Journal of Astronomical History and Heritage 6(1):46-52 2003

Was the supernova of AD1054 reported in European history?

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Abstract
The bright supernova of AD 1054, which produced the Crab Nebula, was extensively reported in East Asia and there is also a brief Arabic reference. Whether the star was recorded in European history has long been a matter of debate. In this paper we investigate in some detail purported European accounts of the supernova. We conclude that none of these are viable. The new star probably escaped notice in Europe because at the time astronomical knowledge was generally very limited.

Keywords: *calendar; chronicles, Crab Nebula, Europe, history, Moon, supernova*

1 INTRODUCTION

The stellar outburst which occurred in AD 1054 is without doubt the most well-known of all historical supernovae. At optical wavelengths, its remnant – discovered by John Bevis in 1731 – is by far the brightest supernova remnant. This object, listed as the first entry in the catalogue of spurious 'comets' by Charles Messier, was named the 'Crab Nebula' by Lord Rosse in 1844. The Crab Nebula was identified as the remnant of the supernova of AD 1054 as long ago as 1921 (by Knut Lundmark). Radio waves were detected from the object in 1949 and the discovery of a pulsar within it in 1968 attracted tremendous interest internationally.

The supernova explosion in AD 1054 was widely reported as a bright 'guest star' in China and was also noted in Japan. Yet only a single record of the star from outside East Asia is *definitely* known; an Arabic work cites an observation which probably originated from Constantinople. In recent years, several possible sightings recorded in European literature have been proposed. In this paper we discuss these suggestions in some detail.

2 HISTORICAL SUPERNOVAE

On the available historical evidence, only five galactic supernovae have been observed over the last 1500 years. These events occurred in the years AD 1006, 1054, 1181, 1572, and 1604 – and thus were all prior to the telescopic era (Stephenson and Green, 2002). Each of these temporary stars was observed by Chinese and other East Asian astronomers (either in Japan or Korea) and many important records are preserved today. Only records of the earliest two events (AD 1006 and 1054) have so far been identified in Arabic literature. The two most recent outbursts occurred after the Renaissance and both supernovae were extensively observed by European astronomers, notably Tycho Brahe (in AD 1572) and Johannes Kepler (in AD 1604).

Of the three medieval supernovae, the most brilliant appeared in Lupus in AD 1006. This was indeed a spectacular object, attaining a magnitude of around –7.5 (Winkler *et al.*, 2003), and remaining visible for at least three years. Several European chronicles contain reports of this star, which also attracted widespread attention in the Arab world (Goldstein, 1965; Stephenson and Green 2002). By contrast, there seems little doubt that the relatively faint supernova of AD 1181, which was located in Cassiopeia, was not noticed outside East Asia. Its peak apparent magnitude was probably close to zero and – although the star was circumpolar – it was lost to view after six months.

One of the Chinese accounts of the supernova of AD 1054 relates that it was visible in the daytime for twenty-three days. As this star was well placed for visibility before dawn, its position would be relatively easy to locate after the Sun had risen. Hence the apparent magnitude of the star at maximum may be estimated as around –3.5 or –4. The supernova, which appeared in the (Western) constellation of Taurus, remained visible for twenty-one months. Before considering the question of European observations, we need first to summarize what is known about the appearance and location of the star, as derived from East Asian sources. The material in Section 3, below, is largely based on the investigation of Stephenson and Green (2002), to which the reader is referred.

3 EAST ASIAN OBSERVATIONS OF THE SUPERNOVA OF AD 1054

The supernova of AD 1054 was carefully recorded in China, and a brief but important report is also preserved from Japan. As quoted in both the *Songshi* and the *Wenxian Tongkao*, Chinese astronomers first detected the supernova on the day *jichou*, in the fifth lunar month of the first year of the Zhihe reign period; the equivalent Julian date is AD 1054 July 4. The date of last reported sighting (as also noted in China) corresponds to AD 1056 April 6. Conjunction with the Sun is not mentioned in the extant records, but these are no more than summaries of what were originally extensive observations.

Both Chinese and Japanese sources describe the supernova as a 'guest star' (*kexing*); this was the usual term for a strange star-like object, although the

expression was occasionally applied to comets. No motion over the twenty-one months of visibility is mentioned in any of the preserved East Asian accounts. This rules out any possibility that the object might have been a comet. Comets seldom remain visible to the unaided eye for more than six months. Further, in twenty-one months both the orbital motion of a comet and that of the Earth – which would have completed nearly two orbits around the Sun – would have resulted in a marked change in relative position.

