



0083-6656(95)

A Re-evaluation of the Eastern and Western Records of the Supernova of 1054

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Abstract: The Chinese and Japanese records are our primary evidence of the supernova of 1054. But their evidence is not entirely consistent, and recent scholarly discussion of them has not yielded clear-cut results. We have therefore re-examined the original sources in some detail in order to determine their relative historical value and to arrive at as close a determination as possible of the appearance of the event itself. We have established from the Chinese sources that, on the authority of the Chief of the Astronomical Bureau at K'ai-feng, a guest star was first sighted between 9 June and 7 July 1054 to the north-west of ζ Tauri; it became as bright as Venus, was visible in daylight for 23 days and did not disappear from sight until just before 17 April 1056. All this location, duration and brightness data points to this guest star as the supernova progenitor of the Crab nebula. When the Japanese texts are considered the date 4 July 1054 emerges as the most likely date of the first sighting of this supernova. Recent claims for both Middle-Eastern and Western European records are evaluated in the light of this result.

1. INTRODUCTION

In 1928 Edwin Hubble, remarking that Duncan's measurement of the rate of expansion of the Crab nebula implied that it originated about 900 years ago, suggested that a guest star¹ observed by Chinese astronomers in 1054 may have been the origin of the Crab nebula. Ten years later, the distance to the Crab having been established together with brightness information published by Yba from Japanese chronicles, led K. Lundmark to reiterate Hubble's suggestion and to conclude that the guest star of 1054 had been a supernova. Finally in 1942 the Dutch orientalist J. Duyvendak, at the instigation of the Dutch astronomer J. Oort, studied and published the Chinese and Japanese texts referring to the guest star of 1054, and in the

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¹ The term "guest star" was used in Chinese astronomical records to designate variously novae, comets and even meteors, see Peng-Yoke et al. (1972, p. 5). In this case the duration indicated by the Chinese records rule out all but the first of these meanings.

same year Mayall and Oort published their argument in favour of identifying this guest star with the Crab nebula. Ever since then the identification of the Crab nebula with the guest star of 1054 as its supernova progenitor SN1054 has been widely accepted by the astronomical community. However in a footnote to Duyvendak's article Oort did point out the disconcerting discrepancy that, whereas Duyvendak's interpretation of the Chinese records placed the guest star south-east of ζ Tauri, the Crab is in fact about one degree north-west of that star. This discrepancy naturally raised some doubts and in a 1972 review of all of Duyvendak's oriental sources Peng-Yoke, Paar and Parsons seriously questioned the identification. Subsequently, Williams (1981), even more strongly challenged the credibility of the identification on the basis of both the observed direction and distance of the Crab nebula from ζ Tauri, and the date of the supernova inferred from the observed rate of expansion of the nebula. More recently, Williams (1995), reiterated his 1981 assertions and suggested that European records of the event are more to be relied upon than the Chinese records.

Up until 1978 it was a matter for repeated comment that searches of Western chronicles failed to yield any record of a sighting of SN1054; so profound was the apparent record "blackout" that some even proposed that European skies had been obscured for the relevant two years by a volcanic eruption. However in 1978 Brecher et al. published an excerpt from an Arab medical textbook *Uyun al-Anba* in which an account copied from the autograph of Ibn Butlan, a Christian physician from Baghdad, reported that a "spectacular star appeared in Gemini in the year 446 H", that is from 12 April 1054 to 1 April 1055, which has been accepted as a sighting of the supernova. In his 1981 article Williams proposed that a chronicle from Bologna recorded a cryptic Italian observation, while more recently it has been proposed by Guidoboni et al. (1992) that Italian and Flemish records preserve a European observation of the supernova on April of that year, though we regard both of these as very dubious as will be discussed below. Finally petroglyphic records in Arizona and south-west India have been proposed by Miller (1955) and Brandt (1977), though these must naturally be treated with caution, see Ellis (1975).

It is now over fifty years since Duyvendak presented his evaluation of the Chinese and Japanese records and in that time a great deal has been learned about the nature of supernovae, see for example Shklovsky (1968), Rees and Stoneham (1982) and Murdin (1985). As well as this in the past decade computer-based sky simulation programs such as the MICA computer program or the commercially-available Voyager program, together with visibility modelling tools published by Schaefer (1993) may be used to examine historical records to help establish their authenticity or otherwise. As matters stand at present two serious challenges to the identification by Oort and Mayall have gone unanswered; now therefore, is an appropriate time to undertake a re-evaluation of all the historical evidence that has been published.

2. EASTERN SOURCES

2.1. Chinese Records

In the Sinology journal *T'oung Pao* Duyvendak (1942a) discussed the five Chinese and two Japanese texts which he had located, and he gave for each the Chinese text accompanied by an English translation, see Fig. 1. Several of these texts appeared in more than one source, and so we list here below for each distinct text, in the order presented by Duyvendak (1942a), the reference information supplied by him and, where appropriate, supplemented by the information given by Peng-Yoke et al. (1972). This is followed by Duyvendak's English translation taken verbatim from Duyvendak (1942a).

The original text (quoted by Biot from Ma Tuan-lin's *Wen-hsien T'ung-kao* ch. 294, p. 12a) is found in the *Sung-shih* 宋史 (Treatise on Astronomy, Paragraph on "guest-stars") ch. 56, p. 25a (Po-na ed.). It runs:

A 至和元年五月¹己丑出天關²東南可數寸。
歲餘稍沒³。

"In the 1st year of the period Chih-ho (1054), the 5th moon, the day *chi-ch'ou* (July 4th) (a "guest-star") appeared approximately several inches south-east of T'ien-kuan (♄ Tauri). After more than a year¹) it gradually became invisible"³).

