Estimate of the development of the Chinese astronomy through observations of nova outbursts

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Abstract. More than a hundred descriptions of guest stars observations made by Chinese, Korean and Japanese astronomers within the period from 6th till 17th centuries are examined in this paper. The aim of this investigation is the evaluation of the dynamics of the Chinese astronomy through observations of outbursts of new stars. The comparison of the distribution of star outbursts on galactic latitudes from the Chinese sources with the modern data casts doubt on the reliability of the ancient observations. The text analysis of these observations shows that the technique of the descriptions of the places of outbursts of new stars does not change from the first ancient observations till the 16th century. This is a sign of a lack of precise instrumental measurements until the 16th century and of their own star catalog in medieval China.

Key words: history of astronomy, nova stars, guest stars

1 Introduction

Lundmark's work. One of the first works devoted to the study of explosion of nova stars is the K. Lundmark (1921) paper. Lundmark has used 60 new outbursts reported in the period from 134 BC on August 18, 1828. Most of the data were taken from the encyclopedia Wen-Hieng-Tong-Kao, which are records of Chinese astronomers. The Chinese did not measure the coordinates of "guest stars", but described approximately their location relatively to their constellations-asterisms. The last seven outbursts from the Lundmark list are a result of observation of European astronomers, that is why the coordinates are measured accurately. As a result, the author has calculated the distribution of the registered nova outbursts in galactic latitude-longitude coordinates. As expected, the majority of the outbursts grouped in the plane of the galaxy, but in 10 cases, the latitude exceeded 40 degrees.

At the beginning of the 20th century, the mechanism of nova outbursts was not yet known. Lundmark assumed that some of the irregular variable stars in the later stages of evolution may explode as nova. In particular, he believed that the stars of the type R Northern Crown could be ancient novae. Lundmark made a sample of 18 irregular variable stars and obtained the distribution of the outbursts on galactic latitude, analogous to the distribution of 60 chronicles of nova stars. Unfortunately, he was wrong twice. First, at present it is known that each nova star is a close double system, one component of which is a white dwarf. "Ordinary" single stars cannot explode as a nova at any stage of evolution. Second, the nature of variability of the stars, selected by Lundmark, was quite different. Four of all eighteen stars belong to the type of T Tau, four more stars are related to the type of the carbon stars R CrB, three stars of the type of Z And, two irregular stars, a recurrent nova (U Sco), an eclipse (SY Cep), an eruptive type γ Cas (X Per), one mirida kind (UV Cen) and one more star with a constant magnitude (X

Vir). Therefore, the Lundmark work is of interest only from a historical point of view.

Stephenson and Clark's study. Among other studies, Stephenson and Clark's (1977) work attracts special attention. From the sources of Ho Peng Yorke (1962), His Tse-Tsung and Po Shu-Jen the authors picked out 75 events that are possible nova outbursts. The authors adduced the only coordinate for the events number 12, 20, 23, 31 and 32. They estimated the value of declination for all these outbursts at 65 degrees. Unfortunately, there are no comments in the text, for what reasons these assessments were made. It's impossible to define the location of an outburst only by one coordinate; therefore these events can't be used for the analysis. It seems the events numbered 73 and 74 are the description of one and the same outburst made by different observers. The places of outbursts differ only by 7 degrees, and the dates of outbursts differ in 4 days. Among the rest descriptions, the authors have excluded another five observations, so the working data set consists of 64 observations of guest-stars.

As a result of the calculation, Clark and Stephenson received approximately isotropic distribution of outbursts of nova stars on the celestial sphere. They explained the isotropic distribution by proximity of bright novae to the viewer. The authors provided a "conservative estimate" of limit magnitude of a bright nova star about $+3^m$.

"The isotropic distribution of the short-duration objects is that which would be expected both for the comets and for novae close enough to stand a reasonable chance of being discovered. (Stephenson (1976) has estimated an average distance for novae bright enough to be noticed of about 500 pc. From Payne-Gaposchkin (1957) the average distance from the galactic plane in the vicinity of the Sun is 275 pc. Thus a fairly isotropic distribution in galactic longitude and latitude is expected.)"

Indeed, the similar result can be obtained if we assume the limit visibility of a bright nova on distance of about 500 parsecs. However, equity of this assessment is questionable. Table 1 shows the distance and visual magnitudes of some bright nova stars, observed in the 20th century, taken from Pskovskiy (1985).

Nova Star	**D, pc**	$\mathbf{m}_{Max}$	$\mathbf{m}_{min}$	**M**
Perseus 1901	470	0	13	-9
Aquila 1918	350	-1	12	-9
Cygnus 1920	1680	2	17	-10
Pictor 1925	350	1	12	-7
Hercules 1934	270	1	15	-6
Lacerta 1936	1940	2	15	-9
Puppis 1942	700	0	17	-9
Cygnus 1975	1350	2	17	-10

Table 1. The distance and visual magnitudes of some bright nova stars, observed in the 20th century.

In this table, D - the distance in parsecs, m_{Max} - the visual magnitude of nova in maximum, m_{min} - value of magnitude after outburst, M - the absolute magnitude of nova in maximum.

Following Clark and Stephenson we'll accept that a bright nova has to correspond to the star with brilliance brighter than 2^m-3^m. This brilliance approximately corresponds to the stars of the contour of easily recognized constellations of Ursa Major and Cassiopeia; and a star of such brightness will change the appearance of any constellation. According to Table 1, the distance to the nova Cygni 1920, Lacertae 1936 and Cygni 1975 is $3 \div 4$ times as high as Stephenson's assessment, which makes up 500 parsecs; although a star of a second magnitude should be regarded as a bright nova.

Moreover, it is easy to estimate that, if we hypothetically remove nova Persei 1901, Aquilae 1918 or Puppis 1942 to the distance of one kpc, their brilliance will remain greater than the brightness of a second magnitude. Therefore, the assessment of the distance of the observation of a bright nova, proposed by Clark and Stephenson, is understated; and the isotropy of outbursts of novae according to galactic latitude, which they received, is explained by other effect.

In present time, there are large amounts of observational data of outbreak of new stars of various types. Over the past decades, the lists of Chinese, Korean and Japanese observations of guest stars were clarified and supplemented by new data. In some cases, the descriptions of the same guest stars by different observers lead to more confidently exclude the option comet. The increase in the total number of outbreaks by adding previously unknown observations permit to get more accurate statistical estimates. The purpose of this study is to assess the dynamics of the Chinese astronomy observations of outbursts of nova stars.

2 Information from the ancient and medieval observations

As the initial data, the work of Pankenier et al. (2000), containing the texts of observations in Chinese and their English translations, was used. In all there are 102 descriptions of observations of different guest stars conducted in China, Korea and Japan. Some outbursts are described simultaneously in several sources and it allows to make some clarifications. Compiling the list of nova stars, the authors conducted a strict selection having excluded all the descriptions, where locations of outbursts were indicated very inaccurately, the descriptions which resembled in some way the observation of a comet or vague descriptions containing the phrase "strange star" or "abnormal star." The contents of the observations can be divided into three categories.

Date of observation. In the descriptions, the date of observation usually reports the name of the day in the 60-day cycle, the month of the lunar calendar and the year of the rein of a certain emperor of a certain dynasty. Using the time-tables, it can be converted to Julian calendar dates that had already been done by the Pankenier et al. (2000).

Location of an outburst. In almost all cases, the localization of an outburst is given to within nearest asterism or a lunar mansion. A lunar mansion is one of the 28 asterisms, located near the ecliptic plane. Typically, lunar mansions were used to describe positions of the Moon and planets. Taking into account the location on the celestial sphere identified Chinese asterisms, we can find out locations of outbreaks with 10-20 degrees accuracy. In addition, there is one Japanese (N642) and three Korean observations (N1163, N1356 and N1399), where the places of the appearance of new stars are given relative to the Moon: *"A guest star entered the Moon"* and *"A guest star trespassed the Moon"*. Stephenson (1968) estimated the coordinates of a new star to within several degrees by studying the Japanese observation. Such precision is quite acceptable for our study; therefore, we will use the Stephenson's results, and will apply his methodology for the three Korean observations. Note that the drawback of these observations is the dependence of the location of new star on calendar dates. In the case of error of dates of about 2-3 days we can get very different place of the outbreak. However, verification shows that in all cases the guest-stars were observed near the Milky Way, so we'll consider them reliable.

