The Star of the Last Millennium

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Abstract. In this paper we re-examine historical references to the supernova event of 1054 CE with a view to establishing a sequence astronomical events which minimizes apparent conflicts between various historical sources. We find that the explosion of the supernova is likely to have occurred weeks to months before the commonly accepted date of July 4th 1054. This view is strongly supported by a number of European references to events visible in the evening sky during the spring which are likely to be associated with the appearance of the supernova. The absence of European reports of the "star" in the morning sky may be linked to other events that transpired during the summer of 1054 CE.

Introduction

In the summer of 1054 CE a star exploded which was visible in the sky near a third magnitude star known as ζ-Tauri. The event was recorded by the Chinese, Japanese, a physician in Constantinople, and perhaps the Native North American Indians. There is apparently no record of the event in Europe and that belief has always mystified me. There can be little doubt that this event took place for the remains of the explosion are visible today as the Crab Nebula in the constellation Taurus near where the Chinese located the event of 1054 CE. The angular expansion rate of the nebula, which can be directly measured, when combined with the measured velocity of approach, yields both a distance to the object and a date when the object exploded. The date corresponds with 1054 CE within the error of measurement.

The canonical view is the event was a Type II Supernova which happens when a massive star collapses after running out of nuclear fuel. The collapse creates conditions that result in a titanic explosion expelling the majority of the star initially at near the speed of light, but leaving behind a stellar core comprised of a rapidly spinning magnetic neutron star called a pulsar. We see such a core in the center of the Crab Nebula today. The explosion liberates as much energy in a few minutes as the star has radiated during its entire lifetime.

The explosion appears in the sky as a 'new star' or supernova. This "star" rises in brightness during a period of days to weeks and then slowly fades during the course of many months. At maximum brightness it may easily be several million times brighter than the precursor star which, in the case of a Type II supernova, would be nearly a million times brighter than the sun. There is also a Type I Supernova whose maximum brightness is slightly greater than the Type II, but whose precursor star is a white dwarf about the size of the earth and perhaps a hundred times fainter than the sun. We shall briefly return to this type later.

The visual impact of such an event is hard to exaggerate. If the brightest star in the sky (Sirius) were to become a supernova, it would probably spell the end of life on the earth as we know it. Fortunately the Crab Nebula is nearly a thousand times further

away than Sirius so its impact on the earth would be a million times less. However, that is not trivial! At maximum brightness it would appear brighter than -5 magnitude which is more than 100 times as bright as the brightest star in the constellation Orion. This is brighter than an aircraft landing light seen at a distance of a few miles and in the case of the supernova, would be concentrated at a point.

This latter point should be emphasized since it means that the "star" will "twinkle" and being that bright its appearance will be quite animated. Indeed, when the star is near the horizon (rising or setting) it will dance around a great deal and change colors. The Chinese describe it as shooting our fire. So marked would the twinkling be that it may well appear to have a finite disk. The Japanese actually use their word for comet to describe it initially probably because of this effect. The Chinese first report of the star's appearance in the morning sky is on July 4th 1054 CE and indicates that it was visible during the day time until the end of July. It vanished from the nighttime sky a year and half later in April 1056 CE.

In light of the magnitude of the event, it is hard to accommodate the apparent lack of references from Europe. In my youth, I was taught that it was due to bad weather. I found and still find this to be an awful explanation and that led me to look at this event more closely and to see if there exists any sequence of astronomical events that would minimize conflict among the majority of the known historical references. I note with some sadness that a current paper by Stephenson and Green (2003) reports "*The new star probably escaped notice in Europe because at the time astronomical knowledge was generally very limited"*. This parochial attitude of European activities is typical of the current status of the historical view regarding this event. I would note that one does not need a course in Astronomy 101 to look up and be amazed by events in the sky and the less visible supernova in 1006 CE was reported in Europe. However, one should not expect references to astronomical events to carry the same precession as those from the east as eastern instruments of observation were simply not available in Europe.

