Wednesday, January 29, 2014

First Exam and Skywatch extra credit, Friday February 7. Get a head start on the skywatch on clear nights.

Astronomy in the news?

PBS special on Stephen Hawking, A Brief History of Mine, Tonight 9 pm.

# Update on new “nearby” supernova in M82

A team to which I belong used a telescope in Spain to show that the light from the supernova is polarized.

A normal star supported by thermal pressure regulates its temperature. If excess energy is lost, the star contracts and heats. If excess energy is gained, the star expands and cools. Feedback loop, akin to the furnace, thermostat in your house.

A white dwarf, supported by the quantum pressure, cannot regulate its temperature. If excess energy is lost (the case for the vast majority of white dwarfs), they just get cooler. If Excess energy is gained, they heat up and can explode.

Behavior of white dwarf, Quantum Pressure, worked out by S. Chandrasekhar in the 1930's

Limit to mass the Quantum Pressure of electrons can support

***Chandrasekhar mass limit*** ~ 1.4 $M_{\odot}$

density ~ billion grams/cc ~ 1000 tons/cubic centimeter

**Maximum mass of white dwarf**.

If more mass is added, the white dwarf must collapse or explode!

# One Minute Exam

If nuclear reactions start burning in an ordinary star like the Sun, what happens to the temperature?

➡ The temperature goes up

⬅ The temperature remains constant

⬆ The temperature goes down

⬇ Insufficient information to answer the question

One Minute Exam

If nuclear reactions start burning in a white dwarf, what happens to the temperature?

➡ The temperature goes up

⬅ The temperature remains constant

⬆ The temperature goes down

⬇ Insufficient information to answer the question

# *SUPERNOVAE*

**Catastrophic explosions that end the lives of stars,**

**Provide the heavy elements on which planets and life as we know it depends,**

**Energize the interstellar gas to form or inhibit new stars,**

**Produce exotic compact objects, neutron stars and black holes,**

**Provide yardsticks to measure the history and fate of the Universe.**

Reading:

Chapter 6 Supernovae

Also § 2.1, 2.2, 2.4 & 2.5 for background

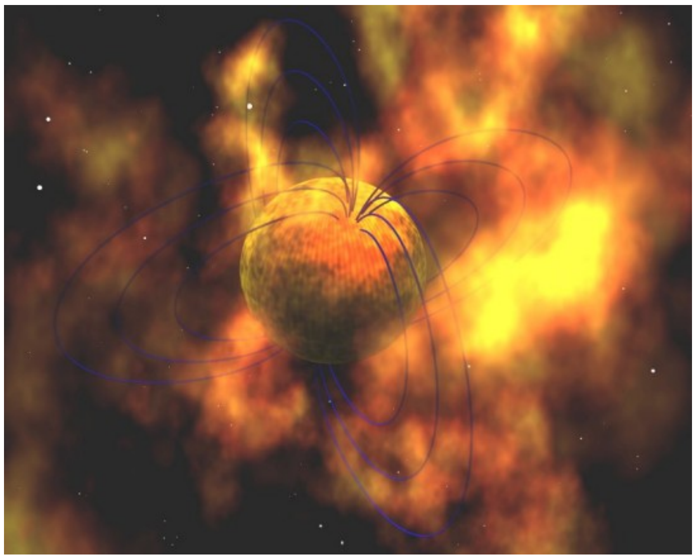
Issues to look for in background:

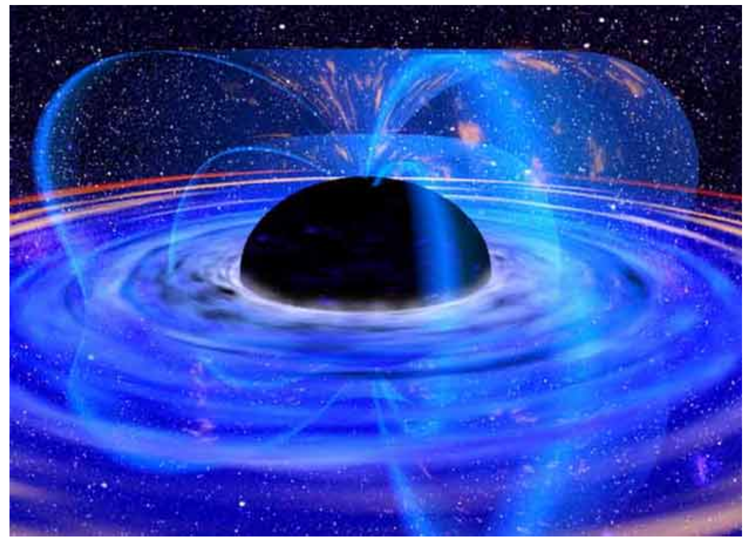
Why is it necessary for a thermonuclear fuel to get hot to burn? - charge repulsion § 2.1 & 2.2

Core Collapse § 2.4 & 2.5

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

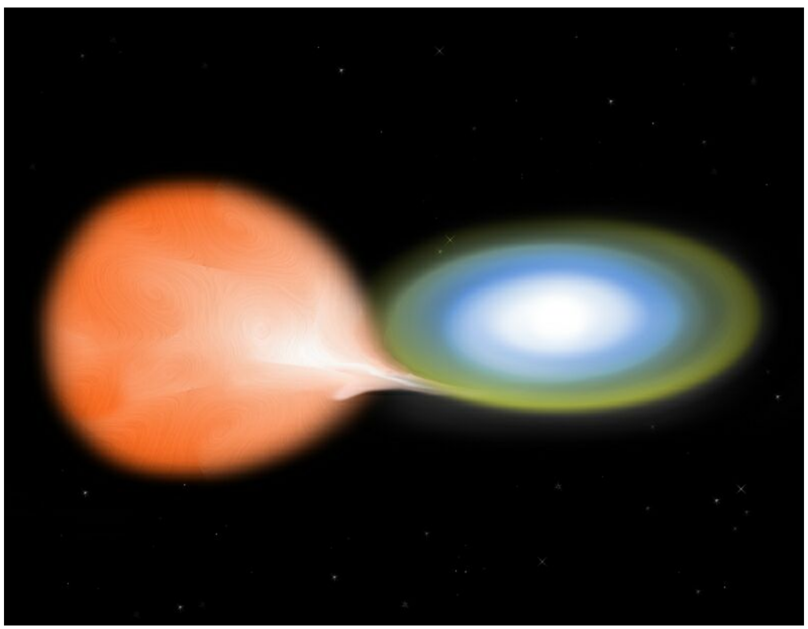
a ***neutron star***, or perhaps a ***black hole***



