PTOLEMY'S ALMAGEST AND FOMENKO'S OPINION ABOUT IT

AND ESPECIALLY: SOME WORDS ABOUT PRECESSION

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ABSTRACT

There are lots of detected anomalies in the works of Claudius Ptolemy, the greatest ancient cosmographist of obscure curriculum. I am discussing 2 such anomalies here.

1. INTRODUCTION

Anatoly (Timofeevich) Fomenko, correspondent member of the famous Moscow Academy and Department leader at Moscow State University (Differential Geometry) is not exactly popular amongst historians. His New Chronology states that the majority opinion about History is erroneous before XIVth century: between AD 700 & 1300 most "historical events" are falsifications; but those events belonging to Classical Antiquity which are not again falsifications, happened in the above period. And then we absolutely do not know about historical events before 700 AD.

Rather strange a picture. However, Fomenko has some arguments, mathematical, physical & astronomical. These are generally ignored by historians, and in exchange he ignores most historical arguments telling that historical sources may have been falsified.

I made some Comments to this controversy ([1]-[3], and also from another viewpoint, [4]), with practically no echo. Now I have chosen a small detail of the problem: the stellar catalog in the Almagest of Claudius Ptolemaeus. I take the opportunity to mention tangentionally another Ptolemy problem too, about geographical longitudes. There is nothing common in the two "anomalies"; only both are rather strange and *maybe* if one gets a good explanation, the other ceases to be an anomaly as well.

Today the opinion of the majority of historians is that Ptolemy lived in the 2nd century AD, and his activity is centered about 150 AD. In contrast Fomenko's opinion (see e.g. [5], [6] & [7]) is that the author of Almagest worked somewhere between 600 & 1300, probably near to the upper bound. If the majority opinion is true, then the anomaly mentioned by Fomenko must have an explanation, absent up to now, and even its abstract existence a matter of faith. On the other hand, if Fomenko is right, then all authors referring Ptolemy up to, say, 1000 are falsifications. It is hard to accept any of the two horns of the alternative.

2. THE MYSTERIOUS KING OF ASTRONOMERS

According to the majority opinion of historians Ptolemy was the greatest astronomer of Classical Antiquity, who incorporated his forerunners' works into a congenial construction which had no real opponents until Copernicus and which had to be put away only because the works of Galileo & Newton. What is interesting, he did *not* live at the end of Antiquity (say, about 400 AD), in which case the collapse of Antiquity would explain the lack of followers, but also not in the classical age of the Alexandria Research Center (put to 330-200 BC by van der Waerden [8], for example), but in an otherwise boring period. The educated guess of History is Alexandria, c.100-178 AD.

Of course, the date is self-consistent. E.g. Ptolemy uses Hipparchus (IInd century BC) and is cited by Pappos of Alexandria (c.320 AD). Also, one of Ptolemy's works, the Geographika, may be helped by the long peace of the Roman Empire in the IInd c. AD. (His extant works are the Geographika, collecting the ancient geographical informations, the Almagest, originally Syntaxis Mathematika, collecting ancient astronomy, and the Tetrabiblon, collecting ancient astrology.) But look: he collects the knowledge about ancient Earth and Sky in 150 AD, and practically nothing happens afterwards until the Arabs take Alexandria in 641!

There is a commonplace explanation, which I cite from I. Asimov, biochemist, science fiction writer and science history writer [9], who tells that all Greek science started to decline after 200 BC, because Greeks left natural philosophy for rhetorics and such: Greek science exhibited symptoms of very serious decline well before Christ. If so, then Ptolemy is alone in a desert of centuries; then History of Science should give some explanation for his excellence.

There is, of course, another explanation for the decline of science *in Alexandria*. The Alexandria Research Center was founded by the first Ptolemy Kings as a Library. Their motives to found it may not be completely known for us, but clearly royal prestige, diplomacy and collection of practical information were among them. For example, Egypt of the Ptolemys and Asia of the Antigonids (both Macedonians) concurred to show the Greeks that they are their natural leaders (and later the Attalids of Pergamum copied the idea of a Library). Now, a Library can operate as a Research Center only if it gets a high enough annual budget. Later Ptolemaids may have lost their interest in the Library among their internecine wars. And finally, when Rome took over in 31 BC, Alexandria ceased to be a royal capitol. Why to support the Research Center from faraway Rome?