In the Annals of the *Sung-shih*, which do not report the phenomenon under the 1st year of Chih-ho, this information is supplemented in an entry under the 1st year of the period Chia-yu. There (ch. 12, p. 10b) we read:

B 辛未司天監言⁴，自至和元年五月¹客星⁵晨
出東方、守天關⁶，至是沒³。

"On the day *hsin-wei* (of the 3rd moon of the 1st year of the period Chia-yu, i.e. April 17th 1056) the Chief of the Astronomical Bureau reported that from the 5th moon of the 1st year of the period Chih-ho (June 9th—July 7th 1054) a guest-star had appeared in the morning in the eastern heavens, remaining in T'ien-kuan (♄ Tauri), which only now had become invisible".

The duration of visibility of this "guest-star" was therefore from July 4th 1054—April 17th 1056.

Further information is found in the *Sung Hui Yao* 宋會要, vol. 52, p. 2b (not numbered):

C 至和元年七月二十二日..... 楊惟德言、
伏觀客星出見、其星上微有光彩黃色。謹案
皇帝掌握占云、客星不犯畢、明盛者主、國
有大賢、乞付史館容。百官稱賀、詔送史館。
嘉祐元年三月司天監言⁴、客星⁵沒³、客去
之兆也。初至和元年五月¹晨出東方守天
關⁶、晝見如太白、芒角四出、色赤白。凡見
二十三日。

Fig. 1. Excerpts of pages 174-5 from Duyvendak's original publication in *T'oung Pao* 36 (Leiden, 1942), showing the Chinese texts. The texts are A = *Sung-shih*, B = Annals of the *Sung-shih* and C = *Sung hui-yao*. Translations of the underlined groups of characters are as follows: 1 = "In the 1st year of the period Chi-ho, the 5th moon"; 2 = "T'ien-kuan"; 3 = "Invisible"; 4 = "The Chief of the Astronomical Bureau"; 5 = "Guest star"; 6 = "Rose in the morning in the eastern heavens guarding T'ien-kuan". Note the repetition of 1 in texts A, B and C, and the repetition of 6 in texts B and C.

Text A

1. *Wen-hsien T'ung-k'ao* by Ma Tuan-lin *ca.*, 1280.
2. *Sung-shih*, Paragraph on "Guest stars" ch. 56, p. 25a (Po-na ed.) compiled in 1345.

"In the 1st year of the period Chih-ho (1054), the 5th moon, the day chi-ch'ou (July 4th) (a "guest star") appeared approximately several inches south-east of T'sien-kuan (ζ Tauri). After more than a year it gradually became invisible."

Text B

1. The annals of the *Sung-shih*, an entry under the first year of the period Chia-yu.

"On the day *hsin-wei* (of the 3rd moon of the 1st year of the period Chia-yu, i.e. April 17th 1056) the Chief of the Astronomical Bureau reported that from the 5th moon of the 1st year of the period Chih-ho (June 9 to July 7 1054) a guest star had appeared in the morning in the eastern heavens, remaining in Tien-kuan (ζ Tauri), which only now had become invisible."

Text C

1. *Sung hui-yao* compiled by Chang Te-hsiang.

"On the 22nd day of the 7th month in the 1st year of the period Chih-ho (August 27th 1054) ... Yang Wei-te said: "Prostrating myself, I have observed the appearance of a "guest-star"; on the star there was slightly an iridescent yellow colour. Respectfully, according to the dispositions for Emperors, I have prognosticated, and the result said: "The "guest-star" does not infringe upon Aldebaran; this shows that a Plentiful One is Lord, and that the country has a Great Worthy! I request that this (prognostication) be given to the Bureau of Historiography to be preserved".

All the officials presented their congratulations and by Imperial Edict it was ordered that (the prognostication) should be sent to the Bureau of Historiography.

In the 3rd moon of the 1st year of the period Chia-yu (March 19th–April 17th 1056) it was reported that the "guest-star" had become invisible, which was an omen of the departure of guests.

Originally this star had become visible in the 5th moon of the 1st year of the period Chih-ho (June 9th–July 7th 1054) in the eastern heavens, in T'ien-kuan (ζ Tauri); it was visible by day, like Venus; pointed rays shot out from it on all sides; the colour was reddish-white. Altogether it was visible for 23 days."

Text D

1. *Ch'i-tan-Kuo chih* by Yeh Lung-li, mid thirteenth century.
2. *Sung-shih hsien-pien* by K'o Wei-ch'i (1497–1574). This text was located by Peng-Yoke et al. (1972, p. 4) and as cited by them consists simply of the sentence "During the first year of the Chih-ho reign period [1054] there was a solar eclipse at midday and a guest star appeared

within the Mao [lunar mansion]:[the Pleiades]”.

“(In the 23rd year of the period Ch’ung-hsi) in the 8th moon the Lord of the country died Previously there had been a sun-eclipse, and in the 1st moon (January 31st–Febr. 28th 1055) a “guest-star” had appeared in the Pleiades. Liu Yi-sou, Senior Vice-President of the Bureau of Historiography, said: “Now Hsing-tsung has died, (these omens) have indeed come true!”

To these four Chinese texts located and translated by Duyvendak we may add the following which was discovered by Peng-Yoke et al. (1972, p. 5). We present here their translation verbatim enclosed in single quotes and, as can be seen, it is somewhat unsatisfactory in as much as they have given a translation of one part and a paraphrase of the second part, with no indication as to how the two parts relate to each other and neither did they cite the Chinese text.

Text E

1. *Hsü Tzu-chih T’ung-chien Ch’ang-pien* by Li Tao who died in 1184.

‘On an *i-ch’ou* cyclical day [in the fifth lunar month] a “guest star” appeared to the south-east of T’ien-kuan, possibly several inches [away]”. The commentary adds that the object only went out of sight during the third month of the first year of the Chia-yu reign-period.’