In addition, it should be noted that none of the surviving references are contemporaneous with the event in 1054 CE. There are numerous reports of this event from Asia, but some appear to contradict others. None are the original. Indeed, the oldest document reporting the event dates to the late 12 century in China. The most commonly cited reports can be traced to about the 14th century, but the originals have been lost. This could account for some of the confusion. All current references are based on documents no longer available. This is true for those I will suggest are European as well as those that are of Eastern in origin. Thus any interpretation of these references should include both the framework of the original reporting and the environment of the secondary documentation. This is particularly important when looking for European references.

What can we say with certainty about the sky in 1054 CE?

Let us begin by reviewing the astronomical situation during the spring and summer of 1054 CE. The Crab Nebula would have been in conjunction with the sun (i.e. behind it) on or about May 27, 1054 CE. Thus, had the Supernova exploded prior to that date, it would have been invisible in spite of its brightness for a period of time when it was close to the sun. Recent advances in almanacs for small computers make it possible to accurately describe the sky as seen from any location on the Earth a millennium ago. My colleagues and I used a program known as Redshift I (see Maris 1993) to reproduce the sky as seen from various locales during the eleventh century. Work by Upgren (1991) and Schaefer (1993) make it possible to estimate the effect of the dawn sky on the appearance of astronomical objects at the time of the reported sightings.

Let us briefly review reports from the East which are generally regarded as definitive for establishing the Crab Nebula supernova as occurring in 1054 CE. Conditions of stellar visibility in the dawn sky during the summer of 1054 cast doubt on the traditional interpretation of the Chinese manuscripts.

Eastern References

The primary references to the Supernova of 1054 CE are found in the Chinese and Japanese chronicles. They were comprehensively translated by Duyvendak (1942), re-discussed and added to by Ho et al. (1972), and re-interpreted by Breen and McCarthy (1995). Ho et al. (1972) correctly point out that there are a number of internal inconsistencies in many of these sources while Breen and McCarthy (1995) go to some lengths to establish that many of the sources are derivative from a single earlier source. Duyvendak (1942) and Ho et al. (1972) suggest that the definitive chronicles are the *Sung-shih* and the *Wen-hsien T'ung-k'ao* complied in 1345, and 1280 respectively. Breen and McCarthy (1995) take the *Sung hui-yao* complied by Chang-Te-haiang to be the definitive text even though Ho et al. (1972) give the earliest known text as *Hsü Tzu-chih t'ung-chein ch'ang-pien* whose author Li Tao died in 1184 AD. The suggestion is that many of the later texts derive from this one. As Breen and McCarthy (1995) point out, the date for the event in this earliest text is internally inconsistent and could either be July 4th 1054 CE, June, or August. However, it must be remembered that all the reports cited in the literature were complied after the event and therefore represent a summary of observations of the supernova made well after the explosion.

While the 4th of July 1054 AD has become generally accepted as the date of the explosion of the supernova, as pointed out by Ho et al. (1972) certain anomalies exist in the Chinese references that are regarded as definitive. For example, the position of the 'guest star' is given as "several inches south east of ζ Tauri". However, the actual location of the Crab Nebula is about a degree north west of ζ Tauri. Ho et al. (1972) make a convincing case for the named reference star actually being ζ Tauri. However, the direction to the Crab Nebula is opposite from that given in the chronicles and the angular distance would correspond to much less than "several inches" if Ho et al's (1972) interpretation is correct. On the other hand, if the reference star is β Tauri, the location of the Crab nebula some 6 degrees 45 minutes south east matches the direction and magnitude given by the Chinese

record remarkably well. To evaluate the plausibility of the account in referring to ζ Tauri, we used Redshift to reproduce the eastern sky for the morning of July 4th 1054 AD. At the beginning of Astronomical Dawn ζ Tauri is a mere 3 degrees above the horizon. Upgren (1961) gives a minimum altitude of 6-8 degrees for a third magnitude star to be visible. This result is in full agreement with a more extensive extinction-calculation based on the work of Schaefer (1993). Therefore, a star which is too low to be visible at the beginning of Astronomical Dawn is not likely to be seen at all due to the rapidly brightening sky near the horizon. We quantified this analysis in Collins et al (1999).

