IV. ASTRONOMICAL AND COSMOLOGICAL KNOWLEDGE IN HISTORICAL SOURCES AND LITERATURE

WERE THE 185 A.D. AND 369 A.D. "GUEST STARS" SEEN IN ROME?

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Abstract

Since Clark and Stephenson (1977) proposed that the supernova remnant (SNR) G315.4-2.3 should be identified with the historical supernova (SN) seen by Chinese observers in the year A.D. 185, a great deal of work has been done by theoreticians and observers to test the hypothesis. Some authors have proposed the SNR G320.4-1.2 as a better candidate, while, on the basis of a reinterpretation of the *Houhan-shu* original text, even the very nature of the A.D. 185 event has been questioned, leading to the hypotheses of a cometary transit (Chin and Huang 1994) or a combination of Comet P/Swift-Tuttle and a nova (Schaefer 1995, 1996). In fact, a cometary transit was apparently registered in one of the Priscilla Catacomb frescoes, an ancient Roman artwork dating from the end of the second century. During our examinations of Roman Catacomb frescoes in an attempt to discover representations of "guest star" apparitions in Imperial Rome, we also discovered what seems to be a record of SN 369, indicating that this may have been the explosion which originated Cas A.

Key words: historical supernovae, SN185, SN369, Cas A, catacombs, Paleo-Christian Art.

The 185 A.D. "Guest Star"

Galactic Supernovae (SNe) are rare events and sightings of them are extremely important from both the astrophysical and the historical points of view. Only nine astronomical events recorded in ancient chronicles are considered *bona fide* SNe. In many cases they are only reported in Far Eastern (Chinese, Japanese and Korean) sources, where they are usually named "guest stars" (see, e.g., Stephenson and Green 2002; Xu et al. 2000).

The earliest "new star" which is worthy of investigation as a possible SNe was seen in China in A.D. 185. This event is reported in just one independent source, the *Hou-Han-shu*, which was composed towards the end of the third century A.D. The new star was recorded as being visible for at least 8 months, or possibly even 20 months (depending on whether part of the record is taken to mean 'next year' or 'the year after next'). The star was reported to be within the *Nan-mên* asterism. Although some authors have questioned the identification of this asterism, a comparison with contemporary records and star charts supports the usual identification of *Nan-mên* with α and ß Cen, which lie close to the Galactic equator (Stephenson and Green 2002; Xu et al. 2000).

Here is the text in full, in the Clark and Stephenson (1977) translation:

Hou-Han-shu *(Astronomical treatise Chapter 22)*

"2nd year of the Chung-p'ing reign period [of Emperor Hsiao-ling][1] 10th month, day kuei-hai, a guest star appeared within *(chung)* Nan-mên. It was as large as half a mat; it showed the five colours and it scintillated. It gradually became smaller and disappeared in the 6th month of the year after the next *(hou-nien)*".

Rwc 86 or Rwc 89?

On the basis of the positional information given by the *Hou-han-shu*, Clark and Stephenson (1977) proposed that the SN 185 remnant was the nebula G315.4-2.3 (RCW86: R.A = 14h 43m 04s , decl = -62° 27.7'). However, one argument against this identification (among others) is the absence of any observed plerion (a supernova remnant with a filled centre) in RCW86. Not even the latest-generation of X-ray instruments

[1] The date corresponds to 7th December 185.

have been able to resolve this issue, detecting only uncertain point-like sources within the nebula (Gvaramadze and Vikhlinin 2003; Kaplan et al. 2004; Vink et al. 2000). The detection of a plerion would be a considerable help, among other things, in establish the age of the remnant. Indeed, estimates obtained from dynamical nebula expansion or ionization models are very uncertain, because of observational as well as theoretical difficulties. Rough Sedov-phase expansion estimates lead to ages that are too large (~7000 years: Chin and Huang 1994; Jones et al. 1998; Rosado et al. 1996; Borkowski et al. 2001 – the last having a contradictory result on the ionization age). More sophisticated models, including different expansion phases (i.e. varying shell velocities), can reconcile the SN 185 age with the dynamical model of RCW86 to some extent, but only when *ad hoc* assumptions are made concerning the explosion energy (Bocchino et al. 2000; see also: Petruk 1999, and Vink et al. 2006).

As an alternative to RCW86, several authors have proposed the SNR G320.4-1.2 (RCW89: R.A=15h 13m 35s, decl = -59° 00.2') as a better candidate. One of the reasons is the fact that a pulsar, PSR B1509-58, has actually been found in the latter remnant, and the plerion age is estimated to be reasonably coincident with the required value (Thorsett 1992; Kaspi et al. 1994).

