

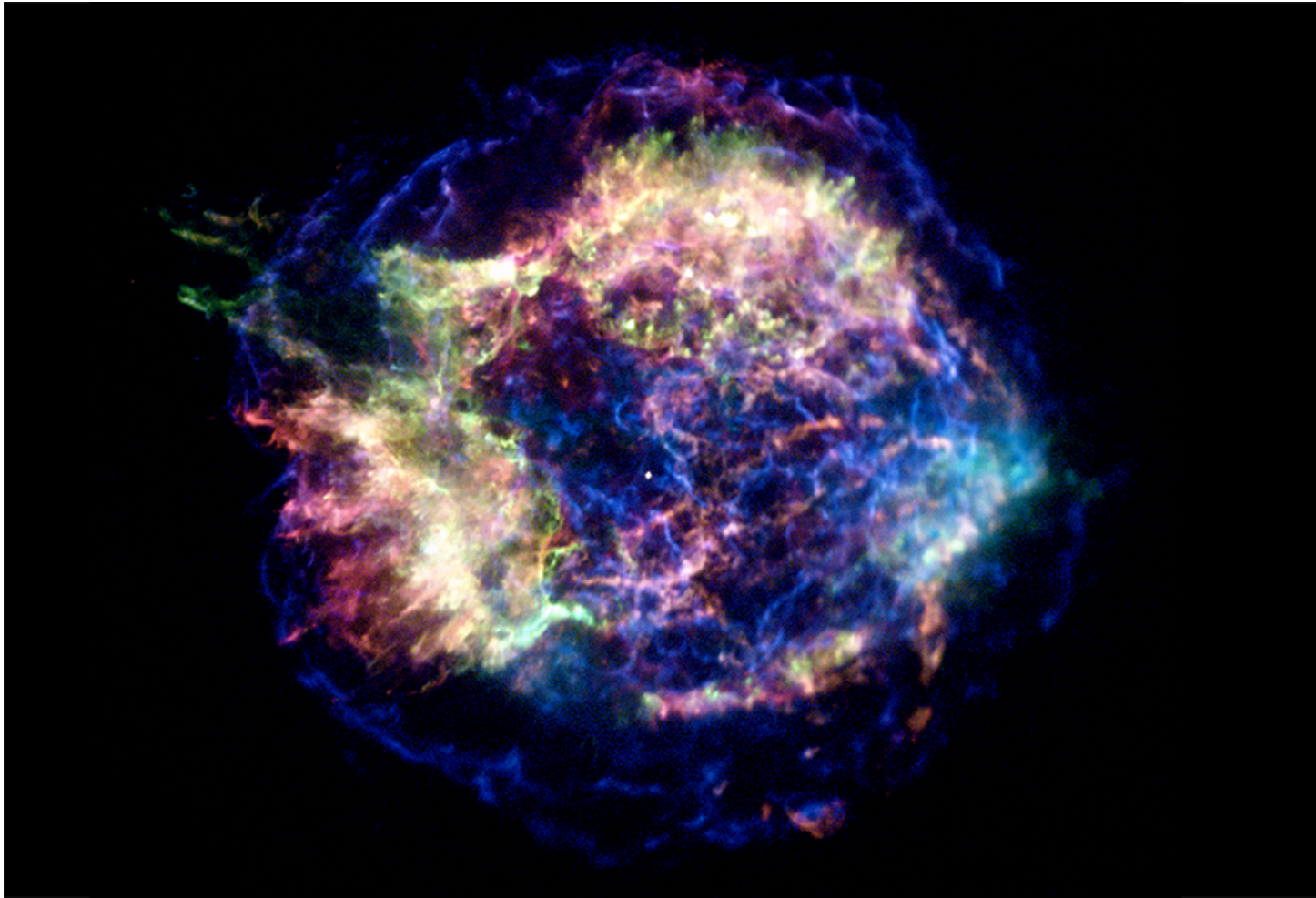
Wednesday, January 27, 2016

Powerpoint of lectures is posted as pdf after every class.

Wednesday Star Parties RLM, Friday/Saturday Public nights on Painter Hall. Option for doing Sky Watch.

Astronomy in the news?

# Supernovae!



Reading:

Chapter 6 Supernovae, §6.1, 6.2, 6.3

Background:

Chapter 1 Introduction, §1.1, 1.2.1, 1.3.1, 1.3.2

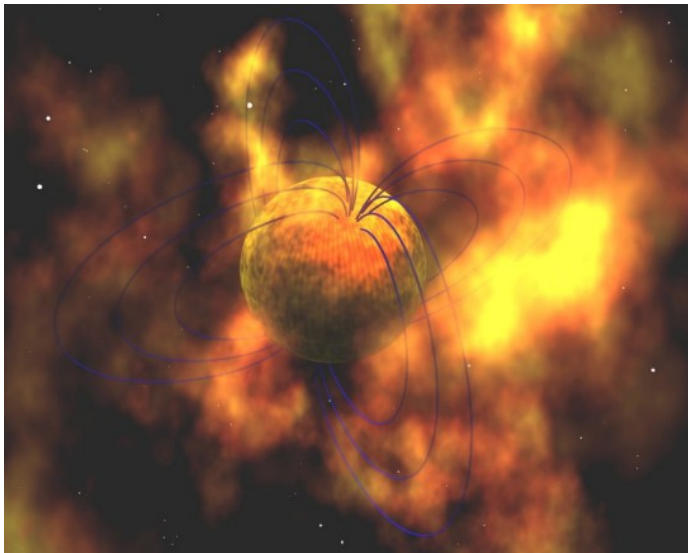
Chapter 5 White dwarfs, §5.1

One type of supernova is powered by the *collapse* of the core of a massive star to produce

