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ABSTRACT

Although the connection of the Chinese "guest" star of 393 AD with the Galactic supernova remnant RX J1713.7-3946 (G347.3-0.5) made by Wang et al. in 1997 is consistent with the remnant's relatively young properties and the guest star's projected position within the "tail" of the constellation Scorpius, there are difficulties with such an association. The brief Chinese texts concerning the 393 AD guest star make no comment about its apparent brightness, stating only that it disappeared after eight months. However, at the remnant's current estimated 1–1.3 kpc distance and $A_V \simeq 3$, its supernova (SN) should have been a visually bright object at maximum light (−3.5 to −5.0 mag) if $M_V = -17$ to −18 and would have remained visible for over a year. The peak brightness ≃0 mag adopted by Wang et al. and others would require the RX J1713.7-3946 supernova to have been a very subluminous event similar to or fainter than SN 2005cs in M51. We also note problems connecting SN 393 with a European record in which the Roman poet Claudian describes a visually brilliant star in the heavens around 393 AD that could be readily seen even in midday. Although several authors have suggested this account may be a reference to the Chinese supernova of 393, Scorpius would not be visible near midday in March when the Chinese first reported the 393 guest star. We review both the Chinese and Roman accounts and calculate probable visual brightnesses for a range of SN subtypes and conclude that neither the Chinese nor the Roman descriptions are easily reconciled with an expected RX J1713.7-3946 supernova brightness and duration.

Key words: ISM: individual objects (G347.3-0.5) – ISM: supernova remnants – supernovae: general

1. INTRODUCTION

Since the middle of the 19th century, astronomers have known about pre-Tychonic bright new or "temporary" stars recorded in ancient Asian, Arabic, and European texts chiefly through the works of Biot (1846), Chambers (1867), Williams (1871), Humboldt (1871), Clerke (1890), and Lundmark (1921). With the discovery of supernovae (SNe) early in the 20th century (Baade & Zwicky 1934), extensive searches for historic sightings of Galactic SNe were made by Kanda (1935), Hsi (1955), and Ho Peng Yoke (1962, 1966), with Clark & Stephenson (1976, 1977) and Stephenson & Green (2002) presenting detailed analyses of the most likely historic SN sightings along with relevant cultural and background material.

Only a handful of celestial objects reported between the years 1 and 1000 AD have descriptions or durations indicating a likely Galactic SN event (see Stephenson & Green 2002 for details). Among these are three Chinese "guest" stars reported during the second half of the 4th century remarkably separated by less than 25 years, namely, the new stars of 369, 386, and 393 AD. Of these, the most likely SN event is the one seen in 393 due to its nearly eight-month period of visibility.

The Chinese description of the 393 star is contained in just two brief and nearly identical records from the Jin dynasty (the *Songshu* and the *Jinshu*; Clark & Stephenson 1977; Wang et al. 1997; Xu et al. 2000; Stephenson & Green 2002). The translated texts state that during the second month of the 18th year (February 27–March 28 of 393 AD) a guest star appeared within Wei (the tail of Scorpius) and lasted until the ninth lunar month (October 22–November 19) when it was extinguished (or disappeared).

Stephenson & Green (2002) note that the use of the term "zhong" in the text, meaning "within," is unique among celestial descriptions recorded during the Jin dynasty and hence strongly implies that the 393 star appeared within the bowl-like boundaries of Scorpius' tail. The Galactic plane virtually bisects the well-defined Chinese asterism Wei making up the tail of Scorpius (see Figure 2 in Wang et al. 1997), consistent with a nova or an SN occurring in or close to the Galactic plane.

Pskovskii (1972) argued that the 393 star was likely a recurrent nova since Chinese records also reported a star with Wei in 1600 AD. A nova interpretation was also suggested by van den Bergh (1978) due to the lack of an optically bright supernova remnant (SNR) in that region. However, the star's eight-month period of visibility, ending only when it began setting around sunset, has been viewed as strong evidence for it being a Galactic SN.