These Chinese records do not give a consistent account of either the date or the location of the object, and it is therefore worthwhile examining these sources afresh in order to assess their evidential character. Both Duyvendak and Peng-Yoke identified, and Williams accepted, text A as the “original text” and they all presented it as the first of their Chinese texts, but they offered no justification whatsoever for this conclusion. The date of composition of this record is not known and that it certainly is not contemporary with the apparition of the “guest-star” is implicit in its vague statement that “after more than a year it gradually became invisible”. The earlier of the two sources is Ma Tuan-lin’s encyclopaedia of Chinese civilization, compiled largely from Sung records, *Wen-hsien T’ung-kao* (Comprehensive Study of (the History of) Civilization), begun in 1254 and finished in about 1280, which was regarded by the Chinese as a work of great authority and learning. Book 294 contains a list of extraordinary celestial phenomena from antiquity up to the thirteenth century, and it is from this that our record of the guest star of 1054 comes. The second source is from the *Sung-shih*, the History of the Sung dynasty (960–1279), compiled in 1345. It is identical with Ma Tuan-lin’s record and is almost certainly a copy of it. We are therefore dealing with only one source, the language and historical background of which indicate that it was not contemporary.

Text B is a brief annalistic entry for the year 1056 within the annals proper of the *Sung-shih* and it is a doubly valuable record because it is both contemporary and states explicitly its authority, i.e. “On the day *hsin-wei* (April 17th 1056) the Chief of the Astronomical Bureau reported ...”. It contains a partial¹ transcript of his report of the apparition, giving explicitly an initial month and implicitly a precise terminal date of visibility of the guest star, saying that on April 17, 1056 it “only now had become invisible”. Peng-Yoke et al. (1972, p. 4) were

¹ We regard it as a partial transcript because, as we show below, text C contains a continuation of his report and also it seems certain that the original report must have included the precise day of the Bureau’s first observation of the guest star. Compare for example the Bureau’s report on the supernova of 1006.

the first to draw attention to the fact that the character *shou*, which precedes T'ien-kuan in the Chinese text, has the very clear connotation of "guarding" or "protecting", which sense has not been preserved by Duyvendak's translation that the guest star had been "remaining in T'ien-kuan" until it became invisible. Duyvendak also translated the character *ch'u* simply with the verb "to appear", where in fact it carries the specific connotation¹ "to rise", so that the phrase in text B which located the object should read, "the guest star rose in the morning in the eastern heavens guarding T'ien-kuan", and we shall see that this has profound implications for the observed location of the guest star. Regarding the location of T'ien-kuan in the sky, Peng-Yoke et al. made a valuable contribution to the discussion when, by means of a detailed examination of Chinese astronomical material, they established that T'ien-kuan is to be identified with ζ Tauri, see Peng-Yoke et al. (1972, p. 6–10).

Text C, our fullest source, is from the *Sung hui-yao* (History of the Administrative Statutes of the Sung Dynasty) and it is clearly based upon contemporary source material since it gives the name of the Chief Astrologer, Yang Wei-te, whom we know from independent sources to have been at his post as early as 1008, see Duyvendak (1942a, p. 175, fn. 1). It precisely dates his prognostication to 27th August 1054 and quotes his interpretation of the meaning of the guest star's appearance, which was, by imperial edict, duly noted and recorded. The second part² gives a description of the apparition which is identical with that in the Annals of the *Sung-shih*, as may be seen from an examination of the Chinese texts in Fig. 1, however Duyvendak's translation seriously misrepresents the content of this text.³ Firstly we see that the title "Chief of the Astronomical Bureau" and the date of his report are both given verbatim in the Chinese, as are his statement of the month of the first appearance and the location of the guest star in the eastern heavens. Duyvendak's translation completely ignored the identical Chinese texts which he presented and he replaced the explicit authority of the "Chief of the Astronomical Bureau" with the anonymous "it was reported". Likewise he omitted the time of the observation "in the morning", which he had included in his translation of text B, and he translated the character *shou* simply as "in T'ien-kuan" where previously he had translated it, unsatisfactorily as we have said, as "remaining in T'ien-kuan".

Thus Duyvendak's translation completely fails to record the fact that all the important observational and chronological information found in text B has been reproduced verbatim in the first thirty two characters of the second paragraph of text C. The only element in these characters not found in the Annals of the *Sung-shih* is the interpretation attributed to the Chief of the Astronomical Bureau that the disappearance of the guest star "is an omen of the departure of the guest". This interpretation may be thought an interpolation, but it should be noted that the Astronomical Bureau's report on the supernova of 1006, which is given below, also includes an astrological evaluation of the event, so that it is more likely that in text C only a reordering has occurred. In either case the fact that all the rest of his astronomical assertions have been transmitted verbatim gives us great confidence in the data found in text B. Furthermore it is clear from both their content and position that the last eighteen characters of the second paragraph in text C, viz. "it was visible by day, like Venus; pointed rays shot out from it on all sides; the colour was reddish-white. Altogether it was visible for 23 days"

¹ We are very grateful to Dr. David Chek Ling Ngo of OnScreen Interactive Ltd., Dublin for his assistance with the Chinese texts in Duyvendak (1942a).

² That is paragraphs three and four of Duyvendak's English translation or the second paragraph of his Chinese text, see Fig. 1.

³ A comparison of his translations in Duyvendak (1942a) and (1942b) shows signs of confusion; in (1942b) paragraphs two and three are printed in a larger font, suggesting that they are not actually citations from the Chinese text, whereas in (1942a) they are all in a single size and enclosed within double quotation marks. It seems clear that the U.S. editor of (1942b) took paragraphs two and three to be paraphrases.

are actually a continuation of the report of the Chief of the Bureau of Astronomy. We would suggest therefore that the second paragraph of text C should read as follows:

“In the third moon of the first year of the period Chia-yu [March 19–April 17 1056] the Chief of the Astronomical Bureau said, “The guest star has become invisible, which is an omen of the departure of the guest. Originally, in the fifth month of the first year of the period Chih-ho it had risen in the morning in the eastern heavens guarding T’ien-kuan. It was visible by day, like Venus; pointed rays shot out from it on all sides. The colour was reddish-white. Altogether it was visible for twenty three days.””

