Historische Supernovae

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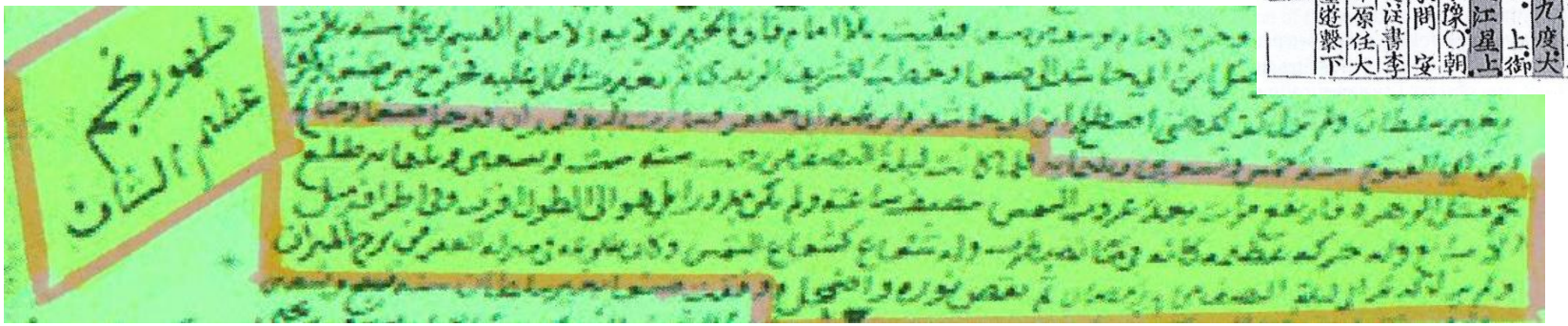

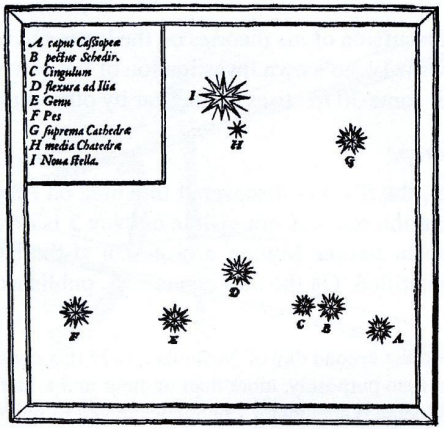

Historische Supernovae

1. **Einführung**
2. **Kepler (SN 1604)**
3. **Tycho (SN 1572)**
4. **Cas A (~ 1680)**
5. **Crab (SN 1054)**
6. **SN 1006**

Historische Beobachtungen (galaktischer) Supernovae

sind wichtig für:

➔ Lichtkurve ➔ Typ der Supernova: thermonukleare SN I (Doppelstern)
oder Kern-Kollaps SN II (massereicher Stern)

➔ Feststellung des Ortes der Supernova (SN)
➔ Identifizierung des SN-Überrestes und ggf. des Neutronensterns
➔ damit grobe Entfernungsbestimmung

➔ Helligkeit im Maximum (bei bekannter Entfernung) ➔ Typ der SN

➔ Zeitpunkt der Explosion: exaktes Alter von SN-Überrest (und Neutr.stern),
(sonst nur sehr grob bekannt)

➔ ggf. Identifizierung eines Run-away-Sterns bei SN II im Doppelstern
➔ damit genaue Entfernungsbestimmung

➔ ggf. Lichtecho-Spektroskopie ➔ Typ der SN, Asymmetrie etc.

Kriterien für die Klassifikation historischer Beobachtungen als Supernovae

im Gegensatz zu anderen transienten Ereignissen wie Novae und Kometen:

- ➔ Sehr hell
- ➔ lange Sichtbarkeit, mehrere Monate
- ➔ stationär, d.h. keine Bewegung relativ zu den Sternen
- ➔ SN II eher in der galaktischen Ebene, meist in OB Assoziationen
- ➔ Spätere Identifikation von SN-Überrest und ggf. Neutronenstern

Standardwerk: Stephenson & Green “Historic Supernovae and their Remnants”

Historische Supernovae

SN Year	Location δ [°]	Ext. Av [mag]	Peak magnitude hist.	Peak magnitude Equ. (3)
185 ?	Cen −59	6.3(3.2)[1]	−8(2)[2]	−3 to 8
369 ?	(b) ∼ 65		≤ 2[6]	
386	Sgr −19	8.7(3.4)[7,8]	∼ 2[9]	0 to 10
393	Sco −39	3.9(2.4)[19]	−1(1)[20,21]	−8 to 2
1006	Lup −42	0.32(3)[2]	−7.5[24]	−8 to −7
1054	Tau +22	∼ 1.1[25]	−4.8[25]	−7 to −3
1181	Cas +64	1.3(0.2)[34]	∼ 0.7[2]	−6 to −2
1572	Cas +65	2.25(16)[2]	−4.5[2]	−6 to −5
1604	Oph −20	3.27(14)[2]	−3.0[2,9,44]	−3 to −4
∼ 1300	Vel −46	1.63(98)[46]		−12 to −3
∼ 1680	Cas +58	11.6(2.6)[49]	(g)	3 to 11

Historische Supernovae (~2000 Jahre)

Table 1 Historic supernovae in the last 2000 yr. There are several Galactic historic SN sightings since 185 (sorted here by time), but no SN sighting within 200 yr around AD 774/5. This listing shows that SNe were observed before and after the AD 774/5 event. Also, the SNRs Vela Jr and Cas A are listed, because they were considered in M12 to be possibly related to the AD 774/5 event; at the end of the table, we list six more SNRs, which should be related to recent SNe given the ages of the pulsars and/or SNRs; however, all those eight SNRs are all too distant for the AD 774/5 event (if that were a normal SN at ~ 1.24 pc); Vela Jr is too young given its expansion velocity.

SN	Location	Ext. A_V	Peak magnitude		Supernova remnant				Neutron star				SN type
Year	δ [°]	[mag]	hist.	Equ. (3)	G name	d [kpc]	age [kyr]	Ref	name	d [kpc]	age [kyr]	Ref	& Ref.
185 ?	Cen −59	6.3(3.2)[1]	−8(2)[2]	−3 to 8	320.4-1.2	5.0(1.6)	1.7-20	1,3	1513-5908	3.3-8.4	≤ 1.56	3-5	cc(?),2,(a)
369 ?	(b) ~ 65		≤ 2[6]										?,6
386	Sgr −19	8.7(3.4)[7,8]	~ 2[9]	0 to 10	11.2-0.3	5.0(6)	0.4-3.4	10-15	1811-1925		≤ 23.3	16,17	II,16-18
393	Sco −39	3.9(2.4)[19]	−1(1)[20,21]	−8 to 2	347.3-0.5	1.4(5)	1.6-9.0	19-23	CCO (c)			(c)	cc(?),(c)
1006	Lup −42	0.32(3)[2]	−7.5[24]	−8 to −7	327.6+14.6	2.18(8)		24-26	none				Ia,(d),27
1054	Tau +22	~ 1.1[25]	−4.8[25]	−7 to −3	184.6-5.8	2.0(5)	0.953 (21)	29-31	0534+2200	2.0-2.5	≤ 1.24	32,33,115	II,Crab,32
1181	Cas +64	1.3(0.2)[34]	~ 0.7[2]	−6 to −2	130.7+3.1	2.9(3)	0.8-7.0	34-37	0205+6449	3.2-7.5	≤ 5.37	33-39	II,2,40,41
1572	Cas +65	2.25(16)[2]	−4.5[2]	−6 to −5	120.1+1.4	2.25(16)	~ 441	2,42	none	(Tycho's SN)			Ia,43
1604	Oph −20	3.27(14)[2]	−3.0[2,9,44]	−3 to −4	4.5+6.8	3.4(3)	~ 409	2,45	none	(Kepler's SN)			Ia,(e)
Other young SNRs considered in Miyake et al. 2012													
~ 1300	Vel −46	1.63(98)[46]		−12 to −3	266.2-1.2	0.20 - 1	0.4-4.3	47-50	CCO	(Vela Jr)		(f)	cc(?),47,48
~ 1680	Cas +58	11.6(2.6)[49]	(g)	3 to 11	111.7-2.1	$3.5^{+0.3}_{-0.1}$	~ 333	51,52	CCO	(Cas A)		53	IIb,54

AD 185, 369, 386, 393 1006, 1054, 1181 1572, 1604

+ 2 ggf. gar nicht bemerkt: Vel Jr. und Cas A (?)

~ 9 + 2 historische Supernovae seit ~2000 Jahren

(alle innerhalb von 5 kpc):

9 beobachtet in China (z.T. zudem in Korea und Japan),

3 beobachtet in Europa (SN 1006, Tycho 1572, Kepler 1604),

4 beobachtet in Arabien (SN 1006, 1054, 1572, 1604).

Historische Supernovae

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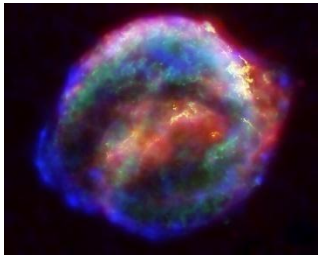
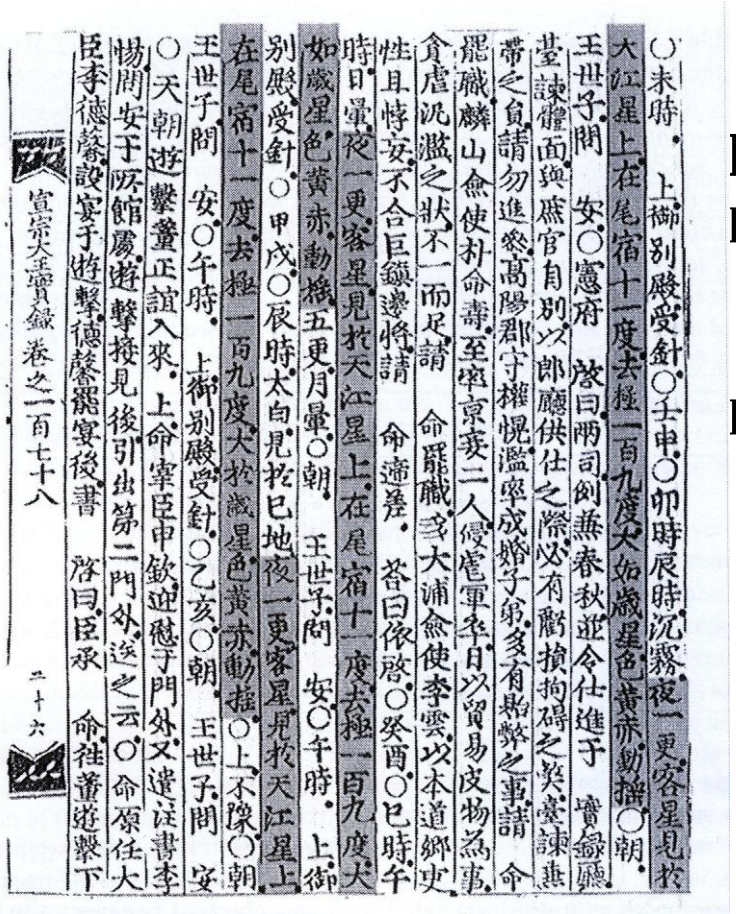
6. SN 1006



China:

Wanli reign period, 32nd year, 9th lunar month, day yi-chou (22) [1604 Oct 10].

At night, at the SW, there was produced a strange star. It was as large as a pellet and its body was orange. It was called a guest star.



Korea:

King Sonjo, 37th year, 6th lunar month, day wu-chen (5) [1604 Oct 13].

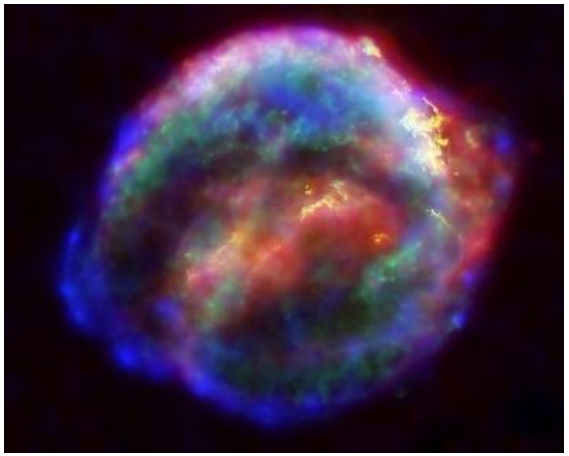
In the first watch of the night, there was a guest star, it was 10 du in Wie lunar lodge and ist distance to the pole was 110 du. Its form was smaller than Jupiter and its color was orange. It was scinntilating.

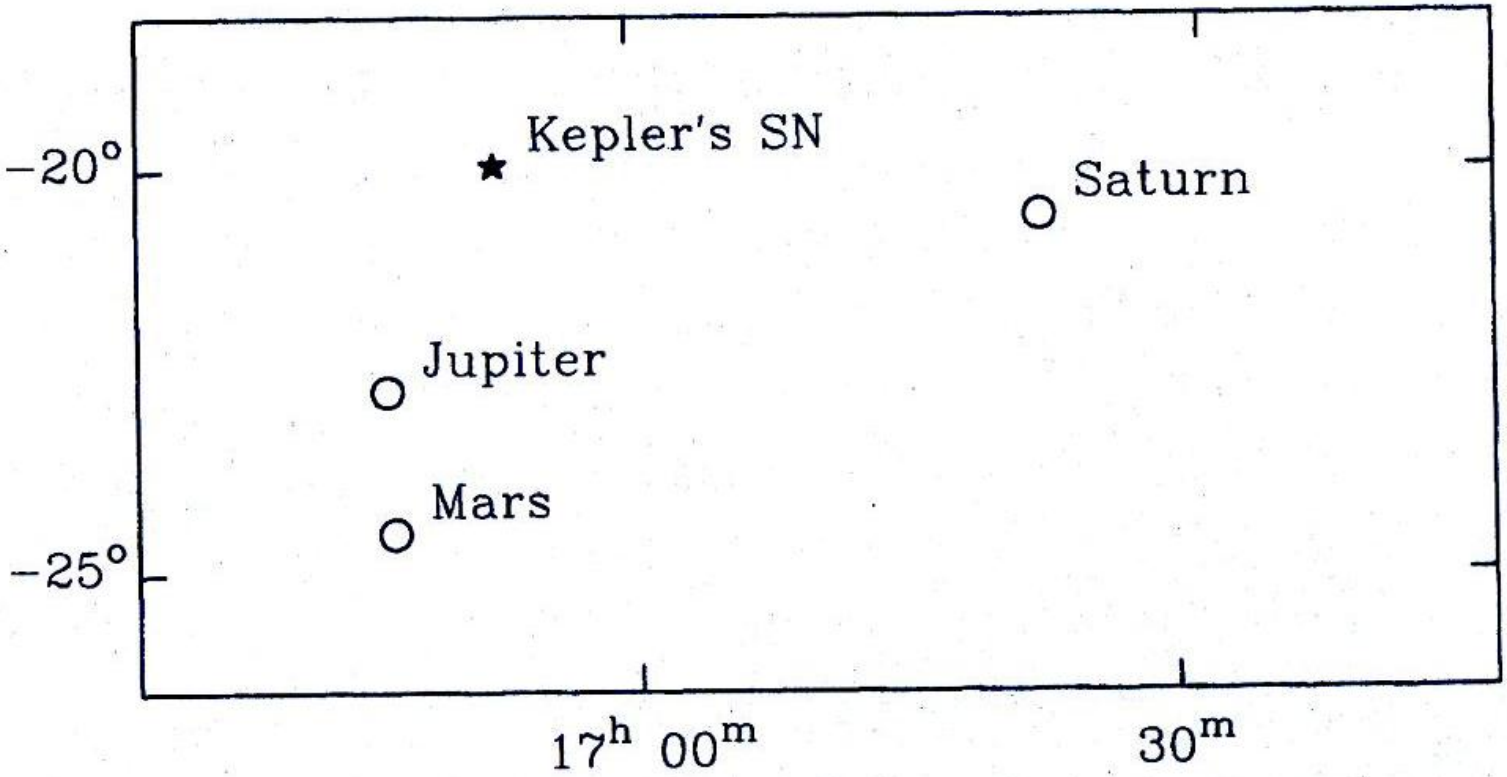
Europa:

ab 9. Okt. 1604 abends durch Altobelli in Verona (am 8. Okt. beobachtet, aber nichts gesehen).

Ab 10. Okt. auch durch Simon Marius in Padua.

Kepler ab 17. Okt.





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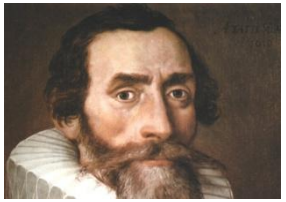

NOVA OPHIUCHI OF 1604 AS A SUPERNOVA*

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Received January 11, 1943

ABSTRACT

Nova Ophiuchi of 1604 is one of the earliest well-observed novae. Its position has recently been redetermined by Schlier and Boehme from the original measures of Fabricius and Kepler. The light-curve, derived in the present paper, shows that the star was a supernova of type I, which at maximum reached the apparent magnitude −2.2. A check of the Chinese version of the apparition against the light-curve shows that the Chinese reports about new stars were based on careful observations.

