

ELEVENTH-CENTURY SUPERNOVAE: ANOTHER WAY TO READ THE MEDIEVAL SOURCES?

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Abstract

The supernova explosions of 1006 AD and 1054 AD are, probably, the astronomical events most carefully studied through the analysis of historical sources. But contradictions are still present in several sources concerning SN 1054 and the historical records are not consistent with the astronomical data. This short analysis aims to highlight all these aspects.

Key words: historical supernovae, SN 1006, SN 1054, Crab Nebula, Middle Ages, historical astronomy.

The Eleventh-Century Supernovae

Two Supernovae (SN) were seen to explode during the 11th century: the first in 1006 and the second in 1054. SN 1006 presents no problem either from the historical or the astrophysical point of view, since there is good documentary evidence of its observation and the light curve that can be deduced from these sources agrees perfectly with the physics of the explosion of a Type Ia Supernova, as expected given the nature of its remnant. But it is not easy to study SN 1054 (or indeed to recognize it at all) in the historical sources. SN 1054 should have been much higher in the sky, and therefore much more visible than SN 1006 in the Northern Hemisphere; but the number of claimed historical references to SN 1054 is less than one half of the number of references to SN 1006. Work on the interpretation of Song Empire sources is still in progress (see for example Pankenier 2006), but despite much research and many publications, no convincing European references to SN 1054 have been uncovered.

Several explanations have been proposed to account for the relatively 'scarce' number of medieval European references: an absence of astronomical knowledge; censorship by the Roman Catholic Church; the supernova was unusually faint; and there was an unusual period of bad weather. But all these arguments are untenable and actually incorrect, because they ignore:

1. the political organization of the Church in the framework of the German Empire and of the Kingdom of Italy in the 11th. century;
2. the social dynamics of early medieval culture and the role of monasteries as individual *scriptoria*;
3. the development of medieval 'historiography' (histories – *historiae* – annals – *Annales* – chronicles – *crhonica*) and the evolution of this genre (Mc-

Cormick 1975; Van Houts 1995); and last but not least

4 the phenomenology of the texts and their transmission.

It is certainly true that the first renaissance of astronomical science in Europe happened in the late 11th century, after the discovery of the Arabic scientific tradition and the circulation of its texts in Europe (Pouille 1981). Nevertheless comets, stars and the like were known, seen and often recorded. It is important to realise that these phenomena were also narrative elements in a genre of text that – despite the difficulty for us in characterising it – had a clear rhetoric and, most important of all, a clear aim. In fact, there are many references to astronomical phenomena (bright lights in the sky, stars etc.) in early medieval historiography: almost every year a bright new 'star' or an unusual light in the sky were registered in the *Annales* or chronicles of some monastery or church, or else in some dynastic chronicles or town chronicles, or else in the *vitae* – biographies – of bishops, saints, or popes. The real problem for us, as historians, is to ascertain whether or not any given reference is a true description of a real phenomenon (see, e.g. Ghignoli and Polcaro 2007).

Besides this, our present-day knowledge of the Crab Nebula and Pulsar suggests that the original explosion was not a weak one, visible to the naked eye for up to two years. It is ludicrous to postulate a two-year-long period of cloudy skies.

The Song Empire Sources and the Problem of the SN 1054 Light Curve

The official history of the Song Dynasty (*Song shi*) was the first to be suggested as witnessing the birth of the Crab Nebula (Hubble 1928). Mayall (1936) found

that this source reports the date when the Song Emperor Renzong was informed by the astronomer Yang Weide about the appearance of the 1054 “guest star” (4th July), its luminosity on this date (“like Venus”), the length of the period during which this star was visible in daylight (23 days), the date when the Emperor was notified of the last sighting (April 17th, 1056) and the “guest star”’s position in the sky.

These data made it possible to identify, though with some problems, this event with the explosion of the precursor of the Crab Nebula (Mayall and Oort 1942; Duyvendak 1942) and Pulsar.