This account of the emergence, location, appearance and implication of the guest star of 1054 should be compared with the following Chinese description¹ of the supernova of 1006, the brightest stellar object known to have appeared in our skies:

“On the first day of the fifth month, in the third year of the Ching-Te reign period [30 May 1006] the Director of the Astronomical Bureau said that at the first watch of the night, on the second day of the fourth month [1 May 1006] a large star, yellow in color, appeared in the east of *Ku Lou*, in the west of *Ch’i Kuan*. Its brightness had gradually increased. It was found in the third degree east of the *Ti* - thus it belongs to the geographical division of Cheng and the station of *Shou-Hsing* The star later increased in brightness. According to the star manuals there are four types of “auspicious stars”, one of which is called *Chou-po*, a yellow and brilliant [object] foreboding great prosperity for the State over which it appears.”

The parallels in the two accounts should be noted; the date and authority for the report, the date and time of the first observation, the location in the sky, the appearance of the object, its change in brightness and an astrological interpretation of the event. It seems very likely that a similar level of detail was recorded at K’ai-Feng for the 1054 supernova, but not so much of it has come down to us. Needham (1959, pp. 188–191 & 418–9) provides a detailed account of the roles of both the Chief Astronomer and Chief Astrologer, which were hereditary offices linked directly to the Emperor, and thus of the highest Imperial status. Both bureaus had a substantial staff to, on the one hand keep a 24-hour watch on the heavens and maintain a daily file of all observations, and on the other to interpret these observations for the guidance of the Emperor. Events deemed by him to be of major significance were then “memorialized” by transmission to the Bureau of Historiography. In 1054 Yang Wei-te was Chief Astrologer and the account in text C is a cogent summary of the orderly sequence of observation, interpretation, Imperial approval and preservation, as executed by the three Bureaus of Astronomy, Astrology and Historiography and the Emperor.

Text D is a record of the Liao dynasty, from its imperial capital at present-day Beijing. It states that a guest star had appeared in the Pleiades in the first month (January 31st–Febr. 28th, 1055), preceeded in the previous year by a solar eclipse (May 10, 1054). Both its date, which is seven months later, and its location about 26" west of ζ Tauri raise serious doubts as to whether this is an observation of the same object recorded in texts A–C.

Text E is the earliest text to state, like text A, that the guest star appeared to the south-east of ζ Tauri, but in other respects it differs significantly from text A. Firstly, as Peng-Yoke

¹ Cited by Williams (1981, p. 343) from B.R. Goldstein & Ho Peng-Yoke (1965), “The 1006 Supernova in Far Eastern Sources”, *The Astrophysical Journal*, 70, p.748

et al. (1972, p. 5) have pointed out, the day *i-ch'ou* is inappropriate to the fifth month and secondly, it gives a specific date for the disappearance of the guest star which is identical with the date given by the report of the Chief of the Astronomical Bureau and almost certainly is drawn from that report or a copy of it. Thus text E clearly postdates the Chief's report and the error in its day *i-ch'ou* suggests that the postdating is substantial. Texts A and E would appear to derive ultimately from a common source which A, in a manner appropriate to an encyclopaedia entry, has abbreviated.

The status therefore of texts A and E can hardly be compared with that of texts B and C, whose astronomical observations are attributed explicitly to the highest astronomical authority in China in 1054 and are explicitly dated to 17 April 1056, immediately following the disappearance of the guest star. This being so, we have it on the authority of a professional astronomer who had witnessed the apparition, that a guest star, bright enough to be seen in daylight like Venus, "had risen in the morning in the eastern heavens guarding T'ien-kuan". The question is therefore, what idea did the Chief of the Astronomical Bureau intend to convey when he said this bright guest star was "guarding" T'ien-kuan in the eastern heavens? One implication is obviously that the guest star was near T'ien-kuan and the other clearly is that, if it were to appear to "guard" the much fainter ζ Tauri (magnitude 2.98) rising in the eastern heavens, then it must have been positioned above it and hence risen before it. The immediate consequence of this is that we have it on the authority of an eye-witness that the guest star was to the north-west of ζ Tauri, and not to the south-east as Li Tao asserted in text E and Ma Tuan-lin repeated in text A.

This position for the guest star reported by the Chief of the Astronomical Bureau is fully consistent with the observed position of the Crab Nebula just over one degree north-west of ζ Tauri and, taken with the brightness and duration of the apparition also reported by him, render the identification of this guest star with the progenitor supernova of the Crab as proven beyond all reasonable doubt. In their challenges to this identification both Peng-Yoke et al. and Williams relied on the positional and directional information in text A, which as we discuss below is specious and derivative. Williams also emphasised the fact that twentieth century measurements of the rate of the Crab's expansion indicate a twelfth rather than an eleventh century date for its origin. However, as he frankly acknowledged, his three astronomical colleagues at Cornell did not regard the expansion argument as decisive just as earlier neither Mayall, Oort nor Baade had considered it a serious impediment, so we therefore feel fully justified in referring henceforth to the Chinese guest star of 1054 synonymously as SN1054 and regarding it as the supernova progenitor of the Crab nebula. Regarding the precise date of its first sighting, we see that all of the texts A, B, C and E all agree either explicitly or, implicitly by their position in a chronicle, that SN1054 was first sighted during the fifth moon of the first year of the period Chih-ho. In particular texts B and C give this to us on the authority of the Chief of the Astronomical Bureau, so that the evidence for this month is quite overwhelming. With regard to the specific day, since text E's day is demonstrably corrupt for the fifth moon, only text A's day of *chi-ch'ou* remains and, when the Japanese evidence is examined, we will see that there is good reason to accept this.

Finally, reviewing all of the Chinese evidence, we are in a position to reconstruct approximately the relationships between these texts. Underlying them all, except text D whose relationship with SN1054 must be regarded as dubious, is the report of the Chief of the Astronomical Bureau issued on 17th April 1056, direct excerpts of which appear in texts B and C. Between that date and before Li Tao died in 1184, someone drew the inference from the Chief of the Astronomical Bureau's use of the word "guard" that the guest star and T'ien-kuan lay north-west/south-east of each other and "approximately several inches" apart. But, as readily happens in the course of a deduction, they transposed their positions thereby spawning the

precise but incorrect record found in texts E and A. This also accounts for the vague unit of distance used viz. “approximately several inches”, so that investigations based upon this assertion, such as those by Peng-Yoke et al. and Williams, are doomed to inconclusion. The fact that the day of the month is also incorrect in text E points to clumsy handling of the data either by Li Tao or by the author of his archetype. Text A appears to be a recension of Li Tao’s archetype, very possibly the work of Ma Tuan-lin, wherein the correct date has been transmitted and the date of SN1054’s disappearance summarised by a general statement.