On the other hand, the dynamical study and dating of RCW89 carries the same uncertainties as with most SNRs, namely that some authors derive ages that are too large from Sedov expansion models (e.g. Kamper et al. 1995).

More Doubts And Hypotheses

Doubts about the positional identification of SN 185 have also been raised, by Huang and Moriarty-Schieven (1987) and then others, which casts doubt upon both SNR hypotheses.

Added to this, on the basis of a reinterpretation of the *Hou-han-shu*, even the very nature of the 185 A.D. event has been questioned, leading to the suggestion that Chinese observers actually witnessed a comet transit (Chin and Huang 1994). These authors retranslated the text and in particular the sentence "within *(chung) Nan-mên*", suggesting that the exact translation is "emerging from *Nan-mên*", thus implying a motion.

Schaefer (1995, 1996) has stressed that a comet does not "scintillate", owing to its large size, and that a comet appearing near α or β Cen (the component stars of *Nan-mên*) must be of m_v –7 to be visible to naked eye, because of the high extinction due to its low height over the horizon. In other words, it would be far too bright for a comet. However, he also noticed that the historical event "light curve" was too short for it to be a supernova - although Thorsett (1992) has argued that the position of RCW86 in the sky would have made it invisible after a short time to southern-Chinese observers.

Furthermore, Schaefer (1995) noticed that the term *hou-nien* is better translated by "a few years later". He thus concluded that the event was most probably a combination of a nova exploding in Centaurus in 185 A.D. and the transit of comet P/Swift-Tuttle, three years later, recorded in the same *Hou-han-shu*, Chapter 20 (Yoke 1962):

"*Chung-p'ing* reign period 5th year, 6th month, day *ting-mao* [28th July 188 AD]. A guest star as large as a vessel with a capacity of three pints appeared at *Kuan-so*. It moved south-west and entered the *T'ien-ahih* [Enclosure]. It reached *Wei* [the 6th Lunar Mansion] and then disappeared".

The question of the nature of the 185 AD "guest star" is thus fully open and it is worth looking for other possible sources concerning this event.

Possible Witnesses in Rome at the End of tThe Second Century

The other highly developed civilization in the 2nd century was the Roman Empire. Though there is no reference, to our knowledge, to astronomical events in Roman texts of this period, we can look for them in the arts, in order to see if some unusual celestial phenomenon is recorded – as in the case of Giotto's fresco representing the Halley's Comet transit of 1301, or the fresco of San Pietro in Valle representing the apparition of SN 1181 (Polcaro 2005). Some clues suggesting an unexpected and impressive phenomenon in the sky of Rome at the end of the 2nd century have been actually found in one of the oldest of the Christian catacombs of Rome: the Priscilla Catacomb on Via Salaria.

Excavated from soft volcanic terrain, the galleries of this Catacomb stretch out for approximately 13 kilometres with an irregular pattern. The bodies of the deceased were laid in the *loculi*, narrow rectangular tombs carved out of the gallery walls. These *loculi* were sealed using marble or terracotta slabs. Today, these slabs are no longer *in situ* owing to the almost complete despoliation of the galleries in the past. However, some fragments of these stones with their Latin or Greek inscriptions can be seen on the walls of the galleries, and sometimes these inscriptions report a date, giving a precise time reference. Sometimes one comes upon a cubicle that was used as a family or group tomb

or for the burial of a martyr: these cubicles are often decorated by frescoes.

Inside one of these cubicles, on the ceiling of a niche dug out from the upper wall of a gallery for a venerated tomb, there is a very evocative image of the Madonna and Child with a prophet in a tunic and *pallium* (see Plate V: Fig. 1, left) pointing to a star. This has been considered (see, e.g., Biamonte 1997, and references therein) to be an allusion to the biblical prophecy of Balaam (Num 24:15-17):

"A star shall come forth out of Jacob, and a sceptre shall rise out of Israel".

The style of the fresco and its location (in one of the oldest areas of the cemetery) indicate a date around the end of the second century A.D., making it the oldest known image of the Mother of God.

We thus have an image of a man (who may be Balaam) indicating a star, depicted a few years (at most) after the apparition of the 185 A.D. "guest star". We now have to investigate whether these two facts are in some way connected, bearing in mind, of course, that if the 185 A.D. "guest star" was actually the SN that originated RCW86, it could not have been seen in Rome, since it was far too far South, and the same holds if we choose RCW89 as the remnant of SN 185.