Extra information. In some cases the color of the star, comparison of the visual magnitude of the new star with a planet or another star, or the duration of visibility is reported. This information makes it possible to assert with greater confidence that the observer registered the outburst of a new star, rather than a comet or some atmospheric phenomenon. Moreover, the duration of visibility provides the opportunity to define the type of novae to which the star can be related to.

Accuracy of the localization of outbursts. Assessing the accuracy of describing the situation of a guest star is a very important task. If the locations of outbreaks are given with errors in the tens of degrees, the analysis of such information does not make sense. We have estimated that the error description of an outbreak is usually not more than 10-20 degrees. However, the error can be independently checked by using the descriptions of observations of historical supernova Sn1006, Sn1054, Sn1181, Sn1572 and Sn1604 which locations are precisely defined by remnant. We have considered all available descriptions of each outburst.

Supernova Lupus of 1006. Out of six adduced observations of the supernova Lupus of 1006, in the first two Chinese chronicles the location of the outburst is not reported, and these observations are identified with a supernova Wolf only by date. In three more observations the position of the outburst is described by using simultaneously lunar mansion and the nearest asterism. If we calculate the distance from the center of the third lunar mansion (star α Lib), formally, we'll get the distance to the supernova equal to 26 degrees. However, the real accuracy of observations is higher as the text states that the star was observed at three degrees south of the mansion. If the distance is assessed through the western part of asterism *Quigan*, which corresponds to a fragment of the western part of the constellation Centauri, which in the 11th century could be seen in China, then the distance to the supernova can be estimated from 5 to 15 degrees. Finally, the most accurate assessment is provided by Japanese observation in which the outburst is described concerning the asterism with the main star κ Lup. In this case, the error is only a few degrees.
1. "... A guest star emerged in the southeast quarter. ... " Song shi Tianwen

zhi ch. 56.
2. "... a ZHOU BO star appeared. " Song shi Zhenzong san ch. 56.
3. "... It was yellow, and it emerged east of KULOU and west of QIGUAN. It grew brighter by degrees and it was measured to be three du in DI [LM 3]. ... " Song huiyao jigao ch. 52.
4. "... A star emerged south of DI [LM 3], one du west of QIGAN. ..." Song shi Tianwen zhi ch. 56.
5. "... A guest star entered QUIGAN. ..." Ichidai yoki tei.
6. "... Some wondered whether the QICHEN JIANGJUN star had changed the original body and increased in brightness. ..." Mei getsu ki ch. 23.

Supernova Taurus of 1054. Supernova of Taurus is described in four Chinese and two Japanese chronicles. It is indicated in all sources that a guest star was observed near *Tianguan* or ζ Tau. It corresponds to the accuracy of descriptions about one degrees. In two last cases, the descriptions by lunar mansions are presented. If we estimate the average distance from the centers of the lunar mansions to the supernova, we'll get the distance ofabout 20 degrees.
1. "... A guest star emerged several cun southeast of TIANGUAN. ..." Song Shi Tianwen zhi ch. 56.
2. "... a guest star has appeared in the east at dawn guarding TIANGUAN. ..." Song Shi Renzong zhi ch. 12.
3. "... [The guest star] appeared at dawn in the east guarding TIANGUAN. ..." Song huiyao jigao ch. 52.
4. "... A guest star appeared several cun southeast of TIANGUAN. ..." Xu Zizhi tongjian chang bian ch. 176.
5. "... a guest star emerged in the space of ZUI [LM 20] and SHEN [LM 21]. It appeared fuzzy in the east at the TIANGUAN star. ..." Mei getsu ki ch. 23.
6. "... A large guest star emerged in the asterisms of ZUI [LM 20] and SHEN [LM 21]. It was seen in the east fuzzy at the TIANGUAN star. ... " Ichidai yoki tei.

Supernova Cassiopeia of 1181. This outburst is described in four chronicles. In the first source, the place of outburst is given by the lunar mansion and the nearest asterism. The distance from the supernova to the central star of 15^{th} lunar mansion (η And) is about 40 degrees, but the distance to the stars of asterism *Chuanshe* is about several degrees. In the second and third observations, the place of the outburst is described by the stars ψ, α and β Cas, which provides the accuracy of descriptions about several degrees. In the last Japanese observation is told that the guest star appeared in north-east direction. In the beginning of August, when the outburst occurred, the constellation of Cassiopeia rises on latitude of Japan in north-east direction.
1. "... A guest star emerged in lunar mansion KUI [LM 15] and trespassed against the stars of CHUANSHE. ..." Song Shi Tianwen zhi ch. 56.
2. "... A guest star appeared in HUAGAI. ..." Jin Shi Tianwen zhi ch. 20.
3. "... a guest star appeared in the north close to WANGLIANG guarding CHUANSHE. ..." Mei getsu ki ch. 23.
4. "... a guest star appeared in the gen [NE] direction. ..." Azuma kagami ch.

2.

Tycho's supernova of 1572. Supernova of 1572 is described only in two chronicles. In the Chinese observation, the location of the outburst is indicated through the 14^{th} lunar mansion with the center near γ Peg, which approximately conforms to the ecliptic longitude of the outburst; and asterism Gedao with the center φ Cas. The distance from the supernova to the center of the 14^{th} lunar mansion is about 50 degrees; however, it was only 6 degrees from the center of asterism *Gedao*. In the Japanese observation, the location is described concerning the γ Cas, which corresponds to the accuracy of descriptions about 3 degrees.
1. "... It emerged beside GEDAO in the space of BI [LM 14]. ..." Ming Shenzong shilu ch. 6.
2. "... A guest star appeared beside CEXING; it was lager than Venus. ..." Yijo sillok Sonjo sujong ch. 6.

Kepler's supernova of the year 1604. In four of the six descriptions of the supernova of 1604, the outburst is described concerning the lunar mansion *Wei*, the center of which is the star μ Sco.
1. "... It was situated in WEI [LM 6]. ..." Ming Shenzong shilu ch. 404.
2. "... From the 9^{th} month of the 32^{nd} year on, the guest star appeared in the space of WEI [LM 6]. ..." Ming Shenzong shilu ch. 412.
3. "... In the space of WEI [LM 6] there was a star the size of a crossbow pellet and reddish-yellow in color. ..." Ming Shi Tianwen zhi ch. 27.
4. "... During the first watch of the night, a guest star was at the tenth du of WEI and distant 110 du from pole. ..." Yijo sillok Sonjo ch. 178.

The distance from the central star of asterism to the supernova is 17 degrees. The latter text adduces the measured distances from the supernova to the lunar mansion and the pole; however, such measurements are no longer found in other surveys. In the last two descriptions, in one case, the location of the outburst is not specified at all; and in the other case, the location is indicated by means of the nearest asterism. This gives an error of about 3 degrees.
5. "... At night, in the southwest a strange star was produced. ..." Ming Shenzong shilu ch. 400.
6. "... The guest star appeared above TIANJANG and was larger than the Fire Star of XIN [LM5]. ..." Chunbo munhon pigo ch. 6.

To complete the picture, let's examine the guest stars of 185, 386 and 393, which in Green and Stephenson's opinion can be outbursts of supernovae. Note, that these stars are known only from the Chinese observations, although at the time of these outbreaks Greek astronomers were active.