The response to diminishing atmospheric extinction with the rising of the star supports the claim that a star not visible at the beginning of Astronomical Dawn will generally remain invisible to the un-aided eye. Allowing for about a degree of motion along the steeply inclined ecliptic per day, we can show that it will be more than a week after the 4th of July before ζ Tauri becomes visible in the dawn sky. Thus the Chinese reference to ζ Tauri as the companion star to the Supernova is either incorrect or it is based on later observations. In that regard, it is worth noting that the chief astrologer did not make his 'prognostications' concerning the "guest star" until August 27th (see Ho et al. 1972) by which time the Supernova was no longer visible in the day time and would have faded to a more stellar-like appearance. In addition, it would have been well away from the sun and surrounded by a reasonably rich and presumably familiar stellar field from which to establish its astrological significance. Thus, it would appear that July 4th is just one of many observations which went into the Chinese record and it is perhaps presumptuous to attribute any great significance to the date as representing the date of the explosion.

Ho et al. (1972) note that the Japanese references all give the fourth month as the first appearance of the Supernova. One of the references specifically suggests May 20 through May 29 for a date of the appearance of the star. However, Breen and McCarthy (1995) present a protracted argument suggesting that all the Japanese references derive from the same source and there is an error in the month and the date should be June 28th - July 7th in order to agree with the Chinese date. They rule out the actual date of the fourth month by citing Mayall and Oort (1942) that ζ Tauri was in conjunction on the 27th of May so that no 'guest star' would be visible. However, the actual Japanese date would place it near Orion in the time interval of May 20th -29th.

On May 20th, the supernova would have been seven degrees east of the sun and would be quite visible at dusk as a bright star near the constellation of Orion as described. However, the Japanese reference refers to the star as being seen in the east and as Breen and McCarthy (1995) point out Orion is not visible in the morning sky during June and most of July. This apparent inconsistency in the Japanese references can be understood by consulting the translation of the *Mei Getsuki* by Xi and Bo (1966b):

> *After the 2nd third of the 4th month, the second year in the Ten Ki period of Japan, at the time of Chhou, a guest star appeared three times at the Hsiu Tsui (Turtle). It was seen in the east, "with Ten Kwan Hsing, as big as Jupiter."*

The references to multiple appearances suggest that this report spans some time. This could include evening observations during the stated fourth month when it would have been seen in the vicinity of Orion during the 20th -29th of May as well as a later time when it appeared in the eastern sky at dawn near *Ten Kwan Hsing*. These authors make this aspect of the translation a separate sentence whereas the translation presented by Ho et al. (1972) which is repeated by Breen and McCarthy (1995) and both of which derive from Duyvendak (1942) include this as part of the previous sentence and the reference to "three times" is absent. The presence of the "three times" also indicates that the record is a summary of observations made well after the event.

Finally there are two Chinese references which relate the appearance of a 'guest star' during a solar eclipse in 1054. The first of these is the *Ch'I-tan-kuo chih* (Text D of Breen and McCarthy 1995) written during the middle of the 13th century. The second is the *Sung-shih hsin-pien* prepared by K'o Wei-ch'i in the 15th century. Ho et al. (1972) give a translation of the latter as:

> *"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]".*

They further explicitly state that no date is given other than the year and that the passage is the same as that given in the first reference stated above.
Their translation of the former is:

> *"During the eighth month [of the twenty-third year of the Chung-his reign-period][1055] the King passed away… Previously there was a solar eclipse at midday and a guest star appeared within the Mao [lunar mansion][the pleiades]. The Assistant Officer in the Bureau of Historiography, Liu I-shou, said, 'Isn't this an omen that [the King of Ch'I-tan] Hsing-tsung will die?' The prediction did come true. The same passage is given in Liao-shih-i".*

Breen and McCarthy (1995) give a translation as:

> *"(In the 23rd year of the period Ch'ung-his) in the 8th moon the lord of the country died…. Previously there had been a sun-eclipse, and in the 1st moon (January 31st-Feb 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!"*

Ho et al.'s (1972) translation suggests that the sighting of the guest star occurred during the solar eclipse. Breen and McCarthy's (1995) version suggests that the guest star sighting had nothing to do with the solar eclipse and occurred in January 1055. If the Ho et al.'s (1972) translation is correct, then a firm date and location for the sighting can be found from the only solar eclipse in China in 1054 which occurred on May 10th. Had the Supernova exploded in April or early May, it certainly would have been visible during totality. What astronomical constraints can be placed on the event?

