4.18 GUEST STARS: HISTORICAL SUPERNOVAE AND REMNANTS

T. Velusamy
Radio astronomy Centre (TIFR)
P.O.Box.8, Udhagamandalam-643 001
India

Supernova explosions occur in massive stars in their final stages of stellar evolution. The explosion leaves behind a collapsed object, usually a neutron star observable as a pulsar, and an expanding outer envelope of the star observable as a supernova remnant (SNR). Because of the large amount of energy in the range of 10^{50}-10^{52} ergs released in the explosion, the energy radiated by the exploded star is equivalent to that of millions of normal stars. Thus a "new star" seems to appear and is easily visible to the naked eye for several months. Astronomers have estimated that in our galaxy such supernova explosions occur once about every 50 years. In ancient times, the occurrence of supernova might have been noticed as appearance of a bright new star which faded away into obscruity after a few months. Thus the "guest stars" in the ancient records are indeed possible occurrences of supernova explosions in the galaxy. The guest star of 1054 A.D., well recorded by Chinese and Japanese astronomers is the best known historic supernova (Brecher et al. 1983; and references therein); today its remnants the Crab Nebula and the pulsar are observable over the entire electromagnetic spectrum from radio to γ-rays. Of the 150 SNRs known in our galaxy, only about 10 have been identified with guest stars of historical supernovae.

Since the invention of telescope no supernova explosion has been observed in our galaxy and our observational knowledge is confined to supernovae occuring in distant external galaxies. For any "observational" information about the supernova explosions in our own galaxy we have to depend only on the records of pretelescopic civilizations. Today we know of nine pretelescopic historical supernovae. The supernovae of AD 1572 and AD 1604 have been well recorded by the famous astronomers Tycho and Kepler. The identifications of the others are based mostly on Chinese records, often confirmed by Korean and Japanese records. Also the ancient literature and historic records of many other civilizations, such as those in ancient Greece, Rome, Arab, Babylon, Europe have been searched for any records of the occurance of guest stars but no evidence has been found so far. However, the Indian literature and records essentially remain unexamined for guest stars.

A detailed account of the historical records examined so far is given by Clark & Stephenson (1977) and in the later reviews by Clark & Stephenson (1982) and Trimble & Clark (1985). As the ancient Chinese believed in the controlling influence of heavens on the destinies of men, in parti-

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cular kings, professional astrologers and astronomers were appointed to maintain a constant watch of the sky in order to report and interpret any unusual events happening in the sky. Thus the Chinese have official records of astronomical events during various dynasties with almost a continuous record covering nearly 2000 years, as far back from Han Dynasty (202BC-220AD). We now find a wealth of astronomical recordings of eclipses, comets, meteors, planetary conjunctions, new stars etc. Similar records have been maintained by the Koreans and Japanese during the later years. How does one recognise a supernova in these records? The appearance of a new star are recorded typically as: "guest star or visiting star; broom stars or sweeping stars", "ray stars or bushy stars". The appearances of comets can be easily identified from the description of their motion, and the others are potential events of novae and supernovae. In Fig.1 are shown the light curves of Nova Cygni 1975, Type I supernovae observed in external galaxies, and light curve of supernova AD1054 deduced from descriptions in the ancient historical records. Since supernova are brighter than novae by several orders of magnitude and are observable for much longer period, it is possible to distinguish between them. In a supernova the increase to maximum brightness is slower than for a nova and it is possible to detect a supernova before it reaches maximum brightness. A supernova explosion occuring about 2 kpc (~6000 light years) away from the earth will have a peak brightness of about -5mag and can be seen by naked eyes in daytime for about 3 weeks and in night for several months. Further, in a supernovae explosion the outer envelope of the exploded star is ejected out into the surrounding interstellar space at velocities of several thousand km/sec. This expanding envelope, known as supernova remnant (SNR) contains gas and very energetic particles, and the emission from it is observable with radio, optical and X-ray telescopes for thousands of years after the explosion.