A simple explanation for a decline starting c.200 BC. But then why Ptolemy, the Astronomer, is in floribus c. 150 AD?

The end of the Library is also obscure. There is a popular theory that Iulius Caesar's Alexandria battles are responsible for the burning of the Library in 46 BC. Even more popular is the theory originating from French Enlightenment that the Alexandria Christian Church is responsible, which organized the lynching of great Hypatia (beautiful, charming, author of scholarly commentaries, nice behaviour in all-male scientific community [8] and everything as you want, although as for the nice behaviour see App. A...). According to the ecclesiastic history of Socrates the mob of the city, under the influence of Bishop Cyril or at least of turbulent monks, killed her with chips of ceramics (or by another interpretation, by shells) in 415. However Theodosius the Great closed down the non-Christian temples in 393, and the Library, as a Museum, was the temple of the Muses, so it is rather nontrivial how it may have existed in 415.

Still, there are also stories about the Moslim conquerors heating the public baths of Alexandria for 8 months in 641. Finally, Islamic Internet sites sometimes mention that the Alexandria Library was demolished by the Crusaders. My guess (and some *experiences* of mine about central falsification of history are related to those of Fomenko, albeit not identical) is that in the last 2000 years any and all ideologies accused their oppositions with harming the Alexandria Library.

So, while the 150 AD datum is *possible* for Ptolemy's work, we could imagine other data as well. Melanchton's opposite opinion will come soon.

Now, there is some anomaly about the Astronomer. Maybe his original name was Greek: Klaudios Ptolemaios; its canonical Latin translation is Claudius Ptolemaeus. The problem is: why Klaudios and if so, why Ptolemaios?

Ptolemaios is a Greek/Macedonian name. In earlier centuries a kin of the Ptolemy Kings of Alexandria may have accumulated substantial research funds and *then* his authorship of 3 big compilations would get automatic explanation. But not after 31 BC.

As far as we know the royal Ptolemy family was extinct in 31 BC, and even in wider sense in the time of Nero. Of course very far kins may have remained in Egypt, or possibly Klaudios came from a disjoint Ptolemy family. Another idea is that maybe he was the citizen of the only Greek polis in Egypt, *Ptolemais* at Thebes. (Alexandria was not in Egypt, only adjacent to.) But anyways: he has the family name of Kings of Alexandria & Egypt *while his given name*

is par excellence Latin!

Klaudios was not a Greek given name. It was purely Roman. Sure, between 41 & 54 AD a hyperloyal Alexandria family may have given the name of the *actual* Roman Emperor; but a hyperloyal family would not use the name of an Emperor dead for half a century. By other words, an individual born in Alexandria about 100 AD as *Klaudios Ptolemaios* is highly improbable. Of course probability considerations are irrelevant *if* the individual is well documented. If...

And finally let us see Martin Luther's right hand man and chief scientific advisor, Melanchton. He organised the first printed edition of Ptolemy's Tetrabiblos (the astrological book), to which he wrote a Postscript in 1553 (you can check it in a modern edition [10]). Now, here Melanchton tells that "when the Saracen barbarism ... destroyed ... the Alexandria Academy", the science of Astrology would have been lost unless "not much before the Saracen incursion" Ptolemy had compiled the full Science of Astrology. So Melanchton's opinion is that Ptolemy lived in centuries VI or VII AD.

3. "PTOLEMY'S CRIME"?

This title comes from Newton (but not I. but R. R.), whose book has the title "The Crime of Claudius Ptolemy" [11]. His claim goes back to Delambre (1819) who believed that Ptolemy fabricated some solar eclipse data without observing the eclipses. I cannot decide if Ptolemy falsified or not and do not want to.

Another accusations from the 80's tell that Ptolemy's Stellar Catalog contains a lot of stars whose positions he did not observe. The idea is the following. Hipparchus discovered the precession. Then Ptolemy calculated that the precession between Hipparchus and himself must be 2°40', and for a lot of stars he simply took Hipparchus' positions + this precession shift while he declared that he reobserved them. The modern authors claim that they detected this practice from anomalous distribution of measurement errors + lack of any peculiar motion (which did not exist in Greek theory) + the incorrect value of precession. The literature is big, not unequivocal but fairly convincing.