A search for the remnant of the supernova led to the discovery of a small patch of emission nebulosity, which is undoubtedly a part of the masses ejected during the outburst. The investigation of this remnant meets with unusual difficulties because the supernova is behind heavy obscuration. The determination of the distance and the luminosity of the supernova must therefore be left to future observations.

TABLE 2

ESTIMATES OF BRIGHTNESS AND COLOR OF NOVA OPHIUCHI OF 1604

Date (Gregorian)	Brightness of Nova	Color	Observer
1604 Oct. 8....	Not seen	.....	Several
Oct. 9....	As bright as Mars	Like Mars	Anonymous physician (Cosenza)*
	As bright as Jupiter	Like half of ripe orange	Altobelli (Verona)†
Oct. 10....	Somewhat brighter than on Oct. 9	.....	Anonymous physician*
	Very similar in brightness to Mars	Like Mars	Capra-Marius (Padua)‡
Oct. 11....	Still brighter than on Oct. 10	.....	Anonymous physician*
	Twice as bright as Jupiter	.....	Heck (Rome)§
Oct. 12....	Almost as bright as Jupiter	.....	Roeslin (Hagenau)‖
Oct. 15....	As bright as Jupiter or somewhat more	Like Jupiter	Anonymous physician*
	Much brighter than Jupiter; no further increase after this day	.....	Altobelli†
	As bright as Jupiter or a little more; no further increase afterward	.....	Capra-Marius‡
	A little brighter than Jupiter	Like Jupiter; white, not red	Fabricius (Osteel)¶
	As bright as or brighter than Jupiter	.....	Brenzoni (Verona)**
	Brighter than Jupiter and equal to Venus	.....	Maestlin (Tübingen)††
Oct. 17....	Much brighter than Jupiter (almost twice as bright)	.....	Kepler (Prague)‡‡
1605 Jan. 3....	Brighter than α Sco, much fainter than α Boo	.....	Kepler‡‡
Jan. 13....	Brighter than α Boo and Saturn	.....	Kepler‡‡
Jan. 14....	About as bright as Mars (in Oct., 1604)	.....	Fabricius¶
~Jan. 21....	About as bright as α Sco, a little brighter than Saturn	.....	Maestlin††
End of Jan....	As bright as α Vir	.....	Heydon (London)§§
March 20....	Not much brighter than ζ and η Oph	.....	Kepler‡‡
March 27....	Not much brighter than ζ and η Oph	.....	Brengger (Kaufbeuren)‖‖
~March 28....	Not much brighter than η Oph	.....	Cristini¶¶
April 12....	As bright as η Oph	.....	Fabricius¶
April 21....	As bright as η Oph	.....	Kepler‡‡
Aug. 12–14.	As bright as ξ Oph	.....	Kepler‡‡
Aug. 29....	About as bright as ξ Oph	.....	Kepler‡‡
Sept. 13....	Fainter than ξ Oph	.....	Kepler‡‡
Oct. 8....	Difficult to see; fainter or equal ξ Oph	.....	Kepler‡‡

TABLE 3

POSITIONS AND MAGNITUDES OF MARS, JUPITER, AND SATURN, 1604–5

Planet	Date	α 1604.0	δ 1604.0	log r	log Δ	m_v
Mars.....	1604 Oct. 9	$17^h13^m\ 7^s$	−24° 39′.0	0.1446	0.1870	+0.90
Jupiter.....	1604 Oct. 8	17 12 0	−22 51.6	.7180	.7475	−1.87
	Oct. 15	17 17 26	−22 58.2	.7178	.7546	−1.84
	Nov. 12	17 40 40	−23 19.2	0.7171	0.7775	−1.73
		α 1605.0	δ 1605.0			
Saturn.....	1605 Jan. 13	17 22 9	−21 57.6	1.0044	1.0387	+0.78

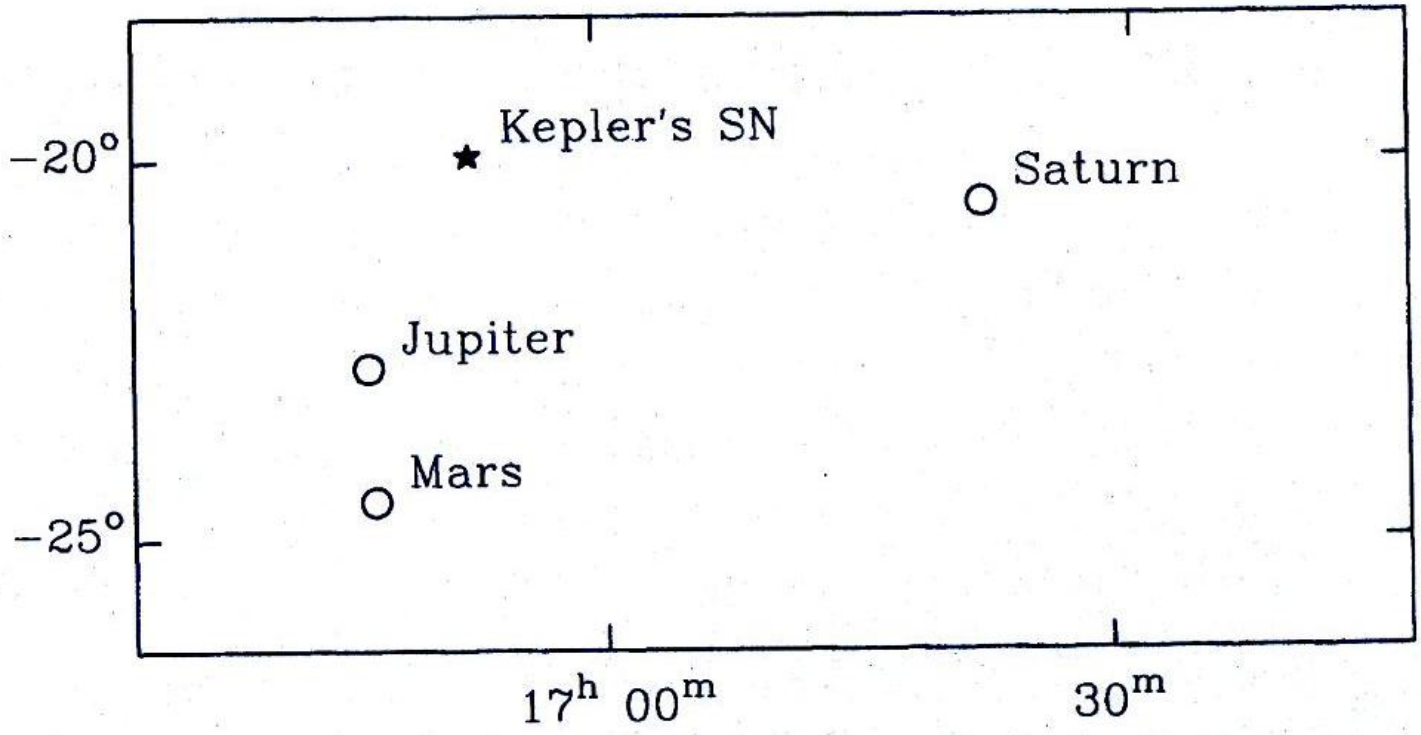


TABLE 4

MAGNITUDES OF NOVA OPHIUCHI OF 1604

Date (Gregorian)	Observed Magnitudes	Adopted Magnitude
1604 Oct. 8.....	Fainter than mag. +3	$>+3^m$
Oct. 9.....	+0.9; (−1.9)	+0.9
Oct. 10.....	+0.1; +0.9	+0.5
Oct. 11.....	−0.7; (−2.9)	−0.7
Oct. 12.....	−1.5	−1.5
Oct. 15.....	−2.1; (−3.0); −2.1; −2.3; −2.2 (brighter than −3.0)	−2.2 } −2.25
Oct. 17.....	−2.6	−2.6 }
1605 Jan. 3.....	+0.7; +1.0	+0.9
Jan. 13.....	−0.3; +0.3	0.0
Jan. 14.....		
~Jan. 21.....		
End of Jan.....		
March 20.....		
March 27.....		
~March 28.....		
April 12.....		
April 21.....		
Aug. 12–14...		
Aug. 29.....		
Sept. 13.....		
Oct. 8.....		

SN Ia or II ?

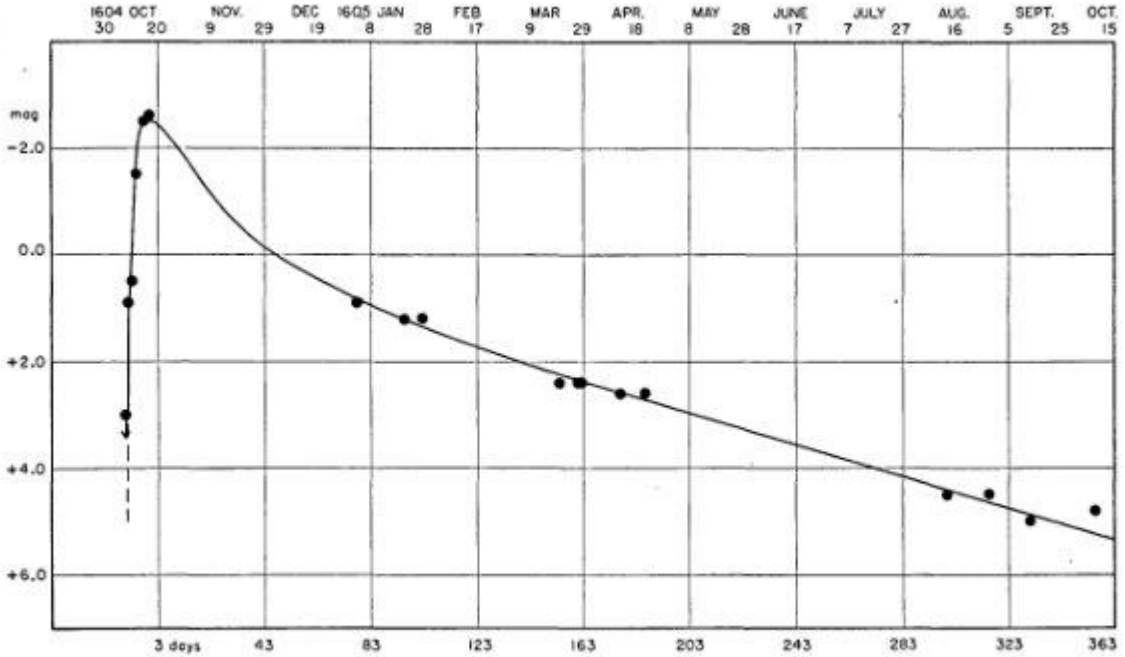
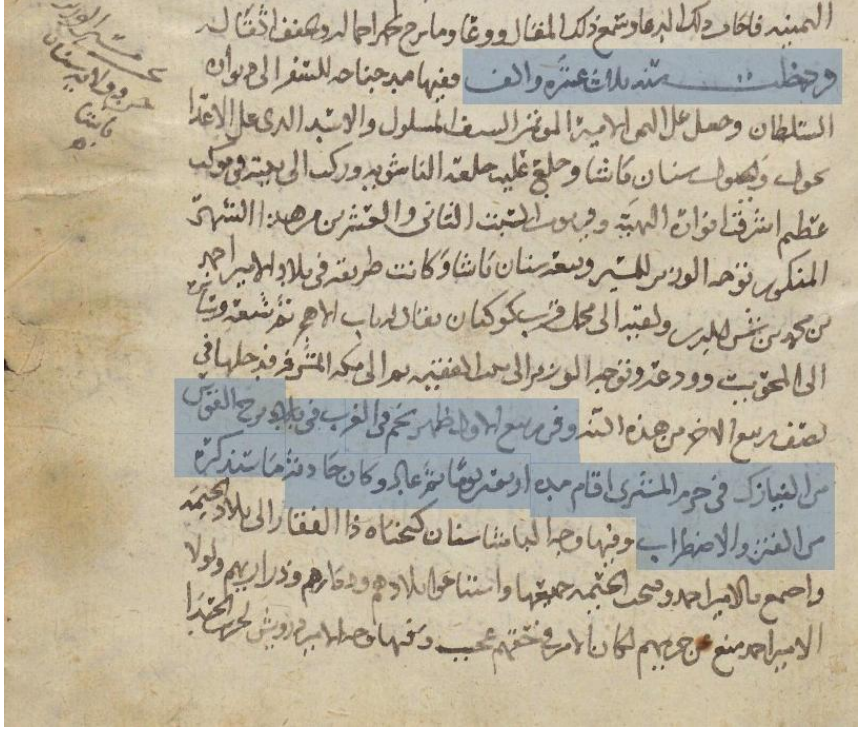


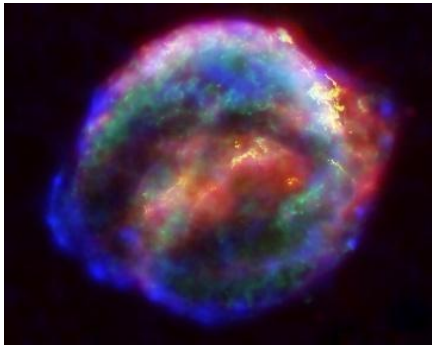
FIG. 1.—Light-curve of Supernova Ophiuchi of 1604. The smooth curve representing the descending branch is the visual light-curve of the recent supernova in IC 4182, properly adjusted.

Keplers Supernova (SN 1604):



Ibn Lutf Allah ben al-Mutahhar:
„Während des Monats Rabi`a I
im Jahr 1013 Hidschra
(d.h. Oktober 1604)
erschien ein Stern vom Westen in Sagittarius aus
in Gestalt von Jupiter **(d.h. so hell wie Jupiter).**
es war einer der Nayazik (d.h. einer das transienten)
und blieb fast 40 Tage und wurde dann schwächer.“

(Kepler ab 17.10., andere in Italien ab 9.10.)



(RN, Rada, Kunitzsch, JHA, submitted)

Exkurs:

Solar, lunar, and luni-solar calendars

Solar, lunar, and luni-solar calendars

Solar calendar:

(tropical = astronomical) year: from vernal (spring) equinox to next.

1 year = 365 days 5 h 46 min 46 sec = **365.24220 days**

(synodic) month:

(from same phase to next same phase, e.g. from new moon to new moon)

29.26 to 29.80 days (average: 29.53 days)

(orbits of Moon around Earth and of Earth around Sun

are not perfect circles, but they are eccentric)

➔ year is neither a multiple of a day nor of a month

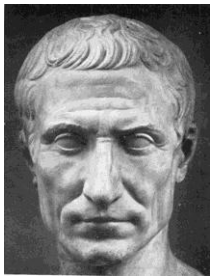
(1 tropical year = 12.36851 synodic months)

Solar, lunar, and luni-solar calendars

Solar calendar:

(astronomical) year: 365 days 5 h 46 min 46 sec = **365.24220 days**

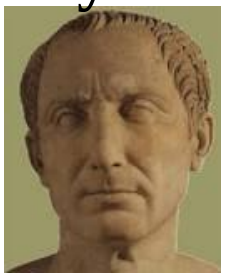
Hipparcos (190-120 BCE): 365 days 5 h 55 min 12 sec = 365.24667 days



➔ **Julian calendar (Julius Caesar, Rome, 46 BCE):**

1 year = 365 days + one leap day every 4th year

= 365.25 days (following Sosigenes)



Start of the year: January 1

Length of the months as we know today

Leap day: technically after Feb 24 (not Feb 29), but don‘t worry

(full implementation slowly …)

Difference between Julian year and (astronomical) year amounted to 10 days by the year 1582 CE !

Solar, lunar, and luni-solar calendars

Solar calendar:

(astronomical) year: 365 days 5 h 46 min 46 sec = **365.24220 days**

Difference : 10 days by the year 1582 CE !

Gregorian Calendar (Pope Gregor XIII, Rome, 1582 CE):

After 1582 Oct 4 (Thursday), next day was Oct 15 (Friday).

Same as Julian calendar, but little less leap years,
so that average length of year is 365.2425 days
(error of 1 day after more than 3000 years). Ok !

Solar, lunar, and luni-solar calendars

Gregorian solar calendar might be ok,

but ist months are not connected to lunar phase.

Luni-solar calendar: (leap month)

➔ **year is made up of 12 month + leap month some times**

e.g. pre-Islamic Arabic (Babylonian) calendar,

with different rules to decide as to when to place a leap month.

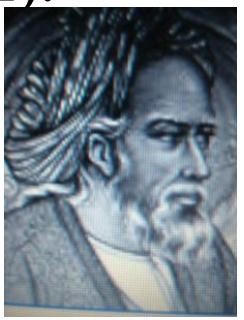
Lunar calendar:

➔ **year is made up of 12 lunar month, e.g. Islamic Calendar,**

seasons move thru the year

Calculated Islamic calendar

Start of Hijrah era (Caliph ᶜUmar, year 17 Hijrah = 638 CE):



Year 1 Hijrah (1h) at the first day of the first month (Muḥarram) of the year, in which the Hijrah took place

(i.e. the emigration of Prophet Muḥammad from Mecca to Medina)

The first day of the first month (Muḥarram) started at the evening of the first sighting of crescent new moon.