Identifying the remnant of a historic SN is often difficult and the guest star of 393 is no exception, with nearly a dozen Galactic SNRs located within the tail of Scorpius (Green 2009). The remnants of G348.5+0.1 (CTB 37A) and G348.7+0.3 (CTB 37B) were initially seen as possible SNR candidates to the 393 guest star due to their small angular sizes of 15′ and 17′, respectively (Clark & Stephenson 1977; Stephenson & Green 2002). However, these remnants lie ≃10 kpc away (Reynoso & Mangum 2000; Aharonian et al. 2008; Nakamura et al. 2009) and such large distances near the Galactic center likely imply considerable interstellar extinction, decreasing the chance of an associated visually bright guest star. The same is true for the apparently very young SNR G350.1-3.0 whose distance is only ∼3.4 kpc, but it lies behind an estimated ≃20 mag of visual extinction (Gaensler et al. 2008).

Pfeffermann & Aschenbach (1996) announced the *ROSAT* discovery of the Galactic remnant RX J1713.7-3946 (G347.3-0.5) in Scorpius. The remnant's location near the SN 393 reported position along with Pfeffermann & Aschenbach's estimated remnant distance of 1.1 kpc and 2100 year age led Wang et al. (1997) to suggest it as the likely remnant of SN 393.

Table 1
Observed Galactic Supernovae over the Last Two Millennia in Order of Increasing Distance

SN	Reported[a] m_V^{max}	Duration (months)	Confirmed or Proposed SNR	SN[b] Type	SNR Distance (kpc)	A_V (mag)	Expected[c] m_V^{max}
393	~0	8	RX J1713.7-3946	CCSN	0.9–1.7	3.0	−3.8 to −5.2
1054	−5.0	21	Crab Nebula	CCSN	1.8–2.0	1.6	−4.9 to −5.1
1181	~0	6	3C58	CCSN	2.0–3.2	2.1	−3.4 to −5.4
1006	−7.5	36	SNR 1006	SN Ia	2.1–2.3	0.3	−7.3 to −7.5
185	−6.0	8+	RCW 86	SN Ia	2.5–3.2	2.5	−4.4 to −4.9
1572	−4.5	18	Tycho's SNR	SN Ia	3.0–5.0	2.0	−4.0 to −5.0
1604	−3.0	13	Kepler's SNR	SN Ia	3.0–5.3	2.8	−3.2 to −4.4

Notes.
[a] Estimated peak magnitudes and durations are from Clark & Stephenson (1977), Brecher et al. (1983), Schaefer (1996), Stephenson & Green (2002), Ruiz-Lapuente (2004), and Stephenson (2010). The value for SN 393 reflects the brightness adopted by Clark & Stephenson (1977).
[b] Estimates of SN subtype are based on the presence (CCSN) or absence (SN Ia) of a compact stellar remnant in the confirmed or proposed associated SN remnant.
[c] Estimated peak apparent visual brightnesses were calculated using the M_V^{max} (SN Ia) = −19.4 (Leibundgut 2001; Riess et al. 2005); M_V^{max} (CCSN) = −18.0 (Richardson et al. 2002, 2006).
References. SN 185: Westerlund 1969; Rosado et al. 1996; Vink et al. 2006; Yamaguchi et al. 2008; SN 393: Koyama et al. 1997; Fukui et al. 2003; Uchiyama et al. 2003; Koo 2003; Koo et al. 2004; Aharonian et al. 2004; Cassam-Chenaï et al. 2004; Moriguchi et al. 2005; Tanaka et al. 2008; Acero et al. 2009; SN 1006: Schweizer & Middleditch 1980; Winkler et al. 2003; SN 1054: Trimble 1968; Davidson & Fesen 1985; SN 1181: Green & Gull 1982; Roberts et al. 1993; Fesen et al. 2008; Kothes 2010; SN 1572: van den Bergh 1978; Ruiz-Lapuente 2004; Warren et al. 2005; Krause et al. 2008; Cassam-Chenaï et al. 2007; Hayato et al. 2010; SN 1604: Reynoso & Goss 1999; Reynolds et al. 2007.

Although Stephenson & Green (2002) and Nickiforov (2010) have argued for a distance for the remnant of 6 ± 1 kpc based on possible associations with nearby molecular clouds (Slane et al. 1999) which would rule out its association with SN 393, more recent distance estimates of RX J1713.7-3946 firmly place it between 0.9 and 1.7 kpc, and most recent papers on RX J1713.7-3946 cite the Wang et al. (1997) proposed SN 393 connection.

We note here, however, that a distance less than 2 kpc for RX J1713.7-3946 raises problems with the expected SN maximum apparent brightness and durations which appear in conflict with the Chinese records. Below we discuss how neither the Chinese record of the guest star nor a long known but rarely cited European account of a bright star reported about that same year are consistent with RX J1713.7-3946 as the remnant of the probable Chinese supernova of 393 AD.