Astronomical Constraints

Much has been discovered about supernovae since the early discussions of Mayall and Oort (1942) so that we may assess the likely maximum apparent magnitude of the various types of supernovae appropriate for the supernova that led to the formation of the Crab Nebula. The light curves appropriate for various types of supernovae may then be compared to observations from the time.

Points on such a light curve come from the Chinese observations of day-time and night time visibility. Ho et al. (1972) conclude from *Sung-shih* and the *Wen-shien t'ung-k'ao* that the duration of visibility was from July 4th 1054 AD to April 17th 1056 AD. The *Sung-hui-yao* suggests that the duration of daytime visibility was 23 days. Taking the initial observational date as July 4th, the Supernova would have been about 60 degrees west of the sun 23 days later so that a comparison with Venus at Greatest Elongation, and which is visible in the day time, is not inappropriate. So the Supernova was about -3.5 ± 0.5 m_v at the end of July when it disappeared from the daytime sky. This suggests a drop of about 10 magnitudes in the 630 days when it disappeared from the night sky on April 17th 1056 AD. However, other Chinese reports only specify the time of disappearance to the third month so that a duration of 615 ± 15d seems a prudent range for the interval between the disappearance from the day- and nighttime skies. Since 6th visual magnitude is about the faintest that one can see in the dark sky, let us assume that at disappearance from the night sky the supernova was 6.0 ± 0.5 m_v. Unfortunately the acceptable range in distances (e.g. Trimble 1973) introduces a range of half a magnitude in the apparent magnitude at maximum. So combining the maximum absolute magnitude for supernova with a distance of 2 ± 0.5 kpc for the Crab Nebula, one would expect an apparent visual magnitude at maximum to be between -4.5 to -7.0 visual magnitude nicely bracketing the traditional value of -5 used by Mayall and Oort (1942). These values would make the supernova the brightest object in the sky other than the sun or moon that anyone of that time had ever seen. The twinkling of a point source of such brightness would indeed appear to have "pointed rays shot out from it on all sides" as described by the Chinese. However, it is highly likely that if maximum occurred near conjunction with the sun, it would not be seen for several weeks

The strongest constraint on the light curve is placed by the two points marking the disappearance from the day and night time skies. It is difficult, but not impossible to fit this slope with typical Type II light curves. Even Type Ib fades too quickly to readily fit the curve. However, it should be noted, the light-curve for Type Ia fits remarkably well with the most probable peak occurring around May 14th.

While some have suggested that the large temporal interval for the two Chinese points is greater than any supplied by contemporary observations, it should be noted that Kirshner and Oke, (1975) followed Type Ia supernova 1972e for over 700 days and found no departure from the linear decline in brightness. Minkowski (1964), Shen (1969) and others have also noted that Type Ia light curve fits the Chinese points better than any other options. However, Minkowski (1968) found other reasons to question the Crab progenitor being Type Ia and ends his review article with the statement *"The available data are too*

scanty to permit the assignment of a type to the supernova of +1054." Certainly contemporary models for Type Ia supernovae leave no residual pulsar and therefore make it difficult to declare the Crab to have been a Type Ia supernova. Nevertheless, the remarkable agreement of the light curves with the Chinese points must be added to the growing list of anomalies for the Crab. Apparently abundances cannot definitively assign a supernova type to the Crab (Luck 1998). Van den Berg (1973) notes that the expansion velocities agree better with Type Ia expansion velocities rather than Type II and Zimmer (1998) has reviewed the well known 'missing mass' discrepancy suggesting that the mass of the Crab is only a few percent of that expected from a Type II supernova explosion. Perhaps it is possible that these anomalies can be resolved through the extreme variability of Type II supernovae or other variations of Type I so we adopt Minkowski's (1968) view given above.