Days run from evening to evening ! (also months and years)

1 Muḥarram year 1 Hijrah

= evening of 15 July to evening of 16 July in year 622 CE

(but maybe evening of 14 July to evening of 15 July)

Calculated Islamic calendar

Calculated Islamic calendar:

Start of year 1 Hijrah on evening of 15 (or 14) July 622 CE

then months with alternating 29 or 30 days

then one leap day in 11 of 30 years (extra day in last month).

(synodic) month:
(from same phase to next same phase, e.g. from new moon to new moon)

29.26 to 29.80 days **(average: 29.53 days)**

Difference between 29.5 and 29.53 is 0.03 days per month

➔**0.03 x 12 days per year = 0.36 days per year** (about every 3rd year)

➔ **It is not known a posteriori, when the crescent was seen.**

Calculated Islamic calendar - example

Example: Death of caliph Abū Jaᶜfar al-Manṣūr according to „The History of al-Ṭabarī“: „The night when Abū Jaᶜfar al-Manṣūr died … was Saturday, 6 Dhū al-Ḥijjah, 158 Hijra …“

Conversion tables from Spuler & Mayr (1961):

„Wüstenfeld – Mahler‘sche Vergleichstabellen“

— 5 —

151—200 H.
768—816 n. Chr.

Hiğra-Jahr	Muḥarram 30 Tage	Ṣafar 29 Tage	Rabi'I. 30 Tage	Rabi'II. 29 Tage	Ğumādā I. 30 Tage	Ğumādā II. 29 Tage	Raǧab 30 Tage	Ša'bān 29 Tage	Ramaḍān 30 Tage	Šawwāl 29 Tage	Dū'l-qa'da 30 Tage	Dū'l-ḥiǧǧa 29—30 Tage
	n. Chr.											
151	768 I26 C	II25 E	III25 F	IV24 A	V23 B	VI22 D	VII21 E	VIII20 G	IX18 A	X18 C	XI16 D	XII16 F
152	769 I14 G	II13 B	III14 C	IV13 E	V12 F	VI11 A	VII10 B	VIII 9 D	IX 7 E	X 7 G	XI 5 A	XII 5 C
153	770 I 4 E	II 3 G	III 4 A	IV 3 C	V 2 D	VI 1 F	VI30 G	VII30 B	VIII28 C	IX27 E	X26 F	XI25 A
154	770 XII24 B	771 I23 D	II21 E	III23 G	IV21 A	V21 C	VI19 D	VII19 F	VIII17 G	IX16 B	X15 C	XI14 E
155	771 XII13 F	772 I12 A	II10 B	III11 D	IV 9 E	V 9 G	VI 7 A	VII 7 C	VIII 5 D	IX 4 F	X 3 G	XI 2 B
156	772 XII 2 D	773 I 1 F	I30 G	III 1 B	III30 C	IV29 E	V28 F	VI27 A	VII26 B	VIII25 D	IX23 E	X23 G
157	773 XI21 A	XII21 C	774 I19 D	II18 F	III19 G	IV18 B	V17 C	VI16 E	VII15 F	VIII14 A	IX12 B	X12 D
158	774 XI11 F	XII11 A	775 I 9 B	II 8 D	III 9 E	IV 8 G	V 7 A	VI 6 C	VII 5 D	VIII 4 F	IX 2 G	X 2 B
159	775 X31 C	XI30 E	XII29 F	776 I28 A	II26 B	III27 D	IV25 E	V25 G	VI23 A	VII23 C	VIII21 D	IX20 F
160	776 X19 G	XI18 B	XII17 C	777 I16 E	II14 F	III16 A	IV14 B	V14 D	VI12 E	VII12 G	VIII10 A	IX 9 C

On Calculated Islamic Calendar:

1 Dhū al-Ḥijjah 158 Hijrah = evening 1 to evening 2 Oct 775 CE (B=Monday)

➔ 6 Dhū al-Ḥijjah 158 Hijrah = evening 6 to evening 7 Oct 775 CE (Saturday)

Calculated Islamic calendar

Comparison Calculated Calendar to history:

+/- 1 day due to uncertain era start: eve of 14 or 15 July 622 CE

+/- 1 day because it is not known a posteriori, when in history a month had an extra day (not known for most months)

➔Total uncertainty +/- 2 days !!!

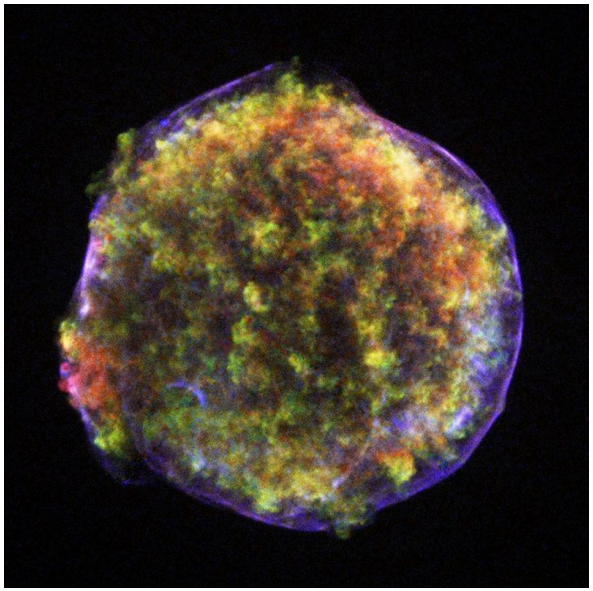
On Calculated Islamic Calendar:

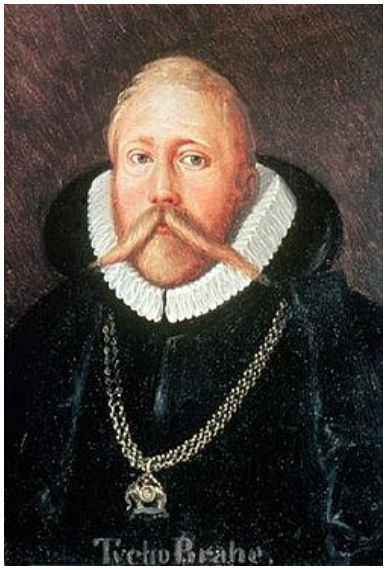
6 Dhū al-Ḥijjah 158 Hijrah = 775 eve Oct 6 (+/- 2) to eve Oct 7 (+/- 2)

(evening of 5 to evening of 6 Oct if era started on evening of 14 July)

Historische Supernovae

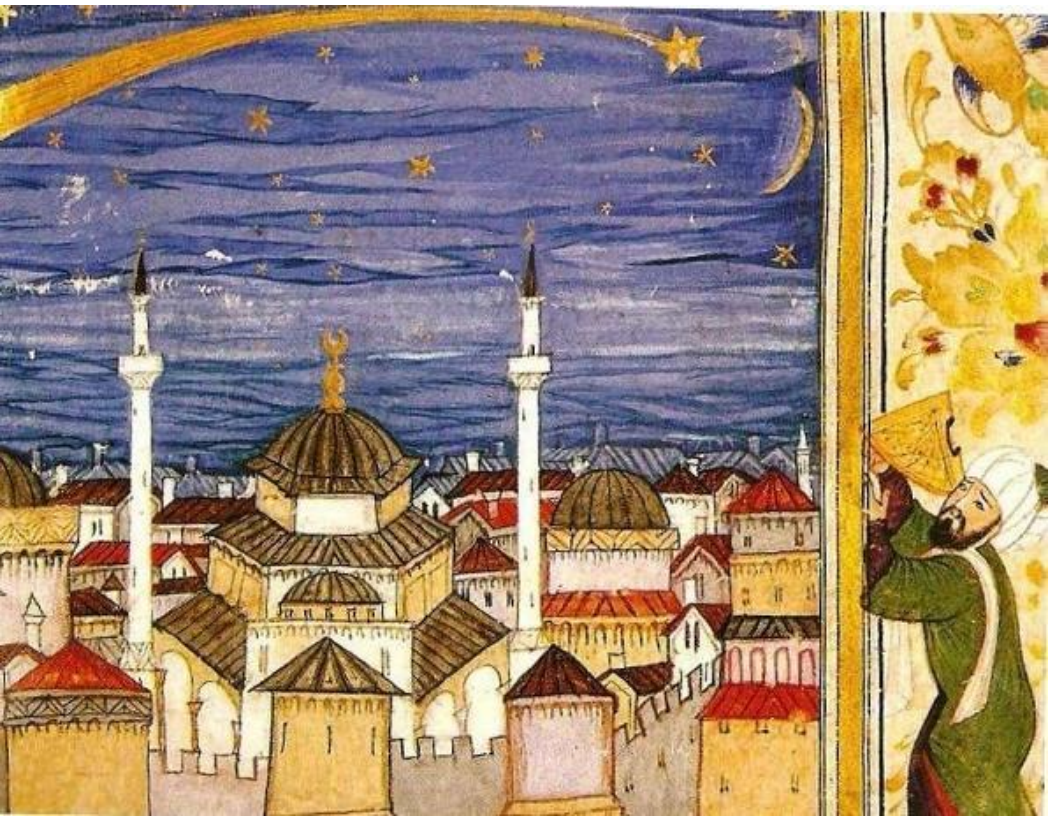
1. Einführung
2. Kepler (SN 1604)
3. Tycho (SN 1572)
4. Cas A (~ 1680)
5. Crab (SN 1054)
6. SN 1006





Tycho Brahe (1546-1601):
transiente Phänomene nicht sub-lunar
(entgegen Aristoteles).

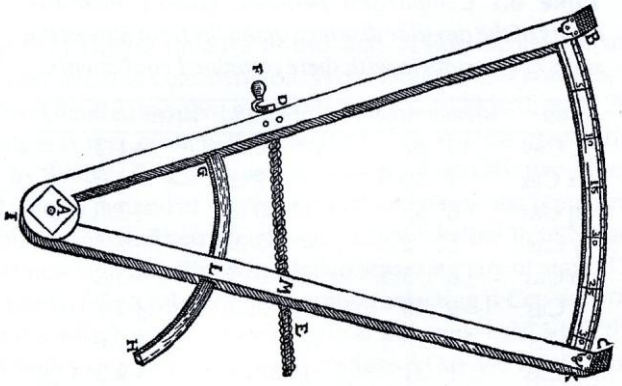
Komet 1577

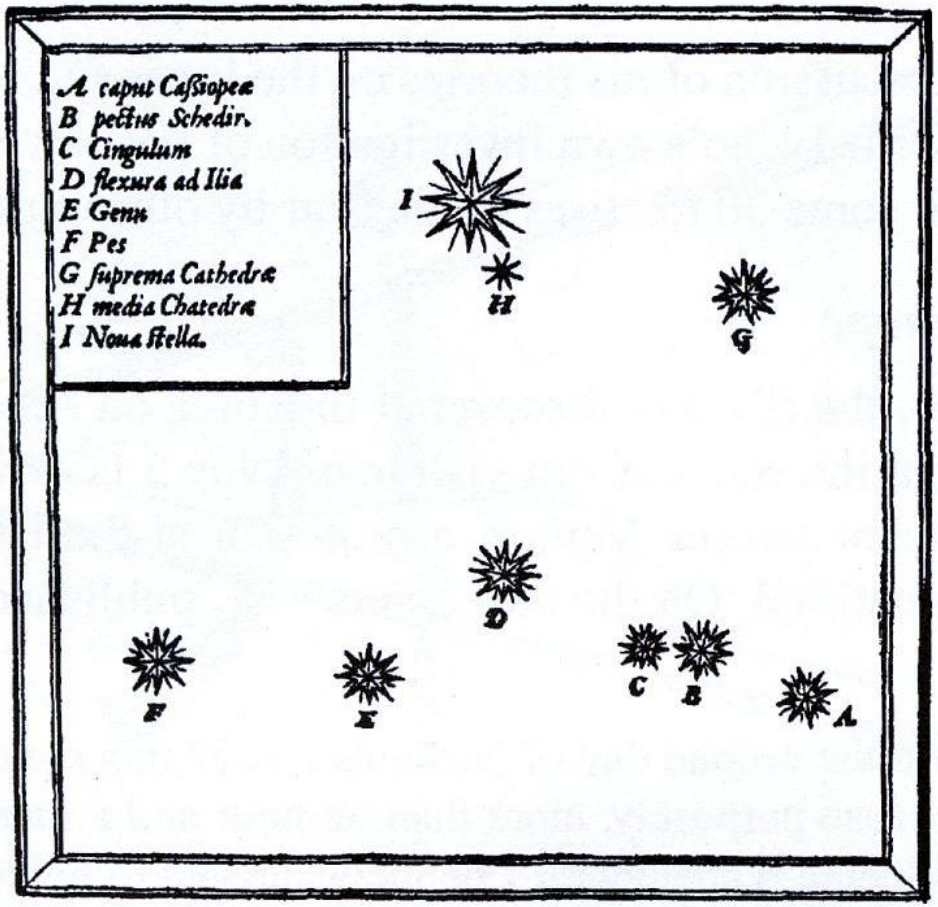


Supernova 1572

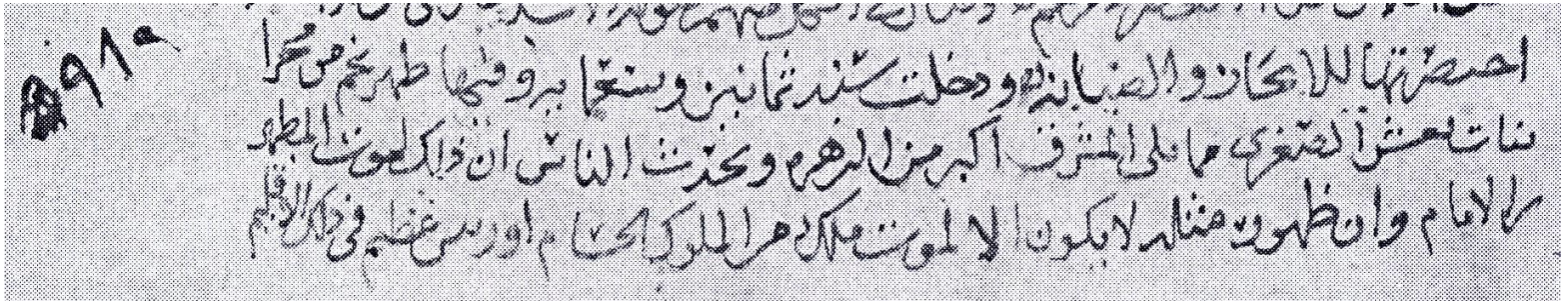
Tycho Brahe 1572:
„nova stella“ = neuer Stern

(später: Nova bzw. Super-nova)





Tychos Supernova (SN 1572):



Ibn Lutf Allah ben al-Mutahhar:

„Then began the year 980h
[14 May 1572 to 2 May 1573 A.D. ± 2 days].

> In it there appeared a star [*najm*] in the path [*majrā*] of Ursa Minor [*Banāt Naᶜsh al-Ṣughrā*] towards the East. It was larger than Venus. People said that this would indicate the death of al-Muṭahhar, the son of the Imam, and that the appearance of such [objects] only happens in order to indicate the death of some mighty king or a great leader in that region.“

(RN, Rada, Kunitzsch, JHA, submitted)

Tychos Supernova (SN 1572 Nov 6):

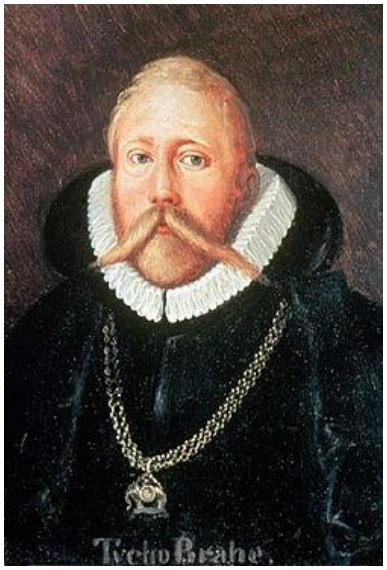
Ibn Lutf Allah ben al-Mutahhar:

"… indicate the death of al-Muṭahhar, the son of the Imam …"

The mentioned *Imam* is the Shi'ite Zaydite Imam and leader al-Mutawakkil, who died in March 1555 A.D.

His eldest son took up the leadership, called *al-Muṭahhar, the son of the Imam.*

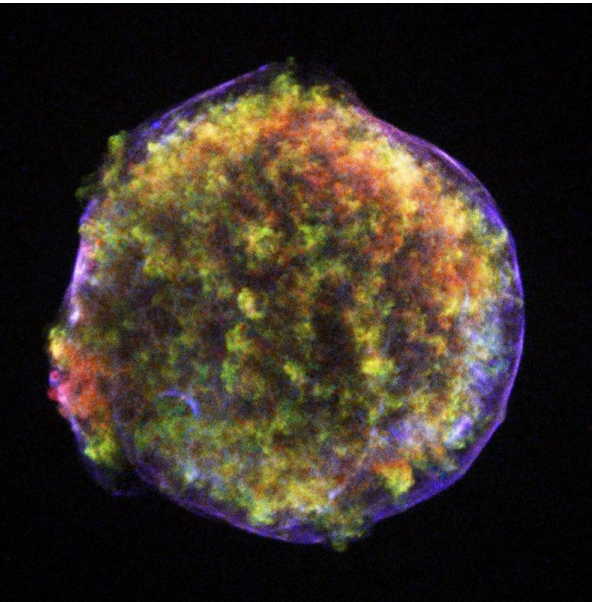
This person is the grandfather of the author of our MS: ᶜĪsā b. Luṭf Allāh b. al-Muṭahhar, meaning *ᶜĪsā son* (or: *descendant*) *of Luṭf Allāh son* (or: *descendant*) *of al-Muṭahhar*, a rare name. It is also known that the mentioned grandfather of our author died of a sudden and unexplainable death on A.H. 980 Rajab 3 (A.D. 1572 Nov 9).