2. THE RX J1713.7-3946 REMNANT

The remnant RX J1713.7-3946 exhibits several properties suggesting a relatively young age, probably less than a few thousand years and thus potentially consistent with an SN event around 393 AD. Its X-ray emission is that of a featureless nonthermal continuum consistent with a shock velocity of several 1000 km s^{-1} (Koyama et al. 1997; Slane et al. 1999; Uchiyama et al. 2003, 2007; Fukui et al. 2003; Cassam-Chenaï et al. 2004). While the shock's velocity is probably high, it is likely less than 4500 km s^{-1} based on a limit of the angular displacement of the remnant's outer X-ray emission over a six-year period (Uchiyama et al. 2007). Ellison et al. (2010) found that velocities ~3000 km s^{-1} were required in order to model the shock kinematics in an evacuated cavity at an assumed age of 1600 years.

RX J1713.7-3946 is also one of only a few Galactic SNRs which exhibit gamma rays with energies up to 100 TeV. In this respect it resembles several other young Galactic SNRs including RCW 86 (SN 185) and the SN 1006 remnant. Observations show a close correlation between the remnant's X-ray and gamma-ray emissions suggesting a causal connection between the processes generating both types of emissions (Aharonian et al. 2007). Since high shock velocities are required to generate a significant nonthermal X-ray and gamma-ray flux (see, e.g., Zirakashvili & Aharonian 2007), the presence of an X-ray synchrotron emission and coincident gamma-ray emission in RX J1713.7-3946 favor a distance of ~1 kpc, which would rule out the age of 20,000–40,000 years which is based on the much larger distance estimate of 6 kpc (Slane et al. 1999).

The presence of a compact X-ray source 1WGA J1713.4-3949 at a projected location near the remnant's center with an X-ray-derived N_H column density similar to the remnant's central regions (Cassam-Chenaï et al. 2004) implies that it is associated with the remnant, thereby indicating that the remnant is from a core-collapse SN (CCSN). The remnant's 65′ × 55′ angular size and recent distance estimates ~1–1.3 kpc (Fukui et al. 2003; Moriguchi et al. 2005) when combined with a high-velocity shock suggests a relatively low ambient interstellar medium density (~0.01 cm^{-3}) like that expected in a stellar-wind-driven cavity generated by a high-mass progenitor which exploded as a Type II/Ib,c SN (Cassam-Chenaï et al. 2004).

3. PROBLEMS WITH AN SN 393–RX J1713.7-3946 CONNECTION

Of the currently known SNRs located near the Chinese reported position of SN 393, RX J1713.7-3946 would seem a good candidate remnant for the presumed SN of 393. It is a relatively young SNR and lies within the tail of Scorpius consistent with the Chinese report about the location of the 393 guest star. However, there are difficulties with this SN–SNR connection. Below we discuss these difficulties along with a European report of a bright daytime star around 393 AD which is unlikely to be a sighting of the Chinese 393 SN.

3.1. Expected Brightness of an RX J1713.7-3946 SN

As shown in Table 1, recent distance estimates for RX J1713.7-3946 range between 0.9 and 1.7 kpc (Fukui et al. 2003; Koo 2003; Koo et al. 2004; Aharonian et al. 2004; Cassam-Chenaï et al. 2004; Moriguchi et al. 2005) with a concentration of recent values around 1–1.3 kpc. This would place

Table 2
Apparent SN 393 Magnitudes by SN Type[a]

SN Type[b]	M_V	m_v[c]		
		t_0	t_{240}	t_{360}
SN II-P	−17.0	−3.5	+1.0	+2.0
SN II-L	−18.0	−4.5	+1.5	+2.5
SN IIb	−17.5	−4.0	+1.5	+2.5
SN Ib,c	−18.5	−5.0	+1.0	+3.0
SN IIn	−19.0	−5.5	0.0	+1.0

Notes.
[a] Rounded to the nearest half-magnitude assuming $d = 1.3$ kpc and $A_V = 3.0$.
[b] Assuming SN light curves from Turatto et al. (1990) and templates provided by P. Nugent (http://supernova.lbl.gov/~nugent/nugent_templates.html). Reported values can deviate ±1.0 mag or more. For SN IIn, the t_{360} value is an extrapolation from the slope of late-time light curves. Peak absolute magnitudes are from Richardson et al. (2006).
[c] Estimated visual magnitudes for March 393, September 393, and March 394, i.e., days 0, 240, and 360 post-maximum.

an RX J1713.7-3946 supernova closer than any historic Galactic SN recorded during the past two millennia. A distance of just 1–1.3 kpc also means that its SN should have been visually bright if (1) the optical extinction to it is fairly low and (2) it was not an unusually faint event.