Following the traditional interpretation (see, e.g., Clark and Stephenson 1977), the official Song Court texts thus give us two photometric points: on July 4th 1054 it was “like Venus”, i.e. of visual magnitude $\cong -4.5$, and on April 17th 1056 it was “visible no more”, i.e., of visual magnitude ≥ 5.5 . However, as was stressed by Collins et al. (1999), if we assume July 4th 1054 to be the date of the Supernova explosion, these two photometric points do not fit any core-collapse supernova light curve, even taking into account the large error bars both in luminosity and time.

On the other hand, since SN 1054 was certainly a core-collapse SN (having generated a pulsar), the conclusion is unavoidable that there is a contradiction between the usual reading of the “official” Song Court report and the present-day astrophysical models. A great deal of theoretical work has been done in order to build up an astrophysical model that can explain the SN 1054 light curve given by the official Song Court report (see, e.g., Sollerman et al. 2001; Utrobin 1978; Swartz 1991, and references therein). However, none of these models is fully convincing.

The Complete Set of Data Concerning SN 1054

Collins et al. (1999) have listed all the historical observations that might possibly relate to the Crab Supernova. Polcaro and Martocchia (2006) attempted a hypothetical reconstruction of the SN 1054 light curve from this data set. However, a more detailed analysis revealed that none of these sources is fully reliable: most of the dates are actually highly speculative, and several Western and Eastern sources must be further checked in order to be sure that they actually refer to the Supernova.

Consequently, all we can be reasonably sure about to date, from sources all around the world, is that something unusual, probably the SN, was seen in the sky here and there between April and the beginning of July 1054. Since at this time of year the Crab is only over

the horizon during the daytime, we can specify a lower limit of $v < -4$ between April and June 1054.

Furthermore, the Song Court sources need to be interpreted with care. Let us assume that SN 1054 exploded on April, as seems to be indicated at least by the Arabic source (Brecher et al. 1978; Guidoboni et al. 1994) as well as by the most recent translation of the *Song huiyao* (“Composition of Essential Documents of the Song Dynasty”), which records the date of first sighting as 27 April 1054 (Pankenier 2006). Accordingly, the supernova must have been visible in China during the solar eclipse of May 10th 1054. This can be also deduced from a Liao Kingdom chronicle (though this source also presents some problems – see, e.g. Xu et al. 2000). Following standard Chinese astrology, the omen was clear: the Sun represents the Emperor (actually, the Emperor was the Sun) and the eclipse is a danger to the Emperor’s life. However, the simultaneous presence of the “guest star” indicates the loss of Heavenly support (see, e.g., Sun Xiaochun 2001), and so the danger is unavoidable: the Emperor must leave or die. It is not surprising that such an omen could not be accepted without major political problems. On the other hand, it would have been difficult to justify a different omen from the presence of a “guest star” during a total solar eclipse: if this coincidence actually took place, then it would have been necessary to manage the situation somehow (see, e.g., Polcaro 2007). We stress that we are not claiming that the report from Yang Weide is “false”: we are just suggesting that early observations of the “new star” during the solar eclipse might not have been included in the final official records, in order to “decouple” the solar eclipse from the “guest star”. On the other hand, considering the precision of the reports by the Song Court’s “Astronomical Bureau” official, we can be reasonably sure that on July 4th 1054 the star was “like Venus” ($v \cong -4.5$) and that on April 1056 it had disappeared (i.e. $v > 5.5$).

The actual light curve that can be deduced from the complete set of data concerning SN 1054 available at the present time is thus the one represented in Fig. 1:

As can be seen, the curve is perfectly compatible with the model of a type IIp Supernova, with a production of 0.07 solar masses of ⁵⁶Ni (see, e.g. Sollerman et al. 2001).