a *neutron star*,

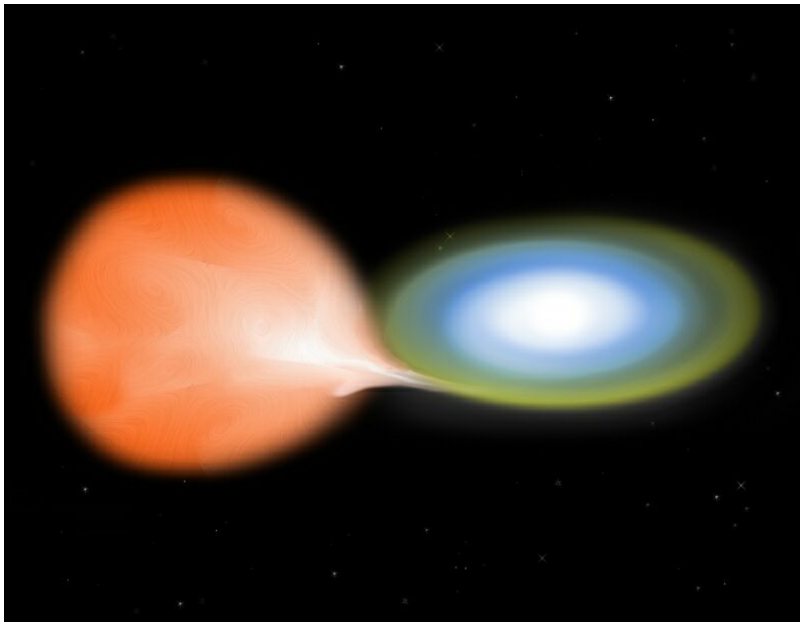
or perhaps

a *black hole*

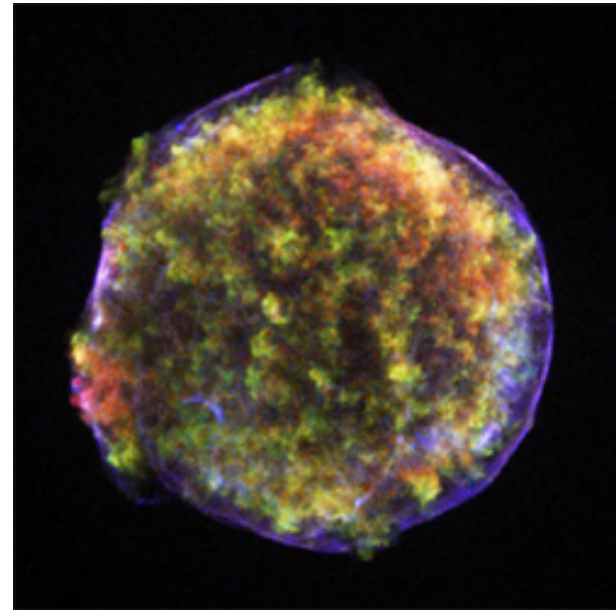


*The mechanism of the explosion is still a mystery.*

The other type of supernovae (Type Ia) is thought to come from a white dwarf that grows to an explosive condition in a binary system.



Chandra X-ray Observatory image  
Of Tycho's supernova of 1572



These explode completely, like a stick of dynamite, and leave no compact object (neutron star or black hole) behind.

Goal:

To understand what we have learned from the study of old supernova explosions in our Milky Way Galaxy.

# Chapter 6 Supernovae

Historical Supernovae - *in our Milky Way Galaxy* observed with naked eye over 2000 years especially by Chinese (preserved records), but also Japanese, Koreans, Arabs, Native Americans(?), finally Europeans. (WD = White Dwarf; NS = Neutron Star)

SN 185	earliest record	No NS	WD
SN 386		NS, jet?	massive
SN 1006	brightest	No NS	WD
SN 1054	Crab Nebula	NS, jets	massive
SN 1181	(Radio Source 3C58)	NS, jets	massive
SN 1572	Tycho	No NS	WD
SN 1604	Kepler	No NS	WD
~1680	Cas A	NS? jets	massive
-----			
G1.9+0.3	latest? 140 years old	No NS	WD
SN 1987A	nearby galaxy	NS? Jets	massive