In China, the new star of AD 1054 was reported (in the *Song Huiyao*) to be "... visible in the daytime, like Venus", and it remained a daylight object for twenty-three days. As the visibility of the star – already some 35 degrees to the west of the Sun on July 4 – would improve with the passing days, any fading would be purely an intrinsic feature. The position of the supernova was described by both Chinese and Japanese astronomers as very close to the Chinese constellation *Tianguan*, which is represented on East Asian celestial charts as a single star. By considering reported positional measurements of *Tianguan*, and also computing the circumstances of planetary conjunctions with this star, it can be conclusively shown to be identical with ζ Tau, a somewhat isolated 3rd magnitude star. The specific positional terms used in both Chinese and Japanese records imply that the supernova appeared less than about 1 degree from ζ Tau. The Crab Nebula is 1.1 degrees from ζ Tau, whose RA and dec. at the epoch AD 1054 were $04^h\ 41^m.6$ and +20°.0 respectively.

A Japanese record in the *Meigetsuki* – compiled nearly two centuries after the event – asserts that the supernova appeared "... after the middle ten-day period of the fourth lunar month in the second year of the Tenki reign period." As the middle ten-day period was equivalent to AD 1054 May 20–29, the indicated date evidently was soon after May 29. Apart from the fact that the star was in conjunction with the Sun on May 28, such an early date is in conflict with additional details in the same entry which state that the guest star was visible in the east "... at the (double) hour *chou* [i.e. 1–3 a.m.]." Since sunrise would occur around 4.50 a.m., the star must have been already considerably to the west of the Sun when it was first noticed. If we read *fifth* lunar month instead of *fourth* in the *Meigetsuki* record – as was first suggested by Duyvendak (1942) – ζ Tau would then be rising more than two hours before the Sun; this is in close accord with observation. The equivalent date of first sighting would thus be soon after June 28, and hence in reasonable accord with the Chinese discovery date. In this context, we may note that the brilliant supernova of AD 1006 was independently detected on the same day by both Chinese and Japanese astronomers, while for the much fainter supernova of AD 1181 discovery in China and Japan occurred only one day apart.

An independent record in the *Qidan Guozhi* from the Liao kingdom in northern China notes both the occurrence of a guest star near Mao (the Pleiades) and a solar eclipse at some unspecified time before the death of King Xingcong – who died on AD 1055 August 28. The guest star almost certainly was the supernova. However, there is nothing in the text to suggest that star and eclipse occurred at the same time; they were both regarded as important astrological events preceding the death of the King. Hence a definite date for the observation of the supernova cannot be deduced from the Liao record.

To the unaided eye, the appearance of the supernova of AD 1054 would be merely that of an unusually bright star. Chinese astronomers noted that "... it had pointed rays on all sides ..."; this was presumably due to distortion within the eye of light from a bright point source. The various records indicate that the other historical supernovae (AD 1006, 1181, 1572, and 1604) all showed similar features.

In summary, if we are to identify any European records of the supernova, we need to consider references to a bright star-like object, probably seen in the northern summer of AD 1054. Both Chinese and Japanese records indicate that the supernova was visible in the eastern sky before dawn. Although the star was located in the constellation of Taurus it would actually be in the zodiacal sign Gemini; the longitude of ζ Tau was then 71°.6, almost in the middle of the range covered by Gemini (60–90°).

4 AN ARABIC RECORD

Brecher *et al.* (1978) were the first authors to provide firm evidence that the supernova of AD 1054 was observed outside East Asia. In a thirteenth century Arabic text – a biographical encyclopaedia of physicians – they discovered a brief reference to a new star seen in or near AD 1054. In this work, entitled '*Uyūn al-Anbā*' and compiled by Ibn Abī Uṣaybi'a around AD 1242, an intriguing report by Al-Mukhtār Ibn Buṭlān is quoted:

> I, Ibn Abī Uṣaybi'a, have copied the following from an account in his [Ibn Buṭlān's] own hand. He says: 'One of the well-known epidemics of our time is that which occurred when the spectacular (*athari*) star (*kawkab*) appeared in Gemini in the year AH 446 [AD 1054 April 12 – 1055 April 1]. In the autumn of that year fourteen thousand people were buried ... in Constantinople ... As this spectacular star appeared in the sign of Gemini which is the ascendant of Egypt, it caused the epidemic to break out in Fusṭāṭ [old Cairo] when the Nile was low, at the time of its appearance in the year AH 445 [AD 1053 April 23 – 1054 April 11] (trans. Brecher *et al.*, 1978).