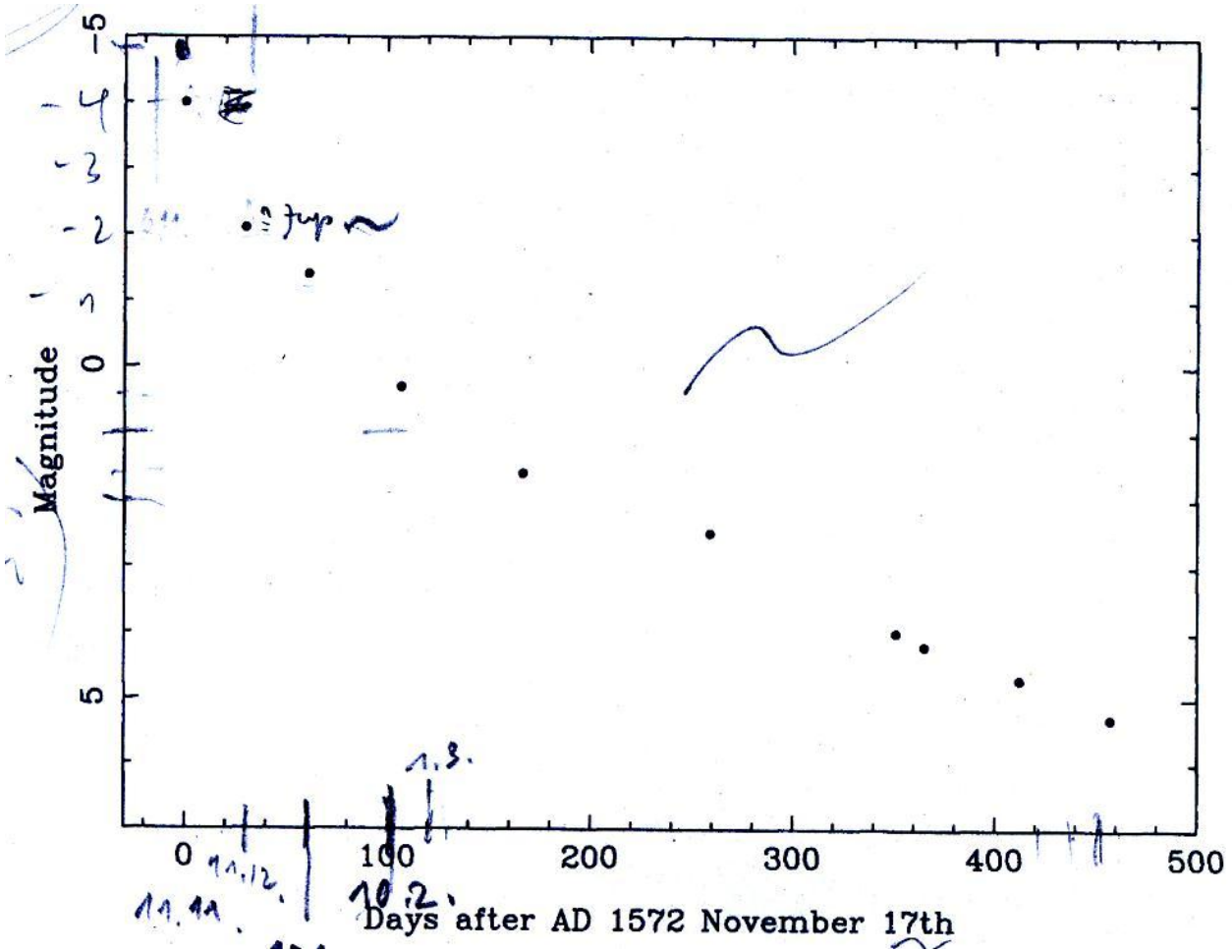


Tycho Brahe (1546-1601)

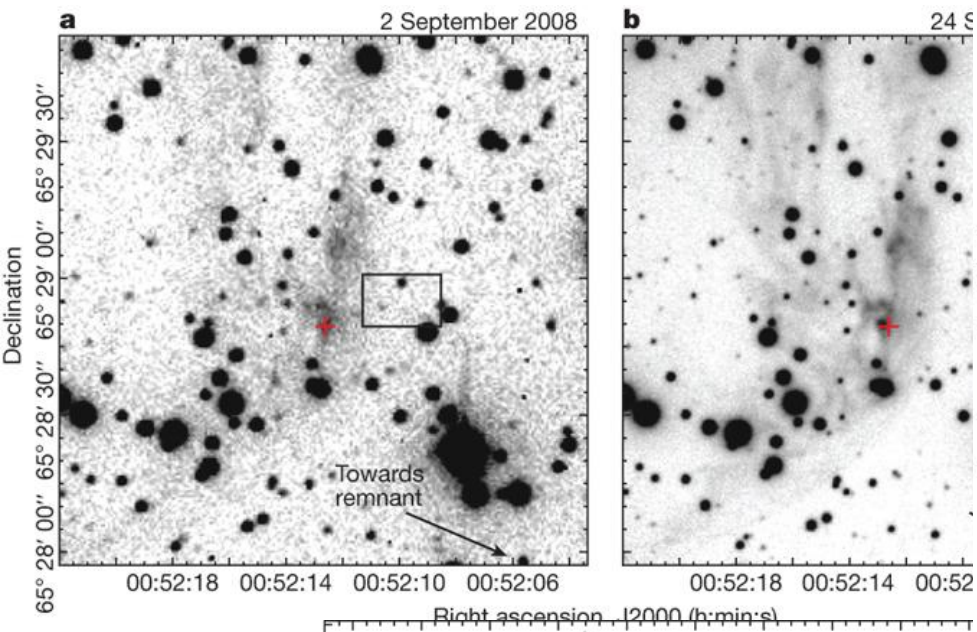
SN Ia or II ?

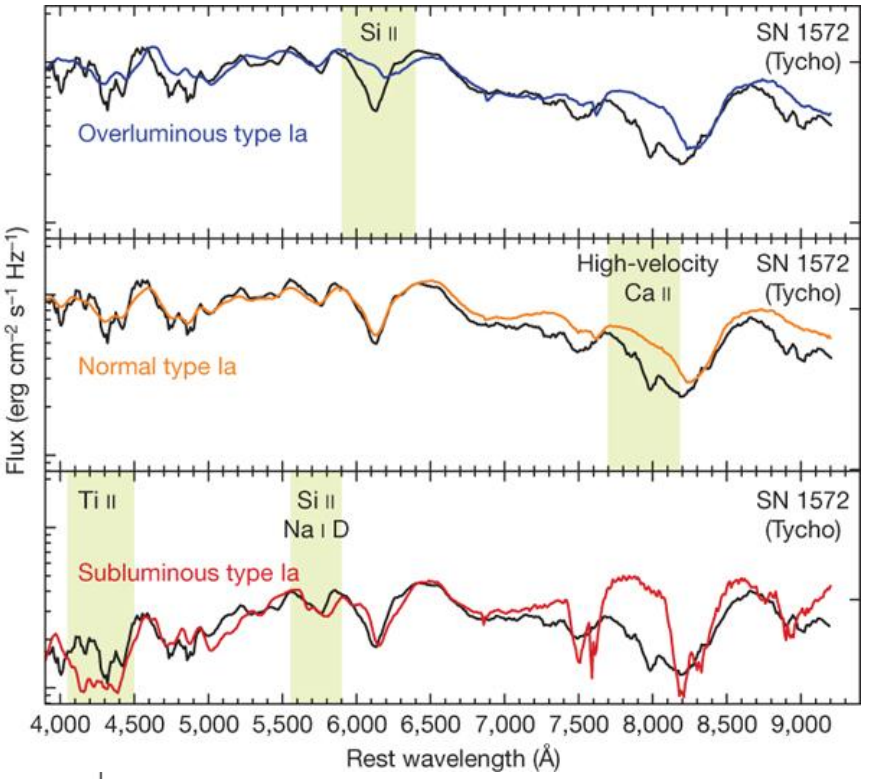
Supernova 1572

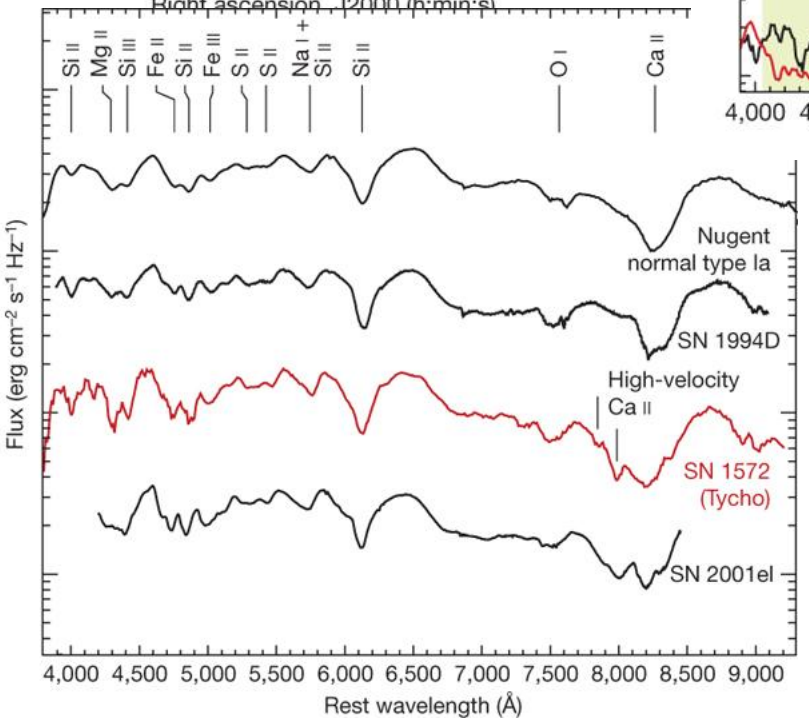




Lichtecho von Tychos SN (1572) ➔ Typ Ia SN







Krause et al. 2008 Nature

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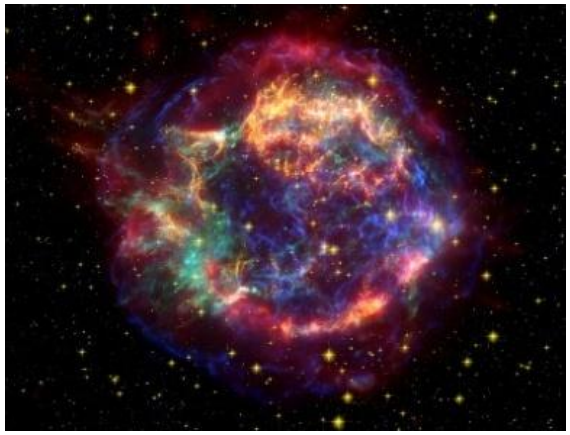
6. **SN 1006**



In Conſtellatione CASSIOPEÆ.

ORDO Pol.	ORDO Trib.	STELLARUM Denominatio.	Bayer. Char.	Aſcenſio Recta.	Diſtantia à Polo B.	Longitudo.	Latitudo.	Varia. Aſc. R.	Varia. D. à P.	Magnitud.
				o ′ ″	o ′ ″	♋ o ′ ″	o ′ ″	′ ″	′ ″	
		Quæ eſt	ε	343 25 0	32 14 20	♈ 21 6 45	56 46 0 B	44 4	22 48	6
				344 7 30	32 20 0	21 29 16	56 26 10	44 34	22 55	7
				347 37 0	33 1 30	23 5 5	54 38 32	46 57	22 20	6
			δ	347 49 30	29 24 30	27 42 49	57 10 12	45 53	23 17	5
	14		τ	353 1 30	33 3 32	26 46 31	52 39 50	50 21	23 40	5

FIG. 1. The positions of the first five Cassiopeia stars, as given in Flamsteed's 1725 catalogue and as depicted in his atlas of 1729.[5] The Flamsteed numbers on the star map have been added.

Possibly observed by Flamsteed
on 1680 Aug 16 at 5th to 6th mag
(Ashworth 1980 JHA)

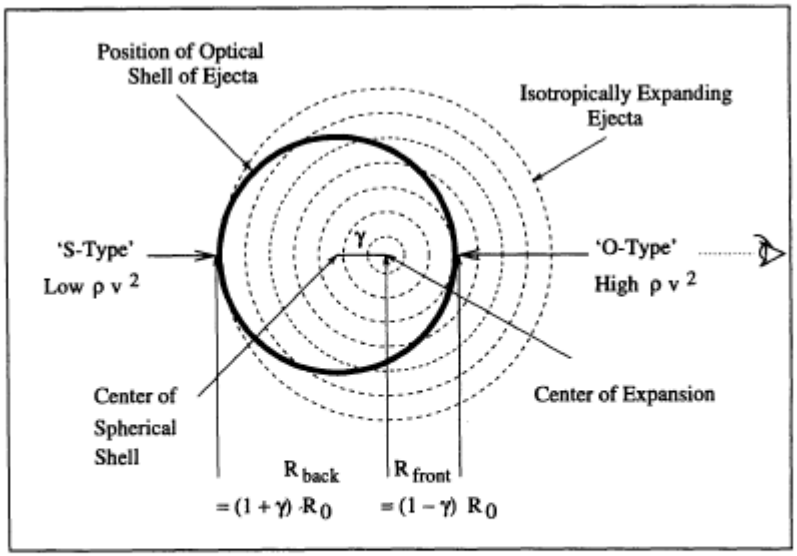


FIG. 6.—A schematic diagram of our model of Cas A, in which the final shell is off center with respect to the expansion center of the SN ejecta. In this diagram, γ represents the fractional displacement of the site of the explosion from the current center of the shell. Knots strong in [O II] predominate on the near side, and those strong in [S II] are seen on the far side of the remnant.

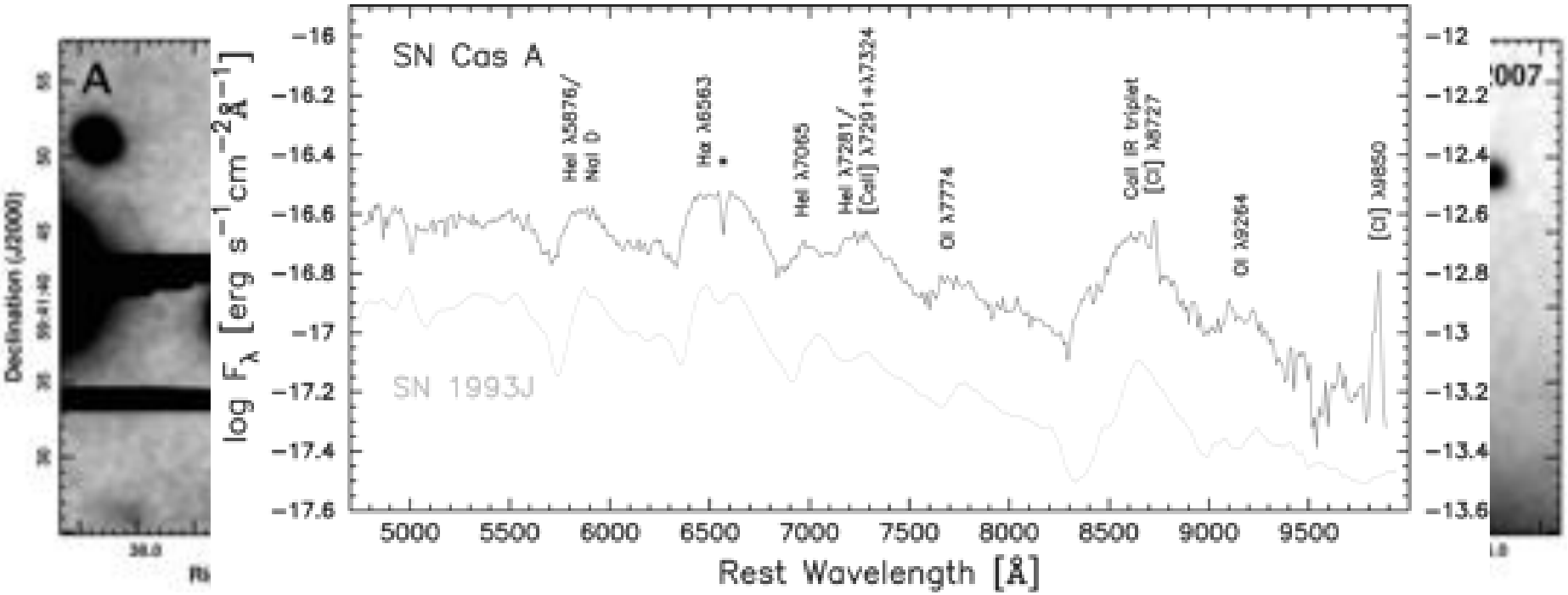
THREE-DIMENSIONAL STRUCTURE OF CAS A SNR. I.