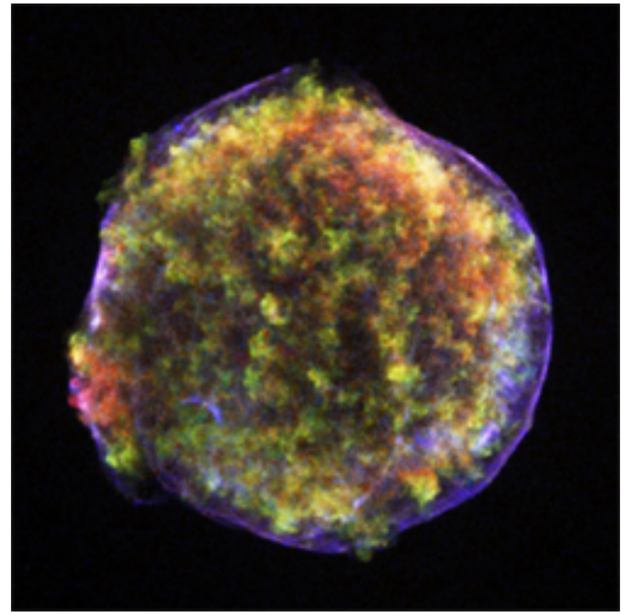


*The mechanism of the explosion is still a mystery.*

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.