In AD 1054, Ibn Buṭlān, a Christian physician, was living in Constantinople, having only recently moved there from Cairo. There is some confusion in the text over the year when the star was said to appear – that is whether it was seen in AH 445 or 446. However, the fact that the star was located in the zodiacal sign Gemini strongly supports its identification with the supernova. The description by Ibn Buṭlān represents the only known Arabic account of the AD 1054 supernova. Since at the time Ibn Buṭlān was domiciled at Constantinople (the capital of the Byzantine Empire), it may be presumed that the new star was seen from here. However, there is a possibility that the observation was made instead at Cairo, which also features in his report.

5. RECORDS OF THE AD 1006 SUPERNOVA IN EUROPEAN HISTORY

Before considering possible European reports of the supernova of AD 1054, it is helpful to briefly cite the known records from Europe of its much more

brilliant predecessor, the supernova of AD 1006. Although this star was in a very southerly declination (–38°), there are several important European accounts (Goldstein, 1965; Stephenson and Green, 2002). The most detailed report is to be found in the *Annales Sangallenses*, the chronicle of the monastery of St. Gallen. This text only specifies the year of occurrence, but describes the supernova as "... a new star (*stella nova*) of unusual size ... glittering in aspect and dazzling the eyes ..." The account adds that the star was seen for three months and that its shape was often distorted, probably due to atmospheric turbulence; the meridian altitude of the supernova at St. Gallen was less than five degrees, so that the star would barely skim the mountainous southern horizon.

A further description – in the *Annales Beneventani*, from Benevento in Southern Italy – again only cites the year (i.e. 1006) and merely relates that "... a very bright star (*stella clarissima*) gleamed forth." Several further European reports describe the object as a "comet", usually without further details. However, the account from Metz in southern France is more specific: "A comet with horrid appearance was seen in the southern part of the sky, emitting flames this way and that ..." (*Alpertus de Diversitate Temporum*). Because of the extremely low meridian altitude of the supernova at Metz (some three degrees), the allusion to flames probably results from atmospheric turbulence, as at St. Gallen.

By comparison, the supernova of AD 1054 (at declination +21°), was extremely well-placed for northern observers. Hence references to the effects of atmospheric distortion are unlikely. We might expect European accounts to mention little more than the appearance of a bright star.

6 POSSIBLE RECORDS IN EUROPEAN LITERATURE

The question whether the new star of AD 1054 was reported in specifically European literature has attracted a number of investigators. Several authors – notably Dall'Olmo (1980), Williams (1981), Guidoboni *et al.* (1992), McCarthy & Breen (1997) and Collins *et al.* (1999) – have proposed references to the star in European chronicles.

Three suggested European sightings of the AD 1054 supernova relate to the appearance of an unidentified bright star near the crescent Moon. However, in two of these instances it is necessary to assume a substantial error in the recorded date. In three further examples, a variety of unusual phenomena are described, sometimes in the form of visions. Curiously, all of the inferred dates of observation are several weeks before the star was first sighted in China, despite the fact that none of the supposed European observers were astronomers. It is difficult to avoid the impression that some of the modern authors cited above were anxious to demonstrate European priority on this occasion.

In this context, it should be emphasized that dating errors in contemporary medieval European chronicles are surprisingly rare. This is evident from a study of the eclipse observations cited in such works; for eclipses, of course, the precise date of occurrence can be verified by modern computation. One of us (Stephenson, 1997) investigated numerous records of total and near-total solar eclipses as reported in European annals between AD 733 and 1544. In as many as forty-eight instances, an explicit date (year, month and day) is given on the Julian calendar. Comparison with the computed dates of these events reveals that forty-two of these forty-eight dates prove to be exactly correct. Of the remaining six records, there are three examples of errors of only one or two days and a further three cases where the year is one year in error but both month and day are correct. This survey should provide a useful reference by which to assess potential European records of the AD 1054 supernova. In particular, if it proves necessary to assume serious dating errors in interpreting purported accounts of the supernova, adequate justification for amending the recorded date is necessary. Caution needs to be exercised in order to avoid playing some sort of 'identification game'.