The chief obstacle for astronomers to the identification of the remains of SN1054 with the present Crab Nebula (NGC 1952) has been the statement in text A that it appeared south-east of ζ Tauri, whereas the Crab Nebula is situated a little more than a degree to the north-west of it. However the source for this statement is not contemporary and its ultimate derivation, before its earliest occurrence in the work of twelfth century author Li Tao is unknown. The doubts that have existed regarding the position of the Chinese guest star of 1054 have all arisen from Duyvendak having taken text A as the primary text, and his having given such poor translations for the Chief of the Astronomical Bureau’s description of the apparition given in texts B and C. The order in which these texts should be presented, if it is to reflect their evidential value, is therefore text B, text C, text E and text A.

2.2. Japanese Sources

Duyvendak identified two Japanese texts which he considered recorded observations from Kyoto in Japan, the *Mei Getsuki* and the *Ichidai-yoki* and remarked of them that “though there are graphic variations, (they) are virtually identical and clearly derived from an earlier text written in running hand.” In Duyvendak (1942a, p. 177) he reproduced the more detailed of the two texts, the *Mei Getsuki* accompanied by an English translation which we reproduce below.

Text F

1. The *Mei Getsuki* by Sadaie Fujiwara ca. 1235.
2. The *Ichidai yoki* of unknown date has a closely parallel text which omits the hour of the guest star.

“In the middle ten-day period of the 4th moon of the 2nd year of the period Ten-ki (i.e. May 20th–29th 1054) and thereafter, between 1–3 a.m. a “guest-star” appeared in the orbit of Orion; it was visible in the eastern heavens. It shone like a comet (?) in T’ien-kuan (ζ Tauri), and was as large as Jupiter.”

A third text located by Peng-Yoke et al. from the *Dainihonshi*, which was completed in 1715, preserves a fragment of the above text saying simply “During the fourth month of the second year of the Tenki reign-period a “guest star” was sighted.” The fact that these three texts all identify the fourth month has been taken by Shklovsky to suggest that the Japanese saw it earlier than the Chinese and, by Peng-Yoke et al., to raise doubts concerning the validity of the Chinese sources. However it must be first of all noted that these three texts clearly derive from a single archetype, so that there is in effect only one independent reference to the fourth month. Secondly the duplications in this text should be noted; the first part locates a guest star (*chia-wu*) with respect to Orion whereas the second part locates a comet/nova (*po*) with respect to T’ien-kuan. Duyvendak united these two descriptions by making a simile of the second, but he clearly was uncertain of his translation since he followed it with a question

mark, viz. “It (the guest star) shone like a comet(?)”. He also rendered the dating clause as reading awkwardly “in the middle ten-day period ... and thereafter” whereas a more faithful translation is simply, “after the second decade”. This being so it is useful to observe the way in which this passage was translated by Peng-Yoke et al. (1972, p. 5), which we reproduce below.

“After the second decade of the fourth month, in the second year of the Tenki reign-period, at the *ushi* [i.e. *ch'ou*] double-hour [01:00–03:00] a “guest-star” [*chia-wu*] appeared within the [same longitudinal] degrees as the Shi(ken) [i.e. Tsui-Hsi] and Shin [i.e. Shen] [lunar mansions] [Orion] and was seen in the east. A *hai* [i.e. *po*] appeared [near] the Tengan [i.e. T'ien-kuan], as large as Jupiter.”

We see that they have rendered the dating clause accurately and have acknowledged the duplication of objects and locations by making a second sentence of the description of the *po*. There is however a problem with their translation of this description inasmuch as the Chinese text simply does not contain any character representing their verb “appeared”, which thus should have been shown within square brackets. In fact the only verb in the second part is the “seen” which immediately precedes the two characters representing “the eastern heavens”, which characters are identical with those providing the same description occurring in texts B and C. Finally, the Chinese character immediately following the two representing “T'ien-kuan” stands for “a star”, and neither of these translations has given any expression to it. We suggest therefore that the text should be rendered as follows:

“After the second decade of the fourth month, in the second year of the Tenki reign-period, at the *ushi* [i.e. *ch'ou*] double-hour [01:00–03:00] a “guest-star” [*chia-wu*] appeared within the [same longitudinal] degrees as the Shi(ken) [i.e. Tsui-Hsi] and Shin [i.e. Shen][lunar mansions][Orion]. Seen in the eastern heavens [near] T'ien-kuan a *po* — a star as large as Jupiter.”

From this may be seen that the second description bears a number of details in common with the description given by the Chief of the Astronomical Bureau at K'ai-feng in text C; both accounts place it in the eastern heavens near T'ien-kuan and compare it to a planet. We suggest therefore that what we have in this second sentence is derived from the Chief's original report, with the character *po* expressing the rays emanating from it¹ and “Venus” corrupted to “Jupiter”. This record has then been conflated in both the *Mei Getsuki* and *Ichidai yoki* texts with an independent Japanese observation of the apparition in the first part.

We turn next to examine the astronomical information contained in the first of these records; firstly, while T'ien-kuan and the Tsui and Shin sections of Orion do lie closely at the same Right Ascension, see Murdin (1985, p.6), for the given interval May 30–June 8 they all rose after the sun and, consequently, any bright object rising at that longitude would be seen much more clearly as an evening object, not in the morning as the text states. Secondly, modelling² the situation using *Voyager*, shows that nothing in the neighbourhood of Orion will rise in Japan anywhere near the stated time of the text i.e. 0:10–0:30; in particular ζ Tauri rose at about 3:36 local time on the east coast of Japan at the very end of the interval on 8 June 1054. Thirdly, as Oort pointed out to Duyvendak, during this fourth month ζ Tauri was in close

¹ Duyvendak (1942a, p. 178, f.n. 5) pointed out that the T'zu-hai “says that a *po* has short rays, shooting out on all sides ... this definition is very similar to what is said of the guest-star in the text of the *Sung Hui Yao*.”

