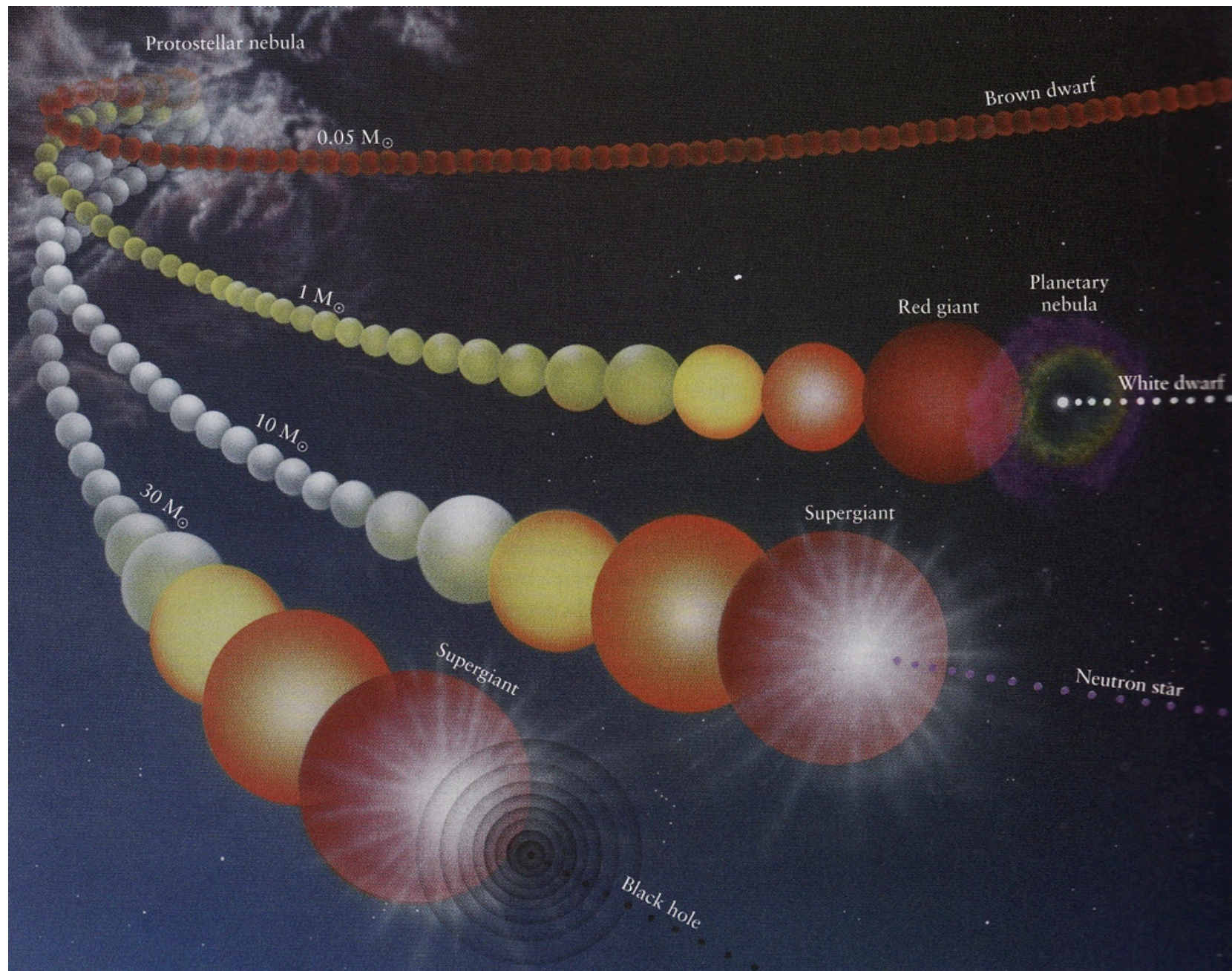


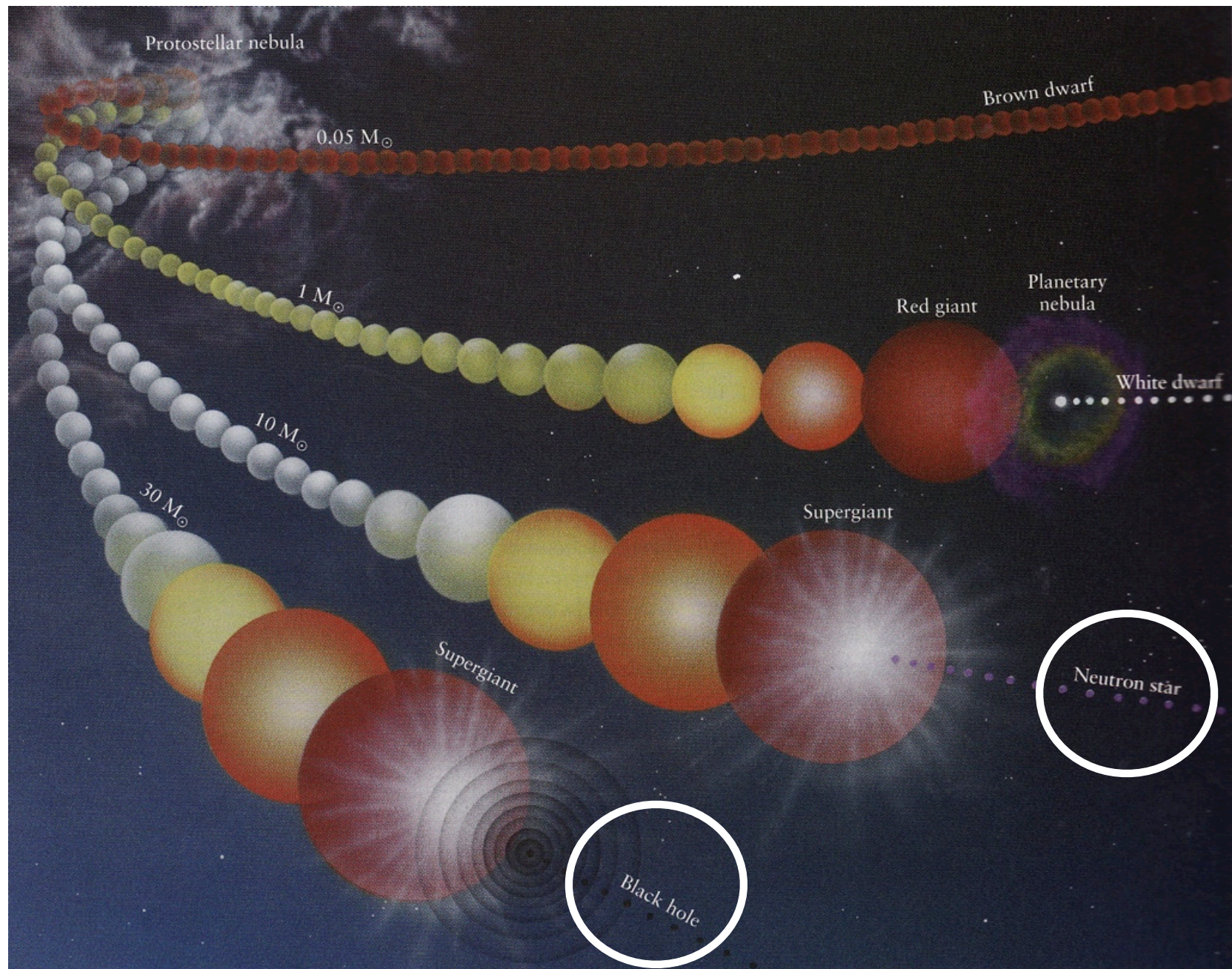
