fig. 5. Talking about coincidences: as incredible as it can be, 36, 72 and 108 all appear as the angular values in the five pointed stars (once the circle is divided into 360 degrees). Moreover they do so in a spree of golden ratios. (Not mentioning the relation between the pentagon and the appearances of Venus along the Ecliptic…)

However, we saw instead that 12, 72 and 108 stem each from a different astronomical observable fact and have nothing to do with each other. They are respectively linked to the ratio between orbital periods of the Earth and of the Moon, to the ratio of orbital and rotational periods of the Earth, and to the sidereal period of the Moon. All quantities totally unrelated and that ancient astronomers were aware of. So their independence and their astronomical origin are safe. Nevertheless we also find 72 and 108 along with their companion 36 (triple of 12, third of 108 and half of 72) all together in the angles of the "magical"[42] five points star[43] (see Figure 5).

[42] The five-pointed star (also known as pentagram, pentacle, pentalpha, pentangle or star pentagon) was used symbolically in ancient Greece and Babylonia and had magical roles over the centuries from Neoplatonism to Freemasonry.

[43] Actually this coincidence, together with their being mutual multiple or divisors and their very simple and basic arithmetical expressions, can well have contributed to their fortune and boosted the prestige of such numbers (and also of the five-pointed star!)

Many more incredible coincidences that simply exist for no reason are common in astronomical numerology[44] and they of course get the work complicated, making a harder task to establish whether a circumstance is a fact or a fortuity without importance.

This very problem arises with Dante, too.

As we all know, Dante was an eager scholar with an incomparable culture. He packed his masterpiece the *Divina Commedia* with the most sophisticated scientific notions, along with sagacious codes and hidden references according to the typical medieval taste[45]. We already saw that the importance of 108 leaked into Western culture (both Greek and Christian) and we noted that numbers 72 and 108 are related to the Sun path. There is no perceptible difficulty in admitting that Dante could be aware of the solar symbolism of 72 and 108. If so, there could be traces in his work. Phaethon is a well known solar myth[46] and Dante mentions it three times in the *Divina Commedia*. The first two mentions are at the verses 72 and 108 of If IX and Pg XVII. No comment is needed of course, but there is more.

The *Commedia* contains 100 *canti*, so we can't check if something peculiar related to the Sun happens in the inexistent "*canto* 108". But we can do it with the *canto* 72[47] which begins with these verses:

S'io ti fiammeggio nel caldo d'amore
di là dal modo che'n terra si vede,
sì che del viso tuo vinco il valore[48]

Such an explosion of unbearable light may well be an allusion to the shine of the Sun[49]. The same happens at the verse 108 of the same *canto*:

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[44] There's no need to list them all. We'll just recall that seven are at the same time the planets, the days of the week (one fourth of the lunar period), and also the main stars in nearly all the most evident asterisms of the sky: Orion, Ursa Major, Corona Borealis, Pleiades.

[45] See for example Paradiso, canto V, vv. 97-111 where an inverse acrostic of the first letter of each tercet reads "PESCE" ("fish") while in the straight text Dante uses a similitude based upon the act of fishing.

[46] It narrates the tragic misadventure of Phaethon, son of Apollo, who tries to drive the car of the Sun but burns the Earth with excessive heat and ends stroked by the lightning of Zeus. We have studied this myth and in a future work we'll make clear its meaning and its odd details.

[47] The 72nd canto of the *Divina Commedia* is Pd V (fifth of *Paradiso*).

[48] "If I dazzle you like a flaming fire of love more than is seen on Earth so that you can't sustain my sight".

nel folgòr chiaro che di lei uscìa[50]

All these notable cases can be clear signs that Dante knew and used the solar connotation of numbers 72 and 108... Or they may be one more fortuitous coincidence in astronomical numerology: further studies will settle the question.

9. Conclusions

This work is compound of two distinct studies.

In the first part we presented a method for quantitatively evaluating the importance of a number in a certain cultural context. It is about counting how many times each number is used and then plot the results, bring the due normalization following the Benford's law and analyse the outcome. We did it with general Western culture taking advantage of Wikipedia's pages as a shortcut for estimating the use of the numbers. We also pointed out that a more exact procedure could be followed if it were possible to actually count the occurrence of the single numbers, as could be done for example narrowing the study to a single work from the ancient texts. In this case a precise "numerological fingerprint" (as much as the spectra used in astrophysics) would result for each ancient literary ambient or author, leading to a better comprehension of the background and reference culture. It would be of extreme interest then comparing the "fingerprints" of works from different epochs, geographic areas or cultural contexts. Moreover, since the cultural context affects the occurrence of numbers in a work, through the study of their *numerological signature* it would be possible to characterize origin and possible influences of each work.

In the second part we have been browsing the numbers that emerged from the previous processing. We discovered that six[51] out of nine of the most relevant numbers in our culture draw their importance from ancient astronomical observations. This demonstrates once more that astronomy was essential for archaic civilizations and closely linked to their cultural evolution, to the point that its legacy lingers on till today, making evident

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[49] Actually the excessive brightness of the Sun is the major difficulty faced by the observer who tries to measure the relative distance of the Sun (as the Author can testify upon his own experience).

[50] "In the bright glare that sparked from her".

[51] The four numbers with a certain astronomical origin are 7, 12, 72, 108; those *sub judice* are 13, 33 and 28. Others (like 23, 40, $144 = 12^2$ and even more) may as well have an astronomical connotation waiting to be clarified.

(and above all it is now measurable) the contribution of astronomy to our present culture. Numbers with a certain astronomical derivation are: 7, 12, 72, 108. We discussed the observations from which they took origin (noting that 72 has nothing to do with the precession of the equinoxes), and outlined in particular the possible history and evolution of the exceptional number 108.

A note was added in which we warn of the dangers of the accidental convergences that flourish within astronomical numerology and we present a possible discovery regarding the use of the numbers 72 and 108 following their astronomical connotations in the *Divina Commedia* of Dante Alighieri.

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