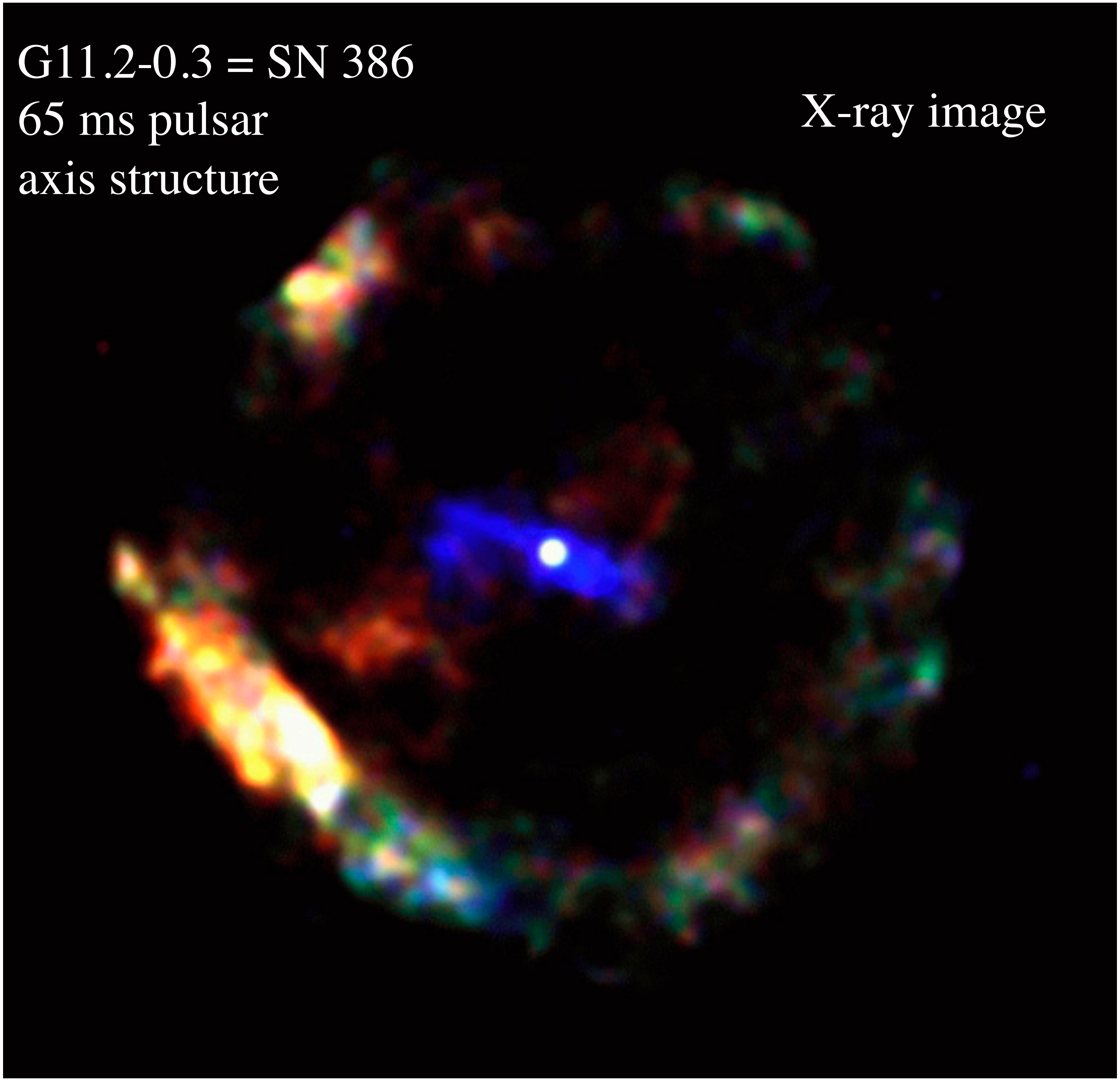
# Chapter 6 Supernovae

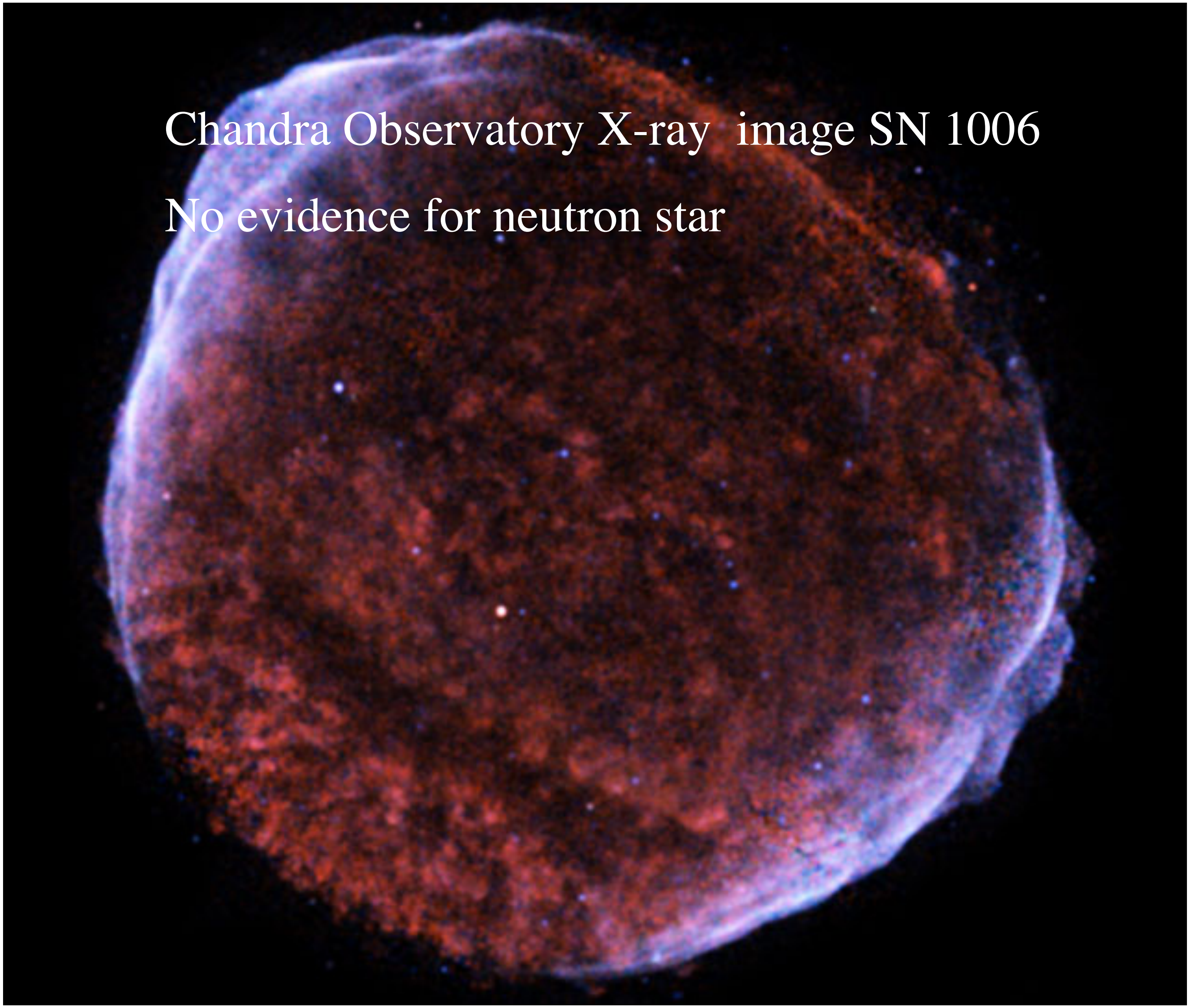
Historical Supernovae - ***in our Milky Way Galaxy*** observed with naked eye over 2000 years especially by Chinese (preserved records), but also Japanese, Koreans, Arabs, Native Americans(?), finally Europeans.