So a lot of authors claim that many observations of Ptolemy are some kind of falsifications.

4. FOMENKO'S NOTE ON PRECESSION

Now let us see [5]. Fomenko tries to find out the time of the life of Ptolemy *from the data in the Almagest themselves*, since falsifications are well known in History. One possibility would be to detect peculiar motions; but results seem equivocal. But then he observes an anomaly in the ordering of stars.

He tells that the first item in the stellar catalog is our Polaris, α Ursae Minoris. Now, the only unique property of α UMi is that it is the northernmost substantial star.

Indeed, Polaris is not the brightest; a fairly bright m=2.1 star, but nothing compared with, say, Sirius. Also, its colour is uninteresting white (F8). While in previous times it was variable, the amplitude was very small in the last centuries and there is no evidence that antiquity observed this at all. Other pecularities were not seen without telescopes. So indeed, if α UMi was unique before telescopes to anybody, it was so because it was the *northernmost* bright star.

However this was not true in Classical Antiquity, as anybody can prove it by simple geometrical construction! You should go into ecliptical coordinate system, take a point at 23°27' from the equatorial pole, and make it to revolve on a circle in 25700 years. Then you can transform the positions to equatorial, and it turns out that because of precession before cca. 800 AD β UMi (m=2.2, K4) was more northern than α UMi. The brightness difference is negligible and peculiar motions cause second order effects only.

Therefore it is sure that Fomenko is right in his statement that the Almagest, *as we know it*, is not older than 800 AD. In contrast to Fomenko, I do not consider this as a proof that mysterious Claudius Ptolemy lived after 800. There is a possibility that he worked in 150 but after 800 a copyist simply exchanged the sequence of α and β UMi. It could be

easy to do this, and the observational evidence that indeed α UMi was the northernmost bright star might have given the motivation. However then look: Orthodox History (of, at least, Science) can be saved if we assume that about 100 AD somebody got an improbable name. Then this fellow collected all Astronomy in a period when natural sciences were already boring for scientists. He also showed outstanding mathematical excellence, while he falsified/stole lots of observations. Then his book vanished from Europe (see App. B), and later somebody unidentified up to now changed his Catalog both in Constantinople and in Arabia!.

Each point is possible, but the full sequence needs some credulity, and the last the biggest one. I think some explanations would be needed.

5. PRECESSION, STRABO AND HISTORY OF SCIENCE

Strabo, the greatest predecessor of Ptolemy's Geography, did not know anything about the precession, although he lived one century after Hipparchus, who in Greece discovered the effect. (And Strabo does cite Hipparchus!) Namely, in Book 1, Chapter 1 he makes an argumentation with Kratés. Kratés was a grammaticus of Pergamum in 2nd c. BC and noted the line XVIII 489 of Iliad (and V 275 of Odyssey) where it is told that the (Great) Bear never washes herself in Oceanus. Kratés knew that in Greece the Bear was not circumpolar, so he assumed that there was some copy error in Iliad, so emended it. Strabo tells that the emendation is not necessary, because Homer means the polar circle when mentions the Bear.

But in fact we now know that Kratés was in error. In his time in Greece the Big Bear was *not* circumpolar; but in Homer's time it had been. Now, had Strabo knew about precession, he could defend Homer's honour (which he indeed defend in Book 1) by referring the changed celestial positions. But in the book Strabo does not mention the precession at all.

Strabo might have learnt about precession from Hipparchus, but he did not. Interestingly, some modern historians also ignore the effect. The general idea is that some captains discovered the navigation by Polaris when they became tricky enough. On the contrary, our centuries were quite lucky about the *existence* of a Polaris. About 1000 AD it was simply impossible to navigate by means a single star. In Classical Antiquity the extension of the line through γ and β UMi more or less showed onto North Pole; but there was no star of any significance near to the Pole as far back as 2000 BC. And obviously the lodestone would have been difficult to invent without a lodestar.