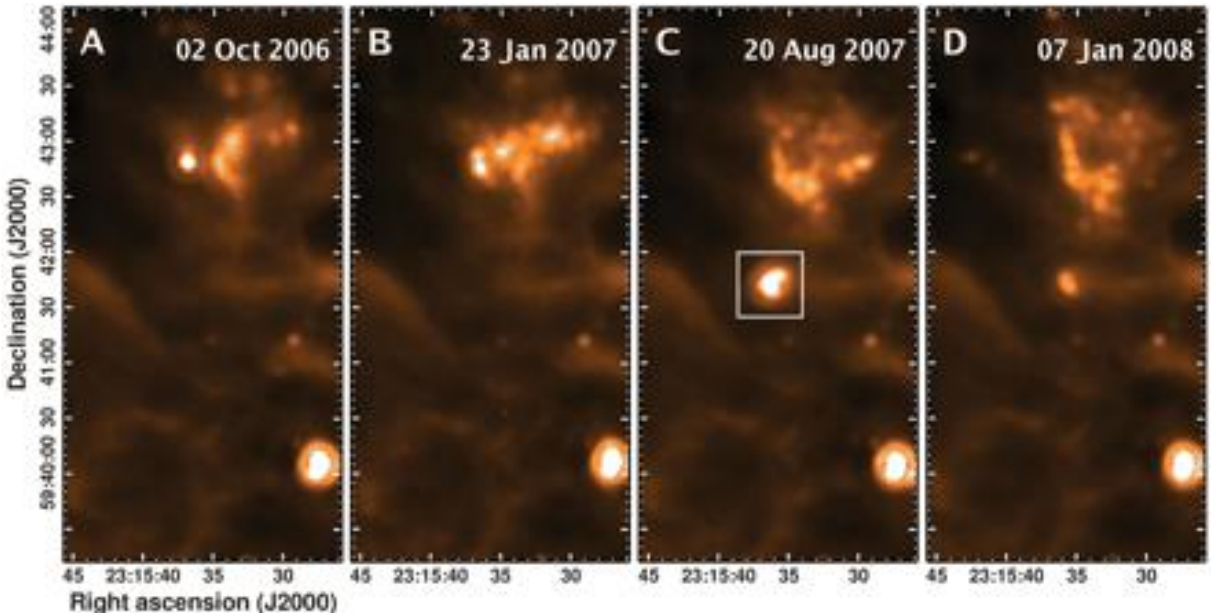
TABLE 3

COMPARISON OF THE V_{exp} AND DISTANCE ESTIMATES OF THREE METHODS

Method	$(\alpha, \delta)_{center}$	v_c(km s^{-1})	v_{exp}(km s^{-1})	D(kpc)
v_r^2 vs. θ^2	Braun[a]	0	5280	2.9 ± 0.1[b]
v_r^2 vs. θ^2	VDBK	0	5600 ± 1000[c]	3.7 ± 0.8[c]
v_r^2 vs. θ^2	Reed et al.	0	5500 ± 850[c]	3.9 ± 0.6[c]
v_r^2 vs. θ^2	Reed et al.	770	5100 ± 550[c]	3.4 ± 0.4[c]
v_{exp} vs. v_θ	Reed et al.	770	5290 ± 90[d]	3.57 ± 0.06[e] ± 0.3[e]
$R = v_{exp}\, t_{1680}$	Reed et al.	770	5390[f] ± 90[d]	3.33 ± 0.06[e]
$R = v_{exp}\, t_{1680}$	Reed et al.	770	5490[g] ± 90[d]	3.39 ± 0.06[e]

Light echo of historic SNe: Cas A (~1680) ➔ SN II





Krause et al. 2008 Science

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6. **SN 1006**

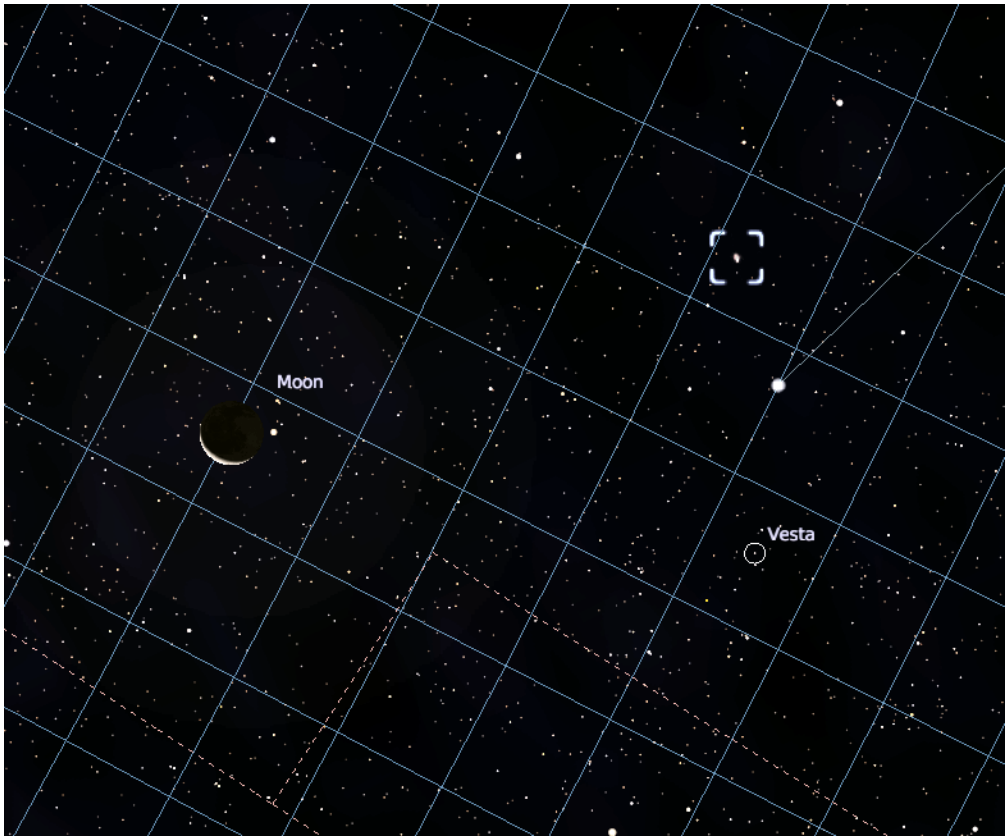
SN 1054 in China

乙酉詔自今三班使臣合入遠地而
文臣例召保官與近地
丙戌廣南西路經略司言融州大丘峒首領楊光朝內
附
乙丑客星出天關之東南可數寸 嘉祐元年三月乃沒
續資治通鑑長編 卷一百七十六 十二
六月乙未詔益州路鈐轄司應蠻人出入處皆預擇人
為備禦時黎州言儂智高自廣源州遁入雲南故也
丙申置廣州管勾城池甲仗庫戰船場使臣一員

歷代名臣奏議卷之三百一
災祥
宋仁宗至和二年侍御史趙抃上言曰臣伏見自去年五月已來妖
星遂見儷及周稔至今光耀未退此谷永所謂馳騁驟步芒炎長短
所歷奸犯其為譴變甚可畏也又去冬連今春京東西路及陝右川
蜀諸郡旱暵不雨麥苗焦死民既艱食寇攘必興此京房所謂欲德
不用茲謂張厥災荒其為災沴復可懼也通來岷嶓山谷驚裂有聲
他郡數處地亦震動此伯陽所謂陽伏而不能出陰迫而不能升蓋
土失其性其為災異益可駭也夫變調陰陽者三公之職天戒若曰
陛下左右輔弼當得忠賢剛正之人為之乃可以召至和之氣消去
萌之戾不然何以妖星譴變也旱暵災沴也地震祥異也三者咎應
粲明如是之著耶臣愚伏望陛下謹天之戒應天以實取天下公議
奏議卷三百一 十
與天下瞻望之所謂賢人君子者陟之使居廟堂之上貢以三公四
輔之事業委注而仰成之若然則陰陽以和災異以消朝廷清明矣
狀畏服太平之風可翹足引領而待之也臣朝夕思慮載惟擇賢命
相繫國家休戚治亂之本伏願陛下慎重之然後發聖斷力行而不
疑則宗廟社稷之福天下生靈之幸
起居舍人知諫院范鎮上奏曰臣伏見去冬多南風今春多西北風
乍寒乍暑欲雨不雨又有黑氣蔽日此皆人事之所感動也黑氣陰
也小人也日陽也君象也黑氣蔽日者陰侵陽小人惑君也欲雨不
雨者政事不決也陳執中為相不病而家居者百日矣陛下以御史
之言決一婢死而欲退宰相為是即乞速退執中以解天意以御史
之言為非亦乞勅執中起視事無使天意久不決也寒暑者賞罰也
乍寒乍暑者不當賞而賞當罰而不罰也鄧保吉有過於法不當為

災田租及倚閣稅戊辰罷上元張燈辛未命輔臣
禱天地宗廟社稷是月大雨雪木冰二月甲辰帝
疾愈御延和殿三月丁巳詔禮部貢舉辛未司天
監言自至和元年五月客星晨出東方守天關至是
沒壬申遣官謝天地宗廟社稷寺觀諸祠癸酉契
丹遣使來謝閏月癸未朔以王堯臣參知政事程戡
為樞密副使詔前後殿間日視事夏四月壬子朔六

SN 1054 in Northern America (?)



SN 1054 (Crab): Beobachtung in China & Arabien

Ibn Abi Usaybi´a, AD 1194-1270 (im Buch Uyun al-Anba):

„Ich [Ibn Abi Usaybi´a] zitiere seinen [Ibn Butlans] folgenden handschriftlichen Bericht. Er [Ibn Butlan] sagte:
Eine der berühmten Epidemien unserer Zeit ist die, die auftrat, als ein spektakulärer (athari) Stern (kawkab) in Gemini erschien, im Jahre 446 H.
Im Herbst diesen Jahres wurden 14000 Menschen in Konstantinopel beerdigt.
Danach starben die meisten Bewohner von Fustat (Kairo) und alle Ausländer in der Mitte des Sommers des Jahres 447 H. …
Während dieser spektakuläre Stern in Gemini erschien, verursachte er den Beginn der Epidemie in Fustat, als der Nil niedrig war, im Jahre 445 H.“

(Brecher, Lieber & Lieber 1978, Nature 273, 728)

Islamisches Jahr 446 Hijjra = 12 April 1054 bis 1 Apr 1055 AD

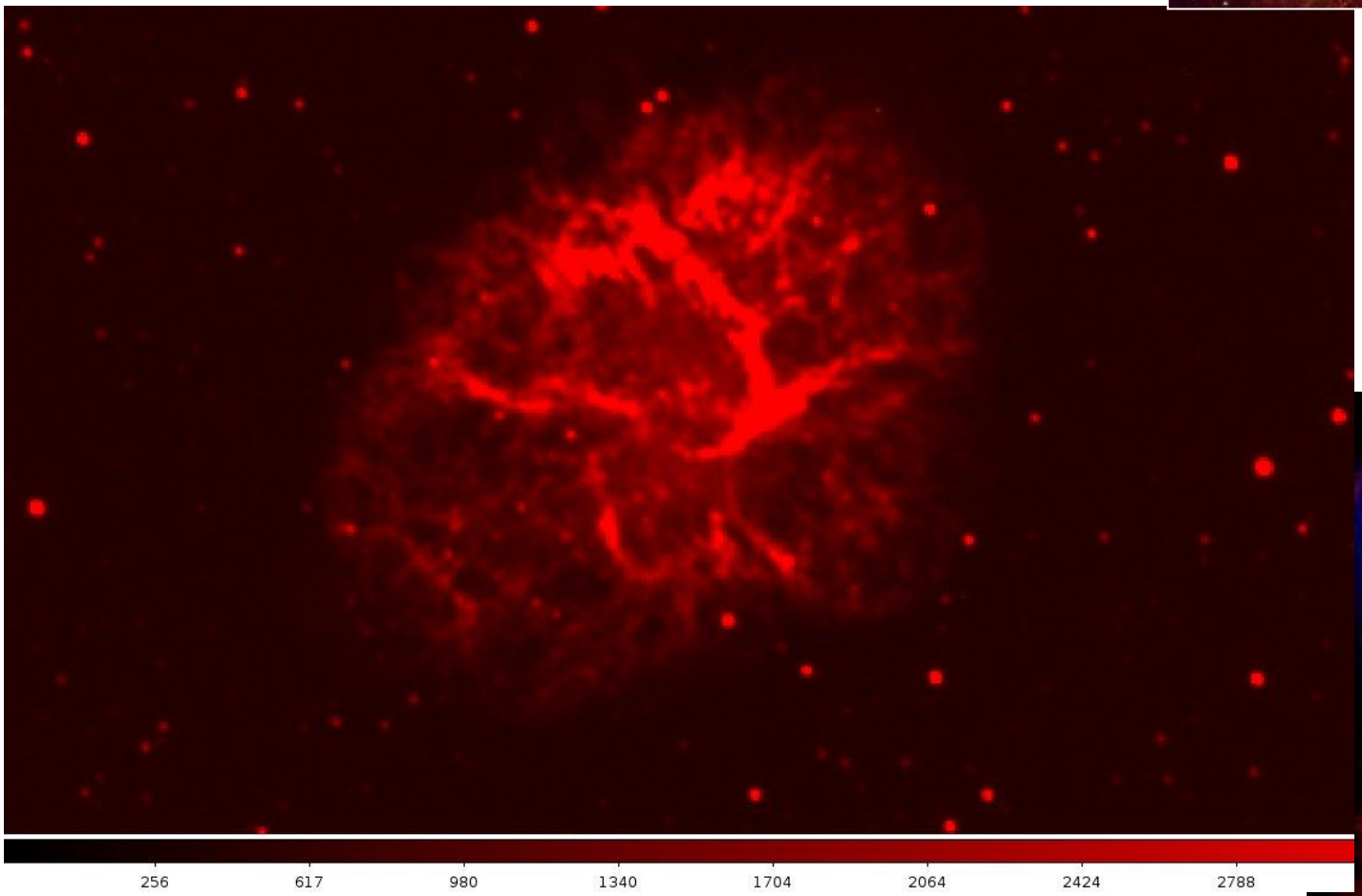
Nil war im Jahre 446 H. niedrig.

SN 1054 beobachtet seit 4. Juli 1054
(chinesische Quellen)

Max am 16. Juli 1054 (tagsüber -6 mag),
= Tag der (ungültigen) Exkommunikation des Michael Cerularius, Patriarch von Konstantinopel

supernova remnants: Crab (1054)

(GSH Dathe et al.)



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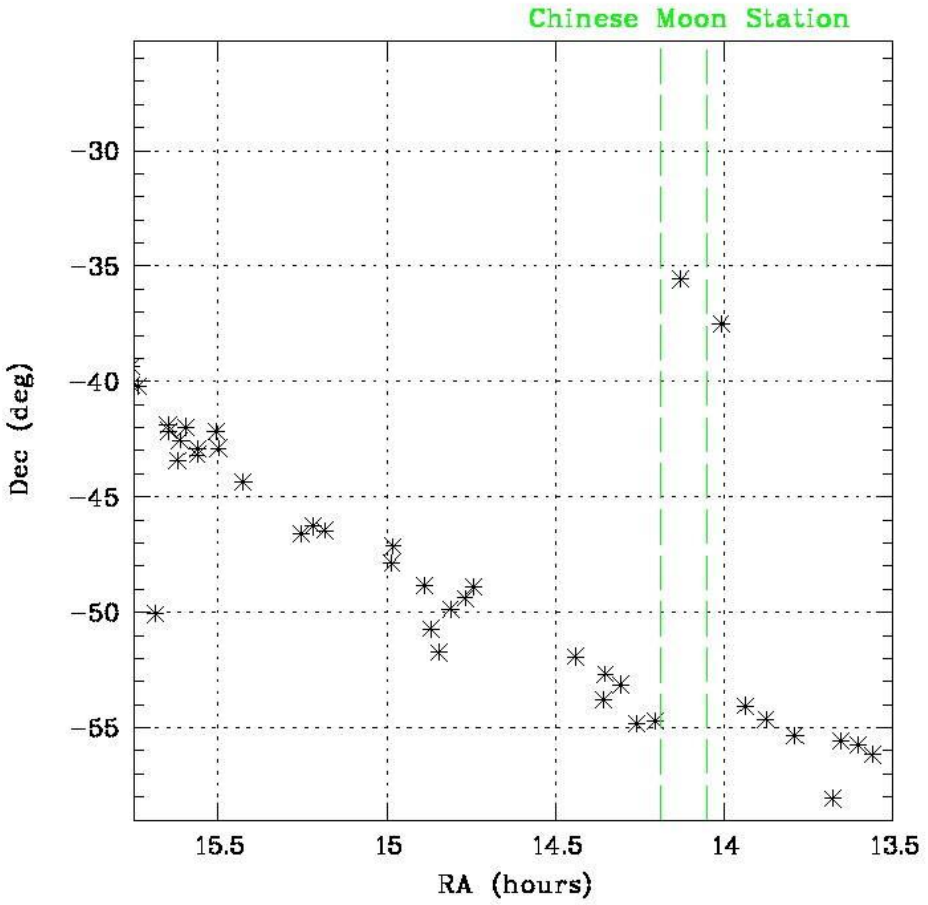
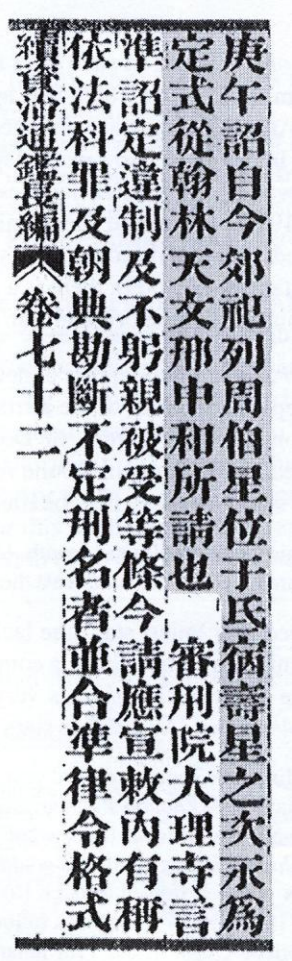
6. **SN 1006**