Inventory of Compact Objects in the Universe



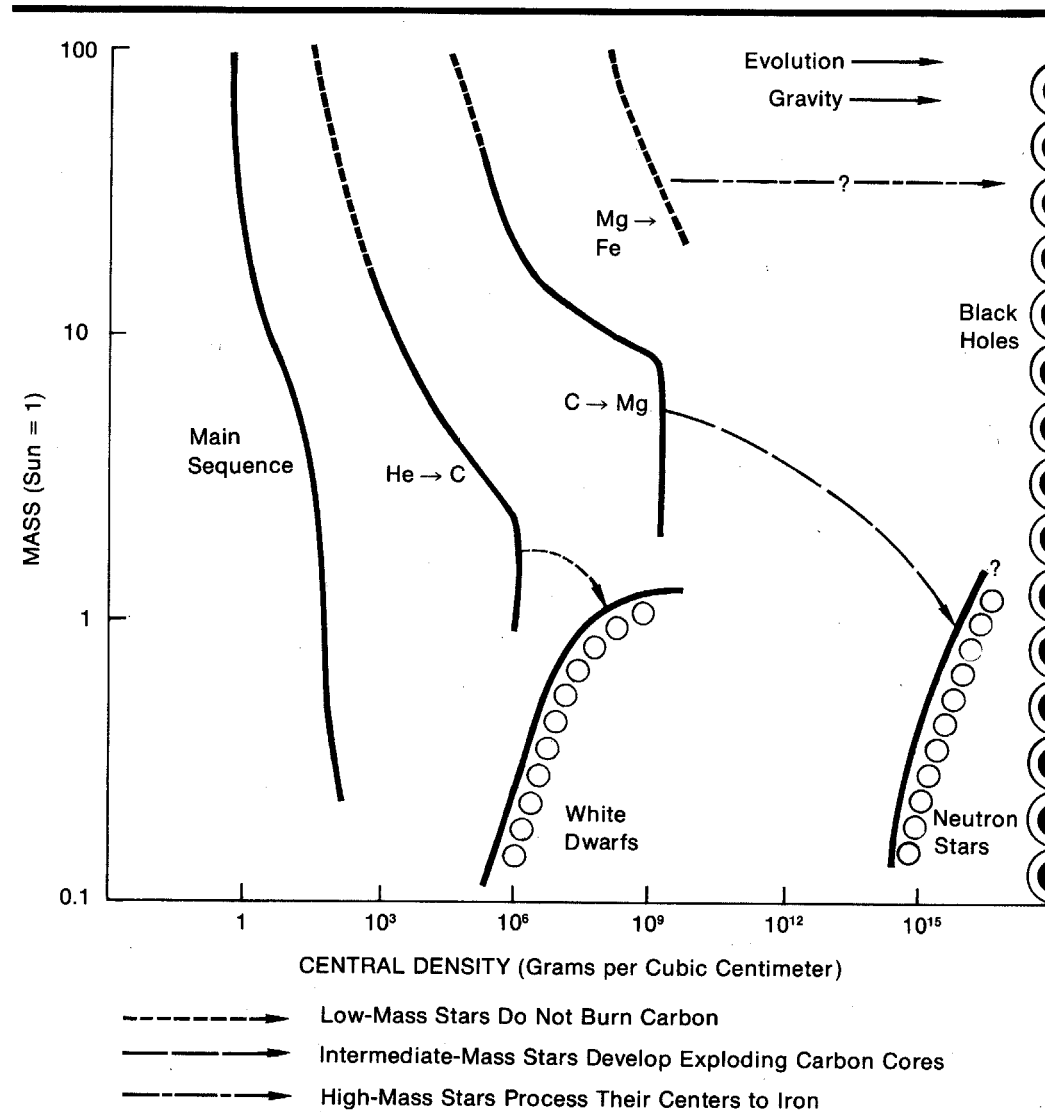