The Problem of the Medieval European Sources Concerning SN 1054

Guidoboni et al. (1992) and Collins et al. (1999), who have studied the three main references to SN 1054 (*De obitu Leonis* by Libuinus, the *Tractatus de ecclesia S.*

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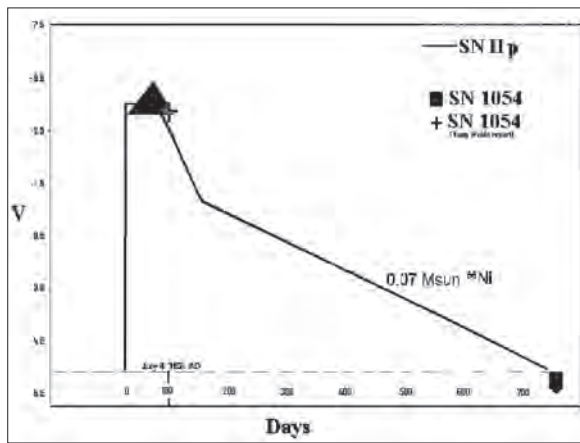


Fig. 1. Comparison between a Type IIp Supernova model and the available photometric data of SN 1054 deduced from the historical sources

Petri Aldenburgensi and the so called *Rampona Chronicle*), worked with an inappropriate method: they read each of those texts as if they belonged to the same vague ‘genre’ of historical works. This assumption can be countered, very briefly, as follows.

1. *De obitu Leonis* is a *libellus* – a “standard” genre of text created in order to support a request for canonization – for Pope Leo IX. The episode of “the innumerable brilliant lamps” is a recurring theme (*topos*) of the genre (*kratophania*) yet it does not appear in the most ancient (12th-century) and only preserved (in the Biblioteca Medicea Laurenziana, Florence) manuscript of this text. Thus we conclude that *De obitu Leonis* by Libuinus does not represent a record of a real celestial phenomenon.

2. *Tractatus de ecclesia S. Petri Aldenburgensi* – if it is not an antiquarian forgery – belongs to the genre of the “legend of the foundation” of a church and it is not hard to demonstrate that Saint Leo IX (the pope) played a central role as “virtual” and much needed founder of the church of St. Peter. This text is not a ‘history’ of facts but a list of miracles.

3. The only certain reference to SN 1054 can be found in the so-called *Rampona chronicle* (which is part of a set of texts) and the recently proposed interpretation of the crucial passage (Collins et al. 1999) is sufficient, although not completely correct. In fact, the author of this late Italian town chronicle (of Bologna), Bartolomeo della Pugliola, wrote between 1395 and 1420, and so was only a contemporary witness of events that happened during that period; he “cut and pasted” news from earlier periods that he obtained from several different sources (Zabbia 1999). Incidentally, taking into account the sound proposal by Collins et al. (1999), the Latin expression “in circuitu prime lune” can be properly translated as simply “on the first day of the new moon”.

Conclusion

It is a fact that SN 1006 was brighter than SN 1054: the first one was a Type Ia supernova while the second one was an intrinsically less luminous Type IIp and they were both at a similar distance (2.18 kpc and 1.83 kpc respectively).

However, this fact alone does not explain the difference in the number of historical sources concerning SN 1006 (19 independent sources found all over the world) and SN 1054 (only 7 or 8).

We suggest that the main explanation is in their position in the sky as well as the explosion dates.

Both supernovae exploded in April, but SN 1006 (R.A. 15h 02m 48.4s) did so when it was nearly in opposition to the Sun and was thus immediately recognized everywhere as a very impressive star (although it was often called “a comet” for political or cultural reasons).

SN 1054 (R.A. 05h 34m 31.97s), on the other hand, exploded when it was nearly in conjunction with the Sun. Thus it took some time before it was clearly seen and recognized as “a star” (apart from in China, where it should have been seen during the solar eclipse of May 10th 1054). When SN 1054 finally became visible at night, it was already three months old, and thus much less luminous and impressive for people with a scarce sky knowledge (such as the Europeans) as well as for people with very strong political reasons for ignoring it as long as possible (such as the Chinese).