SN 1006:

China: Am zweiten Tag des vierten Mondmonats (**1.5.**) wurde in der ersten Nachtwache ein großer Stern gesehen. Seine Farbe war gelb … seine Helligkeit war langsam angestiegen. Seine Position war 3 Grad in der Mondstation Di …,

Mondstation., d.h. Rektaszension



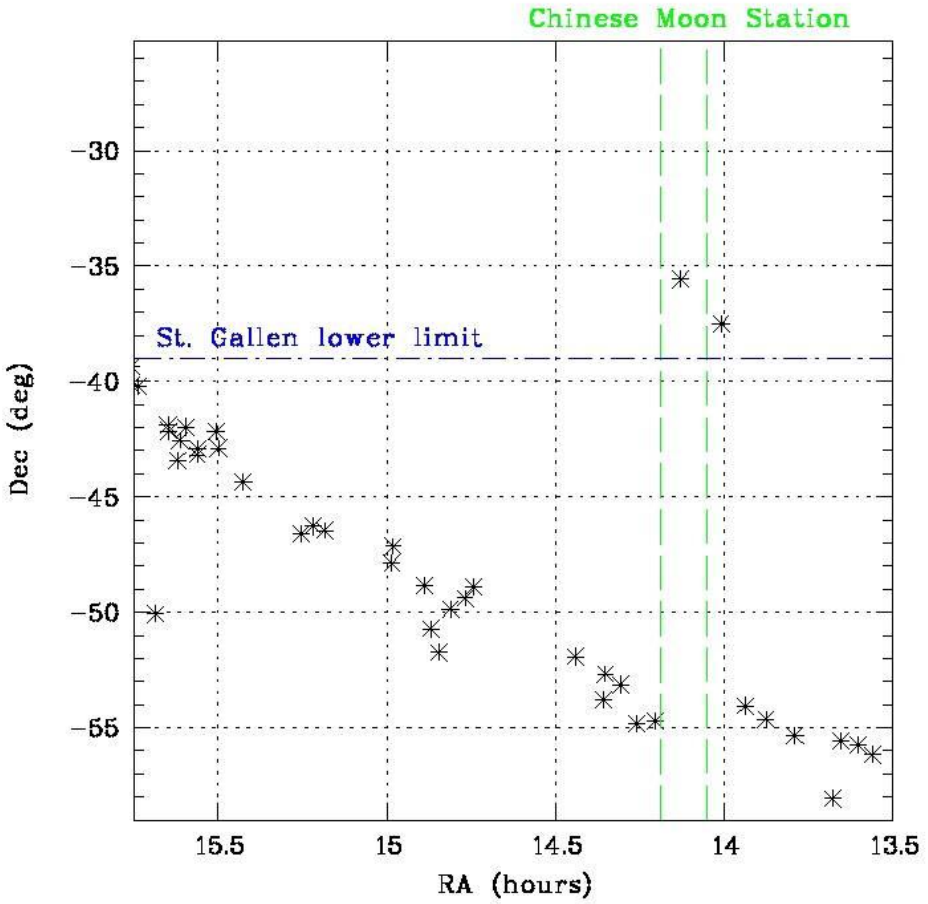

庚午詔自今郊祀列周伯星位于氏宿壽星之次永爲定式從翰林天文那中和所請也　審刑院大理寺言準詔定違制及不躬親被受等條今請應宣敕內有稱依法科罪及朝典勘斷不定刑名者並合準律令格式

續資治通鑑長編卷七十二

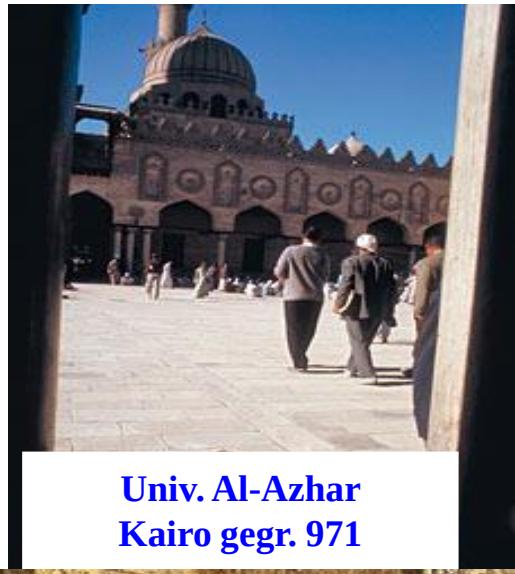
SN 1006:

St. Gallen: Ein neuer Stern ungewöhnlicher Größe funkelte stark … und war manchmal wie ausgelöscht. Er wurde aber drei Monate lang gesehen im äußersten Süden unterhalb aller Sternbilder des Himmels.

Sichtung in St. Gallen, d.h. südliches Deklinationslimit um -39 Grad



SN 1006: ᶜAlī b. Riḍwān (geb. AD 989 oder 998), Kairo:

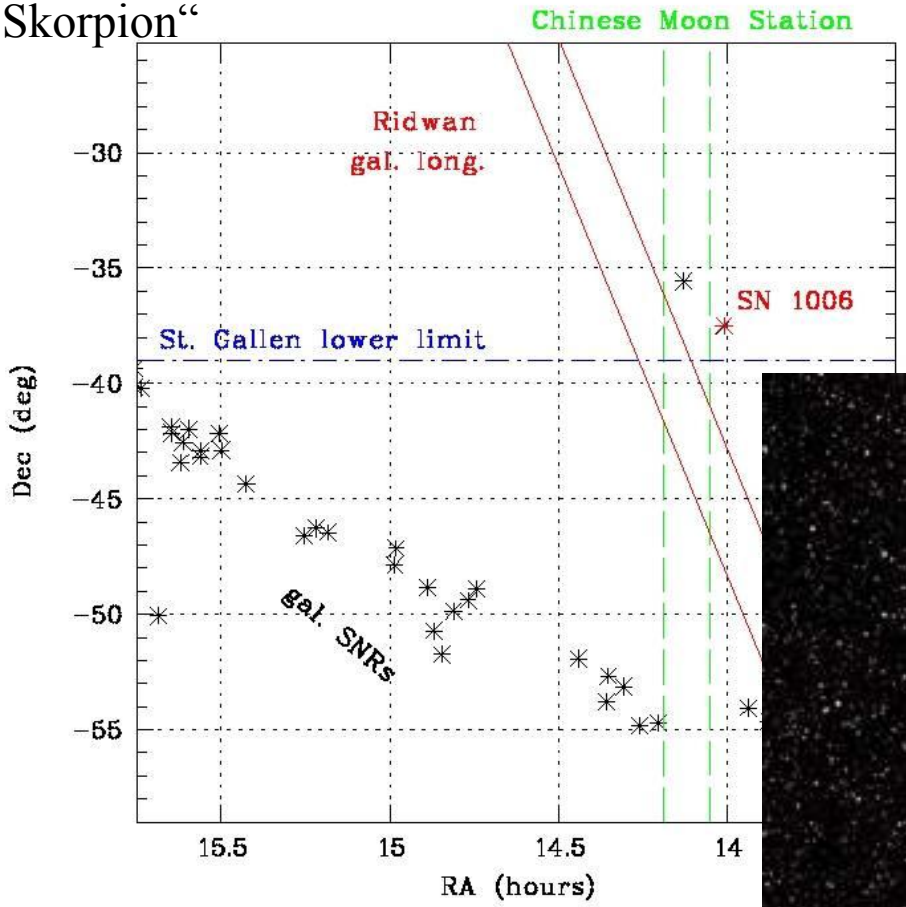


Univ. Al-Azhar
Kairo gegr. 971

SN 1006:

ᶜAlī b. Riḍwān, Kairo: Ich beschreibe nun einen Stern, den ich am Anfang meiner Ausbildung selbst gesehen habe … im 15. Grad von Skorpion … 2.5 bis 3 mal so hell wie Venus … wie ein Viertelmond … er bewegte sich mit den Sternen … er verschwand nach drei Monaten … Die Position der Planeten war wie folgt: (Sonne, Mond, Saturn, Jupiter, Mars, Venus, Merkur Positionen ➔ Zeitpunkt **30.4.**1006)

„15. Grad Skorpion“ d.h. ekliptikale Länge



SN 1006, weitere arabische Berichte:

Yaḥyā b. Sa`īd:

396 H. Ein großer Stern erschien am Himmel am Samstag, den 2. Tag des 2. Monats (2./3. Mai 1006) … große Helligkeit wie der Mond … für vier Monate …

Ibn al-Jawzī:

Links der Gebetsrichtung erschien ein großer Stern – wie Venus in Größe und Helligkeit … in der Nacht auf Freitag, den 1. Tag des Monats Sha`bān (1./2.5.) … Er blieb bis zur Mitte des Monats Dhu al-Qaᶜdah (13. Aug. 1006)

Ibn al-Athīr:

zitiert i.w. Ibn al-Jawzī

Bar Hebraeus:

396 H. Es erschien ein Stern wie Aphrodite in Größe und Schönheit im Sternzeichen Skorpion … er blieb vier Monate und verschwand dann.

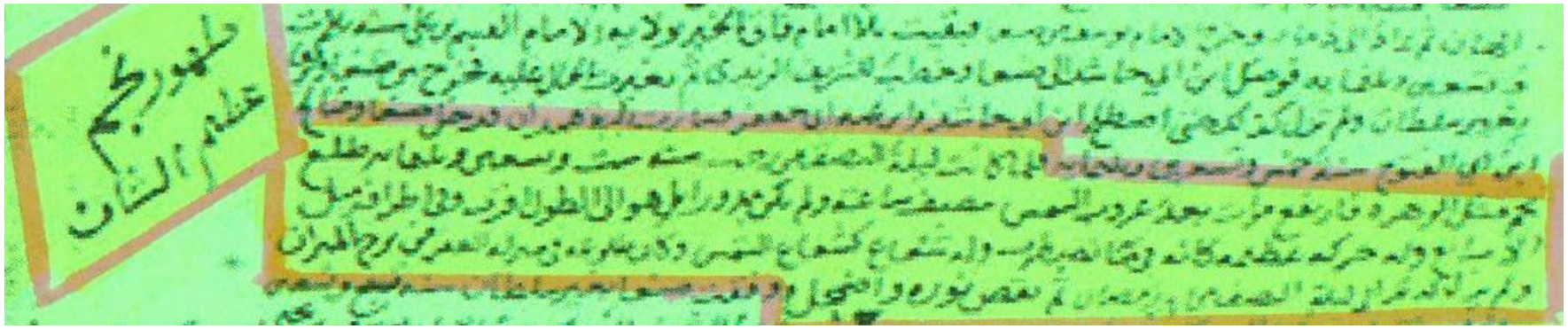
Annales Regnum Mauretaniae:

Im Jahre 396 H. erschien ein großer heller (Schweif-)Stern. Es war einer der 12 Nayazik. Er erschien am 1. Tag des Monats Sha`bān (1./2.5.), zuerst vor Sonnen-untergang … Der Stern blieb für sechs Monate (bis 2.11.)

… sowei bekannt (Stephenson & Green)

Neue alte Berichte: Supernova 1006

Ibn al-Daybaᶜ (AD 1461 - 1537), Yemen:



Al-Yamānī (died AD 1342),Yemen:

" فلما كان نصف رجب (سنة 396 هجريه) ليلة النصف طلع نجم من المشرق مثل الزهرة أربع (1) مرات بعد غروب الشمس بنصف ساعة ولم يكن مدوراً بل هو إلى الطول أقرب ، وفي أطرافه شعب مثل الأصابع وله حركه عظيمه كأنه في ماء يضطرب ، وله شعاع كشعاع الشمس وكان طلوعه في برج الميزان من العقرب ودام كذلك فلما كان ليلة النصف من رمضان نقص نوره ثم اضمحل " .

(1) إرتفع

Newly found old reports from Yemen: Supernova 1006

Al-Yamānī (died AD 1342), Yemen:

" فلما كان نصف رجب (سنة 396 هجريه) ليلة النصف طلع نجم من المشرق
مثل الزهرة أربع (1) مرات بعد غروب الشمس بنصف ساعة ولم يكن مدوراً بل هو
إلى الطول أقرب ، وفي أطرافه شعب مثل الأصابع وله حركه عظيمه كأنه في ماء
يضطرب ، وله شعاع كشعاع الشمس وكان طلوعه في برج الميزان من العقرب
ودام كذلك فلما كان ليلة النصف من رمضان نقص نوره ثم اضمحل " .

(1) إرتفع

(additional text from Ibn al-Dayba^{c} (AD 1461 - 1537), Yemen, depends on al-Yamānī)

Al-Yamānī:

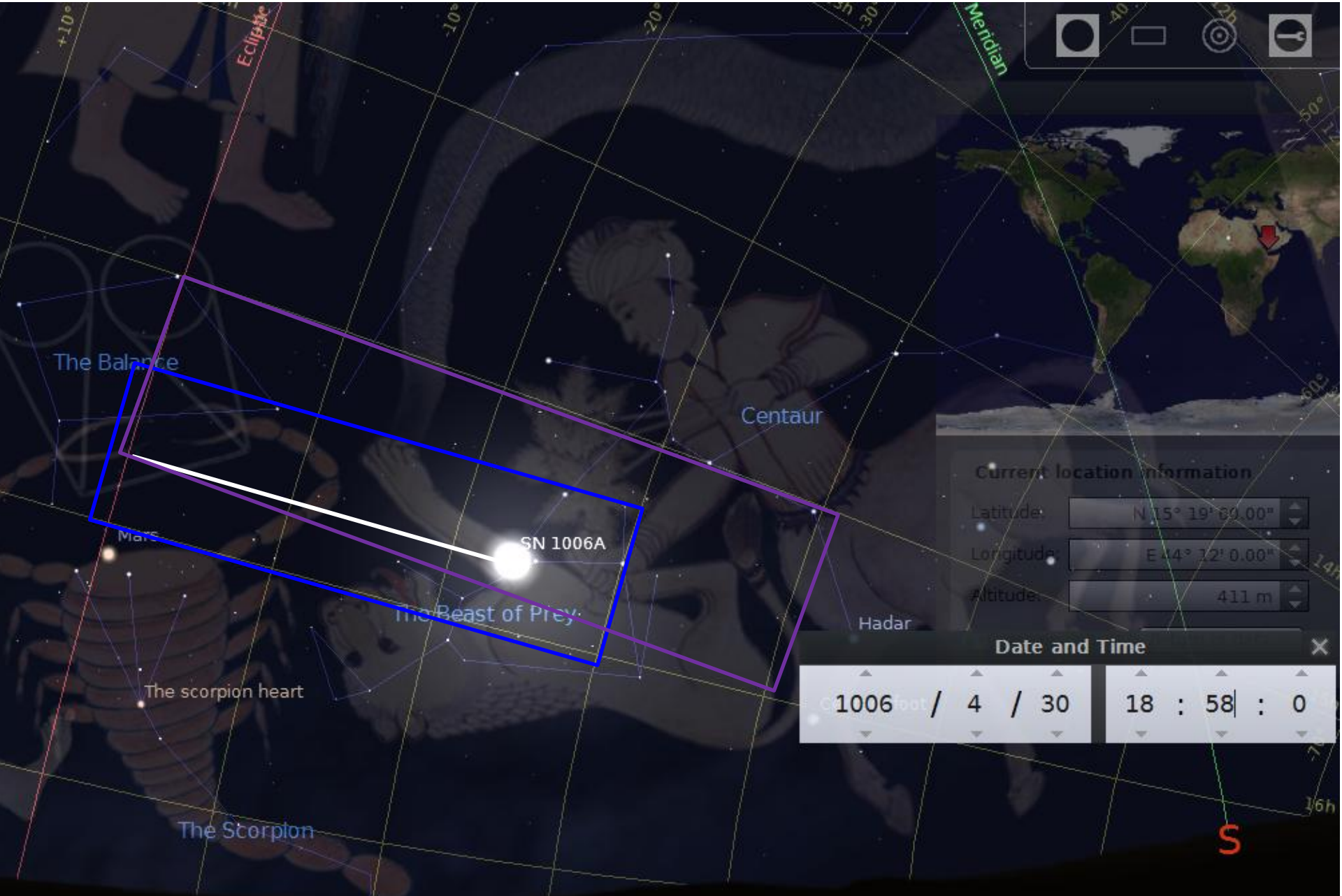
On the night of mid-Rajab [15th of Rajab], in the year 396h [AD 1006 Apr 17 ± 2],
a star appeared from the east at half an hour after sunset.
It was four times as large as Venus.
It appeared in the zodiacal sign of Libra in Scorpio and remained unchanged like that.
In the night of mid-Ramaḍān [3 months later]
its light started to decrease and gradually faded away.