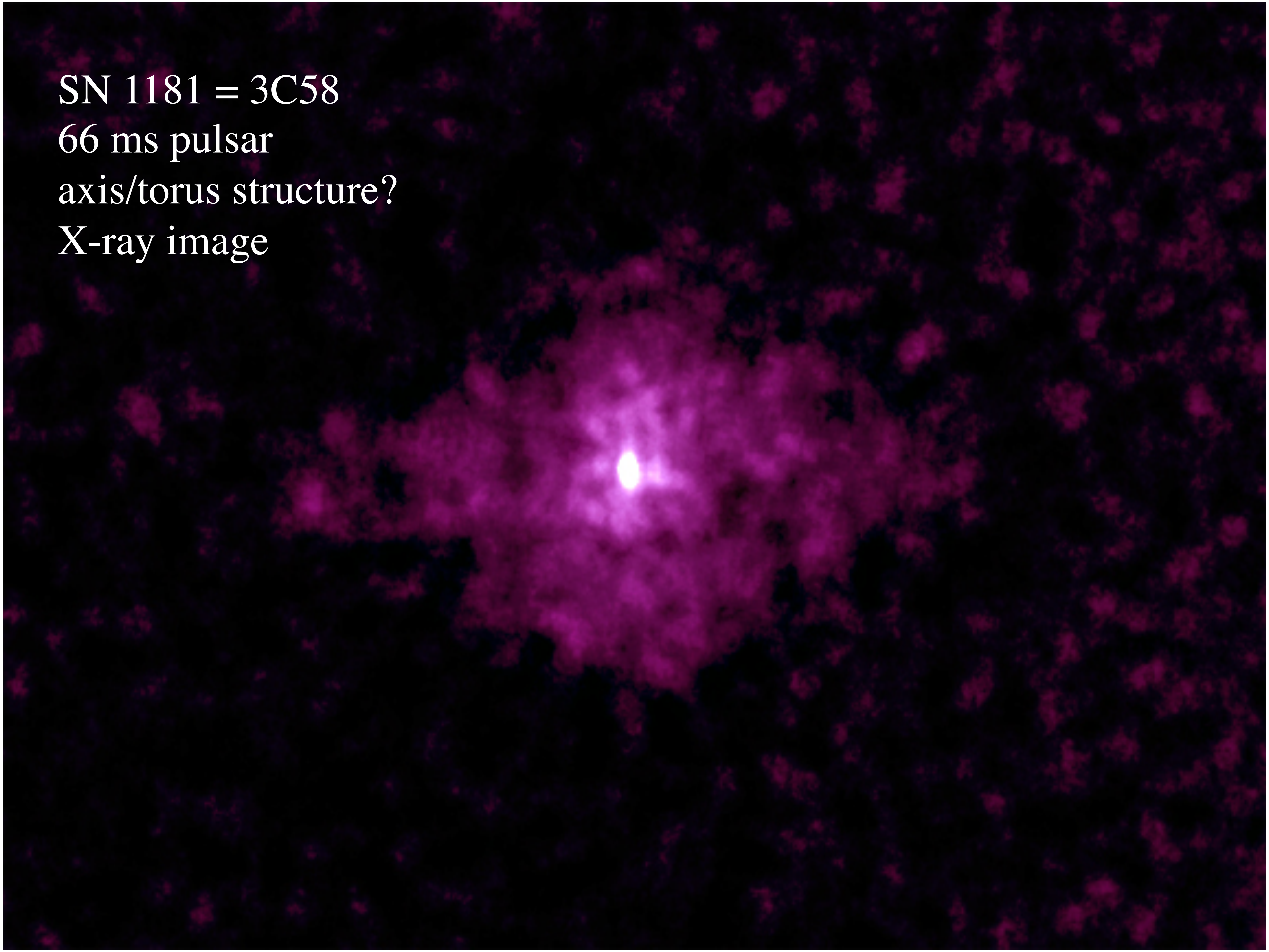
| | | |
|---|---|---|
| SN 185 | earliest record | No NS |
| SN 386 | | NS, jet? |
| SN 1006 | brightest | No NS |
| SN 1054 | Crab Nebula | NS, jets |
| SN 1181 | (Radio Source 3C58) | NS, jets |
| SN 1572 | Tycho | No NS |
| SN 1604 | Kepler | No NS |
| ~1680 | Cas A | NS? Jets |
| SN 1987A | nearby galaxy | NS? jets |