² We are very grateful to Mr. Tom Hayes of Dublin for his assistance with the use of *Voyager* to simulate these events.

conjunction with the sun, so that it is completely implausible that any guest star near ζ Tauri was sighted from Japan or anywhere else at that time. On the other hand after the 20 June ζ Tauri did begin to rise earlier than 3:00 on the east coast of Japan; thus all the weight of the dating evidence in this Japanese text points towards the month being incorrect, and it should be amended to read "after the second decade of the *fifth* month" i.e. June 28–July 7.

Thus we find from a detailed examination of the Japanese sources that they confirm both the Chinese month of the first observation of SN1054 and its location near ζ Tauri. Moreover the precise date of first sighting found in text A, viz. 4 July, falls within the third decade of the fifth month, i.e. 28 June–7 July, so that this Japanese record does, in fact, provide independent support for text A's date. In these circumstances and, as we shall see, in the absence of any convincing date from Western sources, we suggest that the date of 4 July should be accepted as the most plausible date of first sighting. Even in the event that text A should prove faulty and only text F correct, we shall not be in error by more than six days. To be fair to Duyvendak we should point out that, Oort having shown him that it would be impossible to observe anything near ζ Tauri when it was in conjunction with the sun, he himself amended the "fourth" to the "fifth" month. Nobody however, so far as we are aware, has examined the implication of the time element in this record, which renders the case for the amendment even stronger.

Finally having established with confidence the location of the guest star and its date of first sighting, we return to consider the description of the guest star given by the Chief of the Astronomical Bureau at the end of text C. Using *Voyager* we examined the visibility considerations from K'ai-Feng (114°30'E, 34°48'N) on the morning of 4 July 1054, taking the guest star to be located at the present position of the Crab nebula. From this it emerged that SN1054 rose at UT 18:50 (Local time 2:50 a.m.) at which time the sun was at altitude $-23^{\circ}20'$. At the commencement of astronomical twilight (magnitude 6 stars just visible at the zenith and the sun at altitude -18°) at UT 19:30 (LT 3:30) SN1054 was just $7^{\circ}30'$ above the horizon. At the commencement of civil twilight (sun at -6°) at UT 20:45 (LT 4:45) SN1054 was at $22^{\circ}24'$ and at sunrise at UT 21:15 (LT 5:15) it was at an altitude of $28^{\circ}31'$. Thus choosing a time to observe the colour and shape of SN1054 in the days immediately after 4 July, when we expect it reached its brightest (magnitude -5 according to Oort and Mayall (1942, p. 98)), was a compromise between having it high enough so that it was not extinguished by the earth's atmosphere, but early enough so that its details were not lost in the dawn light from the rising sun. It seems that the half hour between 3:30 and 4:00 LT, when SN1054 was between $7^{\circ}30'$ and $13^{\circ}23'$ above the horizon would have been approximately the best viewing time. This being so it is certain that substantial reddening of the object would occur due to atmospheric scattering of the blue end of its spectrum, so that the Chief's description of it as "reddish-white" is completely plausible. Likewise the varying refraction implicit in its light traversing a long path through the earth's atmosphere would cause substantial scintillation or twinkling. A point source such as a supernova with such intensity as -5 magnitude would consequently appear to randomly emit short rays in all directions, as is clearly suggested by the Chief's description that "pointed rays shot out from it on all sides". We see therefore that the description of the guest star given in text C is fully in accord with what we should expect of a very bright point source near ζ Tauri rising in early July. This completes our examination of the Eastern sources.

3. WESTERN RECORDS

3.1. *Middle-Eastern*

Ibn Butlan was a Christian physician from Baghdad who moved from Cairo to Constantinople in late 1052 or early 1053 and subsequently wrote a report relating natural catastrophes to cosmic events which was later reproduced by Ibn Abi Usaybi'a in his composition 'Uyun al-Anba. This provides the only known Arabic reference to SN1054 as follows taken from the translation given by Brecher et al. (1978, p. 729):

Text G

1. 'Uyun al-Anba. by Ibn Abi Usaybi'a, written *ca.* 1242.

"One of the well-known epidemics of our own time is that which occurred when the spectacular (*athari*) star (*kawkab*) appeared in Gemini in the year 446H [12 April 1054–1 April 1055]".

He then outlines the spread of the epidemic from Constantinople to Fustat (Old Cairo) to Iraq and then continues:

"As this spectacular star appeared in the sign of Gemini which is the ascendant of Egypt, it caused the epidemic to break out in Fustat when the Nile was low, at the time of its appearance in 445H [23 April 1053–11 April 1054]"

The two years are, of course, contradictory, and Brecher et al. argue plausibly that the latter should be amended to read 446H so that the advent of the star is in the summer, when the Nile is low, and consistent with the Eastern records of its first appearance in early July. Again Ibn Butlan's placing of the star "in Gemini" can be reconciled with the Eastern records by assuming that he was using astrological conventions and that precession of the equinoxes had placed the constellation of Taurus under the sign of Gemini around the year 1000. Overall this evidence, though slight and corrupted, is convincing as a record of a sighting of SN1054 from the middle-east.

3.2. *Italian/Flemish Records*

Two possible accounts from western Europe of SN 1054 are found in documents concerning the death of Pope Leo IX which have been proposed by Guidoboni et al. (1992). The first of these describes a celestial apparition at the hour of Leo's death, which it places on "18 Kal. Maii. feria 2" i.e. Monday, 14 April 1054:

Text H

1. *Tractatus de ecclesia S. Petri Aldenburgensi*, taken from Holder-Egger (1898).