X-ray-derived N_H column densities for the remnant's central X-ray-emitting regions range from $(4–8) \times 10^{21}$ cm^{-2} depending on the blackbody or power-law model adopted (Cassam-Chenaï et al. 2004). Adopting $A_V = N_H/1.8 \times 10^{21}$ cm^{-2} for a typical gas-to-dust ratio (Bohlin et al. 1978; Predehl & Schmitt 1995; Kim & Martin 1996) yields A_V values around 2.2–4.4 mag. In the following discussions, we will adopt an $N_H = 5 \times 10^{21}$ cm^{-2} consistent with the remnant's central compact X-ray source 1WGA J1713.4-3949 modeled by a two-component blackbody (Cassam-Chenaï et al. 2004), which translates to $A_V \simeq 2.8$ or roughly 3 mag of extinction.

As shown in Tables 1 and 2, if the RX J1713.7-3946 SN had an M_V of −17 to −18 in line with the typical absolute visual magnitudes for core-collapse SNe II or SNe Ib,c (Richardson et al. 2002, 2006; Drout et al. 2011), then the RX J1713.7-3946 supernova should have been a visually brilliant object. For example, at a distance between 1.0 and 1.3 kpc and $A_V = 3.0$, an SN would have been $m_v = -3.5$ to −5.0 for $M_V = -17$ to −18. In fact, it would have been a bright guest star almost regardless of the specific SN subtype, i.e., Type Ia, II, Ib,c, or IIn, unless it was a very subluminous event.

Pushing the numbers toward fainter apparent magnitude limits by adopting the largest distance recently estimated for RX J1713.7-3946, namely, 1.7 kpc, $A_V = 4$ ($N_H = 7 \times 10^{21}$ cm^{-2}; Cassam-Chenaï et al. 2004), and an M_V of −16.0 equal to the faintest Type Ib,c SNe (Drout et al. 2011), the SN would still have been quite bright with $m_v \approx -1$ and should have remained visible well into 394 AD. Smaller distances of around 1 kpc as suggested by Fukui et al. (2003) and Moriguchi et al. (2005) but keeping $A_V = 4.0$ lead to apparent magnitudes around −2, or about as bright as Jupiter.

To place these brightness estimates in context, we list in Table 1 the reported peak visual magnitudes (to the nearest half-magnitude where possible) of all Galactic SNe over the last two millennia based on ancient records (Stephenson & Green 2002). The listed peak magnitudes, especially for the older SNe, are often uncertain due to the sometimes fragmentary nature of the existing records and possible observer error or exaggeration. For example, whereas the estimated distance and visual extinction to the SN 1006 remnant imply a maximum apparent visual brightness around −7.5 (Winkler et al. 2003), analyses of reported descriptions suggest values 2 mag higher or lower (Stephenson 2010). This, plus uncertainty in remnant distances, has led to somewhat different values listed in Table 1 from other authors (e.g., Schaefer 1996).

Despite these caveats, one finds that the peak magnitude estimates from ancient descriptions are, in most cases, in rough agreement with visual magnitude estimates based upon the likely SN event. We have identified CCSN events in cases where a compact central object is present in the likely associated SNR. Listed in Table 1 are the current estimates for remnant distances and line-of-sight visual extinctions. Besides the 393 SN, the worst agreement between the predicted and reported brightness is perhaps that of SN 1181 with the remnant 3C58 about which there has been considerable debate as to that remnant's age and distance estimates (see Fesen et al. 2008; Kothes 2010, and references therein).

3.2. Estimates on the Apparent Brightness of SN 393

As noted above, the Chinese records include no comment about the star's brightness. This leaves one to wonder why they did not include such a comment, especially if SN 393 is related to RX J1713.7-3946 as it might have rivaled Jupiter or even Venus at its brightest. One possible solution might simply lie in the extreme brevity of the existing Chinese records. The description is about as short as one could write a record concerning the appearance of a guest star.