The guest star of the year 185. The star in the year of 185 appeared in the asterism *Nanmen* and being visible for at least 8 months, it changed a few colors. This last feature is the strongest argument in favor of the emergence of a supernova. The asterism *Nanmen* corresponds to the neighborhood of the stars α, β Cen; but some authors believe that the appointed location of the outburst is unreliable (Clark & Stephenson 1977). The point is that *Nanmen* the area is relatively not high above the horizon, even for 20 degrees north latitude. For the capital of the empire, located in the latitude of 35 degrees, visibility is even worse, so the possibility of prolonged observation of the guest star is doubtful. We consider several options for the location of the star of 185: the area of α and ε Cen, β and ε Cen. Chin & Huang (1994) believe that the outburst occurred in the vicinity of the stars α and ξ Cen. They substantiate the assumption that the confusion arose at a later stage of the correction of the text. They explain the changing of the color of the star by atmospheric phenomena due to the proximity to the horizon. If we, however, identify the location of the guest star near α and β Cen, where the plane of the galactic equator passes, then the most preferable options of identification with a star of 185 are the remnants of G315.4-2.3 and G320.4-1.2 (=MSH 15-52). The latter remnant is associated with pulsar PSR 1509-58; the characteristic age of which is about 150 thousand years. The age of the remnants themselves, estimated by the Sedov model, exceeds 10 thousand years, so Chin & Huang make the assumption that in the Chinese chronicles a comet, not a supernova, is described.

Guest star of AD 386. The guest star of AD 386 appeared near the group of stars *Nandou* (λ, μ, φ Sgr) and was observed for 3 months. We mention at once, that the reason, why this outburst is identified with a hypothetical outburst of a supernova, is unknown. In China, the constellation of Sagittarius can be seen high enough above the horizon, but the outburst of the guest star was being observed just for 3 months. Such period of visibility corresponds to the "slow" kind of nova.

Assuming that the Chinese observed a supernova, the only possible identification is the remnant of G11.2-0.3 with 65 millisecond pulsar PSR J1811-1925 in the center of it. Using radio observations at 20 cm and 6 cm wavelengths, the Tam (2003) determined the angular velocities of the expansion of the nebula, which are respectively 0.057 +/-0.012 "/year and 0.040 +/-0.013 "/year. Knowing the angular size of the nebula ~4.5' (Green - online catalogue) and assuming a linear expansion, it is not difficult to estimate the lower and upper boundaries of the time of the outburst from 2000 to 5000 thousand years. Estimation through the average speed expansion gives the age of about 2800 years. All the assessments quite correspond to the historical age of 1600 years, differing from it a little more than a millennium. On the other hand, the characteristic age of the pulsar, defined by the slowing of its rotation, is about 24 thousand years; this is 15 times higher than the expected age of the remnant. Even if we assume that the initial period of rotation of the pulsar was half of the modern one, its age will be about 18 thousand years. Therefore, in order to link the pulsar with the remnant with certainty, we should assume that the initial period didn't differ greatly from the present one and was about 62 ms.

Most likely, in 386 there was a nova outburst, as evidenced by a short duration of its visibility. In this case, the decisive argument is the duration of the outburst. It is known, that the supernovae of 1054 and 1604 were still observed a year after the outburst. The connection with the remnant G11.2-0.3 is accidental, although it roughly corresponds to the age of the outburst.

Note, that the outburst was observed in the direction of galactic nucleus; the description of the location of the outburst is inaccurate, as well as the datings of the remnants themselves. Therefore, it is not surprising that in the field with the size of several tens of degrees it is possible to show a certain remnant, which is approximately suitable for the age.

Guest star of AD 393. The guest star of AD 393 was visible for 8 months in the asterism *Wei*, which lies near the galactic equator. Clark and Stephenson (1977) examined seven possible supernova remnants that are in the asterism Wei. The authors identified as possible candidates G348.5+0.1 and G348.7+0.3, but both of them are 10.5 kpc away and have unsuitable age. Pfeffermann and Aschenbah (1996) were offered to identify the star of AD 393 with the remnant RX J1713.7-3946. They determined the distance to the remnant of about 1.1 kpc, and estimated the age of the remnant of about 2100 years using the Sedov model. Given that the remnant is located in the asterism *Wei* and has appropriate age, the identification of the guest star of AD 393 with the remnant RX J1713.7-3946 seems quite logical. However, more recent studies show that the assessment of the distance to the remnant has been significantly underestimated (Uchiyama et al. 2002). The research has shown that the remnant is surrounded by a molecular cloud with a concentration of about 1000 particles in cm^3, which interacts with the expanding remnant of a supernova. It was found out that the distance to the cloud was equal to about 6 kpc; it follows from this that the age estimate of the remnant is from 19 to 41 thousand years. Such age of the remnant RX J1713.7-3946 excludes the possibility of its identification with the guest star of AD 393.

Conclusion. Studies of the texts with the descriptions of outbursts of historical supernovae showed that the best accuracy is reached by the description of the location of outburst through the nearest asterism. In this case, the error of localization of the outburst is only about several degrees. In cases, when the location of the star is described simultaneously through the lunar mansion and the nearest asterism, the precision of the description through the lunar mansion reaches tens of degrees. Such picture was observed in the descriptions of 4 Sn1006, 1 Sn1181 and 1 Sn1572. When location of the outburst is described only through a lunar mansion, the precision can be better; that is observed in the description Sn1604. On the other hand, the error in tens of degrees during the description of the location of the outburst, through the lunar mansion, is not a standard or a general rule. Centers of lunar mansions *Fang* [π Sco], *Xing* [σ Sco], *Wei* [μ Sco], *Nandou* [φ Sgr], *Zui* [λ Ori], *Jing* [μ Gem] are located near the plane of the Galaxy, where the emergence of a nova is most likely. Therefore, the description of the location of the outburst concerning one of these lunar mansions doesn't mean wittingly low accuracy of the localization of the outburst. However, if the text contains several variants of location of the outburst we'll give preference to the description made through the nearest asterism.

3 How are outbursts of novae spread in the sky?

To study the distribution of outbursts of novae in the sky, the general catalog of variable stars (Durlevich - online catalogue) was used. We grouped the novae according to the classification adopted in the catalog, and supplemented them with the class of symbiotic stars of type Z And. Fig. 1 shows

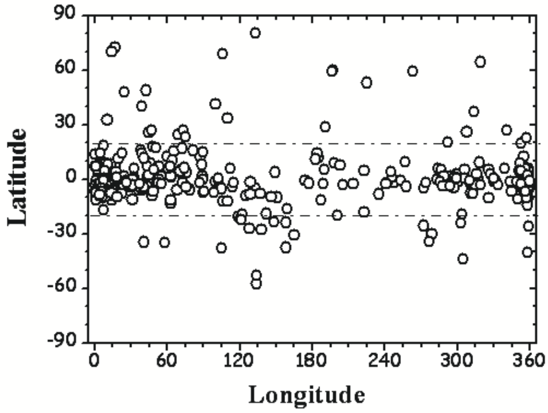

Fig. 1. Distribution of novae and stars of Z And type.

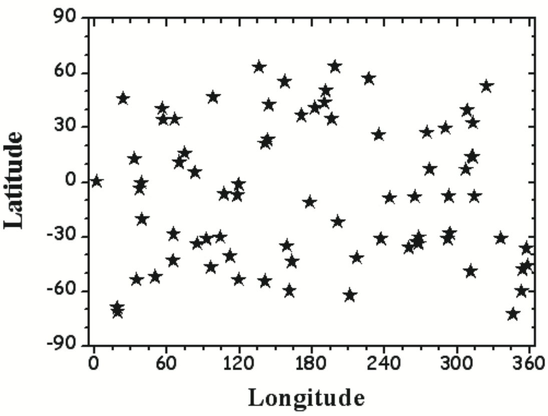

Fig. 2. Distribution of novalike stars.

the distribution of novae of different types and the stars of Z And type in galactic coordinates. The calculation shows that over 85% of stars have an absolute value of latitude less than 30 degrees, and only 3% of stars have the value of latitude exceeding 60 degrees. Consequently, most of the outbursts

were recorded at low latitudes, near the galactic equator. The nucleus of the Galaxy is located in the range of longitudes from 0 to 60 degrees, so the greatest amount of outbursts is observed here. Symbiotic stars of the type Z And have the similar distribution. These stars do not belong to the type of novae, but they have amplitudes up to several stellar magnitudes.
Novalike stars, (Type NL) Fig. 2, have quite different distribution. The outbursts of these stars have never been observed, however, their spectra resemble the spectra of novae in the post-outburst. Novalike stars are distributed uniformly to 60 degrees latitude, and relatively small number of stars of this type is located in the galactic equator.
The differences of the distributions of novae and novalike stars have a simple explanation. Most of the known novalike stars have a brilliance of $11^m \div 16^m$, which changes slightly within the limit of $1^m \div 3^m$. The identification of weaker novalike objects is difficult, therefore we can see only the nearest stars. The amplitudes of the outbursts of new stars reach $7^m \div 16^m$, so with the same visible brilliance of $11^m \div 16^m$, we can observe the outburst of novae from a much greater distance. Large remoteness leads to the fact that, unlike novalike stars, the novae are closely clustered along the galactic equator.