After searching through the records available over two thousand years period, Clark & Stephenson (1977) find evidences for occurence of 75 new stars. Of these only about 20 were visible for periods longer than 50 days, and these are possible candidates for historical supernovae. In Tables 1 and 2 we have reproduced from Clark & Stephenson (1977) the list of medium and long duration new stars, and identification of some of the new stars as the historical supernovae and their remnants. For example, the description of the guest star AD1054 (the historical supernova of the Crab Nebula in the Taurus) in the astronomical treatise of the Sung dynasty compiled around AD1345 is given as: "In the first year of the period Chih-ho (July 4) (a guest star) appeared approximately several inches (roughly 0.3 to 0.5 degrees) to the south-east of T'ien Kuan (the star Zeta Tauri). After a year or more it gradually vanished".

In Tables 1 and 2 we have included the guest star of AD1408. Although there is no mention of its duration, its description as reported by Li (1979) suggests that it might have been a supernova: "Reign Ying-le Year 6, winter, month 10, day Geng-chen, at night near the meridian, to the south-east of Niandao, there is a star like a lamp, its colour is yellow, its lusture smooth, it shows up and does not move, it is a

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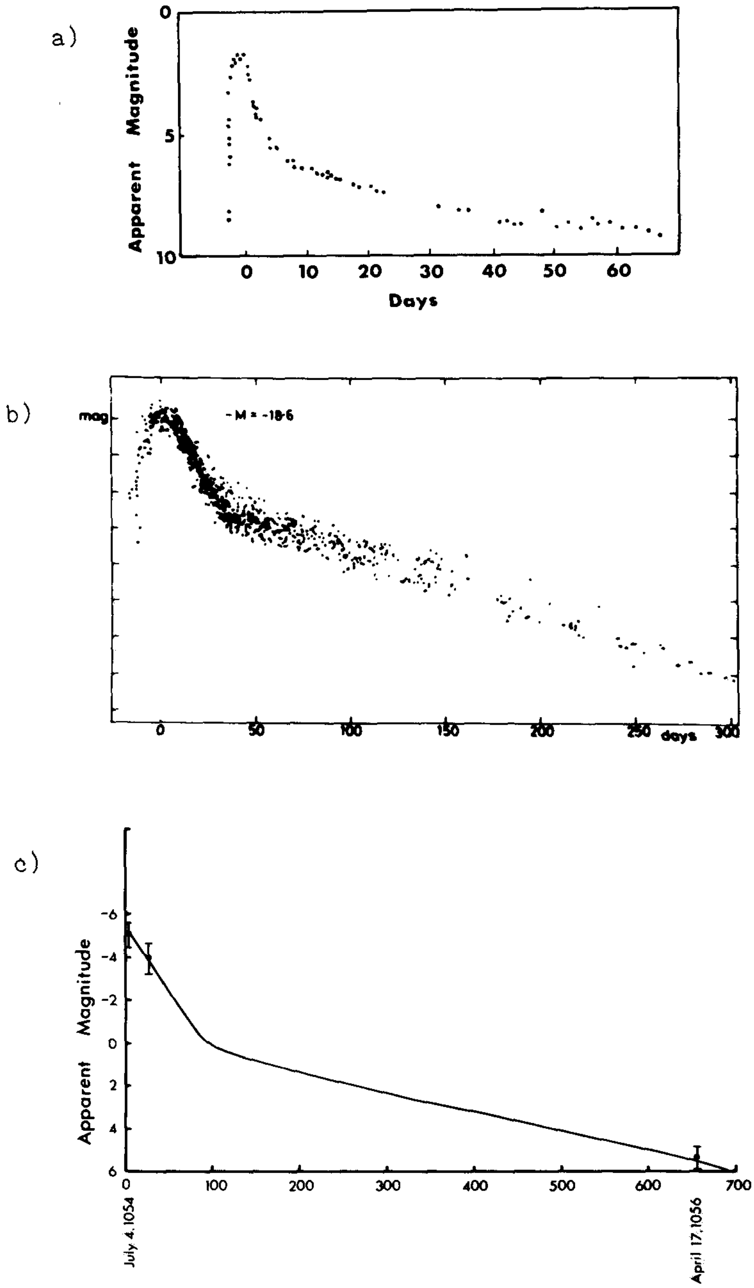

Fig.1. Observed brightness as a function of time,
a) Nova Cygni 1975
b) Type I supernova observed in external galaxies
c) AD1054 Supernova explosion (the Crab Nebula) as deduced from historical records.