Chandra Observatory X-ray image, Spitzer, WISE infrared image  
SN 185 = RCW 86

No evidence for neutron star



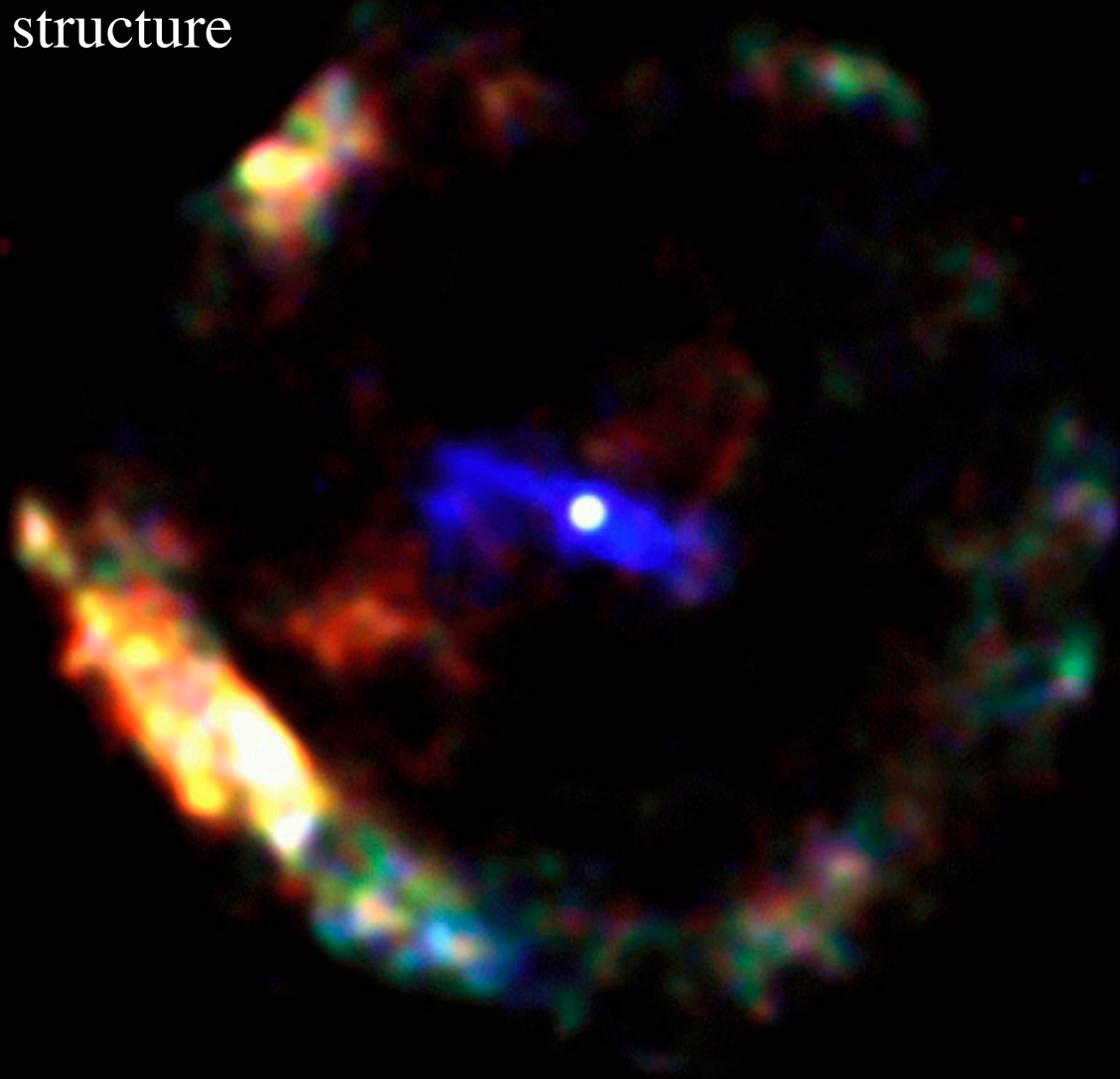


G11.2-0.3 = SN 386

65 ms pulsar