Let us consider in more detail the likelihood of registration of an outburst of a nova star depending on the galactic latitude. For this, we calculate the absolute value of galactic latitude of the selected stars and sort them into groups with a step of ten degrees on the latitude. As a result of this operation, we will determine the frequency of hit of outbursts in each of the ranges. If we divide the values of frequencies by the total number of outbursts, we'll get the dependence of the probability of detecting an outburst on galactic latitude.

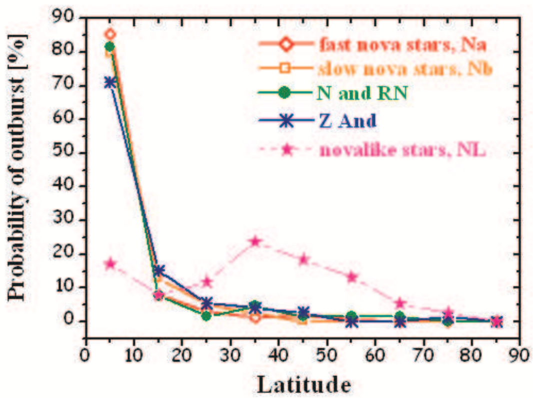

Fig. 3. Probability of nova explosion depending on galactic latitude.

Fig. 3 shows the distribution of numbers of nova explosions of different types, depending on galactic latitude. It follows from the figure that over 80%

of outbursts of "ordinary" novae of Na ("rapid" nova), N, and Nb ("slow" nova) type fall on galactic latitudes upto 10 degrees, and less than 10% of the total number of outbursts fall on the latitudes of more than 20 degrees. Z And-type stars have much smaller amplitude of luster compared with the luster of nova stars. Therefore, we can observe the stars of this type at a much closer range, and they are located at a greater remoteness from the galactic equator.

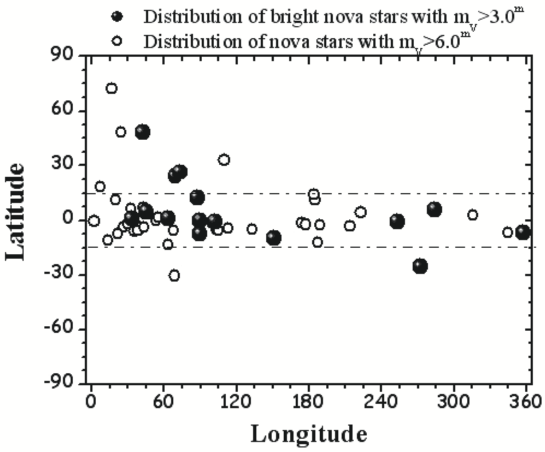

Fig. 4. Distribution of outbursts of bright nova stars in galactic coordinates.

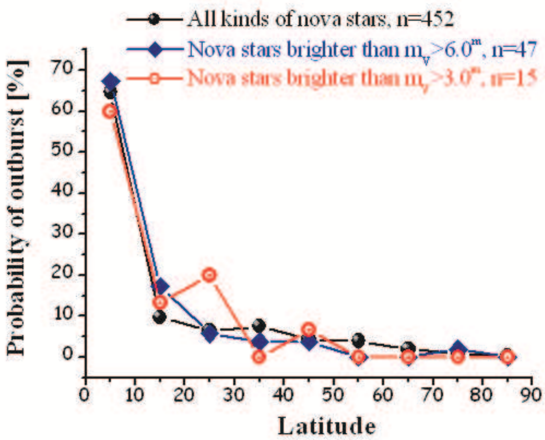

Fig. 5. Probability of outburst of a bright nova star depending on galactic latitude.

The above result was obtained when using all the catalog stars, most of which are not visible with the naked eye. However, ancient and medieval observations of Chinese astronomers were visual. Hence, there is a need to estimate how the brightest novae, which in maximum brilliance could be seen with the naked eye, form groups on latitudes.

Fig. 4, 5 show the latitudinal distribution of outbursts of bright novae, which could be visible in the maximum with the naked eye.It follows from Fig. 4 and Fig. 5 that even the brightest novae, which can be seen with the naked eye, obey to the established conformity. The outbursts are closely grouped in the region of galactic equator, and 80÷85% of the total number of outbursts of novae fall on galactic latitudes between -20 and 20 degrees. Only one outburst is registered above 50 degree of latitude. The bulk of outbursts are grouped in the interval of longitudes [0, 60] degrees, which corresponds to the direction to the nucleus of Galaxy.

A similar distribution pattern can be set by bright stars of the Earth sky. For this purpose, we took the stars with brightness m_V greater than 2.5^m, and using certain parallax (ESA 1997), we estimated their absolute magnitudes without taking into account the interstellar absorption (see Fig. 6). In Fig. 6, the small circles indicate bright stars with brilliance m_V higher than 2.5^m. Stars, the absolute magnitude of which exceeds -4.0^m, are marked with large circles. From the figure it follows that most of the bright stars grouped near the galactic equator and only 3 stars, out of 25 (α Car, β Ori, ε Peg), do not fall into the interval of latitudes [-20, 20] degrees, and only one star, ε Peg, has mid-latitude in the interval [30, 60] degrees. The stars, marked with orange circles, are giants and supergiants. Their absolute stellar magnitudes in most cases are in the range from -4^m÷-6^m. However, the absolute magnitudes of nova stars in the maximum brightness are between -6^m÷-10^m; it is several magnitudes higher than the brightness of supergiants. Therefore, the outbursts of new stars are visible from a longer distance.

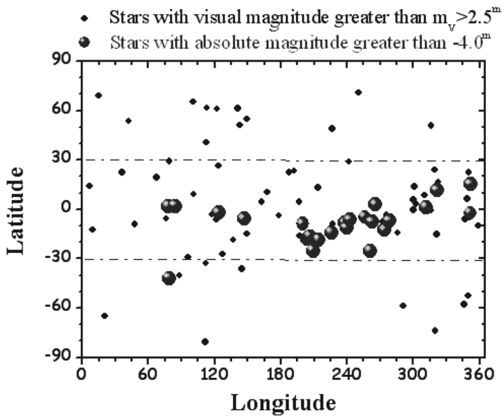

Fig. 6. Distribution of bright nova stars in the Earth sky in galactic coordinates.

This leads to the fact that the distribution of nova stars is flattened and more closely pressed to the galactic equator, as compared with the distribution of supergiants. It follows that the exposed conformity of the distribution of outbursts on galactic latitudes can be extended to the ancient and medieval observations of outbursts, and it opens the possibility for independent verification of the credibility.