For Phoenicians/Greeks β UMi was/might have been an approximate lodestar, but with 5-8° error. While this error is substantial, our lodestones point North with similar errors in some Northern regions because North Pole differs from North Maqgnetic Pole. In Middle Bronze Age α Dra (m=3.6) was a good lodestar, but in that time ships did not take open seas. Maybe the Pyramid Builders of Egypt used α Dra. For some earlier millenia there was no lodestar at all.

Interestingly enough, at the end of XIXth century the astronomer author of a monograph in History of Astronomy, the retired director of the Bruxelles Observatory, writes rather confuse things about precession and lodestars [11].

Houzeau cites Hipparchus, who stated that the North Pole formed "a quadrangle with 3 stars". While such a statement is true for any 3 stars, Hipparchus obviously thought about a regular isoceles quadrangle. Now, Houzeau's guess is that the 3 stars are: 31 Cam (fifth rank) and "...two stars of sixth rank from the neighbourhood of the α of Big Bear". This is quite impossible, even if we emend *Little* Bear here. Then Houzeau cites Delambre's guess [12] that the 3 stars were rather κ Dra and α & β UMa. Anybody may check this and can see the impossibility.

Vila-Echagüe recently have identified the 3 stars of Hipparchus' quadrangle as YBS 4646 (m=5.2 in Cam) and YBS 4687 & 4927 (m=5.5 & 6.0 in Dra) [13]. If these were indeed Hipparchus' "pole stars", their faintnesses indicate the high degree of astronomy of Hipparchus. But obviously such faint stars are useless aboard a ship.

6. THE CIRCUMFERENCE OF EARTH: ANOTHER PTOLEMY MYSTERY?

Ptolemy has a book Geographika. There he tells the methods of geography, the principles of mapping, and then,

organised into chapters, give geographic descriptions of many areas of Earth.

As for methods and tools, it is clear that Greeks and Romans could not observe Longitude; that remained a problem even for the British Navy, and was only circumvented via keeping Greenwich Mean Time in precision clocks in XIXth century.

From time to time astronomical ideas appeared, as e.g. the observation of the same eclipse from two distant places. Already ancients suggested it, but the observations were rather poor. After Newton the British Navy tabulated the eclipses of Iovian moons, and by obseving them, latitude could be calculated. However it is quite obvious that Ptolemy did not observe his Longitudes; then the only way to list them was to calculate them from distances, on the assumption that Earth is a sphere of radius R.

On the other hand, Latitude could be directly observed even in the time of Strabo, via measuring the length of the shadow of a rod (gnomon) at some astronomically unique time, e.g. equinox noon. Strabo gives the results of a lot of such measurements, albeit with great imprecision as we can see. Since Ptolemy's book deals with the theory of *climes*, and his mathematic formalism fully covers the area of latitude measurements with gnomons, we may assume that he utilized some such measurements, because on the long run they are more precise than those via distances. (Errors do not accumulate in gnomon measurements.) Obviously we cannot know how much gnomon measurements he used; but it can be assumed that they formed a skeleton of data and then he interpolated them with latitudes calculated from distances between gnomon latitudes.

The problem is that his radius R was wrong. It seems that he more or less accepted Poseidonius' value. This was more or less inevitable (as we will discuss immediately). However, by *calculating* longitudes from distances while *measuring* latitudes directly introduces a basic anisotropy if the assumption for the radius is wrong. Namely generally the way between 2 points is "oblique", neither NS, nor WE. Then the wrong R value will cause a mean error for the calculated longitudes. That is, however, not seen. Details are coming.
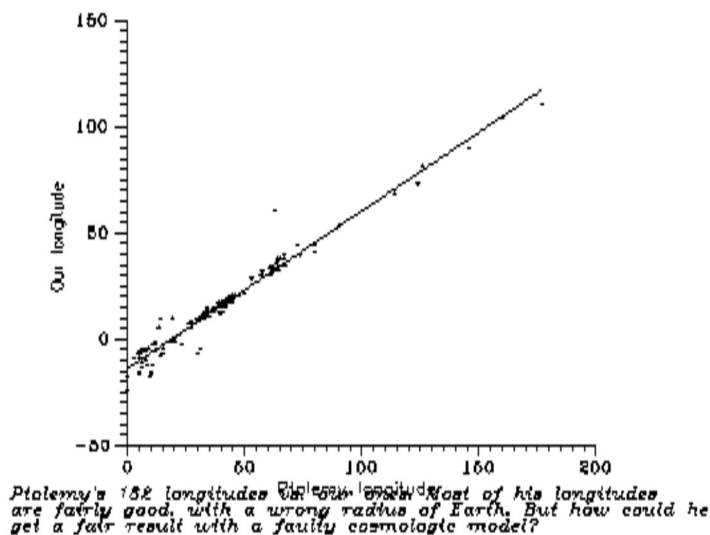
While we will not use any assumption for Ptolemy's R (we saw that his text is not intact), we know 3 different traditions for the circumference $2\pi R$:

Author	Circumference, stadia
Aristotle	400,000
Erathostenes	252,000
Poseidonius	180,000

Although different stadia existed in different cities, the modern value seems to be cca. 220,000.

We do not know anything about the methods behind Aristotle's datum [14], although an observation of Gamow [15] may indicate that it was based on an Eratosthenes-type early measurement (obviously not extending until the Tropic). Eratosthenes, director of the Alexandria Research Complex, combined gnomon and distance measurements. Poseidonios practically did the same, but not with the length of a shadow but he observed the culminations of Canopus in Rhodus & Alexandria. And Poseidonius' measurement was the last of the 3.

Now, the actual value of R will come out from Ptolemy's data. Fig. 1 contains the Ptolemy and modern longitudes of 152 points, collected from the Lacus Curtius site [16]. We will not go into the details of the selection here; they are either globally relevant as easternmost or westernmost points, or important either in the Hungarian/Magyar history (as e.g. the Iazyg settlements between Danube and Tisa or the Riphaean Mountains) or in the history of Relativity (as e.g. the birthplaces of Albert Einstein, Mileva Marity-Einstein and Marcel Grossmann). The dashed line is the best quadratic fit.

Ptolemy's 152 longitudes vs. our longitudes. Most of his longitudes are fairly good, with a wrong radius of Earth. But how could he get a fair result with a faulty cosmologic model?

Let us discuss the Figure. The quadratic term in the fit is very small. The linear part corresponds to a 0 point at our 15°.3 W, which is good for Gran Canaria, and a radius 81 % of the correct value. This is 32,400 km, almost exactly the Poseidonius value.

Almost all the points are very near to the line, except 3 groups:

1) Some of the westermost points. Maybe some hearsay informations were mixed up and some Cap Verde islands were interpreted as Canary Islands. Anyway, Islands of the Blessed are simply the Western ones.

2) Some longitudes in Africa Interior do not fit. Again, these data are hearsay, and the Cap Verde Islands may have been points of reference in some cases.

3) The Riphaean Mountains (the point at 61° Ptolemy longitude) do not fit. True, we do not know what were the Ripheans of Ptolemy; and they can be nonexistent. But in all ancient reports the Riphaeans are in the Northern Scythean region; and there the only mountain is the Ural. (Some ancients tell that gryphons live in the Ripheans. An idea is later that Huns came from the Ripheans. Magyar language belongs to the Ural-Altaic group, within that it is one of the Uralic language. Should we call the group Riphean?). The Ptolomean position of the Riphaean would be cca. that of Moscow, and there is no mountain there.

But otherwise the points fit the line quite tightly and do not show the spread expectable from a wrong radius up to 19 % error. The mystery is how Ptolemy was able to prevent the internal discrepancies from the wrong size of the globe. Namely, assume that you measure latitude directly and distances for longitude. Then the calculated longitude y is obtained as (for simplicity's sake, for nearby points)

(1) $y_i = (d_i^2/\sin^2\theta - R^2(\theta - \theta_o)^2)^{1/2}/R$

in radians, where all d_i's are measured from the zero point (Western Blessed/Canary Islands).