European References

Breen and McCarthy (1995) discuss several interesting possible European references to the supernova collected by Guidoboni et al. (1992). They cite three references to the death of Pope Leo IX the most relevant of which is from the *Tractus de ecclesia S. Petri Aldenburgensi* (see Holder-Egger 1898). The third reference to *De obitu Leonis* by Libuinus , a sub deacon in the Roman Church (see Watterich 1862 p. 176), describes 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". The second reference to *Desiderii abbatis Casinesis...* also cited by Watterich (1862) seems too metaphorical to be clearly connected to the supernova, but is consistent with it. Breen and McCarthy (1995) dismiss these with the largely *ad hominum* argument that one should not prefer "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". A more sober evaluation of the state of the Roman Church during the eleventh century as compared to the astrologically motivated Chinese observation might call for a less extreme comparison.

It should be noted that at the time of the death of Pope Leo IX (April 19th 1054) there was an extensive display of planets in the western sky. Jupiter, Venus, Mars and Mercury were all visible at the same time along with the bright stars of Orion. It is not unreasonable that these could well be *the innumerable brilliant lamps* referred to in the third reference. Should the supernova have appeared, it would have only contributed to the show. The first of these references refers to "an orb of extraordinary brilliance" which briefly appeared at the "very hour" of the death of Pope Leo IX. Watterich (1862) makes it clear that the canonization of Pope Leo IX proceeded with considerable alacrity. A comparison of his accomplishments with those of his predecessors makes it clear why this should have been so and some of the "exuberance" referred to by Breen and McCarthy (1995) may perhaps have appeared in the form of 'poetic license' regarding the precise timing of the event. However, the description of the 'miracles' required for sainthood would have been founded in widely accepted fact.

Perhaps the most unambiguous European reference to the supernova can be found in the *Rampona Chronicle.* As stated by the general editor, Sorbelli (1905), the *Corpus*

Chronicorum Bononiesium is a comparison of two 14th century compilations, the Rampona Chronicle and the Varignana Chronicle. The former is a history from the beginning of the world to the present (1425) while the latter, written in the Italian vernacular, covers a shorter period of time. As mentioned by Newton (1972) and discussed by Williams (1981), the Rampona Chronicle describes a bright star appearing about the time of the supernova. The Rampona Chronicle as complied by Muratori in the late 15th century (see Sorbelli 1905) is derivative from a variety of sources which now appear to be lost. The relevant Latin passage quoted below with our translation clearly has trouble with dates as exhibited by the curious mixture of Roman and Arabic numbers which Williams (1981) cites as common in the 14th and 15th centuries.

> *Anno Christi Ml8 Henricus tertius imperavit annis xl9. Hic primo venit Romam in mense maii.*
> In the year of Christ 1058 (1055) emperor Henry III was in his 49th (39th) year. He initially came to Rome in the month of May.
>
> *Cuius tempore fames et mortalitas fuit fere in universa terra.*
> At this time there was famine and death throughout the entire land.
>
> *Et obscedit civitatem Tiburtinam diebus 3 mense iunii.*
> He occupied the Tiburtinam State (He stayed in the town of Tivoli, east of Rome) for three days in the month of June.
>
> *Hic Henricus pater fuit matris comitisse Mathilde, ex qua Bonifacius marchio genuit ipsam Matheldam. Tempore ipsius Henrici.*
> This Henry was protector of the mother of the countess Mathilda (Beatrice, widow of the duke of Tuscany and sister of Henry III) from whom the Marquis Boniface begot Mathilda herself. This was the time of Henry.
>
> *Tempore huius stella clarissima in circuitu prime lune ingressa est, 13 Kalendas in nocte inito.*
> During this time (Henry's) an extremely bright star appeared in the circuit of the new moon (at the location of the new moon, i.e. east of, and close to the sun) on the beginning of the night of the 13th of the kalends.
>
> *Huius tempore Hildebrandus cardinalis, qui postea Gregorius papa factus est, cum legatus esset in Gallia et in concilio contra multos simoniacos episcopos processisset,…*
> At this time Cardinal Hildebrand who later became Pope Gregory was in council as Papal legate in France where he moved against those who were Bishops by way of simony,…

I have placed in parentheses corrections or explanations of certain aspects of the text. The chronicle continues from this point with a detailed description of Hildebrand's actions against simonies of the bishops in France. It is reasonably clear from the description that these were actions taken under the auspices of Pope Victor II in 1055 AD specifically

at the councils of Lyons and Chalons where Hildebrand with full legatine authority dealt with several simonies' of the Bishops. An alternative could be the Council of Sens which concerned the heresies of Berengarius and his philosophy concerning the celebration of the Holy Eucharist. This Council was also presided over by Hildebrand with full legatine authority in 1054 AD.