4 Verification of the data of Chinese canon of nova stars.

Now we have the necessary information for the historical and astronomical analysis. The problem consists in the following: on the one hand, Stephenson and Clark (1977) got isotropic distribution of annalistic outbursts across the sky. However, they underestimated the assessment of the distance to a bright nova, and so the proposed explanation of this effect is erroneous. On the other hand, chronicles of distribution of outbursts, obtained by Stephenson and Clark (1977), are not consistent with the current observational data. Since the accuracy of modern observations is out of doubt, it is suspected that the annalistic observations are unreliable. If so, it is necessary to understand the reason of unreliability of the observations. In addition, it is necessary to estimate since what time the annalistic monitoring should be considered reliable? To answer this question definitely, it's necessary to have a large number of observations, where the place of the outburst is localized with the accuracy to a few degrees. In total, we have at our disposal 102 accessible descriptions, which, in the Pankenier et al. (2000) opinion, belong to different outbursts. Unfortunately, we have not found the identification of outburst number 5, which occurred in asterism *Zhaoyao*. So, we used only 101 descriptions in the calculations. Nevertheless, there is a reason for suspecting the existence of two duplicates that could arise due to erroneous dating of chronicles. In all likelihood, the outburst 98 in our list is in reality the observation of the supernova Sn1604, which corresponds to the outburst 99.

98. AD 1600 Dec 14 [Korea]

"33rd year of King Sonjo, 11th month, day jiyou [46]. A guest star was in WEI [LM 6]. It was larger than Fire Star (HUOXING of XIN [LM 5]). Its color was orange and glittered." [Chunbo munhon pigo] ch. 6.

99. AD 1604 Oct 13 [Korea]

(5):"37th year of King Sonjo, 9th month, day wuchen [5]. During the first watch of the night, a guest star was at the tenth du of WEI [LM 6] and distant 110 du from the Pole. It was smaller than Jupiter, orange in color and scintillated." [Yijo sillok Sonjo] ch. 27.

(6): "37th year of King Sonjo, 9th month, day wuchen [5]. The guest star was in the WEI [LM 6] and larger than Venus. Its color was orange and scintillated. It grew smaller in size through the day gengxu [4] in the 10th month. In the 38th year, yisi [42], 1st month, day bingzi [13] (Dec 27), the guest star appeared above TIANJIANG and was larger than the Fire Starof XIN [LM 5]. Its color was orange and scintillated. By day jichou [26] in the 2nd month [NB: should be 3rd month], it was tiny." [Chungbo munhon pigo] ch. 6.

From the descriptions of the outburst 99, it follows that in mid-October 1604, at the 6^{th} lunar mansion, near μ Scorpio, appeared an orange guest star, which was brighter than the α Sco of the 5^{th} lunar mansion. The description 98 shows that 4 years ago, at the same location, around the 6^{th} lunar mansion, there appeared a new star, orange in color, which was brighter than Antares. The star was bright, but it hadn't been observed either in Western Europe or even in neighboring China. Although the new star in 1600 was located near the galactic equator, the appearance of two bright orange stars in the same area of the sky, at the same time of the year, is theoretically possible but unlikely. Therefore, with high probability, you can identify these two outbursts. The second possible duplicate is one of the outbursts: 85 or 86.

85. AD 1400 Oct 24 [China]

"Emperor Chengzu Ming, 6^{th} year of the Yongle rein period, 10^{th} month, day gengshen [17]. In the night, at the zenith, southeast of NIANDAO, there was a star like oil-cup of a lamp. It was yellow and shiny bright. It emerged, but did not move. It was said to probably be a ZHOU BO, a star of virtue." [Ming Taizong zhilu] ch. 84; [Guo que] ch. 14.

86. AD 1404 Nov 14 [China]

"Emperor Chengzu Ming, 2^{nd} year of the Yongle reign period, 10^{th} month, day gengshen [17]. There was a star like shallow cup southeast of NIANDAO. It was yellow and shiny bright, but did not move." [Ming shi Tianwen zhi] ch. 27.

According to chronicles, both stars appeared in the sky incredibly synchronously: exactly in the 10^{th} month, on the 57^{th} day of the sixty-day Chinese cycle. Therefore, these two outbursts can be identified with high probability. Julian calendar dates of outbursts differ only because of the fact that the Chronicles are dated by different years, and the duration of the Chinese year is not constant and differs from the duration of Julian year. Both stars appear in the same area of the sky, to the south-east of R Lyr. In both cases the star is very bright, has a yellow color and is compared with an oil lamp (lighting fixtures). The descriptions are similar to each other as far as it is possible in principle.

The rest observations are not suspected of duplication, so we have at our disposal at least 99 different descriptions of novae outbursts. The exclusion of two stars out of such an array of data, containing 101 observations, won't change the general picture. Therefore, we left both possible duplicates on our list. We divided the entire array of 102 observations of guest-stars into 4 groups, so that the number of outbursts in the groups was similar, and the first and the last outbursts in the group corresponded to the beginning and the end of the century (see Table 2).

Group	Year	Observations	Description	Centuries
1	-532÷290	25	6(26)=23%	[-6; 3]
2	304÷900	31	14(30)=47%	[4;9]
3	911÷1240	24	11(23)=48%	[10;13]
4	1356÷1690	21	11(19)=58%	[14;17]

Table 2. Chinese canon of nova stars was divided into four groups of outbursts. "Year" means the range of dates, in which observations were made in this group; "Centuries" means the range of centuries, which correspond to the column Year; Observations gives the number of outbursts in each group; "Description" gives the ratio of job descriptions, made with the help of the lunar mansion to the total number of job descriptions in each group.

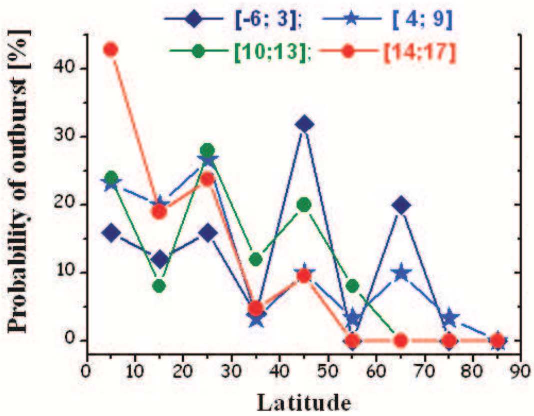

Fig. 7. Probabilities of observations of the outbursts depending on the latitude in four groups.

In the first group of observations, which includes the monitoring up to the 3^{rd} century inclusively, more than half of all outbursts occur in middle and high galactic latitudes, with more than 20% outbursts recorded within the latitudes of 60÷70 degrees. There is a maximum of ~35% in the latitude range of 40÷50 degrees and a small amount of outbursts near the galactic equator. The distribution of outbursts in groups 2 and 3, which corresponds to observations in the [4; 9] and [10; 13] centuries, much better corresponds to the current data than the observations in group 1. However, the total percentage of outbursts in middle and high galactic latitudes (above 60 degrees) is about 30%. This value is approximately 2 times greater than the value, determined by the current data. The total number of outbursts, recorded in the Milky Way area at the galactic latitudes up to 20 degrees, is about 30÷40%; that is 2÷2.5 times smaller than modern values. The distribution of outbursts on latitudes in group 4 is generally consistent with the current data. 62% of a total number of outbursts have been recorded on the latitudes up to 20 degrees, and nova outbursts haven't been recorded in high latitudes. The minor differences with the current data can be explained by the relatively low accuracy of the description of the locations of outbursts, even in the later Middle Ages. This fact is confirmed independently by the above analysis of the description of the location of a supernova outburst in 1604. From Table 2 one can get nearly uniform distribution of outbursts on latitudes, if the frequencies of outbursts in the first two groups are summed up. However, contemporary observations suggest that the distribution of novae on latitudes differs significantly from a uniform distribution and more than 80% of outbursts should not exceed 30 degrees above the galactic equator. Thus, the ancient Chinese observations of outbursts of novae have an "abnormal" distribution on latitudes, which differs from the distribution, based on the current data. One can make the assumption that the "anomaly" of the distribution is caused by worse accuracy of the localization of outbursts in group 1, as compared with group 4. Our estimate, obtained with the help of historical supernovae, show that the error in the localization of an outburst through the nearest asterism is from a few degrees to ten degrees. The error in the description through a lunar mansion may reach tens of degrees. Therefore, if there is a dual description, through the nearest asterism and a lunar mansion, the preference is always given to the description through the asterism. The only exception is the description of Sn1006, in which the location of the outburst was estimated through the center of the 3^{rd} lunar mansion. This was done because the southern asterisms *Quigan* and *Kulou* have great extent. We can expect that in groups with large amount of outburst descriptions through the lunar mansion, localization accuracy will be worse, leading to the effect of uniform distribution of nova outbursts on the galactic latitudes. However, we observe the opposite situation in reality. In Table 2, the column, entitled "description", gives the ratio of job descriptions, made with the help of the lunar mansion to the total number of job descriptions in each group. Note that in group 1, only 6 out of 26 outbursts have been described by means of lunar mansions, and in group 4 - 11 out of 19. Nevertheless, the distribution of outbursts on latitudes in group 4 corresponds to the modern monitoring data, but the distribution in group 1 is significantly different from it. Therefore, the descriptions through lunar mansions and the nearest lunar asterisms, on average, provide quite an adequate accuracy; the difference of the distribution of nova outbursts on latitudes in group 1 from the present data is a result of something else.