Let us suppose first that the man in the fresco actually represents Balaam. He is not a very common character in Christian paintings (for a discussion of the role of Balaam in Christian Art see, e.g., Merlini 1987). Furthermore, Priscilla's Catacomb is one of the very few places, to our knowledge, where he is represented in the act of indicating a star. Everywhere else, he is represented in the framework of the episode of his meeting with the Angel and of the "speaking donkey". This is true in the fresco of the "Via Latina Anonymous Catacomb" (mid-4th century), right up to the famous painting by Rembrandt, passing through most of the few existing images of Balaam in Christian art. We thus have a representation of a star painted during the right period, associated in an unusual way with an unusual biblical character: we can thus imagine that this has something to do with an unusual astronomical phenomenon.

However, this is not enough to state firmly that the 185 A.D. Chinese "guest star" was seen in Rome: we may actually be dealing with an event that occurred a few years later. Actually, P/Swift-Tuttle is a huge comet (2 km in diameter) and in 188 A.D. its minimum distance from Earth was only 0.6 AU. Furthermore, it appeared in the constellation of "Corona Borealis": it was thus perfectly visible in the sky of Rome. The astronomical event that was impressive enough to inspire the Christian painter of Priscilla's Catacomb was thus, more likely, the 188 A.D. passage of the comet P/Swift-Tuttle.

On the other hand, let us now imagine that the character indicating the Star is not Balaam: the fresco then becomes a quite normal representation of the Nativity. It is the first, but it is not unusual, since it fully reflects the symbolism of the Cosmos paying tribute to Christ, the Saviour. In this case, we do not need to suppose that the painter was inspired by some exceptional celestial phenomenon.

The answer to the question: "Was the 185 AD 'guest star' seen in Rome?" is thus most probably negative. But, in this case, it was P/Swift-Tuttle that was seen, and the question of the 185 A.D. "guest star" seen by the Chinese remains fully open.

The Case of the 369 A.D. Guest Star

Let us return to the "Via Latina Anonymous Catacomb". It is a relatively newly discovered (1952) catacomb. It is not a "common cemetery", owned and managed by the whole Christian community, but a private cemetery, most probably owned by a single rich family whose members were both Christians and pagans. It was in use for just a few decades in the middle of the 4th century, and is so richly decorated by magnificent frescoes that it has been called the "Sistine Chapel of the 4th Century" (Biamonte 1997).

Another of its paintings has been interpreted as the prophet Balaam (Ferrua 1960). It simply shows a man, dressed as a typical Roman knight, indicating a star (see Plate V: Fig. 1, right). Another fresco shows the "Crossing of the Red Sea" with a bright star shining over the Jews - though there is no reference to a star anywhere in the Book of Exodus. We thus have two unusual representations of stars, painted more or less at the same time in this catacomb.

Furthermore, a fresco dating to the middle of the 4th century, recovered from another catacomb that was randomly discovered (and destroyed!) during road works, shows two characters seen from behind: one of the two, again identified as Balaam, is indicating something in the sky (Biamonte 1997).

Therefore, three more or less contemporary paintings (mid-4th century) are found in Rome, all referring to something unusual in the sky. It is thus worth checking in the Ho Peng Yoke (1962) list of references to astronomical events reported by Far Eastern sources to see whether an impressive comet or "guest star" is reported in that period. Apart from a number of short-lasting and apparently not very luminous comets, just

one event seems to have been noticed. The related text is the following (Yoke 1962):

Chin Shu (chapter 13/20a)

"During the second month of the fourth year of the *Thai-Ho* reign period of Hai-Hsi-Kung a 'guest star' appeared at the western wall of the *Tzu-Wei*. It went out of sight during the seventh month".

The date of the appearance corresponds to March-April, 369 A.D., and the reported coordinates are roughly equivalent to α = 23h 21m, δ =+58°, i.e. the object was in a circumpolar position easily visible from Rome. Within a radius of a few degrees from that location there is only one very young SN remnant: SNR 111.7-02.1 ($\alpha = 23^h\ 23^m\ 24^s$ δ =+58° 48.9'). This SNR is better known by the name of Cas A.