"Et in ipsa hora transitus sui a corpore non solum Romae, ubi corpus eius iacuit, verum etiam in toto orbe terrarum, circulus eximiae claritatis hominibus apparuit in caelo per spatium fere mediae horae."

[And at the very hour of his passing there appeared in the heavens, not only in

Rome where his body lay, but indeed to men throughout the whole world, an orb of extraordinary brilliance for the space of about half an hour.]

This circle or orb of “extraordinary brilliance” may also be that vaguely alluded to in the following tract :

Text I

1. *Desiderii abbatis Casinensis ... dialogorum libri III*, from Watterich (1862).

“a quo [sc. Leo] omnia ecclesiastica studia renovata, novaque lux mundo visa est exoriri.”

[After he had reformed the discipline of the whole Church a new light was seen to dawn upon the world.]

As well as these, Libuinus, the Roman sub-deacon, in his *De obitu Leonis*, see Watterich (1862, p. 176), relates a similar account of the soul of Leo being taken by angels up to heaven “as along a path strewn with shining garments and lit by innumerable brilliant lamps”. These sources have recently been examined in the context of the supernova of 1054, and adduced as evidence of its observation in western Europe on 11 April of that year, almost three months before its first recorded appearance in China or Japan, see Guidoboni et.al (1992).¹ However, there is no way that such vague and cryptic ecclesiastical records as these can be set against the Chinese records, carrying the authority of a professional astronomer, to derive such a conclusion. In the first place their conclusion implies that SN1054 sustained a brilliance of at least magnitude -4 from 11 April to mid July, which duration far exceeds any observed supernova type, see Murdin (1985, p. 110). Secondly, the only one of these sources with a ring of verisimilitude to it is the annalistic account from Oudenburg, Flanders (text H), which clearly carries corrupt chronological data, since the author made the double error of stating that Leo died on the 18 Kalends of May .i.e. April 14 and on the second feria (Monday), and Leo died neither on April 14 and nor did it fall on a Monday in 1054.² Thirdly both the time “midday”, which is given in the *Tractatus de ecclesia* explicitly just before the excerpt cited in text H, and the duration “the space of about half an hour”, conflict irreconcilably with the eastern accounts of it rising in the morning and remaining visible in daylight for 23 days.³

We conclude therefore that these theses of Guidoboni et al. are quite unsustainable; apart from the inherent improbability of an eleventh century cleric in an exuberantly papalist frame of mind being substantially more accurate in his observation of SN1054 than the Chief of the Astronomical Bureau in China, there is at work behind the associations of the appearance of a brilliant star with the death of Leo, an overwhelming political agenda. Leo was an aggressively reforming pope (cf. Text I), whose attempts to impose Roman practices upon those parts of Italy under Byzantine suzerainty brought him into direct conflict with Michael Cerularius, Patriarch of Constantinople and, like his predecessors, claimant to the title of Ecumenical Patriarch of all Catholics. Not only did Leo’s actions interfere with Michael’s ecclesiastical prerogatives in southern Italy, but they derogated from the status of the Church

¹ Guidoboni et al. p. 31 shift from 14 to 11 April, which fell on a Monday, in order to accommodate both text H’s corrupt “feria 2” and text G’s corrupt “445H”. The effect is to move further from Leo’s death on 19 April.

² Leo died on 19 April 1054; for an authoritative discussion see Jaffé (1956).

³ A striking recurrence of the south-east/north-west location error found in the Chinese texts A and E is also found in Guidoboni et al. Their altitude-azimuth figure on p. 33 showing the positions of SN1054 and the sun from Constantinople on 11 July 1054 clearly has their positions transposed, since the sun is shown to the west of SN1054.

of Constantinople as second in the hierarchy of the universal church after Rome, established since the General Council of 381. Leo's appointment of the arrogant Cardinal Humbert of Silva Candida (a notable exponent of the theory of papal supremacy) to head a legation to Constantinople in April 1054, finally issued in the deposition of a Bull of excommunication against Michael, given in Leo's name although he was already dead, on the altar of the church of *Magia Sophia* on Saturday, 16 July 1054. It is certain that upon the appearance of a wonderfully brilliant new star in the eastern sky at this time, Western European observers would have interpreted it as a sign of God's approval for Leo's actions. This is clearly suggested by the words in text H immediately following the extract given above: "...the Lord perhaps showing thereby that he [Leo] had been found worthy to receive the crown [of righteousness] in Heaven, among those who love Him."¹ Those texts which subsequently associated it with Leo's death² were clearly fulfilling a necessary political agenda in locating it in the sky over Rome and with the death of a pope whose career had become irrevocably linked with the triumph of the papal Church over the Eastern. Indeed the statement in the Oudenburg tract (text H) , which is almost certainly based upon a Roman source, that "the star appeared ... not only in Rome ... but to men through the whole world" is not merely pious hyperbole, but a distinct rebuttal of the claims of the Eastern Church to represent the one true Church of Christ on earth, and was therefore intended as a *post hoc* vindication of Leo and the Church of Rome.³ The most that we can say about these Italian/Flemish records is that they *may* represent a subsequent interpretation of an observation of SN1054 in terms of Leo's death and the triumph of the Roman Church. The only basis for such a view is the correspondence of the year 1054, but the medieval propensity for associating celestial phenomena, imagined or real, with the passing of saintly figures, militates against any certainty even in this limited view.

3.3. *Bologna Chronicle*

In his 1981 challenge to the identification of the Chinese guest star of 1054 with the Crab nebula Williams (1981, p. 346) proposed that a brief excerpt from a chronicle compiled in Bologna about 1476 represented an observation of the guest star. He referred to the chronicle as the "Rampona chronicle", evidently following a citation from R. R. Newton, see Williams (1981, p. 346, fn. 48), though it does not seem to have borne that title hitherto. This provides us with a further text:

Text J

1. Albano Sorbelli ed., *Corpus Chronicorum Bononiensum*, vol. 1 (Bologna, 1939), p. 464.

"Tempore huius stella clarissima in circuitu prime lune ingressa est, 13 Kalendas in nocte initio."