(Rada & Neuhäuser, 2014, AN 336, 249, arXiv:1508.06126)

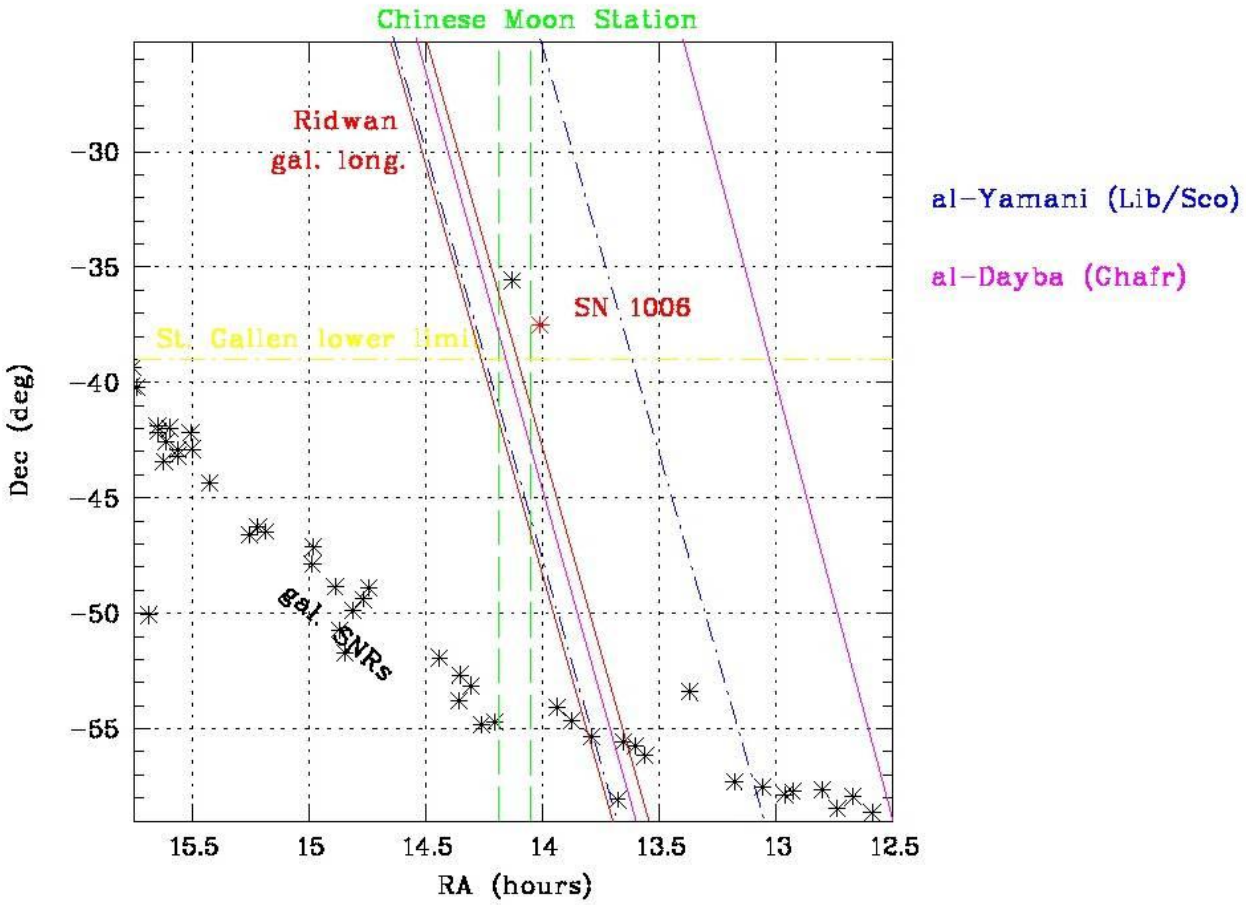
Supernova 1006 am 22. Apr. 1006 von Ṣanʿāʾ, Yemen

SN 1006, 30.4. **ekl. Länge 221.6 (Riḍwān : etwa 224 – 225)**

an der Grenze von Waage zu Skorpion bzw. in al-Ghafr = Beast of Prey = Lupus (?)



Supernova 1006 von Ṣanᶜāʾ, Yemen



Positionen von al-Yamānī und Ibn al-Daybaᶜ sind weniger präzise, aber akurat !

SN 1006, neuer, früher arabischer Bericht:

Ibn Sina = Avicenna (AD 980 - 1037) in Al-Shifa:

… Es passiert, dass das Brennende und Flammende
für eine Weile bleibt – entweder in Form einer Haarlocke
oder mit Schweif - meist im Norden,
aber manchmal auch im Süden,

oder in Form eines Sterns unter den Sternen,
wie der, der im Jahre 397 H erschien [=AD 1006/7].

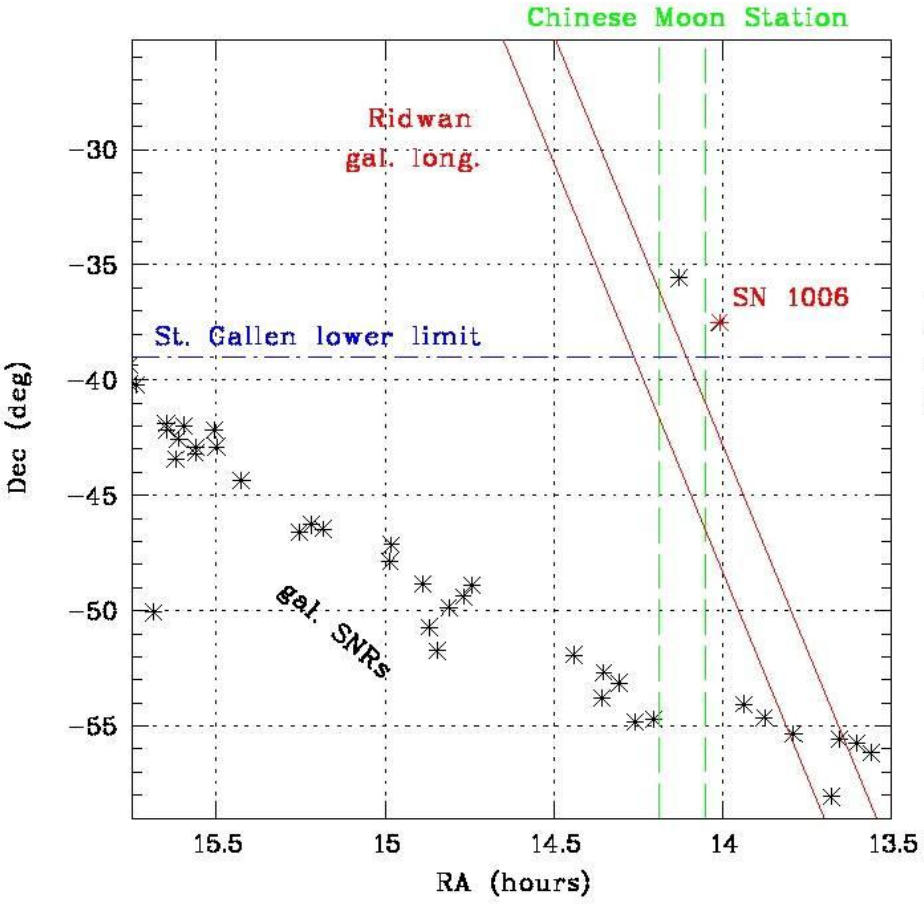
Er blieb nahezu 3 Monate,
dunkler und dunkler werdend bis er verschwandt;
am Anfang tendierte er zu dunkel und grün,
dann begann er zu funkeln,
und dann wurde er mehr und mehr weißlich
und wurde schwächer und verschwandt.

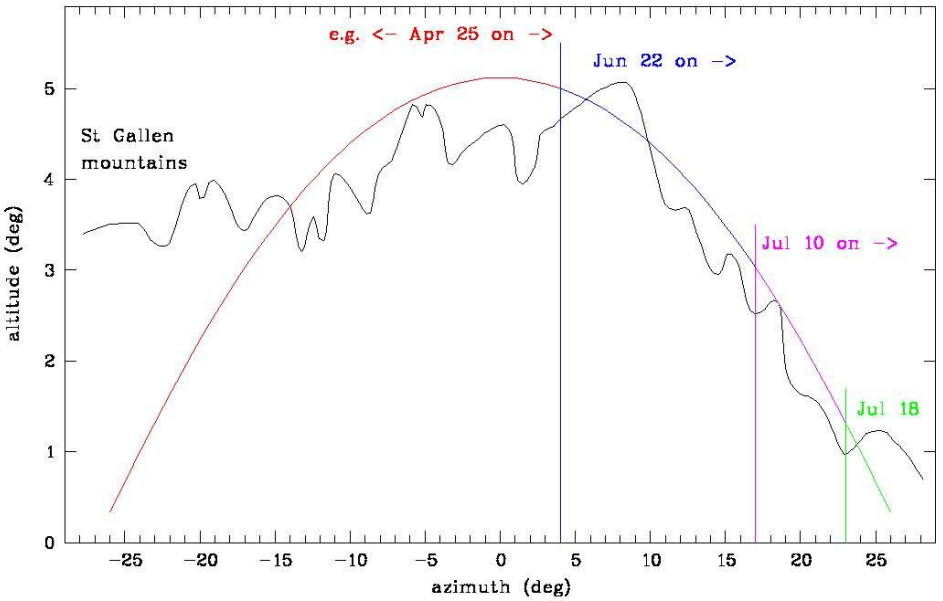
(RN, Ehring-Eggert, Kunitzsch, in press)

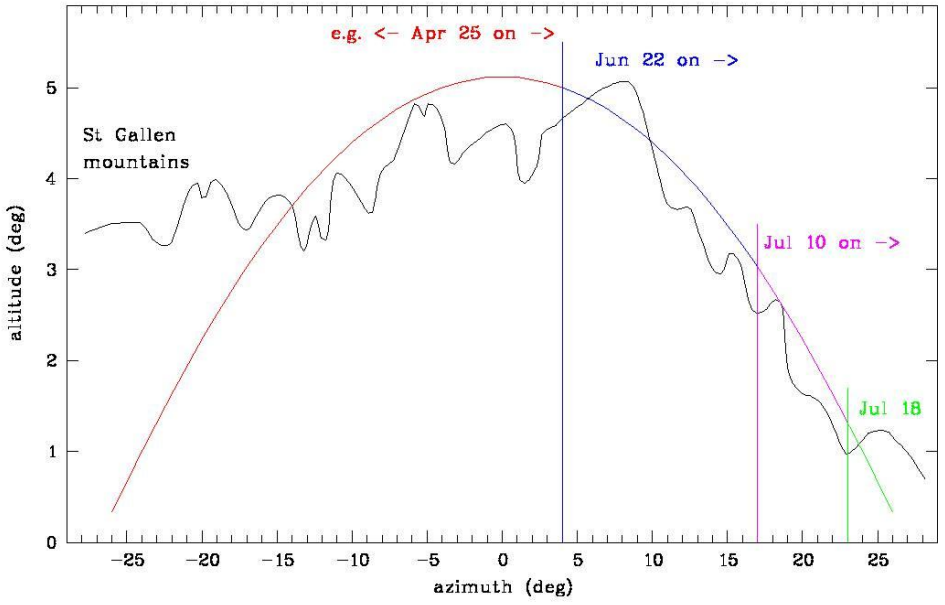
Surprise from Yemen: Early detection around 17 April !!!

Previously: China since 1 May, Arabia since 30 April

St. Gallen: Ein neuer Stern ungewöhnlicher Größe funkelte stark … und war manchmal wie ausgelöscht. Er wurde aber **drei Monate lang** gesehen im äußersten Süden unterhalb aller Sternbilder des Himmels





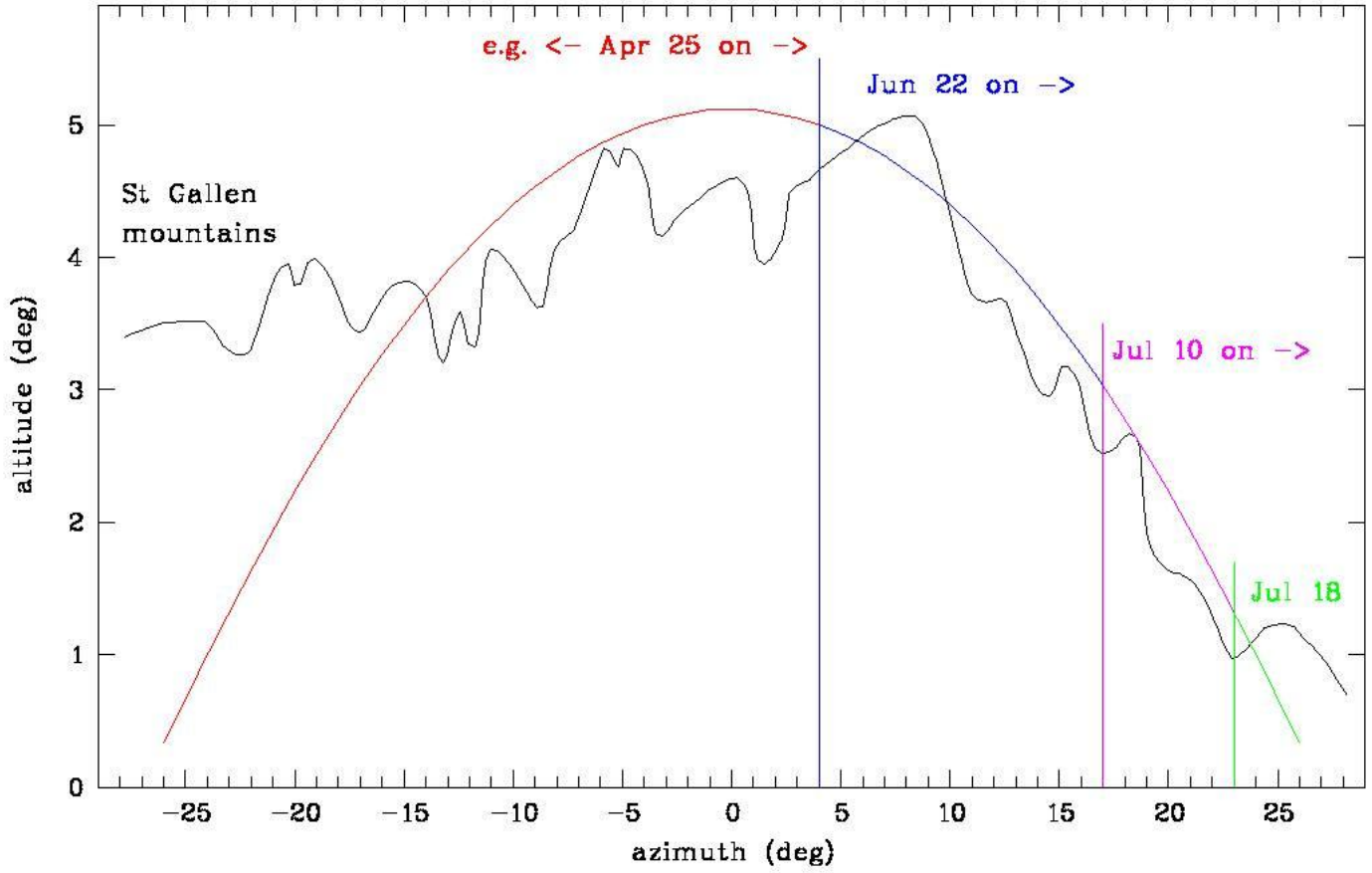


Ein neuer Stern ungewöhnlicher Größe funkelte stark … und war manchmal wie ausgelöscht. Er wurde aber drei Monate lang gesehen im äußersten Süden unterhalb aller Sternbilder des Himmels

Surprise from Yemen: Early detection around 17 April !!!

Previously: China since 1 May, Arabia since 30 April

St. Gallen: „visa est per tres menses“ = „observed for 3 months“



(Neuhäuser et al. subm.)

SN 1006 discovered mid April 1006 ?

➔ Yemen: detected since 1006 Apr 17 ± 2
(high elevation, far south, mid April full moon)
Al-Yamānī:
a star appeared from the east at half an hour after sunset

➔ Arabic observations mostly on new and full moon (lunar calendar),
e.g. ᶜAlī b. Riḍwān on Apr 30

➔ East Asia:
- few reports since May 1, but solar eclipse expected end of May,
- guest star reported in the east for Apr 3,
- possible detection in Japan Apr 16 or 28,
- important political meeting Apr 17,
- no reports / observations Apr 17-27,
- early monsoon in second half of April (?).