axis structure

X-ray image



Chandra Observatory X-ray image SN 1006

No evidence for neutron star

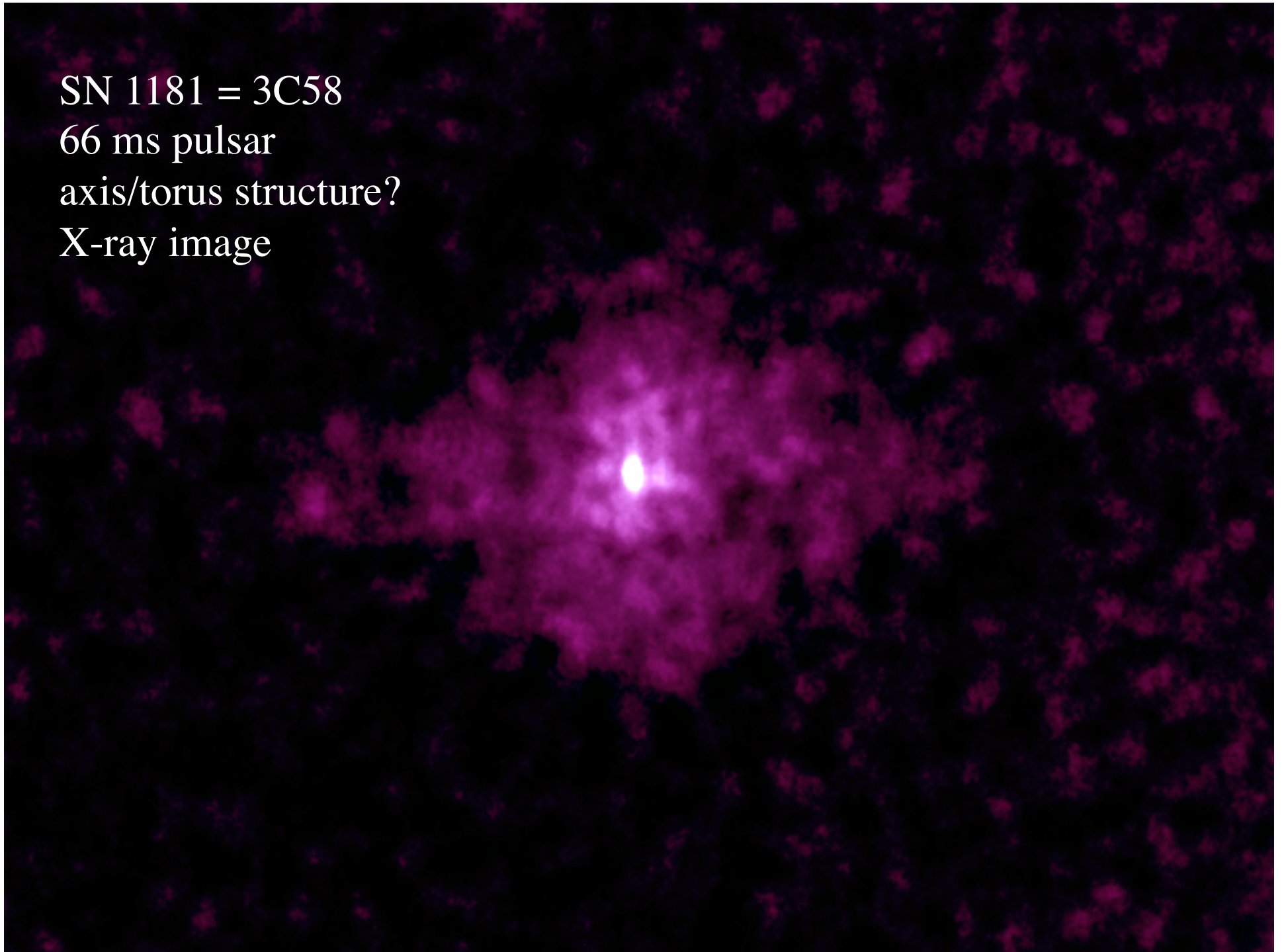


SN 1181 = 3C58

66 ms pulsar

axis/torus structure?