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

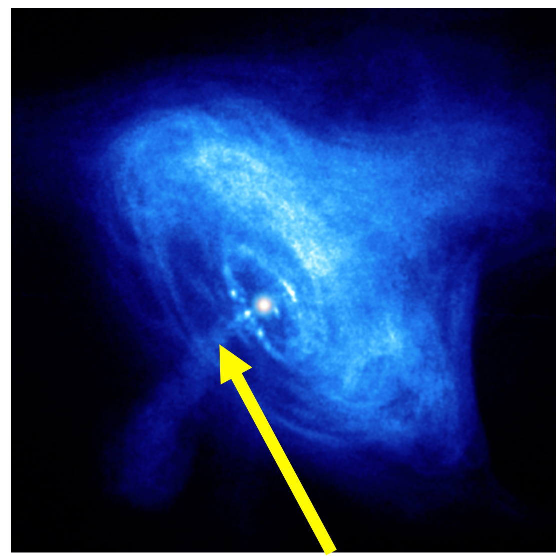

SN 1181 = 3C58
66 ms pulsar
axis/torus structure?
X-ray image

# Crab Nebula

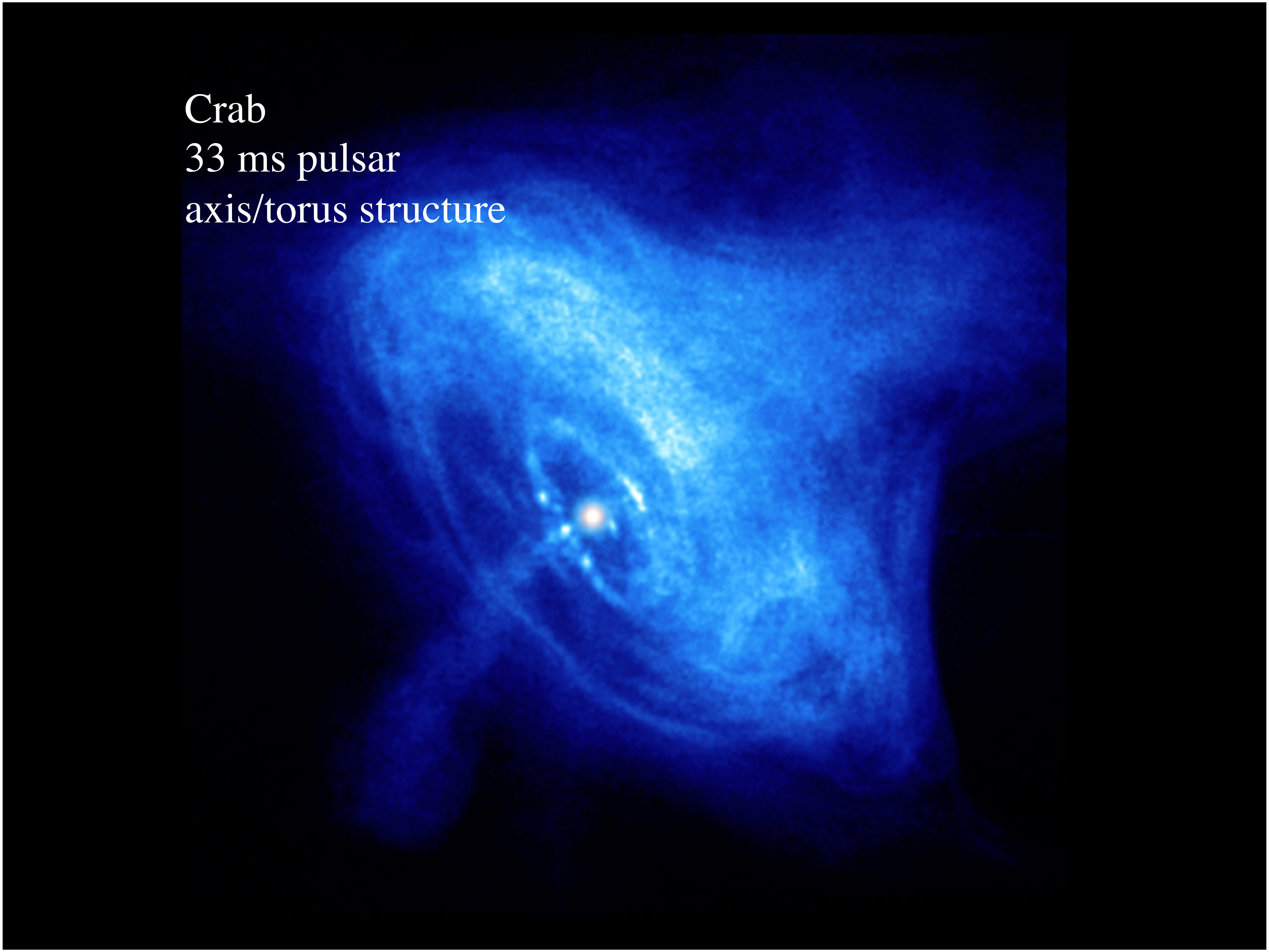
## Remnant of “Chinese” Guest Star of 1054