7 INFERRED CLOSE APPROACHES OF THE MOON TO THE SUPERNOVA

Because the Crab Nebula lies only 1.5 degrees to the south of the ecliptic, occasional close approaches of the Moon to the supernova would perhaps occur during its long period of visibility to the unaided eye. Such an event might well have drawn attention to the new star. The possibility of such a conjunction has attracted the attention of various authors (Dall'Olmo, 1980; Williams, 1981; and Collins *et al.*, 1999).

However – as detailed below – the results of computation are not encouraging during the (northern) late spring and early summer of AD 1054 (i.e. in the months leading up to discovery in China on July 4). We compute that from the point of view of Central Europe (approximate latitude 45° N, longitude 10° E), during the months of April, May and June in AD 1054 the Moon would not be seen to pass within about five degrees (i.e. ten times the apparent lunar diameter) of the supernova. For comparison, the daily mean motion of the Moon is some 13 degrees.

At the epoch J2000, the RA and declination of the centroid of the Crab Nebula are: $05^h\ 34^m\ 31^s$, +22° 01′.0. Reducing to the mean epoch AD 1054.5, the equivalent longitude and latitude are 70°.91 and –1°.42. In April of AD 1054, the closest visible approach of the Moon to the supernova would take place after dusk on the evening of April 13; the Moon and star would then be as much as 5°.7 apart. At that time, the Moon (phase 0.10) would be 38 degrees E of the Sun. A month later, at dusk on May 11, the minimum visible separation would be 5°.1; the Moon would then be a very thin crescent (phase 0.03), some 20 degrees to the E of the Sun. By the next conjunction, on June 8, the supernova would be a little to the west of the Sun; at dawn on this date, the Moon would be 4°.9 from the star. However, the slender crescent – elongation only seven degrees to the W of the Sun – would then be invisible.

Continuing into the summer of AD 1054, the next conjunction between the Moon and the supernova visible in Europe would occur before dawn on July 5. The Moon (phase 0.11) would be 39 degrees W of the Sun. On this occasion, the minimum visible separation would be 2°.8; as seen from Central Europe, the spacing between Moon and star would still be more than five lunar apparent diameters. Before dawn on August 2, the Moon and supernova would be as much as 6°.1 apart, while in

the early hours of August 28, the separation would be 2°.6. It is with these various figures in mind that we may assess proposed conjunctions of the Moon with the supernova.

7.1 A close conjunction recorded in the *Cronaca Rampona*

In a summary table, Newton (1972:690) drew attention to what he described as a "Bright light within the circle of the Moon" in the year AD 1058. This event was recorded in a fifteenth century Bologna chronicle, the *Cronaca Rampona*, compiled around AD 1476. Newton himself did not dispute the recorded year. However, this report was subsequently investigated by Williams (1981), who proposed that – despite various chronological problems – it represented a sighting of the supernova of AD 1054. Although criticized by Breen and McCarthy (1995), Williams' suggestion was taken up by Collins *et al.* (1999).

We have translated the appropriate entry in the *Cronaca Rampona* as follows:

> In the year of Christ 1058 [i.e. Ml8], (Pope) Stephen IX was enthroned on the 28th day of the 9th month ... (Also) in the year of Christ 1058 [i.e. Ml8], Henry III had reigned for 49 [i.e. x19] years. He first came to Rome in the month of May. At this time there was famine and death over the whole Earth. He occupied the Tiburtine state for three days in the month of June ... At this time a very bright star entered into the circle of the new Moon on the 13 Kalends at the beginning of the night (*stella clarissima in circuitu prime lune ingressa est, 13 Kalendas in nocte initio*).

From Williams (1981), combinations of Roman and Indo-Arabic numerals – as found in the above record – were quite common in the fifteenth century, but highly unlikely in the eleventh century. Hence these instances must represent editing by the fifteenth century compiler. It is clear from the neighbouring entries in the chronicle that the compiler indeed intended the year when the "very bright star" appeared to be AD 1058, as there are immediately prior entries in the chronicle sequentially under the years 1046 [Mxl6], 1049 [Mxl9], 1051 [Mli], 1055 [Mlv] and 1056 [Ml6].