The opening reference with the dates of (ml8) and (xl9) probably refer to reading (mliiiii) as (mlviii) and possibly (xxlix) as (xlix) since the former dates correspond to the actual numbers appropriate for the text. Emperor Henry III did indeed travel to Italy in the spring of 1055AD for the installation of Pope Victor II in Florence among other things (see Steindorff 1881). After the death of the Boniface, Marquis of Tuscany, in 1053, Henry took on the role of "father protector" for his sister the widow Countess Beatrice. Hughs (1948) notes that Henry found it necessary in 1055 to dissolve her subsequent secret marriage to Duke Godfrey II of Lorraine who had been at odds with the Emperor for some time. This may have been because Tuscany was the center of opposition to the reform of the Roman Church instigated by the German Popes appointed by Henry and he simply could not afford a union between Tuscany and powerful Lorraine. This would account for the references to the marriage in a source dealing largely with the affairs of Henry III.

It is interesting that famine and plague are also mentioned as occurring at this time in the Near East reference discovered by Brecher, et al. (1978). The general temporal reference to a bright star near the location of the new moon is in keeping with the chronology of this section. However, since the reference clearly refers to the beginning of the night, it is likely that the date is *13 Kalendas Juni* or May 20th. As described above the supernova would have been 7 degrees east of the sun at a location commonly associated with the new moon.

The diversity of sources noted by Sorbelli (1905) is demonstrated by the shift in text and style after the passage concerning the star. This suggests a change of source from a secular one documenting the affairs of Henry III to a clerical source concerned with the detailed actions of the church. However, it is interesting that no mention here is made of the major events in the church of 1054 - notably the death of Pope St. Leo IX on April, 19th, 1054 CE or the Eastern Schism usually dated to July 16th 1054 CE. This suggests that the entry point to the now-lost clerical source is likely to be 1055 CE. While it is tempting to dismiss a chronicle complied so far from the event and containing numerous errors of dates, it must be remembered that the Chinese and Japanese sources are also derivative sources complied at a much later date than the event.

To understand the significance of the Rampona Chronicle, it is necessary to look at the material surrounding the reference to the star. Virtually all the references before and after the section dealing with Henry III and the star are clerical. Clearly the references to the star and the concerns of the Emperor Henry III were inserted into a church history from a different source. The phrase *Tempore ipsius Henrici suggests* that specific dates were relatively unimportant to the original author. However, the choice of the Latin *stella clarissima* likely to describe the star is as superlative as can be expressed suggesting that this was indeed a very bright star.

Breen and McCarthy (1995) translate the words *prime lune* as refering to the "first day of the calendar or ecclesiastical moon…" Since there are no new moons on the 13th of the kalends they reject the entire reference out of hand. They further note that the date disagrees with the Chinese date of July 4th. This interpretation clearly avoids the problem which led Williams (1981) to state that he could make no sense of the phrase *in circuitu prime lune ingressa est.* As appears clear from the style, a secular account would be less likely to refer to the ecclesiastical calendar, than a cleric. Our interpretation is that the phrase denotes a place in the sky rather than a calendar date and avoids this problem makeng this a reference to a dusk sighting most likely on May 20th when the supernova would have been just where one would look for the new moon. Since the events described in the chronicle match actual historical events, it seems plausible to suggest that this indeed represents a European sighting of the Supernova of 1054 CE.

Finally, there are two references from Eastern Europe which are important. The first, discussed at length by Brecher et al. (1978), describes the report of an Iraqi physician Ibn Butlān as recounted two centuries later by Abī Uṣaybiʿa. Two references to the end of the Hegira year of 445 and 446 corresponding to (April 23,1053- April 11, 1054) and (April 12, 1054 - April 1 1055) are given in different sections of the recounting by Abī Uṣaybiʿa. The latter range is generally preferred since it agrees with the Chinese date and subsequent visibility of the event while the former is considered a copying error. However, Guidoboni et al. (1992) take these dates literally suggesting that the earliest date for the supernova should be April 11th 1054 CE.