X-ray image



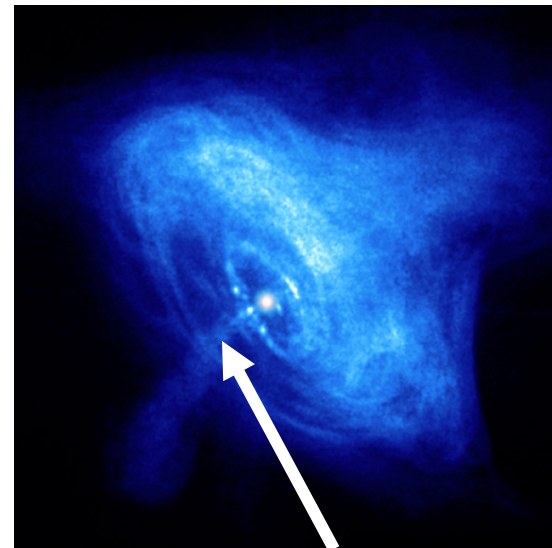
# Crab Nebula

Remnant of “Chinese” Guest Star of 1054

Optical Image

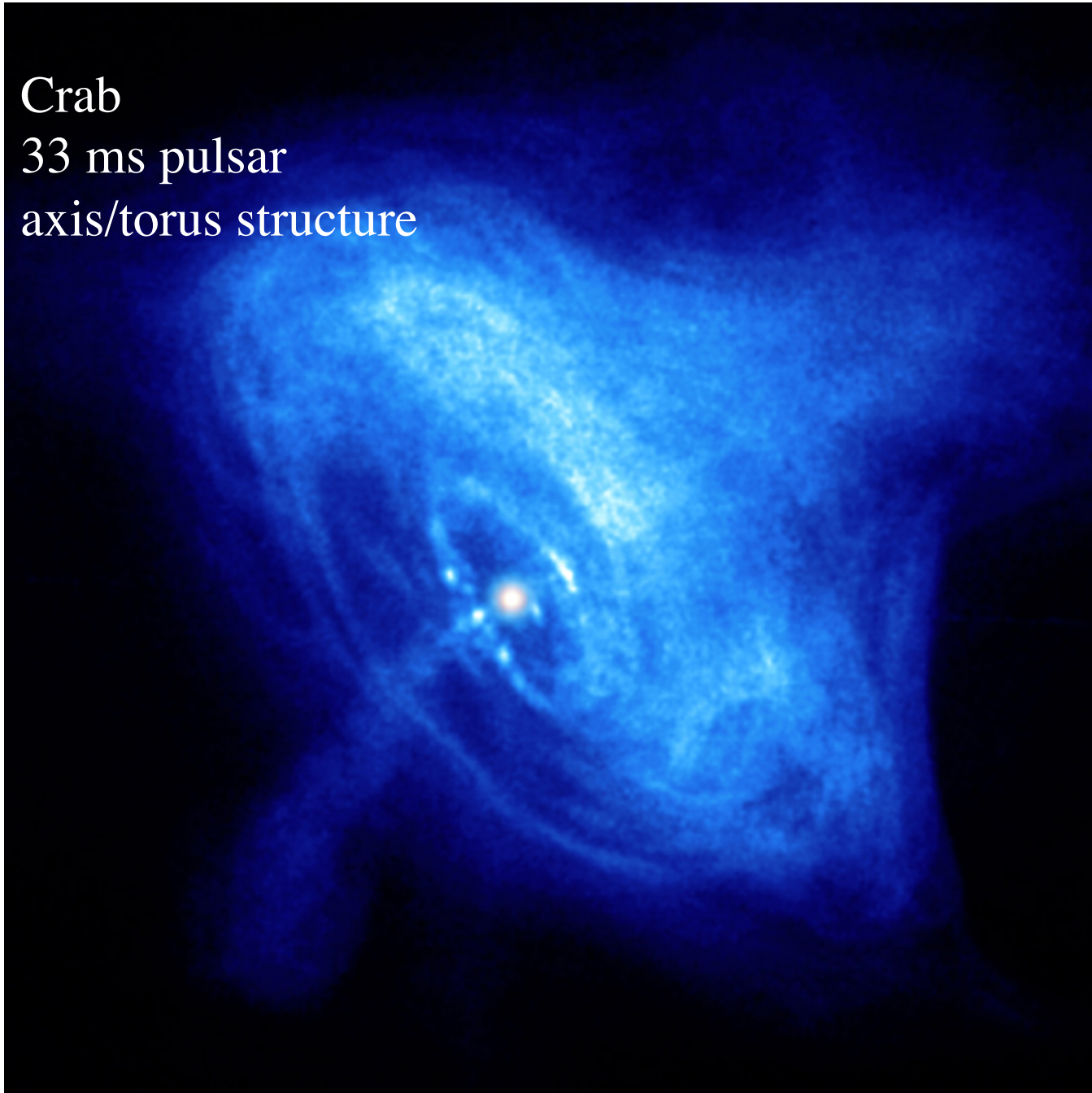


Chandra Observatory  
X-Ray Image



Left-over jet

Crab  