Further study of the 11th-century supernovae needs to be undertaken, both from the historical and the astrophysical point of view.

References

- BRECHER, K., LIEBER, E. and LIEBER, A. E., 1978. A Near-Eastern sighting of the supernova explosion of 1054, *Nature*, 273, 728.
- CLARK, D. H. and STEPHENSON, F.R., 1977. *The Historical Supernovae*. Oxford: Pergamon Press, 1977.
- COLLINS, G. W., CLASPY, W. P., MARTIN, J. C., 1999. A Reinterpretation of Historical References to the Supernova of A.D. 1054. *Publ. Astron. Soc. Pacific*, 111, 871.
- DUYVENDAK, J. J. L., 1942. Further Data Bearing on the Identification of the Crab Nebula with the Supernova of 1054 A.D. Part I. The Ancient Oriental Chronicles. *Publ. Astron. Soc. Pacific*, 54, 91.
- GHIGNOLI, A., POLCARO, V. F., 2007. Eleventh Century Astronomical Events as Recorded in Contemporary European Sources. In: I. LIRITZIS, ed. *Mediterranean Archaeology and Archaeometry*, 6 (3 - special issue), 61-66.
- GUIDOBONI, E., MARMO, C., POLCARO, V. F., 1992. La Supernova del 1054 nelle fonti europee. *Le Scienze*, 292, 24.
- GUIDOBONI, E., MARMO, C., POLCARO, V. F. 1994. Do we need to re-date the birth of the Crab Nebula? *Mem. SAI*, 65, 623.

- HUBBLE, E., 1928. Novae or Temporary Stars. *Publ. Astron. Soc. Pacific Leaflet*, 1, 14.
- MAYALL, N.U., OORT, J.H., 1942 Further Data Bearing on the Identification of the Crab Nebula with the Supernova of 1054 A.D. Part II. The Astronomical Aspects. *Publ. Astron. Soc. Pacific*, 54, 95.
- MCCORMICK, M., 1975. *Les annales du haut moyen âge*. Turnhout: Brepols.
- PANKENIER, D. A., 2006. Notes on translations of the East Asian records relating to the supernova of AD 1054. *Journal of Astronomical History and Heritage*, 9(1), 77
- POLCARO, V.F. MARTOCCHIA, A., 2006. Supernovae astrophysics from Middle Age documents. In: E. J. A. MEURS, G. FABBIANO, eds. *Proceedings of the 230th Symposium of the International Astronomical Union "Populations of High Energy Sources in Galaxies"*. Dublin, Ireland 15-19 August 2005. Cambridge: Cambridge University Press, 264-268.
- POLCARO, V F., 2007. The astronomical bureau during the Song dynasty. In: M.P. ZEDDA and J. A. BELMONTE, eds. *Lights and Shadows in Cultural Astronomy*. Isili, Sardinia: Associazione Archeofila Sarda.
- POULLE, E., 1981. *Les sources astronomiques (textes, tables, instruments)*. Turnhout: Brepols.
- SOLLERMAN, J., KOZMA, C., LUNDQVIST, P., 2001. Why did Supernova 1054 shine at late times? *A&A*, 366, 197.
- SUN XIAOCHUN, 2001. La cartografia celeste In: *Storia della Scienza*, II. Rome: IEI 155.
- SWARTZ, D. A., WHEELER, J., C., HARKNESS, R.P., 1991. Model light curves of linear Type II supernovae. *ApJ*, 374, 266.
- UTROBIN, V. P., 1978. Supernova models with slow energy pumping and galactic supernova remnants. *Ap&SS*, 55, 441.
- VAN HOUTS, E., 1995. *Local and Regional Chronicles*. Turnhout: Brepols.
- XU, Z., PANKENIER, D.W., JIANG, Y., 2000. *East Asian Archaeoastronomy*. Amsterdam: Gordon and Breach Science Publishers.
- ZABBIA, M., 1999. *I notai e la cronachistica cittadina italiana nel Trecento*. Roma: Istituto Storico Italiano per il Medio Evo.