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Zhou-lo, a virtuous star". Also its location in the sky in the region of the peculiar supernova remnant CTB80 suggests an interesting identification (Strom, Angerhofer & Velusamy, 1980; Wang & Seward, 1984).

TABLE 1
LONG DURATION "NEW STARS"

(1) Date		(2) Recorded in	(3) chinese description	(4) Duration	(5) Approximate Galactic coordinates l	b	(6) Remarks
Mar/Apr	5 BC	China	hui	70 days	30^0	-25^0	comet/nova?
Sep 27	AD 61	China	K'O	70 days	60	-70	comet/nova?
May 3	AD 64	China	K'O	75 days	290	+55	comet/nova?
Dec/Jan	AD 64	China	K'O	48 days	215	+45	nova?
Dec 7	AD 185	China	K'O	20 months	315	- 2	supernova?
Jan 16	AD 247	China	hui	156 days	295	+40	comet/nova?
Mar/Apr	AD 369	China	K'O	5 months	-	-	position estimate impossible
Apr/May	AD 386	China	K'O	3 months	10	0	possible supernova
Feb/Mar	AD 393	China	K'O	8 months	345	0	supernova
Jul/Aug	AD 396	China	star	50 days	175	-25	nova?
Nov/Dec	AD 402	China	K'O	2 months	240	+60	comet/nova?
May 3	AD 837	China	K'O	75 days	280	+65	nova?
May 1	AD 1006	Arab China, Europe, Japan	K'O	several years	330	+15	supernova
Jul 4	AD 1054	Arab China, Japan	K'O	22 months	185	- 6	supernova
Aug 6	AD 1181	China Japan	K'O	185 days	130	+ 3	supernova
Oct 24	AD 1408	China	star?		69	+ 3	supernova?
Nov 8	AD 1572	China Europe Korea	K'O	16 months	120	+ 1	Tycho's supernova Type I
Nov 28	AD 1592A	Korea	K'O	15 months	150	-70	Mira Ceti?
Nov 30	AD 1592B	Korea	K'O	3 months	125	0	?
Dec 4	AD 1592C	Korea	K'O	4 months	115	0	?
Oct 8	AD 1604B	China Europe Korea	K'O	12 months	5	+ 7	Keplers supernova - Type I

hui broom star; K'O Guest star

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Finally, Ashworth (1977) has suggested the only possible historic supernova observed after the advent of modern telescope, the candidate AD1679 (Cas A) in Table 2. This identification is based on Flamsteed's observation of a 6th magnitude star on 16th Aug 1680, designated 3 cassiopeiae in the 1725 Flamsteed catalogue. Later astronomers have dismissed this star as spurious. However its close proximity to the supernovae remnant Cas A strongly suggests that Flamsteed observed the faint supernova long after the explosion during its decay phase.

TABLE 2
THE HISTORICAL SUPERNOVAE AND THEIR REMNANTS

Supernova	Radio remnant	Remarks	Approx distances from sun
AD 185	G315.4-2.3 (RCW 86)	Probable	<2kpc
AD 386	G11.2-0.3	Possible	>5kpc
AD 393	G348.5+0.1 or G348.7+0.3 (CTB37 A and B)	Possible	>6kpc
AD 1006	G327.6+14.5 (PKS 1459-41)	Certain	~1 kpc
AD 1054	G184.6-5.8 (Crab)	Certain	~2 kpc
AD 1181	G130.7+3.1 (3C58)	Probable	~8 kpc
AD 1408	G69+2.7 (CTB80)	Probable	~3 kpc
AD 1572	G120.1+1.4 (Tycho's SN)	Certain	~3 kpc
AD 1604	G4.5+6.8 (Kepler's SN)	Certain	~5 kpc
AD 1679	G111.7-2.1 (Cas A)	Probable	~3 kpc

It may be noted that the identifications given in Table 2 are far from being complete. Very recently Wang et al. (1986) have reported six new identifications of historical supernovae from the Chinese records. Guest stars BC523, BC134, BC48, AD125, AD421, AD1523 have been identified as historic supernovae. Identifications of historical supernova are of great astrophysical importance. Accurate ages of the SNRs obtained from their historic supernovae, are exteremely valuable for better understanding of the physical conditions and processes in the individual remnants. Further, completeness of the historic supernovae will be useful to improve the statistics of the supernovae rate in our galaxy.

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