5 Search of Errors

In order to answer the question why the latitudinal distribution of the outbursts of novae, received by ancient observations, differs from the modern data, the observations themselves should be examined. For this, it's enough to analyze the two frequency peaks in the mid-latitudes [30-60] degrees and in high latitudes [60-90] degrees. However, the distribution of these outbursts shows that the observations with "abnormally" high latitude should be better streamlined in terms of proximity to the ecliptic. It's necessary to answer the question whether the majority of these outbursts can be identified with comets or long variable stars?

The first cluster of outbursts. This group was composed of outbursts, located at medium and high galactic latitudes, near the ecliptic.

1. 204 BC Aug 14-Sep 12 [China]

"3rd year of Emperor Gaozu of Han, 7th month. A fuzzy star appeared in DAJIAO for over ten days before going out of sight." [Han shu Tianwen zhi] ch. 26.

2. AD 61 Sep 27

"Emperor Ming of Han, 4th year of Yongping reign period, 8th month, day xinyou [58]. A guest star emerged in GENSHE and pointed northwest toward GUANSUO. [It lasted] 70 days then departed." [Hou Han shu Tianwen zhi] ch. 21.

3. AD 64 May 3 [China]

"Emperor Ming of Han, 7th year of Yongping reign period, the 3rd month, day genxu [47]. Gu jin zhu notes: In the 3rd month, day gengxu, a guest star with bright vapors two chi or so long was located outside the NANDUAN gate of TAIWEI near ZUOZHIFA. In all it was visible for 75 days." [Hou Han shu Tianwen zhi] ch. 21.

4. AD 70 Dec 22 - AD 71 Jan 19 [China]

"Emperor Ming of Han, 13th year of Yongping reign period, the 11th month. Gu jin zhu notes: In the 11 month, a guest star emerged in XUANYAN for 48 days." [Hou Han shu Tianwen zhi] ch. 22.

5. AD 101 Dec 30 [China]

"Emperor He of Han, 13th year of the Yongyuan reign period, 8th month, day wushen [45]. There was a small guest star in the space of four star of XUANYUAN. It's color was bluish-yellow." [Hou Han shu Tianwen zhi] ch. 22.

6. AD 126 Mar 23 [China]

"Emperor Shun of Han, 1st year of the Yongjian reign period, 2nd month, day jiawu [31]. Gu jin zhu notes: In the 1st year of the Yongjian reign period, the 2nd month day jiawu [31] a guest star entered TAIWEI." [Hou Han shu Tianwen zhi] ch. 21.

7. AD 222 Nov 4 [China]

"Emperor Wen of Wei, 3rd year of the Huangchu rign period, 9th month, dau jiachen [41]. A guest star appeared inside ZUOYEMEN of TAIWEI." [Jin shu Tianwen zhi] ch. 13; [Song shu Tianwen zhi] ch. 23.

8. AD 275 Jan 14-Feb 12 [China]

"Emperor Wo of Jin, 10th year the Taishi reign period, 12th month. There was a fuzzy star in ZHEN [LM 28]." [Jin shu Tianwen zhi] ch. 13; [Song shu Tianwen zhi] ch. 23.

We present the main results of observations in Table 3.

N	**Date**	**Asia**	**Europe**	**b$_{gal}$**	**β_{ecl}**	**Comment**
1	14.08÷12.09.-204	Dajiao	α Boo	69	31	10 days; fuzzy
2	27.09.61	Genshe	ϵ Boo	65	41	visible for 70 days
3	03.05.64	Zuozhifa	η Vir	61	1	visible for 75 days
4	22.12.70÷19.01.71	Xuanyan	α Leo	49	0	visible for 48 days
5	30.12.101	Xuanyan	α Leo	49	0	faint, yellow-blue
6	23.03.126	Taiwei	β Vir	61	1	-
7	04.11.222	Zuoyemen	η Vir	61	1	-
8	14.01÷12.02.275	LM 28	γ Crv	45	-15	fuzzy

Table 3. The first cluster of outbursts which are located at medium and high galactic latitudes, near the ecliptic. "Date" is a calendar date of the observation; "Asia" is mean the location of the outburst made by Chinese asterism or lunar mansion; "Europe" is mean european location of the outburst; b_{gal}, β_{ecl} are galactic and ecliptic latitudes.

As appears from the above duration of visibility, the outbursts number 2, 3 and 4 are nova outbursts, since it's impossible to observe a bright comet in one asterism within a period of 1.5÷2.5 months. As it is reported in observation 5, the star was faint, but on the other hand, its color is reported. This is a strange inconsistency, because the human eye can see only the color of the brightest stars, the threshold difference is defined not only by visible brightness of m, but also by excess of color B-V. One can take the star α Sco (Antares) with $m_V = 0.96^m$ and B-V=1.83 as a limit estimate. For a yellow star that brightness will be a little bit less, however, visible brightness of about 1^m can be taken as an assessment. The emergence of such bright comet is a rarity. In addition, the comet trail is excluded by the date of observation, since the elongation of the hypothetical comet is about 150 degrees. There is a long-period variable R Leo in the vicinity of the α Leo, however, its maximum brilliance rarely exceeds 5^m, and the star itself is visible to the naked eye for a short period of time (AAVSO - online catalogue). The faint brightness in the maximum doesn't let equate R Leo with the yellow-blue star from the description 5, and the short period of visibility precludes the identification with the description 4. Similar reasons can easily show that the date of the observation of outburst 6 does not equate it with a comet, since on March 23, 126 the comet was in opposition to the Sun. The duration of the outburst 1 might correspond to the outburst of a rapid nova, which has a very short maximum. The phrase "Misty Star" suggests a comet option, although in this case, the hypothetical comet deviates about 30 degrees from the ecliptic plane. In the description 8, the emergence of a misty star is also reported on and, at first glance, the proximity to the ecliptic guarantees an option with a comet. However, in this case, hypothetical comet will have elongation of 135 degrees on the start date of the time interval on January 14, 275, which by February 12 will be about 160 degrees. An observation of a bright comet with such elongation is fantastic, so it turns out that the term "fuzzy star" does not guarantee a comet option. There is a long variable R Hya at 18 degrees to the east of the γ Crv, but it is impossible to equate it with the nova in 275. The star R Hya is located at a longitude between the 1^{st} and 2^{nd} lunar mansions with centers α Vir and κ Vir. The distance of R Hya from α Vir is 12 degrees, and from κ Vir - 16 degrees. If the observer had recorded the maximum of R Hya, he could have described the place of the outburst more accurately. In conclusion, we note that R Hya is a faint star and its brilliance rarely reaches 4^m. As a result, out of the remaining descriptions, only outbursts 1 and 7, may be regarded as observations of a comet. There are no reasonable grounds for such identification, but even if we equate these outbursts with comets, the overall picture won't change.