[At this time a most brilliant star entered the circuit of the first [day of the] moon on the 13th kalends at the beginning of the night.]

The first problem for Williams is that this item is grouped with another referring to Henry the Third (1039-56), which he asserts is dated textually as "M18" but he reads it as "1058";

¹ *Domino fortasse demonstrante, quod ipse coronam inter diligentes se percipere dignus esset in caelo*, Guidoboni et al. p. 26.

² Holder-Egger (1898, p. 867) has shown that the Oudenburg tract was written some time after 1084.

³ For an excellent discussion of the background to the Great Schism, see F. Dvornik, "Preambles to the Schism of Michael Cerularius", in *Photian and Byzantine Ecclesiastical Studies*, (Variorum Reprints, London 1974, Art. XXII).

if this latter be appropriate then it seems much more likely that the textual date is in fact “ML8” and the manuscript Latin “L” has been read as a “1”. However, since Henry the Third died in 1056, there still remains a problem with “1058” and so, with no stated grounds, Williams proposed that the date be amended to 1054 thereby enabling the reference to “stella clarissima” to be considered as a candidate for a supernova sighting from Bologna. However all the chronological details of the text preclude such a conclusion. Firstly, it states clearly that the star was seen “in nocte initio”, whereas all the Chinese and Japanese records report the supernova as appearing in the morning. Secondly, Williams honestly acknowledges that he had “no idea what “in circuitu prime lune ingressa est”” meant and, notwithstanding this, he was happy to assume that the “13 Kalendas” referred to July and deduce a date of June 18 (i.e. 13 Kalends of July) for the putative observation. But “prime lune” refers to the first day of the calendar or ecclesiastical moon, computed according to the 19-year cycle of Dionysius Exiguus, see Jones (1943, p. 68–75). The year 1054 was the tenth year of Dionysius’ cycle, wherein the new calendar moons fell on 19 Kalends of February to 2 Nones of December; thus in 1054 no calendar “prima luna” fell anywhere near the 13 Kalends of any month. Indeed not between the dates October 20 (13 Kalends November) 1050 through to May 20 (13 Kalends June) 1056 did the 13 Kalends coincide with a “prima luna.”¹ Thus the evidence for rejecting this excerpt as a record of a sighting of the supernova of 1054 is overwhelming, and we do so accordingly. Likewise we must reject as facile the inferences which Williams drew from an another adjacent item in this chronicle reporting widespread famine, to the effect that, “If we assume a cloudy and rainy summer, the result would be both famine and failure to notice the nova”, Williams (1981, p. 347). The supernova of 1054 was very bright and well-placed for observation from the northern hemisphere for the whole winter of 1054/5, so that much more than a cloudy summer for 1054 is required to explain the absence of Western reports.

4. CONCLUSIONS

Given the central role ascribed by modern astronomers to supernovae in stellar evolution and the fact that the Crab nebula is the most substantial supernova remnant available to them to study, it is essential that all the historical evidence bearing on that supernova explosion should be clearly presented to them. This Duyvendak did not do when he presented his interpretation of the Chinese texts in 1942; it would appear that, beguiled by the explicit precision of the guest star’s location and date of first sighting, he presented the text from Ma Tuan-lin’s *Wen-hsien Tung-kao* (text A) as the primary evidence of the appearance of the guest star of 1054. He then, perhaps subconsciously in order that it did not weaken his argument, provided very poor and misleading translations of the evidence from the Annals of the *Sung-shih* and the *Sung hui-yao*. That he did not ultimately intend to deceive is implicit in his parallel publication of the Chinese texts in *T’oung Pao* and neither should we forget that he was working under difficult circumstances in Nazi-occupied Holland at the time. However his status as a Sinologist has ensured that his interpretation has stood firm ever since, and even authors such as Peng-Yoke and Williams who wished to seriously challenge the identification of the guest star as Crab progenitor did not detect the weakness of Duyvendak’s account. Since both of these challenges were based upon Duyvendak’s misinterpretation of the Chinese texts, they both must now lapse. In particular William’s (1981, p. 340) derisory references to the “vaunted accuracy” of the Chinese astronomers, and his invitation to his readers to “share my impatience with the

¹ Derived from the table of Dionysian primations given in M. Walsh & D. Ó Cróinín, *Cummian’s Letter “De controversa Paschali” and the “De ratione computandi”*, (Toronto 1988), p. 214.

constant claim for accuracy of the Chinese when compared with the actual observation”, read rather embarrassing alongside the mishandling and misinterpretation of the Chinese texts by Western authors, himself included.

Looked at fairly, the Chinese and Japanese texts provide extremely cogent and compelling evidence that a star as bright as Venus appeared in early July 1054 just north-west of ζ Tauri and remained visible there up until 17 April 1056. These details come to us with the authority of the Chief of the Astronomical Bureau at K’Ai-Feng, the most senior professional astronomer in China and an eye-witness to the apparition. As such the identification of that supernova as the progenitor of the Crab nebula seems ineluctable and the problem of extrapolating the Crab’s expansion back to 1054 is one to which the astrophysicists must seriously address themselves.

In great contrast to the Chinese records of the supernova, all of the alleged western records of the event are self-evidently not the reports of trained astronomical observers. Of them all we can only admit the record from the Middle-East by Ibn Butlan as a convincing record of an observation. The ecclesiastical records from Rome and Oudenbourg are so strongly conflated with religious-political interpretations of Pope Leo’s death as to render them useless as observational evidence. Finally William’s suggestion from the so-called Rampona chronicle conflicts in its every chronological detail with what has been established concerning this supernova and must likewise be rejected. The puzzle of the absence of references to this event from Western Europe still largely remains,¹ but the indications are that the explanation is chiefly to be sought in the proximity of the supernova to the death of Pope Leo IX and his ambitious political agenda.

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¹ In an article at present in preparation we will present the evidence that a record appearing in the Irish annals preserves elements of an observation of SN1054.

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