The chronology of the above text presents several serious problems – see also Breen and McCarthy (1995). First of all, it is well established that Stephen IX became Pope on AD 1057 August 2. Further, Henry III died on AD 1056 October 5 after a reign of only seventeen or eighteen years (depending on whether exclusive or inclusive counting is used). Henry became King of Germany in AD 1039. He is known to have made two separate visits to Italy. The earlier of these was in the autumn and winter of AD 1046 when he was crowned Holy Roman Emperor. The latter visit occurred in 1056, and it seems that this is the occasion mentioned in the chronicle. There is thus evidence of several major dating errors in this short passage, written more than four centuries after the events described. Hence there must be a strong element of speculation in any attempt to derive the date when the "very bright star" appeared.

Williams (1981) felt that it was "... almost impossible to make astronomical sense ..." of the phrase *stella clarissima in circuitu prime lune ingressa est*. However, in medieval Latin the term *circuitus* can mean "circle" (Latham, 1965:86). Reference to a further medieval Italian text – see below – indicates that *prime lune* may be understood to mean 'new Moon', as also proposed by Breen and McCarthy (1995). Hence we infer an occultation of a bright celestial body by the young crescent Moon in the early evening.

Unfortunately, even the month when the event took place is not specified; the star was seen "on the 13 Kalends" of an unspecified month. In most months, 13 Kalends corresponds to either the 19th or 20th day of the preceding month; for example 13 Kalends April is equivalent to March 20. However, 13 Kalends March would be either February 17 or 18. Breen and McCarthy (ibid.) point out that at no time in AD 1054 did the new Moon fall "... anywhere near the 13 Kalends of any month." They further remark: "Indeed, not between the dates October 20 (13 Kalends November) 1050 and through to May 20 (13 Kalends June) 1056 did the Kalends coincide with a *prima luna*." In particular, the first lunar month of AD 1054 began on January 12 (4 Ides January) while the last full lunar month began on December 3 (5 Nones December).

In view of the wide variety of chronological problems associated with this fifteenth century text, it would seem scarcely justifiable to associate "the very bright star" with the supernova of AD 1054. Even if an alteration of the date by several years could indeed be shown to be acceptable, the fact that no close conjunction of the Moon with the supernova was visible on any evening in April, May or June of AD 1054 would seem to invalidate any attempt to suggest that the *Cronaca Rampona* implies discovery of the star in Europe before it was sighted in China.

Instead, we feel that there is a real possibility that the "bright star" mentioned in the *Cronaca Rampona* was the planet Venus. Although several medieval European annalists had an appreciable interest in astronomical matters, it is apparent from a study of their writings that in general their knowledge of the night sky – in common with many educated non-scientists today – was very basic. Probably very few people of that time would be able to identify the planets (Stephenson and Green, 2002).

In the summary table by Newton (1972:690) mentioned above, he also noted that a similar astronomical report to that in the *Cronaca Rampona* is found under the year AD 1086 in another Italian chronicle, the *Annales Cavenses*. We have consulted a copy of the *Annales Cavenses*, the Latin chronicle of the monastery of La Cava in Southern Italy, as published in volume III of the well-known series *Monumenta Gemaniae Historica, Scriptores*. The appropriate entry may be translated as follows:

> 1086. On the 13 Kalends of March [i.e. February 17] at the beginning of the night a very bright star entered into the circle of the new Moon (*13 Kal. Martii incipiente nocte stella clarissima in circulum lunae primae ingressa est*).

The above terminology is remarkably similar to that in the *Cronaca Rampona* account. Additionally, the day of the month (the 13 Kalends) is the same. The recorded date of the conjunction in the *Annales Cavenses* corresponds to AD 1086 February 17. We compute that on this same evening, the Moon would be a very thin crescent (phase 0.022), only 17 degrees to the east of the Sun. Taking the latitude

and longitude of La Cava as 40°.7 N and 14°.7 E respectively, we compute that at dusk (local time 6 p.m.) on February 17, the topocentric co-ordinates of the Moon were: longitude = 350°.86 and latitude = –1°.45. Comparing with the computed planetary co-ordinates for all five bright planets, we note that Venus (longitude = 350°.94, latitude = –1°.24) was very close to the Moon at that time; the planet would actually be occulted for more than half an hour. There is thus excellent accord between observation and computation, and hence confirmation of the accuracy of our interpretation of the terminology in the text. In particular, there is no need to invoke any new star to explain the report.

Newton (1972:690) also notes that ten years after the above event the *Annales Cavenses* also records a very bright star in "... the circle of the Moon ..." at the time of a lunar eclipse. A translation of this entry is as follows:

> 1096. The Moon, aged 12 days, was obscured when the sky was clear, and a very bright star came into the circle of the Moon (*stella clarissima venit in circulum lunae*) on the 8 Ides August.