Now, *if* latitude was directly measured for almost all points, then

(2) $\text{delta}_{(bias)}y_i \sim -y_i(\delta R/R)$

Indeed, this bias is clearly seen on Fig. 1. However now let us take a Point 1; a Point 2 with the same latitude, and a Point 3 at a different latitude but so that P_2 and P_3 are on the same meridian. If so, d_{12} gives a fully biassed longitude, but in d_{13} the bias is different, because the "vertical component" of d_{13}, which is subtracted before the longitude difference is calculated, is wrong too. Roughly

(3) $(\delta^2_{(spread)}\varphi)^{1/2} \sim (\delta R/R \sin\theta)(\delta^2_{(spread)}\theta)^{1/2}$

Here the spread of θ is roughly proportional to $d\varphi$ and depends on the "steepness" of paths which Ptolemy used. Considering that the book is dominantly about "Mediterranean" locations, we can take $\theta \sim 40°$ and that we already saw a 19% error in R, if the steepness is homogeneous between 0 and 1, then one should see cca. 20% spread on Fig. 1. It is definitely not seen.

Has Ptolemy corrected out the error in his formula? How? His results seem better than his incoming formulae and he could not even feel implicitly the true longitudes!

To be sure, here Fomenko's New Chronology, putting Ptolemy into cca. XIth century, would not help at all. Until the first circumnavigation, so Magellan, nobody was able to guess the true longitudes, and we know that Cristopfer Columbus essentially accepted the Ptolomean longitudes [17].

A partial explanation may be that Ptolemy may have had very much measured distances between a lot of location pairs. Now assume that these measurements are very correct (which is definitely not the case, but the error propagation could be calculated by us in the proper tedious way). First let us neglect the spherical shape of Earth, which is not too big an error if we are in a limited neighbourhood. Then N locations have 2N unknown coordinates. On the other hand, there are N(N-1)/2 independent distances between them, given by the Pythagoras formula. We can calculate the coordinates from the distances, except 2 data of them, belonging to an arbitrary starting point.

Now, take the moderate N=8 for a grid. Then we should calculate 14 data from 28 distances, so the coordinates are overdetermined. *We* know statistical methods by which the errors of the incoming data (of the distances) can be partially balanced, so the coordinates will be more correct. The same is true if the distances are correct but the distance *formulae* are not. So if we have a spherical geometry but our assumption for R is incorrect, we can determine it too from the distances.

However according to the present status of art of History very little of mathematical statistics was known by Ancient Greeks; and the Ptolomean text directly denies of any correction of the radius (see the longitudes).

So I can only tell that C. Ptolemy (or a whole research group using the name as a figurehead as Nicholas Bourbaki in the XXth century) produced a phenomenally self-consistent set of latitudes and longitudes, maybe via intuitive methods completely lost for us. For any case, the long global peace in the Empire in the time of the "good Emperors" was optimal for building up grids of data. And, although Orthodox History is unable to collect data for C. Ptolemy, or for his methods and background, it at least puts Ptolemy to just the decades of good Emperors.

7. CONCLUSIONS

Fomenko's observation about the Star Catalog of Ptolemy seems to be correct: the very first place of α UMI, our Polaris, would be quite inexplicable before cca. 800 AD. True, this does not prove that Ptolemy would have lived after 800.

However it proves a modification of the text about 1000. Now, the problem is that in that time there seems to have been at least two editions of the text: the copies of the Greek original (see Emperor Manuel & King William in App. B) and those of the Arabic translation (e.g. in Toledo). Later both had Latin translations. Did copyists altered the sequence of stars *in both, independently*?

While I can calculate precession without referring authorities, I am no historian of Middle Ages. So I am not going to offer explanations for the anachronistic Star Catalog of Ptolemy. It seems that once again Academician Fomenko (of Differential Geometry) is right in some details; there indeed are anomalies in the history of Ancient & Early Middle Ages.

As for Ptolemy's Geographika I think that in Fomenko's New Chronology it cannot be genuine. To see this, accept Fomenko's scheme [1]-[7] for a moment, and according to that put Ptolemy to XIth century. According to Fomenko

in that time a lot of the mentioned cities not yet existed (e.g. Rome). OK, some cities might have been interpolated later. XIth century Alexandria is peaceful enough (in New Chronology), but Western Europe is not, so it would have been impossible to build up a large enough grid in some regions of Earth.