Optical Image

Chandra Observatory X-Ray Image



Left-over jet

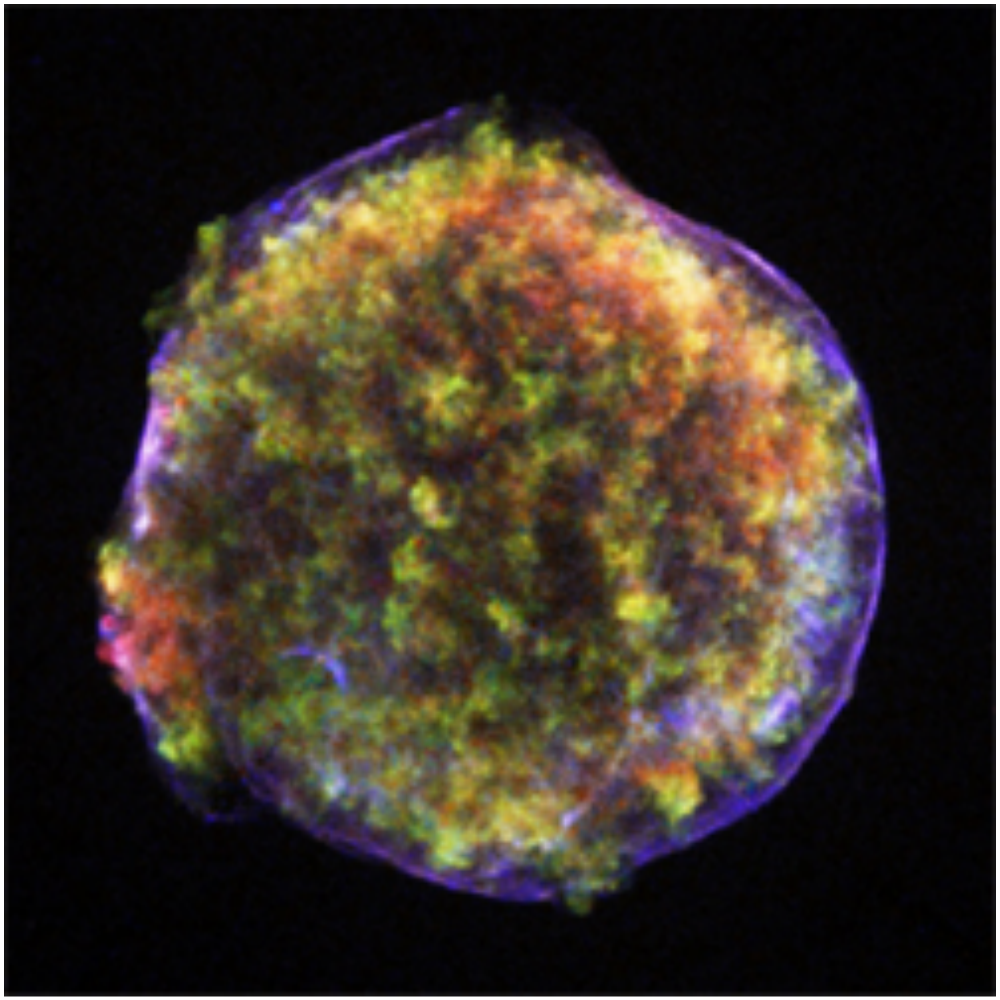

Crab
33 ms pulsar
axis/torus structure

# Kepler

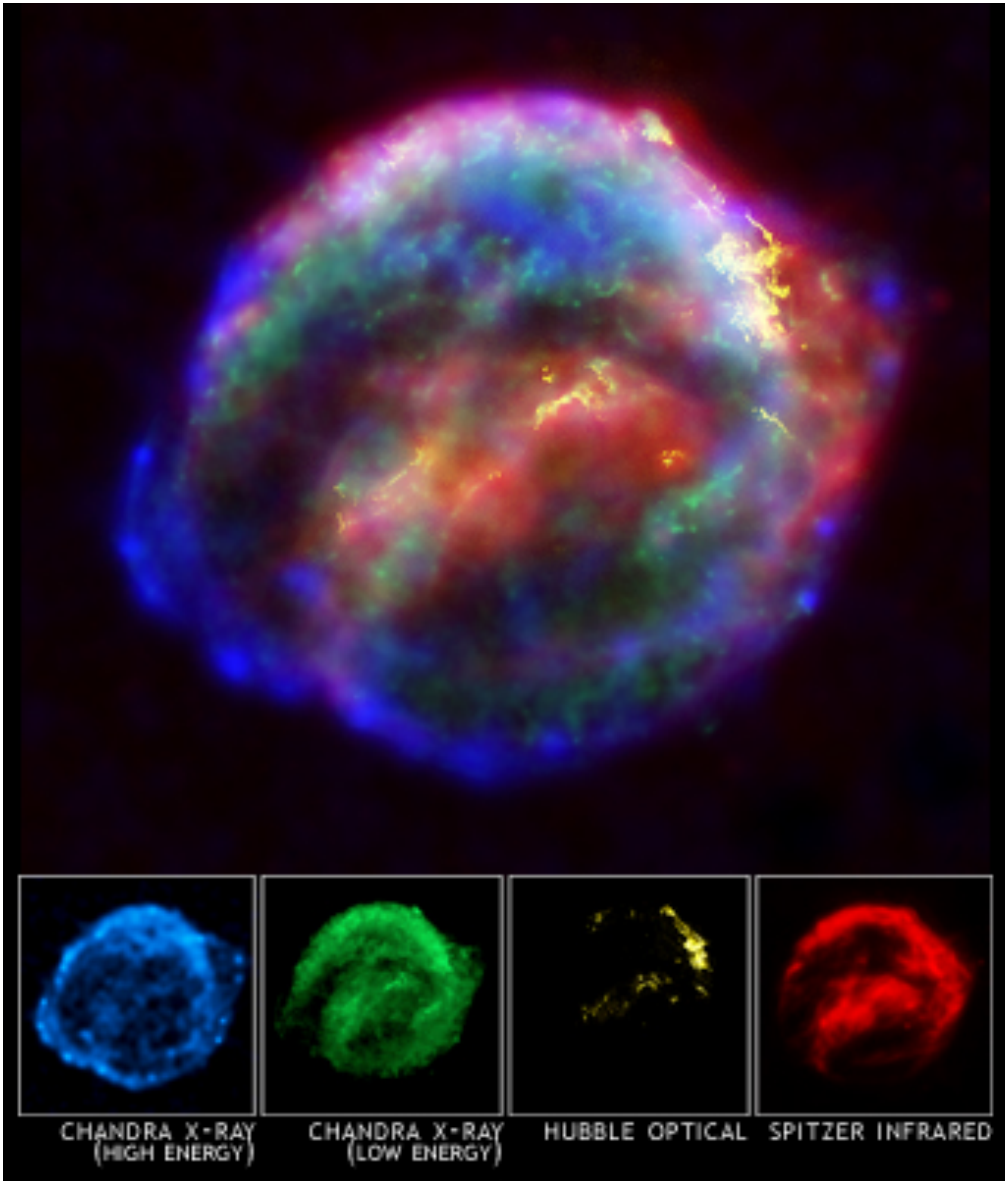
Tycho

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