The equivalent date is AD 1096 August 6. Computation reveals that on this same evening the Moon was indeed eclipsed. The total phase began at sunset and ended a little after 10.30 p.m. At mid-eclipse, the topocentric lunar co-ordinates were: longitude = 320°.22, and latitude = –0°.68. Further, we note that the planet Jupiter (longitude = 322°.70, latitude = –1°.32) was then only about three degrees away from the Moon. About two hours after midnight, the edge of the Moon would pass within one degree of Jupiter; although not an occultation, these circumstances would be in tolerable accord with the record.

We have so far been unable to identify any close conjunction of the Moon with the bright planets Venus or Jupiter which would satisfy the record in the *Cronaca Rampona*. However, the combination of dating errors in the text may well prove prohibitive.

7.2 A close conjunction recorded in the *Chronicon* of Jacobus Malvecius

Dall'Olmo (1980) drew attention to a bright star in another fifteenth century chronicle – compiled by Jacobus Malvecius between AD 1412 and 1461. The appropriate entry may be translated as follows:

> And in those days a star of immense brilliance appeared within the circle of the Moon around the first days of its separation from the Sun (*Et diebus illis stella fulgoris immensi intra circulum lunae apparuit circa dies primos post ipsius separatione a sole*).

The date is not specified directly, but Dall'Olmo notes that at much the same time Malvecius records an earthquake at Brescia in Northern Italy – on a date corresponding to AD 1064 Apr 11. Dall'Olmo "... was inclined to relate this record to the Crab explosion ...", but he gave no satisfactory grounds for amending the date by ten years. He merely suggested that such a discrepancy might have occurred due to a copying error or a very rough date in the original manuscript.

As we have shown, no close approach of the Moon to the supernova of AD 1054 was visible in Europe during the northern spring and summer of that year, which nullifies Dall'Olmo's suggestion. As an alternative, we have investigated the possibility of an occultation of Venus or Jupiter by the Moon during the spring of AD 1054, but no such event was then visible in Europe. However, just what the chronicler meant by "in those days" is unclear.

7.3 A possible close conjunction recorded in the Armenian chronicles

Collins *et al.* (1999) drew attention to a paper by I S Astapovich published in 1974 which noted a possible conjunction of the Moon with a star in the spring of AD 1054, as reported in the Armenian chronicles. These chronicles, covering the period from the ninth to the seventeenth centuries, were compiled by an annalist named Matendaram. Collins *et al.* point out that in 1969, Astapovich, in a joint paper with E E Tumanian, had considered that the appropriate AD 1054 entry merely alluded to some bright meteors. However, in his subsequent paper Astapovich had revised both his interpretation and the presumed date of the event. According to Collins *et al.*, Astapovich gave an amended translation as follows:

> 1054 of the New Era was the fifth of the reign of Leo IXth. That year on the Moon's disc a star has appeared. It happened on the 14th May in the first part of the night.

Leo IX was enthroned as Pope in 1049 February. We have ourselves not seen either of the papers by Astapovich or the entry in the Armenian chronicles. Collins *et al.* calculated that the Moon and Crab Nebula were in conjunction on May 11 and suggested that possibly the supernova was first noticed in Armenia on the night of May 14 and that the phrase translated "Moon's disc" can possibly be rendered as "circuit of the Moon", etc. Although they emphasise that "... support for this hypothesis is unlikely to be found without a reanalysis of the original chronicle, which is unavailable to us...", Collins *et al.* still included the report as a "... possible supernova sighting ..." in Table 1 of their paper.

As in the other examples cited above, an alternative inference is that the Armenian record alludes to a close approach of the Moon to one of the brighter planets. We compute that as seen from Armenia (approximate latitude = 40° N, longitude = 45° E), on the stated evening of May 14 the Moon was in conjunction with Jupiter, although the two objects were some three degrees apart. It seems very plausible that this is the event referred to in the text, although renewed examination of the entry in the Armenian chronicles is desirable.

In summary, none of the three records discussed in this Section provides satisfactory evidence that the AD 1054 supernova was reported in European literature.