In considering this peak brightness issue, it is important to note that the records that have survived from this period in China are condensed summaries of the Jin dynasty history written by imperial scholars many decades and even centuries after the actual events. Moreover, trying to interpret the meaning of the lack of a note about the star's brightness is made more difficult given the fact that no mention is made in the existing records on the brightnesses of either of the other two possible guest stars of 369 and 386.

In the absence of any indication in the Chinese records regarding the brightness for the 393 guest star, Clark & Stephenson (1977) estimated a peak visual magnitude $\simeq 0$. They arrived at this value from the lack of any remark about an extraordinary brightness and a consideration of atmospheric extinction since observers at Nanjing could view the guest star no more than 20° above the horizon.

In like fashion, Wang et al. (1997) estimated it could have been no brighter than −2 mag, reasoning that had the guest star been brighter than this the Chinese astronomers would have compared it to the planets Saturn, Mars, and Jupiter. All three planets were, in fact, visible in the morning sky in the early Spring of 393 AD with apparent visual magnitudes of +0.27, +0.25, and −2.4, respectively, and located within 45° of the reported guest star in Scorpius.

Wang et al. (1997) further argued that if its peak magnitude had been fainter than 0 mag then it would have not been visible to the naked eye for as long as eight months. Adopting a distance of 1.1 kpc, $A_V = 2.0$, and a peak visual magnitude of −2 to 0, they estimated an RX J1713.7-3946 supernova to have been $M_V = -12$ to −14. However, this would mean SN 393 was an unusually low-luminosity SN event similar to SNe 1987A, 1999br, and the M51 object 2005cs with $M_V > -15$ (Richardson et al. 2002; Pastorello et al. 2004, 2006). On the other hand, if the RX J1713.7-3946 supernova had a more

common M_V for CCSNe of -17 to -18, it then should have been easily visible into early 394 AD yet there is no mention of this in the existing Chinese records. So, if the 393 event only reached -2 to 0 mag and was connected to RX J1713.7-3946, then at the distance and visual extinction assumed by Wang et al. (1997) it must have been a very subluminous SN II/Ib,c event occupying the faintest end of CCSNe (Richardson et al. 2002).

3.3. Reported Duration of SN 393

In March 393 when the Chinese reported the first sighting of the 393 guest star, astronomers in Nanjing (latitude +32°) would have been able to see the stars comprising Scorpius' tail rise above the horizon around 1 a.m. local time and reach culmination 22° above the southern horizon in the morning by 5 a.m., roughly a half-hour before the beginning of astronomical twilight. If the guest star was as brilliant as we estimate if it were the RX J1713.7-3946 supernova (-4.5 mag), it would have been easy to follow from night into twilight and then into daytime.

Such a guest star in Scorpius would remain visible at night for the next several months right up until the time it would set in evening twilight around mid-September. A star about as bright as or brighter than the nine stars comprising the Scorpius tail asterism, all but one of which are fainter than second magnitude might stay visible a little longer. Thus, it might have still been visible during early twilight a week or two longer and hence possibly into early October. This would still fall short of the Chinese records which state it lasted until the ninth lunar month, namely, October 22 through November 19. Of course, the description of "until" the ninth month could mean that its visibility continued only up to the ninth month and not during it.

Stephenson & Green (2002) interpreted the duration of the guest star "until" the Chinese ninth lunar month (October 22–November 19) as meaning the star remained visible into the the ninth month. However, on October 22 it would have set just some 15 minutes after sunset and to be visible under these circumstances the star would have required a relatively bright object, thereby implying a brilliant object months earlier at maximum light.

In an attempt to resolve this dilemma, Stephenson & Green proposed a recording error of one month regarding the object's disappearance (the eighth instead of the ninth month), allowing the object to set well after sunset in a dark sky. Considering the visibility of Scorpius' asterism Wei in late September and early October 393 and allowing for atmospheric extinction, Clark & Stephenson (1977) estimated a maximum apparent magnitude around 0 mag or perhaps a bit brighter, noting that had the star been much brighter than this the Chinese likely would have included a comment on its brightness.