No evidence for neutron star



SN 1006

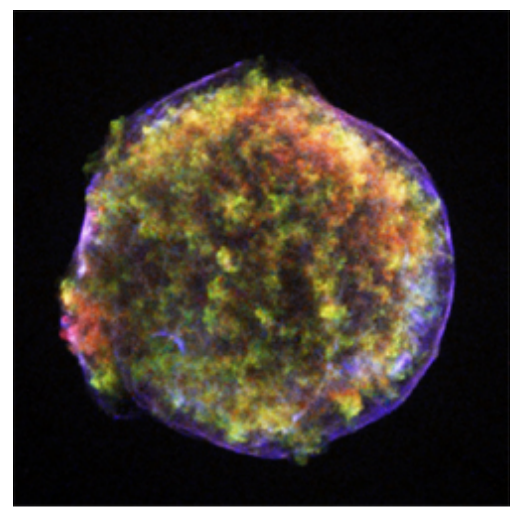



Great Observatories composite of Kepler's supernova 1604

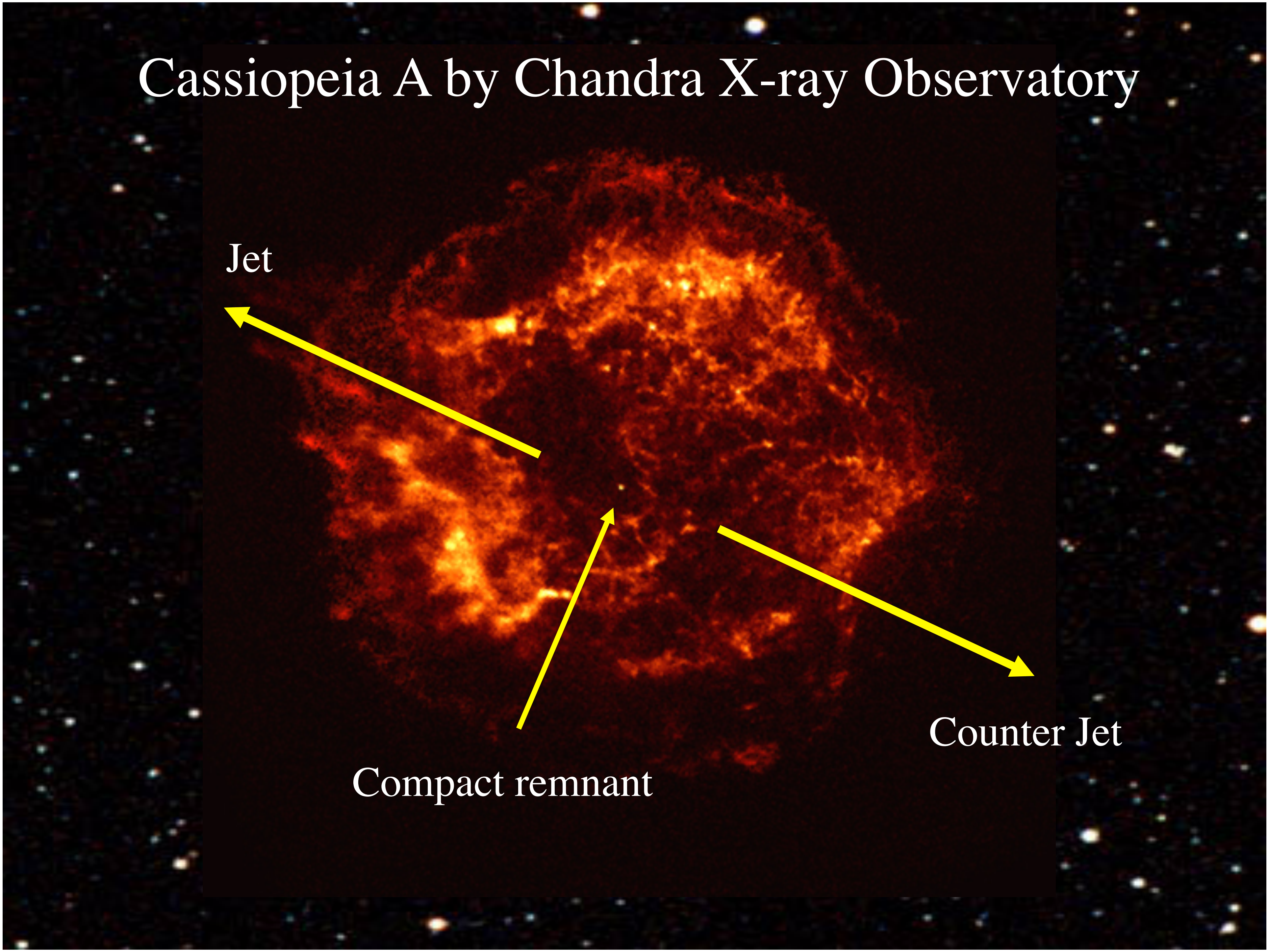
No sign of neutron star

"sideways" alignment?