The second reference is to Armenian Chronicles of the IX through XVII centuries complied by Matenadaran [specifically, see the chronicle of Этум Латмич (E. Patmich) in Akopan (1956)]. Astapovich (1974) corrects the dates and interpretation of an earlier translation by Astapovich and Tumanian (1969) where they felt the reports were of bright meteors. He now believes a proper translation should read "*.. 1054 of the New Era was the fifth year of the reign of Leo IXth. That year on the moon's disk a star has appeared. It happened on the 14th of May in the first part of the night"*. He believes the reported location, time and description more correctly describe the supernova event of 1054 CE. Calculations with the program Red Shift show that the moon and the Crab Nebula were in conjunction on May 11th at approximately 9h UT. This suggests that it is unlikely that the proximity of the moon to the Supernova resulted in the phrase "*…on the moon's disk a star has appeared.*" The words "*That year….*" Also suggest it was more than an ephemeral event such as a meteoroid impact. Astapovich and Tumanian (1969) clearly had difficulty with the translation and interpretation of this passage, but make it clear that the event was very striking and probably represented a new star. An interpretation consistent with their writing is that the star was first noticed on the night of May 14th as a result of either increasing brightness or weather and the phrase "*moon's disk*" may be translated from 'moon's orb', 'moon's orbit', or 'circuit of the moon' indicating a place in the sky such as is the case in the Rampona Chronicles. Unfortunately support for this contention is unlikely to be found without a re-analysis of the original of the Chronicle which is unavailable to us.

What is the most likely history of this event?

The following sequence of events minimizes conflict between and within the historical references in a manner that is consistent with known astronomical constraints. In April or early May of 1054 CE the supernova which has given rise to the Crab Nebula exploded. The rise time to maximum brightness for a Type Ia supernova is poorly known but is expected to be about several weeks while that for Type II is even longer ranging to months. If one takes the error limits to their extreme, it is possible that the supernova exploded in early April which would make Brecher et al.'s (1978) correction to the date given by the Iraqi physician Ibn Butlān, unnecessary for it would have just appeared at the end of the Hegira year of 445. This appears to be the view of Guidoboni et al. (1992) who take April 11th as the first sighting of the supernova. A somewhat later explosion would still have been early enough for the supernova to have provided a heavenly sign for the canonization of Pope St. Leo IX with only minimal poetic license. It even allows for the date of the feast of St. George (April 24th) given in the Irish annals of the extremely metaphorical report discussed by McCarthy and Breen (1997) to be accommodated. An early explosion date allows for the supernova to be visible during totality of the solar eclipse of May 10th and shine brightly in the dusk during the last three weeks of May. The Armenian report in the evening sky on the 14th of May is then easily accommodated as are the Japanese reports of a new star appearing in the vicinity of Orion during late May. It also fits the Rampona Chronicle perfectly for the supernova would have been just 7 degrees east of the sun on the 20th of May in the very location where one looks for the new moon. Maximum brightness is liable to have occurred near conjunction with the sun thereby minimizing its impact on observers. The Japanese and Chinese saw it during late June and July. The identification by the Chinese on July 4th is likely to have been made with respect to β Tauri which would have been about the only star visible close to the Supernova in the morning sky. The reported position is in remarkable agreement with the location of β Tauri. Later, the proximity to ζ Tauri would have it replace β Tauri as the identifier. Much later (August 27th), when the stellar field was more complete, the astrologers would be confident enough to interpret the event for the emperor. By then the star would have no longer been visible in the daytime sky and would properly resemble a "guest star" rising before dawn. For astrological reasons, the Chinese would have continued to observe the guest star until it disappeared from the dark night sky a year an a half later.

It is worth noting that during the early days of the supernova a point source of around -5 m_v or brighter would be an amazing sight. Near dawn the twinkling and color variation due to atmospheric refraction would have made the object appear even more active. It would not be surprising if it were interpreted as showing a disk which may account for the use of the word "po" usually reserved for comets by the Chinese. Later, as it dimmed, it would become a "guest star". Finally, after nearly two years, the star would no longer have been visible in the night sky leading to the final entry from the Chinese reports.