The polestar anomaly does not mean necessarily that Fomenko is right in the foundation of New Chronology. One alternative may be, e.g., that somebody (no name so far) observed about 900 that the sequence at the beginning of the Star Catalog is "inverted". He corrected it; and this corrected Catalog was translated to Arabic, or at least Arabs were informed about the needed correction. But this explanation would imply a live, two-sided connection of "Arabia" and "Europe" during Early Middle Ages. Of course other alternative explanations are also possible, welcome and hoped for by me.

Until that I believe that once more again we have met the consequences of the oversimplifying and ideologistic History of Science of the XIXth century. For that century it was enough to tell colourful stories about European Dark Ages, and draw pictures where the Christian mob kills young and nice Hypatia & Astronomy in one person. But if we are content with colourful stories, later we may be confronted even with New Chronology.

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A discussion of the importance having a polestar with CSc Katalin Barlai is acknowledged. Other colleagues of mine were not even interested about the problem, although I tried to discuss it.

APPENDIX A: WHY TO THROW A MENSTRUAL RAG, OR WHAT IS A MODEST BUT FEARLESS BEHAVIOUR FOR A MAIDEN IN ALL-MALE COMMUNITY

The medieval Suda (or Suidas) Lexicon tells a naturalistic story about Hypatia [18]. But first let us remark that the girl lecturer (according to majority opinion she never married) was neo-Platonist. A good neo-Platonist prefers Spirit to Body. Bodily functions are secondary, at best. Also, note that at her lynching she in her fifties (according to Maria Dzielska, she was even 60 [19]), contrary to the romantic paintings & engravings of XVIIIth and XIXth centuries.

Now, the story tells that one of Hypatia's students was in love with the girl teacher and proposed her repeatedly. The maiden did not like the molestation but the youth was adamant. Then, after the nth proposal, in the lecture hall modest Hypatia threw something at the youth, telling: this is I, not the high spirit you see in me. The bundle proved to be a rag full with menstruation blood. Seems that modest and highly intellectual Hypatia simply snatched her daily intimate rags from under her vestment on the spot. I imagine the hilarity in the lecture hall.

Of course this may be a falsification of history by Suda. (And Suda modestly tells: she *brought* the rags *to* the lecture, and threw them not *at* but *before* him. But why to bring stained odorous rags into a lecture hall? Was she sure she will be molested that day?) However there is an alternative explanation.

We are not informed about relative ages; but we can guess that lecturer Hypatia was older than the student. Now, imagine, say, her as 48 old. Then the rag is an evidence of her relative youth... I think this consideration supports Maria Dzielska; if, according to romantic historians, she had been born in 370, she never would have got into the situation to boast with the stained rags.

I emphasize that I do not detect any evidence to accept Lewis' point of view [20]. He tells about her way of demonstration that "...the most common Prostitute in Venice would blush at"; and according to his reconstruction Hypatia refused the youth because she was interested in Orestes, Prefect of Alexandria. I think a common prostitute of 1721 in Venice was not so sensitive as Lewis believed; and while Hypatia may or may not have been interested in the prefect, any engagement or attempt for engagement with Orestes is without any textual support, and Pana Dzielska could laugh at the idea on chronological grounds.

So much about proofs in History of Science.

APPENDIX B: WHY VIA ARABIA?

"Almagest" seems to come from the Arabic determinate particle "Al"=The + "Megalé Syntaxis" = Great Compilation (or Megiszté=Greatest). The usual explanation of the Arabic interlude is that "in the Dark Ages" science vanished from "Europe". Libraries/schools vanished. The Arabs preserved the knowledge (maybe directly in Alexandria, maybe through the Syrians of Nisibis), later the Arabs translated the original Greek Syntaxis and then Europe got the Arabic texts through Toledo, Hispania.

OK; but look. The original of Megalé Syntaxis was Greek, in Alexandria. With the partition of the Empire in 395 Alexandria went with the East, where, in first approximation, there was no Migration Period, so Dark Ages did not follow. There were almost 500 years that Eastern libraries (e.g. the Imperial Palace in Constantinople) get the book.