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XI A. SUPERNOVOS – KITAS BŪDAS SKAITYTI VIDURAMŽIŲ RAŠYTINIUS ŠALTINIUS?

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Santrauka

Skaityti viduramžių rašytinius šaltinius yra gana sudėtinga. Čia negalime vadovautis paprastu stereotipišku „viduramžių mentaliteto“ supratimu, ypač kai tuose tekstuose reikia rasti astronominę informaciją, kurią būtina palyginti tiek su stebimosios, tiek ir su teorinės

šiulaukinės „objektyviosios“ astronomijos žiniomis. Šis straipsnis iš naujo kelia klausimą dėl viduramžių „vakarietišku“ šaltinių apie XI a. supernovų SN 1006 ir SN 1054 tyrimus. Minėti reiškiniai yra svarbūs šiulaukinei astrofizikai, bet senoviniuose rašytiniuose Rytų šaltiniuose apie juos pateikiami neapibrėžti ir abejotini tvirtinimai (Polcaro and Martocchia 2006). Į išskylančius klausimus apie SN 1054 supernovos pasirodymą atsakymų ieškoma pasitelkus vadinamąją „Ramponos kroniką“ ir „Tractatus de ecclesia S. Petri Aldenburchensis“ (naujai apmąstant šio teksto kilmę ir istoriją) bei įžymų „Libuinus'o tekstą“ apie popiežiaus Leo IX mirtį: vienintelis šio teksto senovinis rankraštis tėra išlikęs ir saugomas Florencijoje (Biblioteca Medicea Laurenziana, ms. Conventi soppressi (Vallombrosa) 331; sec. XII). Šie atpasakojamieji šaltiniai aptariami platesniuose teorinių klausimų rėmuose, taikant filologinės kritikos ir istorinės astronomijos metodus.

Prieinama išvada, kad nė vienas iš tirtų šaltinių negali pateikti naudingų astrofiziniams tyrimams kiekybinių duomenų. Apie supernovą SN 1054 esama gana mažai istorinių šaltinių palyginti su SN 1006, tai iš dalies gali būti aiškinama pastangų tiriant Vakarų rašytinius šaltinius stoka bei patrauklios, bet istoriškai nemotyvuotos „Romos katalikų bažnyčios cenzūros“ teorijos pasekmėmis, kaip ir tuo faktu, jog SN 1006 buvo tikrai ryškesnė negu SN 1054. Mūsų manymu, pagrindinė priežastis, nulėmusi skirtingą dėmesį abiem supernovoms, slypi skirtingose jų padėtyse dangaus skliaute ir sprogimų datose.

Abi supernovos sužibo balandžio mėnesį, bet SN 1006 (R.A. 15h 02m 48.4s) sprogo būdama beveik opozicijoje saulei, taigi iškart galėjo būti visur atpažinta kaip labai išpūdinga žvaigždė (nors dėl politinių ar kultūrinių priežasčių dažnai buvo įvardijama kaip „kometa“). Priešingai, SN 1054 (R.A. 05h 34m 31.97s) sprogo, kai jos padėtis beveik sutapo su saulės padėtimi. Taigi turėjo praeiti šiek tiek laiko, kol ją galima buvo aiškiai pamatyti ir atpažinti kaip „žvaigždę“ (išskyrus Liao karalystę, kur ji buvo matoma jau 1054 m. gegužės 10 d. – saulės užtemimo metu). Kai SN 1054 tapo matoma naktimis, jau buvo praėję trys mėnesiai, ir ji turėjo būti ne tokia ryški ir išpūdinga.

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