The second cluster of outbursts. This group was composed of outbursts, located at medium galactic latitudes, far from the ecliptic.
9. 77 BC Oct 17-Nov15 [China]
"Emperor Zhao of Han, 4^{th} year of Yuangfeng reign period, 9^{th} month. A guest star was situated within ZIGONG, between DOUSHU and [BEI]JI." [Han shu Tianwen zhi] ch. 26.
10. AD 29 [China]
"Emperor Guangwu of Han, 5^{th} year of the Jianwu reign period. A guest star trespassed against YUZUO extremely closely." [Hou Han shu Yanguang zhuan] ch. 83.
11. AD 85 Jun 1 [China]
(I)"Emperor Zhang of Han, 2^{nd} year of the Yonghe reign period, in summer, the 4^{th} month day yisi [42]. A guest star entered ZIGONG." [Hou Han shu Zhangdi ji] ch. 3.
AD 85 Jun 1 [Korea]
(II) "9^{th} year of King Kiru of Paekche, the 4^{th} month, day yisi [42], a guest star entered ZIWEI." [Samguk sagi] ch. 23.
AD 85 Jun 1 [Korea]
(III) "6^{th} year of King P'asa of Silla, the 4^{th} month, a guest star entered ZIWEI." [Samguk sagi] ch. 1.
12. AD 158 Mar 18-Apr 15 [Korea]
"13^{th} year of King Chadae of Kogury, in spring, the 2^{nd} month. There was a fuzzy star in BEIDOU." [Samguk sagi] ch. 15.
13. AD 269 Oct 15-Nov 10 [China]
"Emperor Wu of Jin, 10^{th} year of Taishi reign period, 9^{th} month. There was a fuzzy star in ZIGONG." [Jin shu Tianwen zhi] ch. 13; [Song shu Tianwen zhi] ch. 23.
14. AD 290 Apr 27-May 25 [China]
"Emperor Wu of Jin, 1^{st} year of Taixi reign period, 4^{th} month. There was a guest star in ZIGONG." [Jin shu Tianwen zhi] ch. 13; [Song shu Tianwen zhi] ch. 23.

The main results of observations are presented in Table 4. In the constellation of Ursa Minor and Dragon tail, which are in the area of middle galactic latitudes, six outbursts of novae were recorded. This is about a quarter of all outbursts from group 1, which dates from the [-6; 3] centuries. Such concentration of outbursts in a small sector of the sky on mid-latitudes is a statistically unlikely event.

N	Date	Asia	Europe	b_{gal}	β_{eql}	Comment
9	17.10÷15.11.-77	Zigong	ϵ UMi	31	74	between α and β UMi
10	?.?.29	Yuozou	β UMi	41	73	near to β UMi
11	01.06.85	Zigong=Ziwei	κ Dra	47	61	-
12	18.03÷15.04.158	Beidou	α UMi	27	66	fuzzy
13	15.10÷10.11.269	Zigong	κ Dra	47	61	fuzzy
14	27.04÷25.05.290	Zigong	κ Dra	47	61	-

Table 4. The second cluster of outbursts which are located at medium galactic latitudes, far from the ecliptic. "Date" is a calendar date of the observation; "Asia" is mean the location of the outburst made by Chinese asterism or lunar mansion; "Europe" is mean european location of the outburst; b_{gal}*,* β_{ecl} *are galactic and ecliptic latitudes.*

Note that the outbursts 12 and 13 were described as "fuzzy star". The places of observations of these hypothetical comets are located on a high ecliptic latitude, whence it follows a high inclination of the orbits of the comets in relation to the ecliptic. Theoretically, a high orbit inclination is possible, but statistically it is unlikely, and the identification of these observations with comets is unreliable. Therefore, the phrase "fuzzy star" can't be a universal feature of a comet. In the examined sector of the sky, there are no long variable stars, available for observation with the naked eye. Therefore, none of these outbursts can be equated with a comet or a long-duration variable star.

Conclusion. The analysis of observations of the guest-stars in group 1, which chronologically refers to the time interval of the [-6; 3] centuries, leads to the conclusion, that these observations can not be a survey of comets or long-duration variable stars. Some solitary exceptions are possible however they are unable to change an abnormal distribution of outbursts of new stars on the galactic latitudes. There remains the only option - to consider the observations themselves unreliable.

Conclusion.

The study of the ancient Chinese observations of new stars showed the presence of "abnormal" number of outbursts in middle and high galactic latitudes. The distribution of outbursts of the ancient sources doesn't correspond to the modern observation data. The study of the texts of observations that are "anomalous" outbursts showed that most of the outbursts could not be identified with the observation of comets, or long variable stars. The most plausible explanation for this contradiction is the assumption that the ancient Chinese observations of new outbursts are unreliable. Perhaps, most of these outbursts have never occurred, but were mentioned by chroniclers of any religious, astrological, or other considerations. Over time, the distribution of outbursts on latitude changes, and observations in the 4÷13 centuries better correspond to modern data, and since the 14th century, the Chinese observations of outbursts of novae should be considered reliable.

In conclusion, we note one more important detail. The comparative analysis of the accuracy of localization of outbursts shows that the error and stylistics of descriptions remain unchangeable from the earliest ancient observations until the 16th century. As a rule, the location of the outburst is reported with accuracy to within a lunar mansion or the nearest asterism. Only in some texts we deal with a visual estimate of the distance from one of the stars of asterism to the object and this estimate is apparently visual. This fact makes us assume that before the 16th century the Chinese astronomers hadn't had detailed identification of stars in lunar mansion or asterism. Otherwise, they would have made more accurate descriptions of outbreaks locations.

The first astrometric measurement of an outburst of a nova star is the measuring of the supernova in 1604, which was described in the center of the lunar mansion and the pole of the world. The first instrumental measuring, in which the coordinates of the stars are presented in degrees of longitude from the center of the lunar mansion and declination, is Chinese observation of new outburst on September 29, 1690. These facts are evidence for that in medieval China, before the arrival of the Jesuits, there had not been both instrumental measurements and their own star catalog.

References

AAVSO 2009: The Database of Observations of Variable Stars AAVSO.

Chin Y.-N., Huang Y.-L., 1994, Nature 371, 398.

Clark D.H., Stephenson F.R., 1977: The Historical Supernovae, Pergamon, Oxford.

Durlevich .V., Samus N.N., 2009: General Catalog of Variable Stars of Sternberg Astronomy Institute. http://www.sai.msu.su/groups/cluster/gcvs/cgi-bin/search.htm

ESA 1997: Hipparchos and Tycho catalogs, Vol. 1-20, ESA

Green D.A., 2009: Galactic Supernova Remnants: Summary Data. http://www.mrao.cam.ac.uk/surveys/snrs/snrs.data.html

Lundmark K., 1921 PASP 33, 225

Pankenier D.W., Xu Z., Jiang Ya., 2000: East Asian Archeoastronomy. Historical records of Astronomical Observations of China, Japan and Korea, Gordon and Breach Science Pub.

Pfeffermann E., Aschenbach B., 1996, in Roentgenstrahlung from the Universe, International Conference on X-ray Astronomy and Astrophysics, MPE Report 263 (Zimmermann, Trumper, Yorke ed.), 267.

Pskovskiy Yu.P., 1985: Novie i sverhnovie zvezdi, Moskva, Nauka.

Stephenson F.R., 1968: MNRAS 141, 69.

Stephenson F.R., Clark D.H., 1978: Applications of Early Astronomical Records, Adam Hilger Ltd, Bristol.

Tam C., Roberts M., 2003, ApJ 598, L27-L30.

Uchiyama Y., Takahashi T., Aharonian F.A. 2002: astro-ph/0208049.

Wang Z.-R., Qu Q.-U., Chen Y., 1997: AA 318 L59-61.

Appendix. List of nova stars.