True, the copy of the Imperial Palace may have vanished in 1204, as a consequence of 4th Crusade. But in the previous century the Komnenos Emperors had good contacts with "Latins". They married with French princesses, both from France and from the Outremer; Venice was their vassal and economic partner; and for a time the later Béla III of Hungary, as Alexios, was the Heir Apparent in Constantinople. He was a relative of Emperor Manuel I, who, in turn, was the son of Irene, later saint of the Byzantine Church, but originally Princess Piroska of Hungary, daughter of King Ladislas I, later saint of the Roman Church. Until 1185, if an European scholar (monk or priest) had been interested in Megalé Syntaxis, he could order a copy in Greek for the price of a few mules from the Imperial Library.

And indeed, we have evidence for the existence of Megale Syntaxis in Constantinople and for its Western acceptance in XIIth century. Emperor Manuel did send a copy of the Syntaxis to the "Latins", in 1158, to King William I of Naples & Sicily, who made it to be translated; it is told to be now in Venice as Codex Marcianus 313 saec. X.

So, why through Arabic?

APPENDIX C: GREEKS AND THE LITTLE BEAR

The Bears are two well known asterisms. It is easy enough to find the Big Bear; the little one is not so obvious and the usual amateur way to find Polaris, α UMi, is not through the recognition of the Little Bear (of whose stars 4 are rather faint), but via extending the line between β and α UMa 5 more times.

We generally visualize both Bears as quadrangles with handles. Surely this is the reason that Americans call them Dippers as well. Some Indo-Europeans call the asterisms Cart or Wagon; and the Magyar name is Göncöl's Cart. We are not sure, who was Göncöl, but certainly he was a great Shaman.

The important thing is that moderns do not see bears in the asterisms; but Greeks saw. Hence the Latin name too: Ursae Maior & Minor. Surely the Ursa Maior is Callisto, daughter of Lycaon, King of Lycosura, fellow huntress of Artemis. The myth generally goes that she started an amorous relation with Chief God Zeus, then bathing with virgin Artemis the goddess detected the signs of pregnancy, became angry, and turned Callisto into a bear. Another story tells that Zeus' jealous wife Hera turned Callisto into a bear.

So far so good. But the story becomes self-contradictory with the Little Bear. A story (maybe invented by poet Ovid) tells that the embryo was born, somehow. He was Arcas, and became a big hunter. After many years he was hunting bears and became confronted with his mother. Then Zeus, to prevent matricide, took them into Sky, both as bears.

But Arcas cannot be Ursa Minor; even if Minor is the infant Arcas, he could only be Ursus Minor. Greek and Latin automatically show genders. So obviously the story of the Little Bear is an afterthought, and the original story ended somewhere when the dogs of son Arcas tried to kill mother Callisto in form of a bear. Indeed, the most detailed and most scholarly extant ancient encyclopedia of myths [21] tells the Callisto story, with some variants too, the elevation of Callisto as an asterism, and then the life of Arcas, leader of Arcadians, without any second Bear.

And now back to Strabo. In I.1.6 he is defending Homer against the accusation of ignorance. Yes, he knew only one Bear; but in his time all Greeks knew only the Big One, because the Little Bear as a definite asterism became

established *only after the Phoenicians discovered it and applied in navigation.*

Without precession Strabo believes the same as our historians. Our ancestors were dumb; some others could navigate in ancient times. But in reality, the Little Bear became useful in navigation only in Classical Antiquity. About 500 BC one could make an approximate geometric construction on sky for North Pole roughly as follows. Draw a line between α UMi (m=2.1) and ε UMa (m=1.7). North Pole is not far from the middle of this line; but you can correct it by intersecting this line with the extension of the line of γ & β UMi. But for this you must identify a new asterism containing 3 of the stars in the construction; and the simplest way is to organise the stars into an asterism of the same form as Bear (Callisto), Then the new asterism is smaller, some stars are faint, so it is the *Little* Bear; but still mythology is in confusion who is this Little *Female* Bear.

Even this construction worked better *after* 500 BC. About 1000 BC it would have been rather meaningless. So why to identify an asterism containing α , β & γ UMi together in the time of Homeric Wars?

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