➔ St. Gallen observer must have started in April: *for 3 months*

SN 1006 als Typ Ia

➔ **SNR G327.6+4.6 bei hoher galaktischer Breite: 4.6 Grad !**

➔ **Kein Neutronenstern gefunden**

➔ **SN Typ Ia**

➔ **Kein Reststern (roter Riese) gefunden**

➔ **double-degenerate SN Typ Ia**

➔ **Entfernung (des SNR): 2.18 kpc**

➔ **Max V=-7.5 mag ➔ voll konsistent mit typischer Ia**

Historische Supernovae

SN Year	Location b [°]	Ext. Av [mag]
185?	Cen −59	6.3(3.2)[1]
369?	(b) ~ 65	
386	Sgr −19	8.7(3.4)[7,8]
393	Sco −39	3.9(2.4)[19]
1006	Lup −42	0.32(3)[2]
1054	Tau +22	~ 1.1[28]
1181	Cas +64	1.3(0.2)[34]
1572	Cas +65	2.25(16)[2]
1604	Oph −20	3.27(14)[2]
~ 1300	Vel −46	1.63(98)[46]
~ 1680	Cas +58	11.6(2.6)[47]

↓ AD 393

↓ AD 386

↓ AD 369

一曰：「爲大水。」四年五月，天下大水。五年，穆帝崩。

哀帝興寧元年八月，有星孛于角亢，入天市。案占曰：爲兵喪。三年正月，皇后王氏崩。二月，帝崩。三月，慕容恪攻沒洛陽，沈勁等戰死。

海西太和四年二月，客星見紫宮西垣，至七月乃滅。占曰：客星守紫宮，臣弑主。六年，桓溫廢帝爲海西公。

孝武寧康二年正月丁巳，[二]有星孛于女虛，經氐亢、角、軫、翼、張。至三月丙戌，彗星見於氐。九月丁丑，有星孛于天市。占曰：「爲兵喪。」太元元年七月，符堅破涼州，虜張天錫。

太元十一年三月，客星在南斗，至六月乃沒。占曰：「有兵，有赦。」是後司、雍、兗、冀常有兵役。十二年正月大赦，八月又大赦。十五年七月壬申，有星孛于北河戍，經太微、三台、文昌，入北斗，色白，長十餘丈。八月戊戌，入紫宮乃滅。占曰：「北河戍一名胡門，胡有兵喪。掃太微，入紫微，王者當之。三台爲三公，文昌爲將相，將相三公有災。入北斗，諸侯戮。」一曰：「掃北斗，强國發兵，諸侯爭權，大人憂。」二十一年，帝崩。隆安元年，王恭、殷仲堪、桓玄等並發兵，表以誅王國寶爲名。朝廷順而殺之，幷斬其從弟緒，司馬道子由是失勢，綱紀成矣。

十八年二月，客星在尾中，至九月乃滅。占曰：「燕有兵喪。」二十年，慕容

Zusammenfassung -1-:

Arabische Texte verwenden verschiedene Worte für „nova“:

- **kawkab (Gestirn) SN 1054**
- **athar (Spur) SNe 1006 und 1054**

  (SN 1054: kawbak athari = Stern, der Spuren hinterläßt)
- **najm (Stern) SN 1006**
- **nayzak (Spektakel) SNe 1006 und 1604**

Zusammenfassung -2-:

➔ **Arabische Berichte historischer Supernovae wertvoll**

➔ **Jahr, Jahreszeit und Sternbild der SN 1054 bestätigt**

➔ **SN 1006:** **- Position von ᶜAlī b. Riḍwān ➔ SN-Überrest**
- frühe Beobachtung um 17.4. (Yemen)
- weitere Punkte in Lichtkurve (Yemen)
- Position akurat (Yemen)

➔ **Jahr und Jahreszeit der SN 1604 bestätigt,**
zudem weiterer Punkt in der Lichtkurve

➔ **Weitere Berichte könnten gefunden werden,**
insbesondere von Vela Jr und Cas A (sowie Tycho und SN 1181)

Young nearbyNeutron Stars

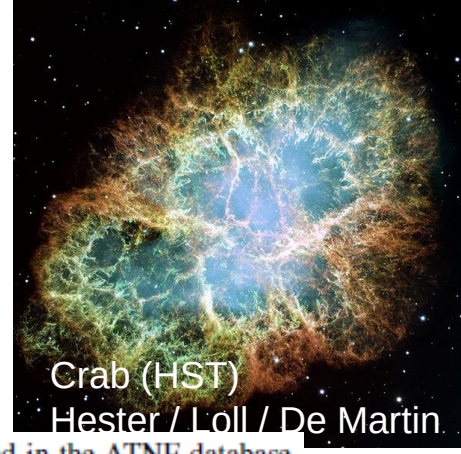


Table 3 **Young neutron stars.** All known neutron stars with characteristic age younger than 2500 yr found in the ATNF database (Manchester et al. 2005) or other literature plus those neutron stars mentioned in Tables 1 and 2 or possibly be related to historic SNe and/or young SNRs, sorted by right ascension. None of them can be related to the AD 774/5 event, if it was a normal SN at ∼ 124 to 260 pc: All of them are too distant (for the pulsars with unknown distances, the SNRs distance is given, also too far away), some of them are also too young.

Name J2000.0	Ref	Period P [s]	P-dot [s/s]	Ref	Distance [kpc]	Ref	SNR	Ref	Age (a) [yr]	Remarks
J0205+6449	38	0.0657	1.9e-13	38,39	3.2-7.5	33	G130.7+3.1	36	5370	SN 1181
J0525-6607	145	8.0470	6.5e-11	146	48	147	N49	147	1960	in LMC
J0534+2200	32	0.0331	4.2e-13	115	2.0-2.5	33	Crab	30	1240	SN 1054
J0540-6919	148	0.0505	4.8e-13	149	48.1	33	G279.7-31.5	150	1670	in LMC
J0855-4644	151	0.0647	7.3e-15	151	0.3-10	151,152	Vela Jr ?	152	141000	152
J1119-6127	57	0.408	4.0e-12	59	2.4-8	57	G292.2-0.5	58	1610	
J1124-5916	121	0.1355	7.5e-13	153	1.2-8	154	G292.0+1.8	121	2850	
J1513-5908	4	0.1516	1.5e-12	5	3.3-8.4	3	G320.4-1.2	4	1560	SN 185 ?
J1550-5418	61	2.0698	2.3e-11	61	4 or 9	60,61	G327.2-0.1	60	1410	AXP
J1617-5055	156	0.0694	1.35e-13	156	6.46	58,148	G332.4-0.4	129	8130	
J1627-41	157	2.5945	1.9e-11	136	11	132	G337.0-0.1	134,135	2200	SGR
J1714-3810	142	3.8	6.40e-11	142	7-14	142	G348.7+0.3	100	950	AXP
J1808-2024	158	7.5559	5-8e-10	159,161	7-18.6	160,162			160-218	SGR
J1811-1925	16	0.0647	4.4e-14	17	4.4-6.6 (b)	11,12	G11.2-0.3	16	23300	SN 386
J1813-1749	84	0.0447	1.5e-13	84	4-4.5 (b)	82,83	G12.8-0.0	82	4600	
J1833-1034	164	0.0619	2.0e-13	90	3.3-4.4	33,165	G21.5-0.9	89,164	4850	
J1841-0456	95	11.7789	4.5e-11	97	7.5-10.6	92	G27.4+0.0	95	4180	AXP
J1846-0258	164	0.3266	7.1e-12	75	∼ 6	71	G29.7-0.3	71	723	Kes 75
J1907+0919	65	5.1689	7.8e-11	66	5-7.7 (b)	63,64	G42.8+0.6	64	1050	SGR
J1930+1852	109	0.1369	7.5e-13	109	3.2-13.2	109,110	G54.1+0.3	111	2900	

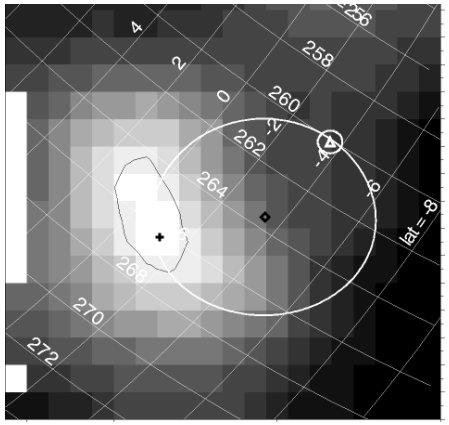
Young nearby SN remnant

Table 2 **Young Supernova Remnants.** All known Galactic Supernova Remnants (SNRs) with a possible age from $\sim$ 150 to 2000 yr, found in Guseinov et al. (2003a,b) or Green (2009) or considered as counterpart to an historical SN or with a pulsar with characteristic age from $\sim$ 150 to 2000 yr (Table 3) - sorted by galactic longitude. None of them can be related to the AD 774/5 event, even if that would have been a normal SN with SNR, because they are all too distant (and Vela Jr is too young).

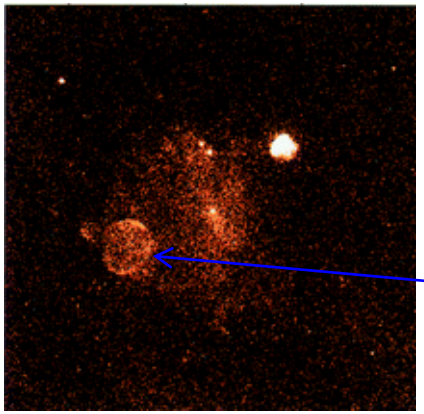
Name (Green)	Position α (J2000.0)	δ	Size [′]	Distance [kpc]	Ref	SNR Age [yr]	Ref	SN year	Pulsar [yr]	Remarks or Ref.
G0.9+0.1	17:47	-28:09	8	5.9-13	63,76	1000-7000	77			a
G1.9+0.3	17:48	-27:10	1.5	6.9-20	63,78	100-150	78-81			
G4.5+6.8	17:30	-21:29	3	3.1-3.7	2	409		1604		SN Ia,Kepler
G11.2-0.3	18:11	-19:25	4	4.4-5.6	11,12,18,19	400-3400	14,15	386	23300	16,17,b
G12.8-0.0	18:13	-17:49	3	4-4.5	82,83	285-2500	82		4600	82-84
G18.9-1.1	18:29	-12:58	33	2-3.4	63,85	2000-6000	86,87			
G21.5-0.9	18:33	-10:35	4	4.1-5.5	63,88	200-1600	89		4850	90,q
G27.4+0.0	18:41	-04:56	4	6-10.6	63,92,93	500-2700	92-96		4180	Kes73,97,c
G29.7-0.3	18:46	-02:59	3	5.1-7.5	71	700-1000	71-73		723	74,d
G31.9+0.0	18:49	-00:55	7x5	7.2-8.5	98	4000-4600	98			r
G39.2-0.3	19:04	05:28	7	6.0-11.3	99,100	1000-7100	94,101			3C396
G41.1-0.3	19:07	07:08	3.5	6.2-12.8	100-103	600-5300	104-106			3C397,e
G42.8+0.6	19:07	09:05	24	5-7.7	63,64	10000	64		1050	66,f
G43.3-0.2	19:11	09:06	4x3	5.3-9	50,63	700-3000	107,108			W49B
G54.1+0.3	19:30	18:52	1.5	3.2-12	109,110	1500-6000	109		2900	109-111
G74.9+1.2	20:16	37:12	8x6	6.1-12	106,112	3000-5000	113,115			SN BC 532 ? (91)
G111.7-2.1	23:23	58:48	5	3.4-3.8	51	$\sim$ 333	52	$\sim$ 1680		Cas A,g
G120.1+1.4	00:25	64:09	8	2.09-2.41	2	$\sim$ 441		1572		SN Ia,Tycho,43
G130.7+3.1	02:05	64:49	9x5	2.6-3.2	34,35	800-7000	35,37	1181	5370	38
G184.6-5.8	05:34	22:01	7x5	1.5-2.5	29	959	31	1054	1240	115,Crab
G266.2-1.2	08:52	-46:20	120	0.20-1	47,48	420-4300	47-50	$\sim$ 1300	CCO	Vela Jr
G291.0-0.1	11:11	-60:38	14	3.5-5.6	63,117,118	1300-10000	117,118		CCO ?	118
G292.2-0.5	11:19	-61:28	20x15	2.4-8.8	55-58	$\sim$ 1700	58		1610	57
G292.0+1.8	11:24	-59:16	10	3.7-6.1	(o)	1600-3400	120-124		2850	121,122
G315.4-2.3	14:43	-62:30	42	0.4-3.2	107,125	400-3100	125	185 ?		126,139
G320.4-1.2	15:14	-59:08	35	3.3-6.6	3	1700-20000	1,3	185 ?	1560	4,127,139
G327.2-0.1	15:50	-54:18	5	4-9	60,61	$\leq$ 1410	61		1410	60,61,j
G327.6+14.6	15:02	-41:56	30	2.10-2.26	24	$\sim$ 1007	24	1006		SN Ia
G332.4-0.4	16:17	-51:02	10	1.6-4.7	63,125	300-4000	128,129		8130	k
G337.0-0.1	16:35	-47:36	1.5	9.6-11	65,132,135	1000-5000	132		2200	132-136,l
G337.2+0.1	16:35	-47:20	14	5.4-5.6	65,137,138	1000-4600	137,138			
G347.3-0.5	17:13	-39:45	60	0.9-1.9	19-23	1600-9000	19-23	393 ?	CCO	15,22,m
G348.5-0.0	17:15	-38 28	10	$\leq$ 6.3	141			393 ?		141
G348.5+0.1	17:14	-38:32	15	6.3-9.5	141	$\sim$ 1500	20	393 ?	CCO	20,CTB37A
G348.7+0.3	17:13	-38:11	17	4.4-13.7	65,100	350-4900	143,144	393 ?	950	142,CTB37B

R)

Discovery in 44 Ti
(Iyudin et al. 1998 Nature)

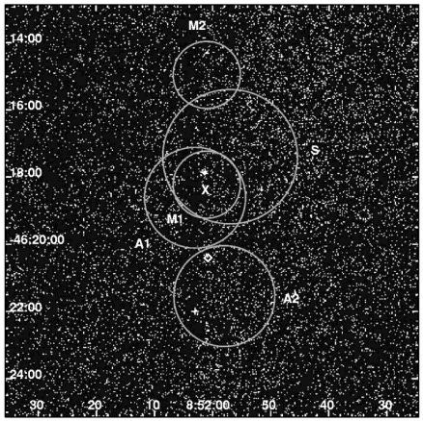


co-discovery with ROSAT
(Aschenbach 1998 Nature)



Vela Jr

CCO detected with Chandra
(Pavlov et al. 2001 ApJ)



Given the 2 deg size,
the 200 to 1000 pc distance,
and expansion velocity,.

Roughly 700 yr only (Iyudin et al.)

Historische Supernovae

Table 1 Historic supernovae in the last 2000 yr. There are several Galactic historic SN sightings since 185 (sorted here by time), but no SN sighting within 200 yr around AD 774/5. This listing shows that SNe were observed before and after the AD 774/5 event. Also, the SNRs Vela Jr and Cas A are listed, because they were considered in M12 to be possibly related to the AD 774/5 event; at the end of the table, we list six more SNRs, which should be related to recent SNe given the ages of the pulsars and/or SNRs; however, all those eight SNRs are all too distant for the AD 774/5 event (if that were a normal SN at ~ 1.24 pc); Vela Jr is too young given its expansion velocity.

SN	Location	Ext. A_V	Peak magnitude		Supernova remnant				Neutron star				SN type
Year	δ [°]	[mag]	hist.	Equ. (3)	G name	d [kpc]	age [kyr]	Ref	name	d [kpc]	age [kyr]	Ref	& Ref.
185?	Cen −59	6.3(3.2)[1]	−8(2)[2]	−3 to 8	320.4-1.2	5.0(1.6)	1.7-20	1,3	1513-5908	3.3-8.4	≤ 1.56	3-5	cc(?),2,(a)
369?	(b) ~ 65		≤ 2[6]										?,6
386	Sgr −19	8.7(3.4)[7,8]	~ 2[9]	0 to 10	11.2-0.3	5.0(6)	0.4-3.4	10-15	1811-1925		≤ 23.3	16,17	II,16-18
393	Sco −39	3.9(2.4)[19]	−1(1)[20,21]	−8 to 2	347.3-0.5	1.4(5)	1.6-9.0	19-23	CCO (c)			(c)	cc(?),(c)
1006	Lup −42	0.32(3)[2]	−7.5[24]	−8 to −7	327.6+14.6	2.18(8)		24-26	none				Ia,(d),27
1054	Tau +22	~ 1.1[28]	−4.8[28]	−7 to −3	184.6-5.8	2.0(5)	0.953 (21)	29-31	0534+2200	2.0-2.5	≤ 1.24	32,33,115	II,Crab,32
1181	Cas +64	1.3(0.2)[34]	~ 0.7[2]	−6 to −2	130.7+3.1	2.9(3)	0.8-7.0	34-37	0205+6449	3.2-7.5	≤ 5.37	33-39	II,2,40,41
1572	Cas +65	2.25(16)[2]	−4.5[2]	−6 to −5	120.1+1.4	2.25(16)	~ 441	2,42	none	(Tycho's SN)			Ia,43
1604	Oph −20	3.27(14)[2]	−3.0[2,9,44]	−3 to −4	4.5+6.8	3.4(3)	~ 409	2,45	none	(Kepler's SN)			Ia,(e)
Other young SNRs considered in Miyake et al. 2012													
~ 1300	Vel −46	1.63(98)[46]		−12 to −3	266.2-1.2	0.20 - 1	0.4-4.3	47-50	CCO	(Vela Jr)		(f)	cc(?),47,48
~ 1680	Cas +58	11.6(2.6)[49]	(g)	3 to 11	111.7-2.1	$3.5^{+0.3}_{-0.1}$	~ 333	51,52	CCO	(Cas A)		53	IIb,54