33 ms pulsar  
axis/torus structure



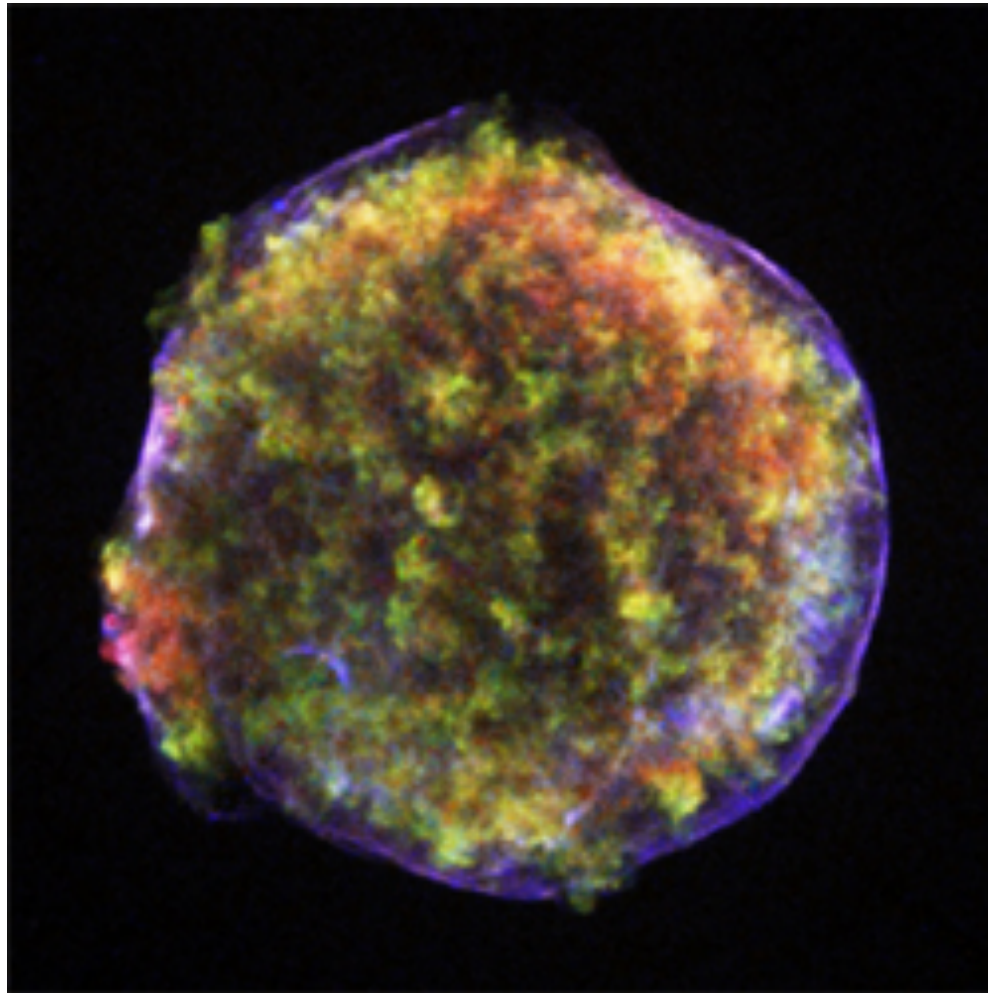
Kepler



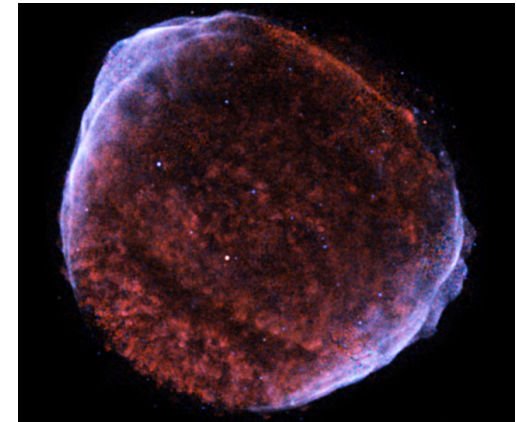
Tycho

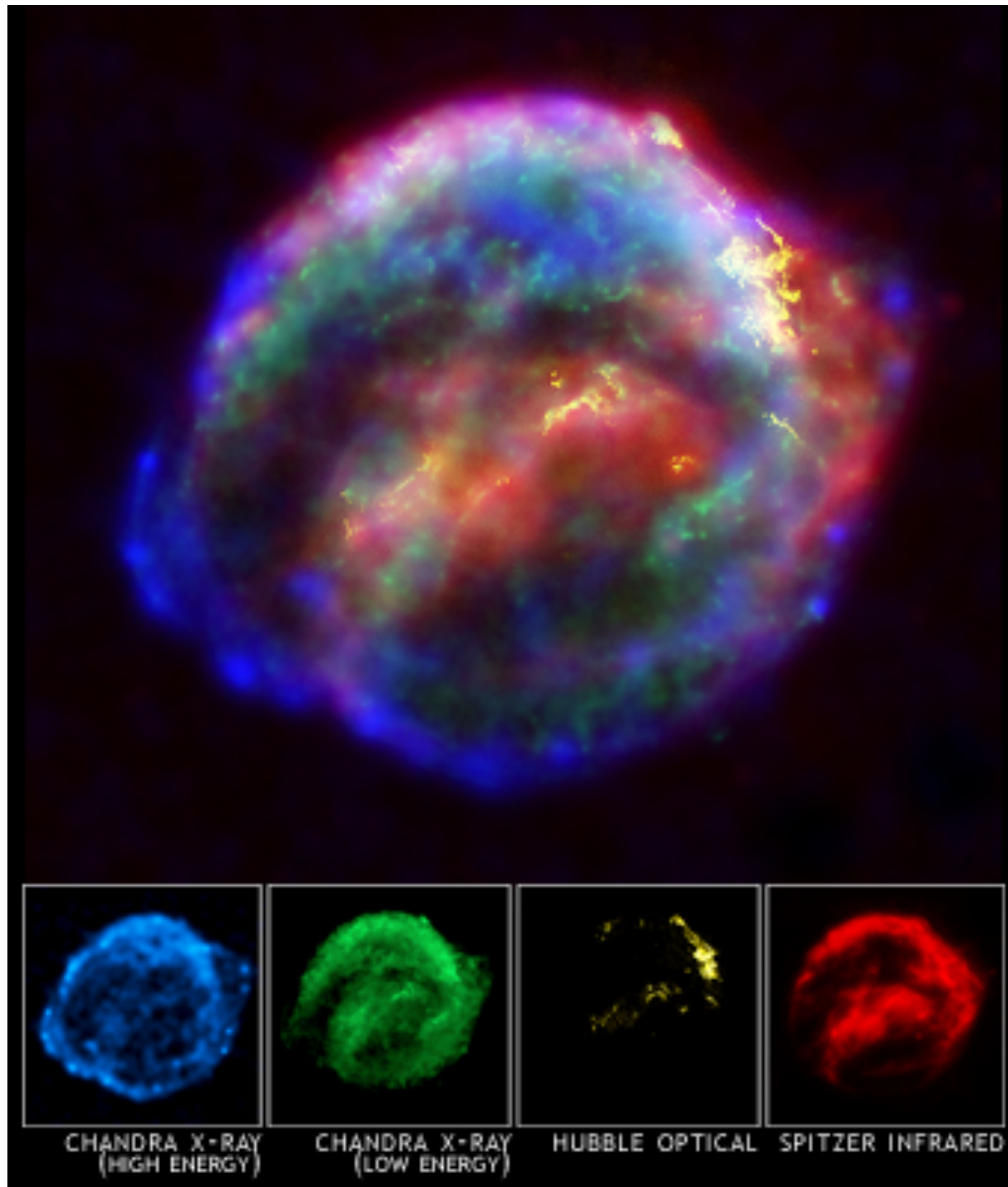
# Chandra Observatory X-ray Image of Tycho's Supernova of 1572