The age of this intriguing object has been estimated, on the basis of dynamical models, to be of the order of a few centuries, and it is generally believed to be the remnant of a supernova that exploded at the end of the 18th century. However, although the telescope was commonly in use by that time and many illustrious astronomers, such as Flamsteed, were active during that period, none seems to have noticed any long-lasting "new star" (see, e.g., Green and Stephenson 2003).

To date, the 369 A.D. guest star has not been considered a reasonable progenitor of Cas A, both because of the dynamical age of the SNR and because it is only reported by a single historical source, and so is not fully accepted as an actual supernova event.

Our possible discovery of an independent confirmation of the event, though still speculative, could support the assertion that Cas A is the only remnant compatible with the 369 A.D. guest star as reported by the *Chin Shu*. However, further studies on the subject are needed in order to test this hypothesis.

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AR ROMOJE 185 IR 369 M. BUVO MATOMA „NAUJA ŽVAIGŽDĖ“?

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Santrauka

Han dinastijos Kinijos metraštyje 185 m. paminėta „nauja žvaigždė“ (pažodžiui – „žvaigždė viešnia“), manoma, buvusi supernova, kurios liekana yra dujų ūkas (SNR) RWC 86. Jei šią hipotezę laikytume patikima, tai būtų pati seniausia identifikuota ir datuota istorinė supernova. Tikslios šio sprogimo datos žinojimas būtų labai svarbus faktas supernovų liekanų tyrimui. Tačiau Y. N. Chin, Y. L. Huang (1994) ir Shaefer (1995) yra abejoję dėl 185 m. reiškinio sąsajų su supernova ir savo ruožtu yra siūlę jį sieti su P/Swifto kometos tranzitu.

Siekdami ištirti šią galimybę, mes analizavome romėniškų katakombų paleokrikščioniską tapybą ir priėjome nuomonę, kad II a. pabaigoje Romos danguje iš tikrųjų buvo stebėtas kažkoks neįprastas šviesulys. Manome, kad šis reiškinys tikriausiai bus buvęs būtent P/Swifto kometos tranzitas. Tačiau klausimas dėl 185 m. reiškinio prigimties vis dėlto kol kas lieka atviras.

Romos katakombų paleokrikščioniška tapyba duoda tvirtą pagrindą teigti buvus ir kitą neįprastą dangaus reiškinį, stebėtą IV a. viduryje. Ho Peng Yoke (1962) sudarytame astronominių reiškinių, minėtų rytietiškuose šaltiniuose, sąraše, ieškodami įspūdingos kometos ar „naujos žvaigždės“ paminėjimo Dzin dinastijos istorijai skirtoje Dzin Šu knygoje aprašytu laiko periodu, randame tiktai vieną vertą dėmesio įrašą, kuriame sakoma, kad 369 m. kovo – balandžio mėnesį pasirodžiusi „nauja žvaigždė“ buvo matoma keturis mėnesius. Minimos šio šviesulio koordinatės atitinka apytikriai α = 23h 21m, δ = +58°, tai reiškia, kad šviesulys yra poliarinėje dangaus srityje, gerai matomoje Romoje. Šioje vietoje kelių laipsnių spinduliu aptinkame vienos labai jaunos supernovos SNR 111.7-02.1 (α = 23h 23m 24s, δ = +58° 48.9') liekaną. Ši supernovos liekana yra žinoma Cas A vardu. Jos amžius buvo apskaičiuotas, remiantis dinaminiu modeliu. Laikoma, kad Cas A amžius yra keli šimtmečiai ir manoma, kad tai yra XVIII a. pabaigoje sprogusios supernovos liekana. Tačiau tuo laiku jau buvo plačiai naudojami teleskopai, bet nė vienas žymus astronomas, pavyzdžiui, Flamstidas, aktyviai dirbęs tuo metu, nėra pastebėjęs jokios „naujos žvaigždės“ (žr., pvz., Green and Stephenson, 2003).

369 m. „nauja žvaigždė“ nebuvo laikoma pagrįstu Cas A pirmtaku dėl dviejų priežasčių: 1) remiantis dinaminiu modeliu, buvo apskaičiuotas kitoks supernovos liekanos amžius; 2) 369 m. „nauja žvaigždė“ tebuvo paminėta tik viename istoriniame šaltinyje. Mūsų pateiktas nepriklausomas šio reiškinio patvirtinimas, nors kol kas ir spekuliatyvus, galėtų sustiprinti nuomonę, kad Cas A yra būtent 369 m. Dzin Šu knygoje paminėtos „naujos žvaigždės“ liekana.

Vertė Jonas Vaiškūnas