N	Date	Asia	Europe	l_{gal}	b_{gal}	Comment
1	spring, -532	LM10	ϵ Aqr	38	-30	China
2	14.08÷12.09.-204	Dajiao	α Boo	15	69	China, 10 days; fuzzy
3	23.06÷21.07.-134	LM4	π Sco	347	20	China
4	-110÷-105	Heshu	β Gem	192	23	China
5	-104÷-101	Zhaoyao	??	-	-	China, fuzzy
6	17.10÷15.11.-77	Zigong	ϵ UMi	115	31	Chi; between α, β UMi
7	03.05÷31.05.-48	LM8	φ Sgr	8	-11	China; bluish-white
8	20.06÷18.07.-47	Juanshe	μ Per	154	-10	China
9	24.04.-4	Hegu	α Aql	48	-9	China
10	?.?.29	Yuzuo	β UMi	113	41	China; near Yuzuo
11	27.09.61	Genshe	ϵ Boo	39	65	China; 70 days
12	03.05.64	Zuozhifa	η Vir	286	61	China; 75 days
13	22.12.70÷19.01.71	Xuanyan	α Leo	226	49	China, 48 days
14	01.06.85	Zigong=Ziwei	κ Dra	125	47	China, Korea
15	30.12.101	Xuanyan	α Leo	226	49	China; faint; yellow-blue
16	13.09.107	Hu	δ CMa	238	-8	China
17	13.12÷11.01.126	Tanshi	ξ Oph	4	9	China
18	23.03.126	Taiwei	β Vir	271	61	China
19	18.03÷15.04.158	Beidou	α UMi	123	27	Korea, fuzzy
20	07.12.185	Nanmen	α Cen	316	-1	China, variegated color
21	06.11.200	LM17-19	η Tau	167	-24	China; fuzzy
22	10.01÷07.02.213	Wuzhuhou	θ Gem	182	15	China; fuzzy
23	04.11.222	Zuoyemen	η Vir	286	61	China
24	15.10÷10.11.269	Zigong	κ Dra	125	47	China, fuzzy
25	14.01÷22.02.275	LM2	γ Crv	291	45	China; fuzzy
26	27.04÷25.05.290	Zigong	κ Dra	125	47	China
27	19.06÷18.07.304	LM19	ϵ Tau	178	-20	China
28	21.10.305	Beidou	α UMi	123	27	China; fuzzy
29	11.08÷09.09.329	LM8	φ Sgr	8	-11	China; fuzzy; 23 days
30	25.03.340	Taiwei	β Vir	271	61	China, fuzzy
31	24.03÷22.04.369	Zigong	κ Dra	125	47	China; 1 month
32	15.04÷13.05.386	LM8	φ Sgr	8	-11	China; 6 month
33	27.02÷28.03.393	LM6	μ Sco	346	4	China; 1 month
34	?.?.396	LM18-19	37 Tau	171	-22	China; yellow; 50 days
35	20.07.414	LM18	η Tau	167	-24	China; fuzzy

List of nova stars. Continue 1.

N	Date	Asia	Europe	l_{gal}	b_{gal}	Comment
36	25.03.419	Taiwei	β Vir	271	61	Korea; fuzzy
37	20.01÷17.03.421	LM27	α Crt	23	-23	China
38	21.06.436	LM4	π Sco	347	20	China; fuzzy
39	26.02.437	LM22	μ Gem	190	4	China; visible at day
40	16.10÷14.11.483	LM21	ζ Ori	206	-17	China; fuzzy
41	11.02÷12.03.541	Zigong	κ Dra	125	47	China
42	26.09.561	LM27	α Crt	23	-23	China
43	27.04.575	Dajiao	α Boo	15	69	China; fuzzy
44	22.11.588	LM9	β Cap	29	-26	China; fuzzy
45	01.08.641	Taiwei	β Vir	271	61	China; fuzzy; 25 days
46	09.08.642	Moon	φ Oph	0	21	Japan
47	28.07.708	LM17-18	δ Ari	163	-32	China; fuzzy
48	16.09.709	Zigong	κ Dra	125	47	China; fuzzy
49	19.08.722	Gedao	φ Cas	127	-4	China; 5 days
50	11.02.725	Huagai	ψ Cas	126	5	Japan; fuzzy
51	08.01.745	Jangjing	γ And	137	-19	Japan; fuzzy
52	01÷29.01.829	Shuiwei	68 Gem	203	16	China
53	29.04.837	LM22	μ Gem	190	4	China, 1 month
54	03.05.837	Pingxing	ξ Vir	260	66	China; 45 days
55	26.06.837	Tianyue	4 Sgr	6	0	China; fuzzy
56	11.05.891	Dongxian	ψ Oph	356	20	Japan
57	04.02÷03.03.900	Huanzhe	60 Her	33	29	China; bright
58	31.05÷28.06.911	Dizuo	α Her	36	28	China
59	summer; 980	Dizuo	α Her	36	28	China
60	28.04.1006	LM3	α Lib	340	38	China, Japan
61	08.02.1011	LM8	φ Sgr	8	-11	China
62	04.10.1031	LM23	θ Can	207	30	Korea; large
63	15.01.1035	Waiping	δ Psc	122	-55	China
64	10.05÷04.07.1054	Tianguan	ζ Tau	186	-6	China, Korea, Japan
65	11.09.1065	Tianmiao	α Pyx	255	6	China
66	25.12.1070	Tianqun	α Cet	173	-46	China
67	09.10.1073	LM14	γ Peg	109	-47	Korea
68	19.08.1074	LM14	γ Peg	109	-47	Korea
69	04.08.1082	Beichen	α UMi	123	27	Korea
70	03.07÷01.08.1087	Wenchang	θ UMi	113	37	China; like a melon

List of nova stars. Continue 2.

N	Date	Asia	Europe	l_{gal}	b_{gal}	Comment
71	15.08.1113	LM13	α Peg	88	-40	Korea; fuzzy
72	11.08.1123	Beidou	α UMi	123	27	Korea; fuzzy
73	09.06÷07.08.1138	LM16	β Aqr	142	-40	China
74	23.03.1139	LM2	κ Vir	334	48	China
75	10.08.1163	Moon	θ Oph	0	7	Korea
76	10.08.1175	Quigong	θ Boo	94	60	China; fuzzy; 5 days
77	06÷11.08.1181	Chuanshi	ψ Cas	126	6	Chi+Jap; 185 days
78	28.07.1203	LM6	μ Sco	346	4	China; bluish-white
79	17.12÷24.01.1220	Beidou	α UMi	123	27	Korea, fuzzy
80	11.07.1224	LM6	μ Sco	346	4	China
81	17.08.1240	LM6	μ Sco	346	4	China
82	03.05.1356	Moon	136 Tau	182	1	Korea
83	23.03.1388	LM14	γ Peg	109	-47	China
84	05.01.1399	Moon	μ Sgr	10	-2	Korea
85	14.10.1404	Niandao	R Lyr	74	18	China; yellow
86	24.10.1408	Niandao	R Lyr	74	18	China; yellow
87	03.09÷02.10.1415	LM8	φ Sgr	8	-10	China, fuzzy
88	03÷09.09.1430	Nanshe	δ CMa	238	-9	China; 26 days
89	04.01.1431	Jiuyou	μ Eri	201	-29	China; yellow; 3 month
90	11.03.1437	LM6	μ Sco	346	4	China; 14 days
91	21.03.1452	LM19	ϵ Tau	178	-20	China; fuzzy
92	22.02÷22.03.1460	LM27	α Crt	23	-23	Vietnam; fuzzy
93	20.09.1497	Tianji	β UMi	113	41	China; dusk
94	13.07÷10.08.1523	Tianshi	ζ Oph	6	24	China; fuzzy
95	06÷11.12.1572	Cexing	γ Cas	124	-2	Chi+Kor; fuzzy; gt Venus
96	11.07.1584	LM4	π Sco	347	20	China
97	23.11.1592	Wangliang	β Cas	118	-3	Korea
98	14.12.1600	LM6	μ Sco	346	4	Korea; orange; gt Antares
99	10.10.1604	LM6	μ Sco	346	4	China; orange
100	26.02÷27.03.1645	LM23	θ Can	207	30	Korea; large
101	13.12.1661	LM10	ϵ Aqr	38	-30	Korea; 1 month;
102	29.09.1690	LM7	γ Sgr	0	-5	Korea; yellow