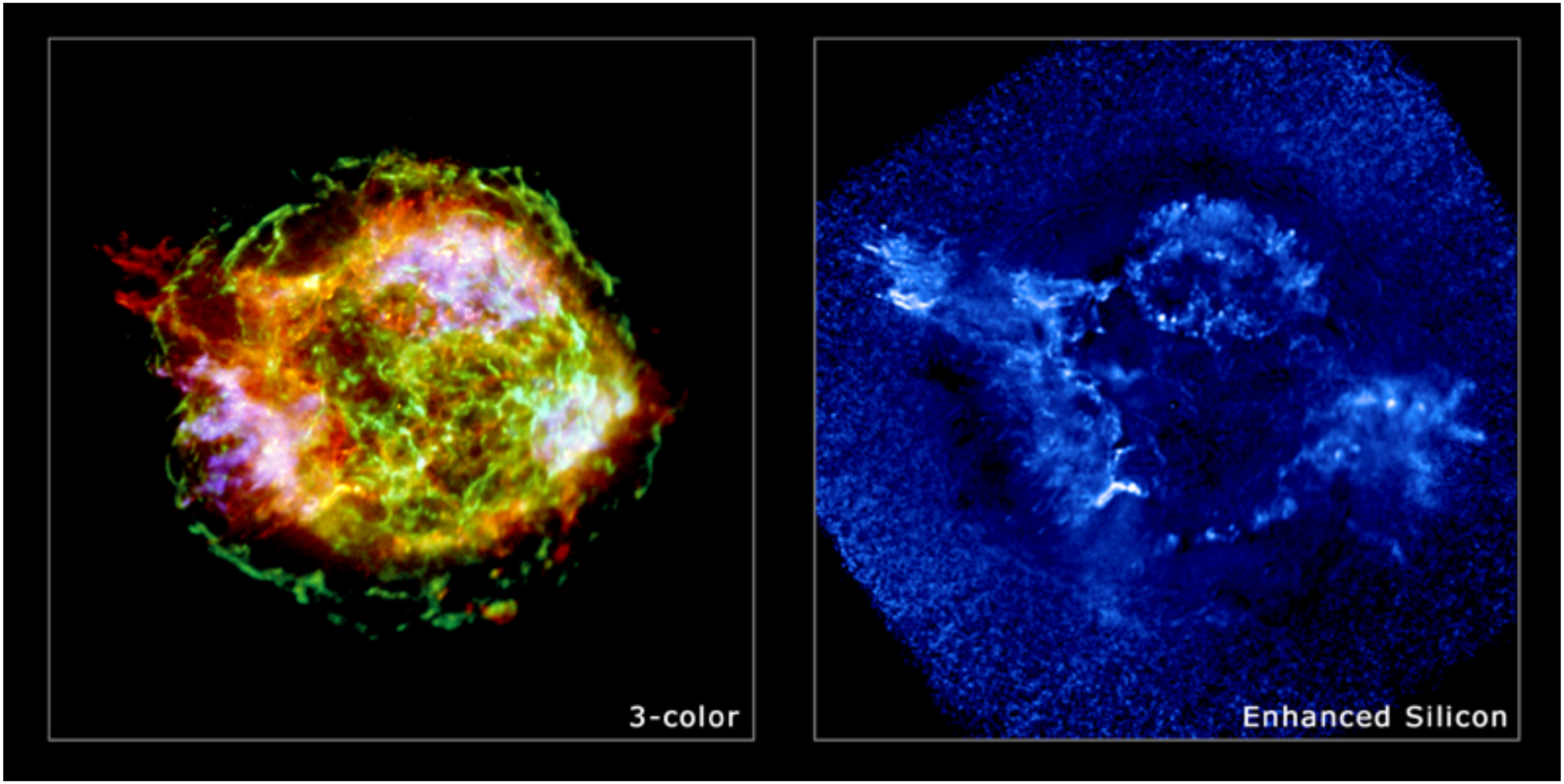
SN 1572 Tycho

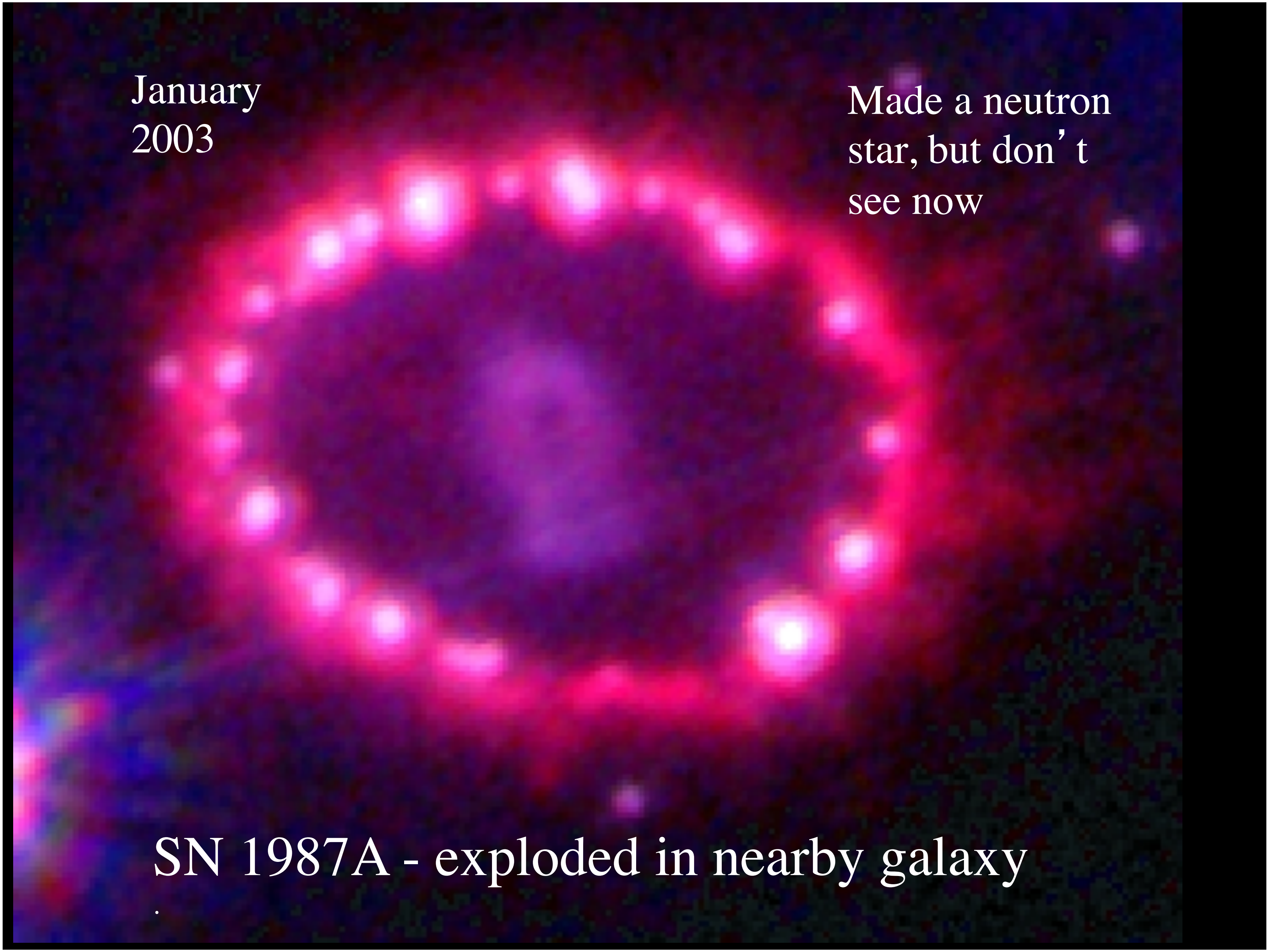


# Cassiopeia A by Chandra X-ray Observatory



# Chandra Observatory X-ray Image of Cas A




January
2003
Made a neutron
star, but don't
see now
SN 1987A - exploded in nearby galaxy

*Sky Watch Extra Credit - location of 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*

## *Betelgeuse - Orion, Red Supergiant due to explode "soon" 15 solar masses*

*Antares - Bright Red Supergiant in Scorpius, 15 to 18 solar masses (+companion)*

*Rigel - Orion, Blue Supergiant due to explode later, 17 solar masses*

*U Sco - Scorpius, possible white dwarf supernova progenitor.*

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

Discussion point: What's going on here?