No evidence for neutron star



SN 1006



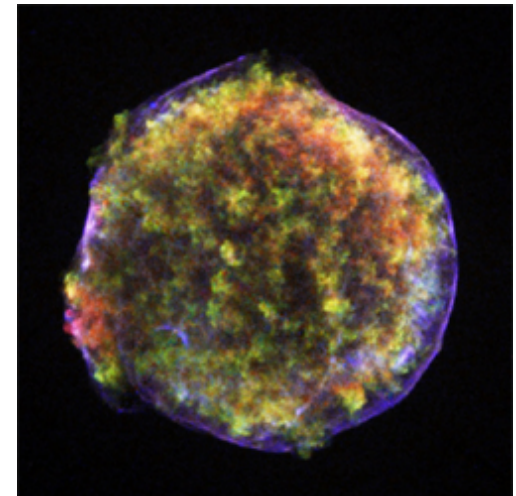


Great  
Observatories  
composite of  
Kepler's  
supernova 1604

No sign of neutron  
star

“sideways” alignment?

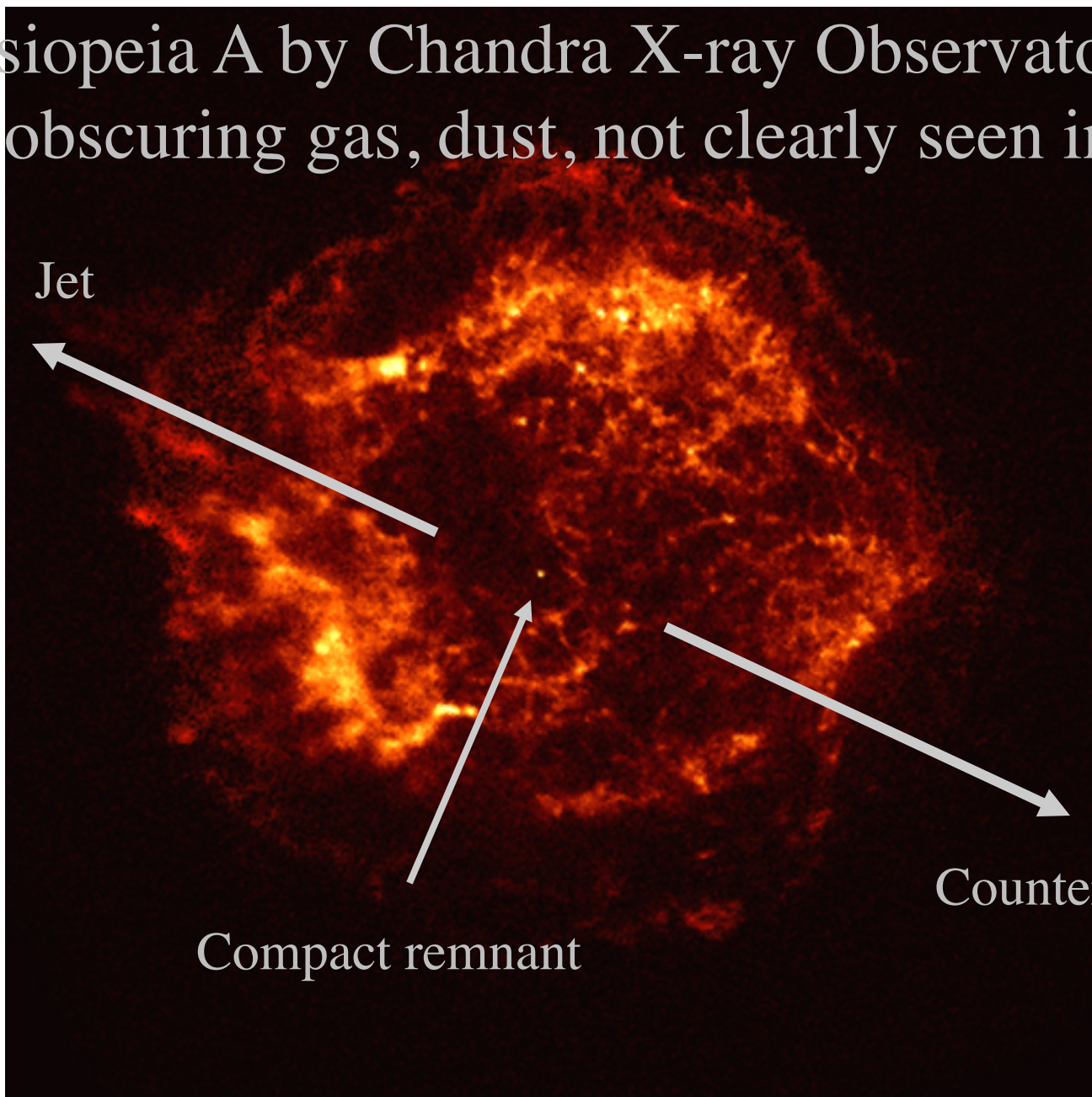
SN 1572 Tycho





# Cassiopeia A by Chandra X-ray Observatory

Behind obscuring gas, dust, not clearly seen in ~ 1680

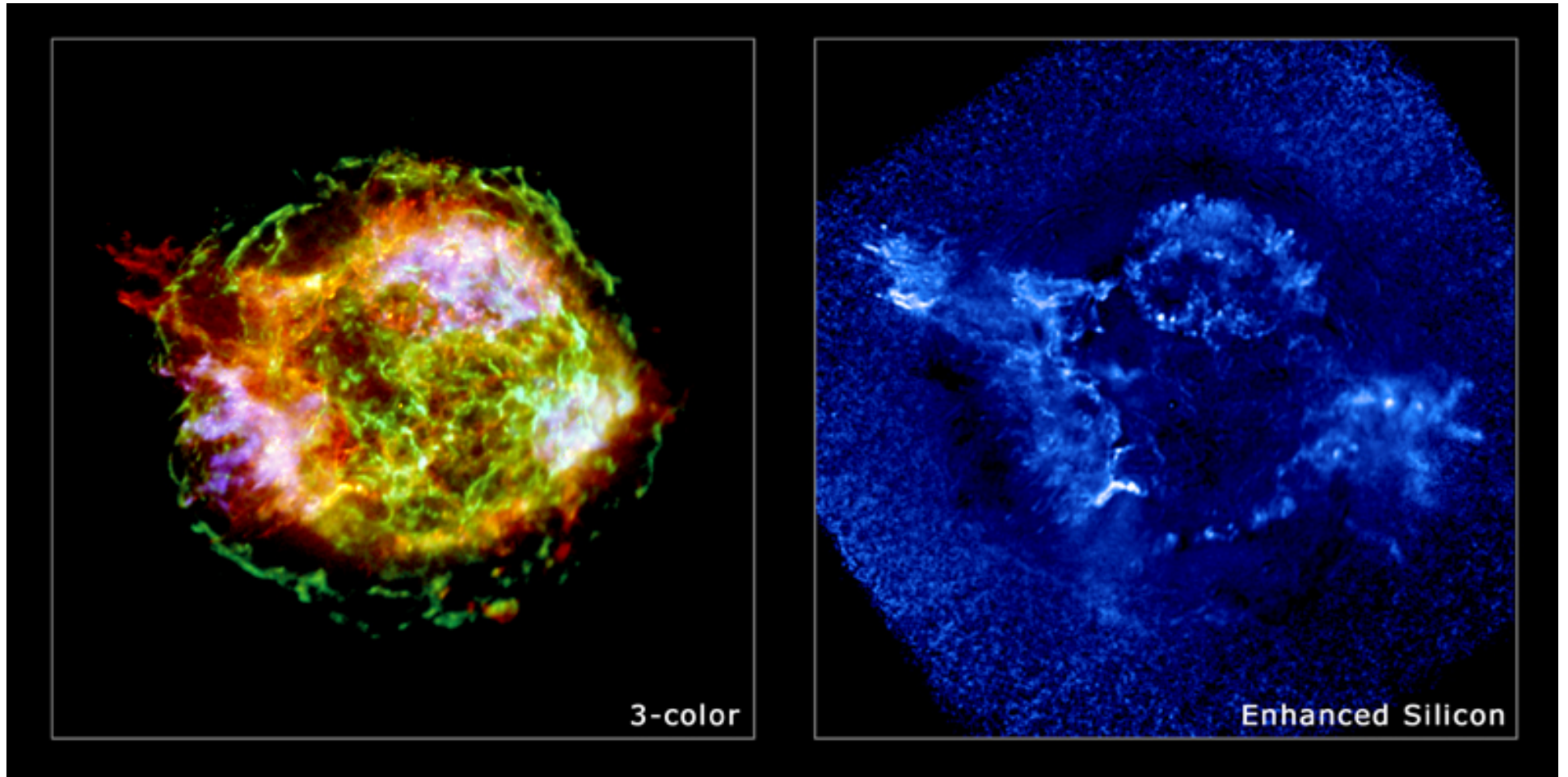


Jet

Counter Jet

Compact remnant

# Chandra Observatory X-ray Image of Cas A



## Chandra Observatory X-ray Image of G1.9+0.3

Youngest supernova detected in the Milky Way  
~ 140 years old. Exploded near center of Milky  
Way, obscured by gas, dust, original explosion  
not observed.



No evidence for neutron star

January  
2003


Made a neutron  
star, but don't  
see now

SN 1987A - exploded in nearby galaxy

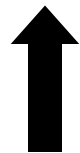



## One Minute Exam

The Crab Nebula supernova of 1054 shows a neutron star in its center. This suggests that:

 It formed in a double-star system

 It was formed by the collapse of a massive star

 It was formed by an exploding white dwarf

 It actually exploded much earlier than 1054

## One Minute Exam

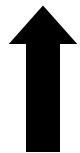
Tycho's supernova of 1572 shows no sign of a compact object left over in its center. This suggests that:



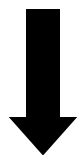
It made a jet



It was formed by the collapse of a massive star



It was formed by an exploding white dwarf



It actually exploded much earlier than 1572

*Sky Watch Extra Credit - location of Galactic (Milky Way) supernovae*

*SN 185 – Circinus/Centaurus (direction of Alpha Centaurus)*

*SN 386 - Sagittarius*

*SN 1006 - Lupus/Centaurus (difficult this time of year)*

*SN 1054 Crab Nebula - Taurus*

*SN 1181 – Cassiopeia*

*SN 1572 Tycho - Cassiopeia*

*SN 1604 Kepler - Ophiuchus*

*Cassiopeia A – Cassiopeia*

*G1.9+0.3 – Sagittarius*