In Table 2, we list the expected brightnesses eight months (day 240) after maximum light for several different CCSN subtypes assuming a distance and A_V equal to that of RX J1713.7-3946. The table shows that in all cases the SN would have been brighter than θ Sco ($m_v = 1.87$), the brightest star in the tail of Scorpius. Thus, if RX J1713.7-3946 is a CCSN and was the guest star seen in 393, then its expected brightness between 0 and +1.5 mag would make it possible for it to stay visible a little longer but perhaps not past the middle of October as the Chinese reported.

A more serious problem with this scenario is that there is no mention of the star being recovered early in 394 AD when it would have again become visible from behind the Sun. Given average luminosity decline times commonly seen for CCSNe, an RX J1713.7-3946 supernova should have been easily visible to observers with an apparent brightness between first and third magnitudes, comparable to the stars in Scorpius's tail (see Table 2). Although the very brief Chinese record should not be interpreted as complete, it is unusual that there were no further reports of its continued presence, especially since reports of other guest stars returning from behind the Sun exist, such as SN 185.

However, in light of the considerable spread in the decline rates of SN Type Ib,c events, the possibility exists that the SN faded below widespread notice when it came from around the Sun three months later. Some subluminous events exhibit a steepening of their light curve at times beyond 120 days, diminishing in visual brightness fairly rapidly. For instance, had an RX J1713.7-3946 supernova followed the light curves of SN 2005cs or SN 2009md (Pastorello et al. 2009; Fraser et al. 2011), it would have faded >5 mag one year past maximum and hence possibly would have been missed.

In closing, we note that if SN 393 had instead been a Type Ia event and unrelated to the CCSN remnant RX J1713.7-3946, similar brightness issues at late times would apply. That is, at day 240 a Type Ia guest star would appear ≃6 mag fainter than at maximum light (Leibundgut et al. 1991). A peak brightness of 0 mag estimated by Stephenson & Green (2002) would mean the guest star would approach the naked eye visibility limit of sixth magnitude some months after maximum. This would have made the star even more difficult to view in early October 393 since it would have been less than 5° above the western horizon at the end of twilight and thus subject to significant atmospheric attenuation.

4. A POSSIBLE EUROPEAN SIGHTING OF SN 393

Relevant to the apparent brightness of the SN 393 guest star, there is an European text written around 398 AD by the Roman poet Claudian describing a bright star which he said was plainly visible even in midday a few years earlier. Claudian viewed this star as an omen of Honorius being made emperor in 393[4] thereby implying that it occurred around 393 AD.

The possibility of a connection between the bright star described in the Claudian poem and the Chinese guest star of 393 AD has been made by several authors including Dreyer (1913), Stothers (1977), Barrett (1978), Clark & Stephenson (1982), Clark (1984), and Ramsey (2006). However, no mention of this reference is found in the most recent astronomical reviews of ancient guest star observations including discussions directly regarding the suspected SN of 393 (Clark & Stephenson 1975, 1977; Wang et al. 1997; Stephenson & Green 2002; Green & Stephenson 2003; Wang 2006).

Interestingly, this Roman record has long been known, going back some 440 years to the time of Tycho Brahe. A year after he sighted his supernova of 1572, Tycho learned about the Claudian text through a letter from Paul Hainzel, a longtime friend and mayor of Augsburg, to the humanist Hieronymous Wolf in which Hainzel mentions the Claudian text about a bright new star in the sky, much like the 1572 star (Brahe 1602). Tycho never reached a definitive conclusion about the meaning of the Claudian poem, i.e., whether it was a description of a comet, a daytime sighting of Venus, or something else, but it was obvious, he concluded,

[4] Honorius was declared emperor Augustus at the age of nine in 393 by his father Theodosius I. With the death of their father in January 395, he and his brother Arcadius divided up the empire, with Honorius becoming the Western Roman emperor.

that new stars like the one he saw in 1572 sometimes appeared in the heavens (Dreyer 1913).

The relevant passages about the new star appear in Claudian's "The Fourth Consulship of Honorius." Since to our knowledge this text has never been presented in the astronomical literature, we reproduce it here. According to the English translation of the Latin by Platnauer (1922, pp. 299–301), the pertinent passages read:

> Never was the encouragement of the gods more sure, never did heaven attend with more favouring omens. Black tempest had shrouded the light in darkness and the south wind gathered thick rain-clouds, when of a sudden, so soon as the soldiers had borne thee aloft with customary shout, Phoebus scattered the clouds and at the same moment was given to thee the sceptre, to the world light. Bosporus, freed from clouds, permits a sight of Chalcedon on the farther shore; nor is it only the vicinity of Byzantium that is bathed in brightness; the clouds are driven back and all Thrace is cleared; Pangaeus shows afar and lake Maeotis makes quiver the rays he rarely sees. 'Tis not Boreas nor yet Phoebus' warmer breath that has put the mists to flight.
>
> That light was an emperor's star. A prophetic radiance was over all things, and with thy brightness Nature laughed. Even at midday did a wondering people gaze upon a bold star ('twas clear to behold) no dulled nor stunted beams but bright as Boötes' nightly lamp. At a strange hour its brilliance lit up the sky and its fires could be clearly seen though the moon lay hid. May be it was the Queen mother's star or the return of thy grandsire's now become a god, or may be the generous sun agreed to share the heavens with all the stars that hasted to behold thee.
>
> The meaning of those signs is now unmistakable. Clear was the prophecy of Ascanius' coming power when an aureole crowned his locks, yet harmed them not, and when the fires of fate encircled his head and played about his temples. Thy future the very fires of heaven foretell.

Although a similar translation is found in Barr (1981), both these authors have taken some poetic license with the text. A more literal translation of the key sentence and a slight modification of that given by Ramsey (2006, pp. 199) is: "Even at midday, the marveling populace beheld a bold and unmistakable star, which was not faint with dimmed ray, but as bright as Boötes is at night. It shone forth, a guest in fiery regions at a strange hour, and it could be recognized although the moon lay hidden."

Although Claudian's description concerning a star being "bold" (audax) and visible even at midday suggesting a very bright object would seem consistent with our estimated peak magnitude around −4.5 for an RX J1713.7-3946 supernova, it appears unlikely that it is a reference to the Chinese guest star of 393. The constellation Scorpius would set by 9 a.m. in the morning of early March 393 and hence no star located in its tail would be visible near midday.

One possibility is that Claudian's star was a sighting of a brilliant −4.5 or brighter SN in late 392 when Scorpius would have been near conjunction with the Sun. However, in that case the Chinese then should have reported it in the early morning by mid-January when Scorpius rises an hour before morning twilight. Additionally, there is no Chinese record concerning a daytime star in 392.

Interestingly, Venus, which can be seen during daylight when brighter than ≈−3.5 mag (Weaver 1947), was near its maximum brilliance of −4.6 mag and near the meridian at 9 a.m. on 23 January 393 when Honorius was declared emperor (Augustus) by his father Theodosius. At noon on that day, Venus would still have been visible some 25° above the southwestern skies. The waning crescent Moon would have already set by midday and might explain Claudian's reference to a star's visibility "though the moon lay hid." So maybe a daytime sighting of Venus is what Claudian was referring to in his poem of adoration to emperor Honorius.

5. CONCLUSIONS

Identifying the remnants of historic SNe is often difficult and this is especially true in the case of the 393 guest star. Given the brief description of the guest star in the Chinese records and the nearly dozen Galactic SNRs currently known within the tail of Scorpius (Green 2009), doubts about any SN 393–SNR association will likely persist.

A connection between the ancient guest star and suspected SN of 393 and the X-ray bright SNR RX J1713.7-3946 has been proposed by Wang et al. (1997). While this connection has been often cited in the literature on the RX J1713.7-3946 remnant and is in line with some of its relatively youthful properties, the Wang et al. (1997) estimated M_V values between −12 and −14 imply a highly subluminous CCSN event.

In this paper, we reviewed both the Chinese and Roman accounts and calculated probable visual brightnesses for a range of SN subtypes. We conclude that neither the Chinese nor the Roman descriptions are easily reconciled with an expected RX J1713.7-3946 supernova brightness and duration. We further note that if RX J1713.7-3946 were the SN 393 remnant, it would then rank as having been the nearest of all the known historic Galactic SNe during the last 2000 years. Its relatively small distance of around 1 kpc plus a moderate amount of optical extinction also means its SN would have likely been a visually brilliant object, certainly as bright as Jupiter and maybe as bright as Venus.

Although a connection between SN 393 and RX J1713.7-3946, or for that matter any other young SNR lying within Scorpius' tail, will likely remain uncertain due to limitations of the ancient records, such an association does not appear consistent with the available historical records. It is hoped that future studies of the RX J1713.7-3946 remnant which provide better estimates as to its age may help resolve the question of the remnant of the suspected SN of 393 AD.

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