8 OTHER CELESTIAL PHENOMENA MENTIONED IN EUROPEAN LITERATURE

Collins *et al.* (1999) have followed Guidoboni *et al.* (1992) in linking two other celestial phenomena mentioned in European writings with the supernova of AD 1054. In both of these accounts the events are

associated with the death of Pope Leo IX, which occurred on April 19 (13 Kalends May) in that year. In a brief discussion (Stephenson and Green, 2002:141), we inadvertently attributed the remarks by Collins *et al.* to Breen and McCarthy (1995). We would like to place on record our sincere apologies to both sets of authors. In fact, Breen and McCarthy are very critical of any links between the recorded events at the death of Leo and the supernova.

One of the celestial phenomena considered by Guidoboni *et al.* (1992) and Collins *et al.* (1999) is described in the *Tractus de ecclesia S. Petri Aldenburgensi* as follows:

> On the 18th Kalends May [AD 1054 April 14], the second day of the week [Monday] at about midday, his soul happily departed. And in the same hour of its departure from his body, not only in Rome, where his body lay, but furthermore over the whole Earth a circle of extraordinary brightness appeared in the sky to men for the space of about half an hour (*verum etiam in toto orbe terrarum circulus eximiae claritatis hominibus apparuit in caelo per spatium fere mediae horae*).

We note that April 14 was a Thursday, not a Monday. As Breen and McCarthy point out, there is a double error in the text; Pope Leo IX died on Tuesday April 19. The term *circulus* usually refers to a circle or ring. Either of these renderings, together with the very short duration of this daytime phenomenon (only about half an hour), suggests that it was a solar halo. The remark that the event was seen over the whole Earth may be understood simply as hyperbole. As we see it, there is nothing in this record to suggest the identification of the *circulus* as a new star, briefly seen in the middle of the day.

Guidoboni *et al.* (1992) and subsequently Collins *et al.* (1999) also considered a reference in a work by Libuinus entitled *De obitu Leonis*. This account describes how at the very time the Pope died, a certain man by the name of Alpertus "... saw as it were the path by which his soul was escorted by the angels to Heaven adorned with shining vestments and gleaming with countless lamps." (*quasi stratam palliis fulgentibus adornatam et innumeris coruscantem lampadibus*).

The description by Alpertus seems more in the nature of a mystical vision than an observation meriting astronomical interpretation. Collins *et al.* note that in the evening Jupiter, Venus, Mars, and Mercury – as well as the bright stars of Orion – were all visible at the same time in the western sky. If the supernova had already appeared by then (April 19) it would add to the spectacle. However, in our view, if an astronomical explanation is at all viable, a vivid auroral display might better fit the phenomenon described. Nevertheless, we note that according to the *Tractus de ecclesia S. Petri Aldenburgensi* – cited above – Pope Leo IX died around midday. A purely literal, pragmatic interpretation of the description in the *De obitu Leonis* may well be futile.

McCarthy and Breen (1997) have discussed in detail a supposed allusion to the AD 1054 supernova in the *Irish Annals* on a date equivalent to 1054 April 24. They translate the item as follows:

> A round tower of fire was seen at Ros Ela on the Sunday of the feast of St George [AD 1054 April 24] for the space of five hours of the day, and innumerable black birds passing into and out of it, and one great bird in the midst thereof ...

This obscure account clearly has a mystical basis. Despite McCarthy and Breen's detailed visibility computations, they affirm that "... it will never be possible to prove conclusively that they [the occurrences described] refer to an observation of the supernova of 1054." In purely physical terms, the phenomenon, which was only visible on a single day, would appear to be of substantial angular size. Rather than relating to a star, it is arguable that a solar halo display (by day) or an aurora (by night) is perhaps more likely. However, such a naive materialistic interpretation may well be inappropriate.

9 CONCLUSION

In total, we have discussed six alleged sightings of the supernova of AD 1054, all of which were said to have occurred between April 19 and May 20 – and thus several weeks before the discovery date in China.

In three instances an object identified as a star was seen in the vicinity of the Moon. However, in two of these cases a substantial error in the date must be assumed. We have emphasized that medieval annalists would probably not be able to distinguish between a bright star and a planet and we have noted that in all three examples the observation may well refer to a close conjunction of the Moon with either Venus or Jupiter.

In a further three instances, the phenomenon described is of a more cryptic character and is thus very difficult to qualify in physical terms. In particular there is little to suggest that a star-like object forms the basis of the report.

In summary, it is our firm view that there is no convincing evidence that the supernova of AD 1054 is reported in extant European literature. We further regard any suggestion that the supernova was sighted significantly before its discovery in China as without foundation.

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