Conclusions

We have reviewed reports from the 11th century regarding events which can be associated with the explosion of a supernova during 1054 CE the remnants of which are most certainly what is known as the Crab Nebula. The interpretation of the section of the Rampona Chronicle dealing with the appearance of a very bright star is new and provides a level of internal consistency strengthening the view that this is an evening sighting of the supernova. The above sequence of astronomical events is consistent with most aspects of the various reports including a number from Europe. These reports when combined with the oriental reports strongly suggest an explosion date of mid-spring 1054 CE. However, all of the European reports refer to events in the evening sky during the spring of 1054 CE while none found so far refer to events in the morning sky of mid June and beyond.

This curious absence still leaves us with a bit of a mystery. Indeed, since the references to earlier evening phenomena clearly demonstrate that such heavenly events were of interest to the residents of medieval Europe, the mystery surrounding the lack of reports describing the later and more pervasive morning-event is only increased. This state of affairs would seem to lend credence to the "conspiracy view" suggested by Thomas (1979), independently elaborated on by Zalcman (1979), and further developed by Lupato (1995) that such writings were suppressed by the Roman Catholic Church. The formal separation of the Church of Rome from the Eastern Orthodox Church, known as the Great Schism, is usually dated from the excommunication of the Eastern Patriarch Michael Cerularius, Emperor Constantine Monomachus and their followers on the 16th of July 1054 CE by three legates of the Church of Rome. This event does coincide with the supernova being brilliantly visible in the dawn sky and on into the day. According to Runciman (1955), the Schism, while of minor importance in the East, was viewed as a most important event in the West so that events surrounding it deserve some attention.

While the stated mission, which brought the three Roman Legates to Constantinople in the summer of 1054 CE, was to form an alliance between the Church of Rome and the Eastern Church by smoothing over past differences (e.g. Runciman 1955, or Steindorff 1881), an excellent case can be made for the two central parties to the Schism wanting the opposite. Cardinal Humbert, who headed up the legation to Constantinople, made requirements which he knew the Eastern Patriarch would not accept. On the other hand The Eastern Patriarch, Michael Cerularius, regarded the Roman See as morally bankrupt and controlled by German barbarians. He clearly desired primacy over his own church. For a variety of reasons, including knowledge of the death of Pope Leo IX in April (e.g. Every 1962) and the legate's ties to the duplicitous Marianos Argyros, military governor of the Greek colony in southern Italy (e.g. Runciman 1955 and Gilchrist 1993), he distrusted the legates and doubted the authenticity of their credentials.

Zalcman (1979) points out that Ibn Butlān, the Iraqi physician, Nestorian Christian, and original author of the Constantinople reference to the supernova (e.g. Brecher et. al. 1978) was a confidant of the Eastern Patriarch so there can be little doubt that the rather mystical (see Runniciman 1955) Michael Cerularius was aware of the new star in the sky. It takes very little imagination to see how he might have used such an omen to support his

suspicion of the legates. The legates, on the other hand, would have preferred that such arguments and their visible proof not be subsequently noted in the West. Thus, perhaps it is not surprising that the only "eyewitness" record to what both sides now seem to regard as a somewhat sordid affair is that of the chief legate and papal secretary Cardinal Humbert de-Silva. Some two years later following the death of Pope Victor II, another of the legates to Constantinople, Frederick of Lorraine, became Pope Stephan IX (X) with the help of Cardinal Humbert. Pope Stephan IX then elevated Cardinal Humbert to Chancellor of the Roman See and Vatican Librarian. Cardinal Humbert's detailed account of the journey to Constantinople contains no reference to the star.

While this argument is largely circumstantial, it does provide a basis for understanding the lack of subsequent references to the supernova of 1054 CE in the largely clerical European literature. It is also superior to the "poor weather" hypothesis suggested by Williams (1981) and suggests if further references are to be found they are likely to reside in the secular literature and historical chronicles whose origin is other than the Church of Rome.

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