structures: compact objects



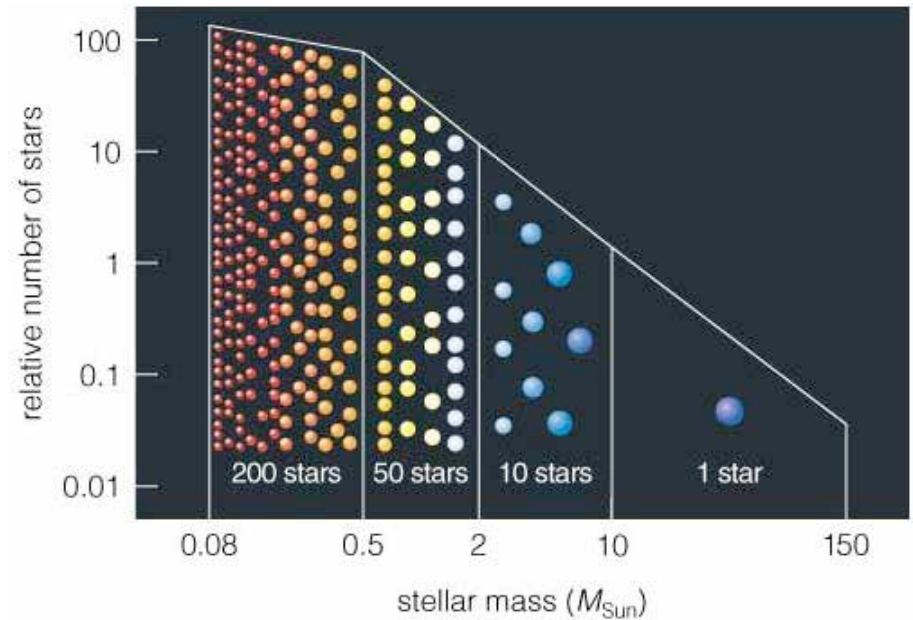
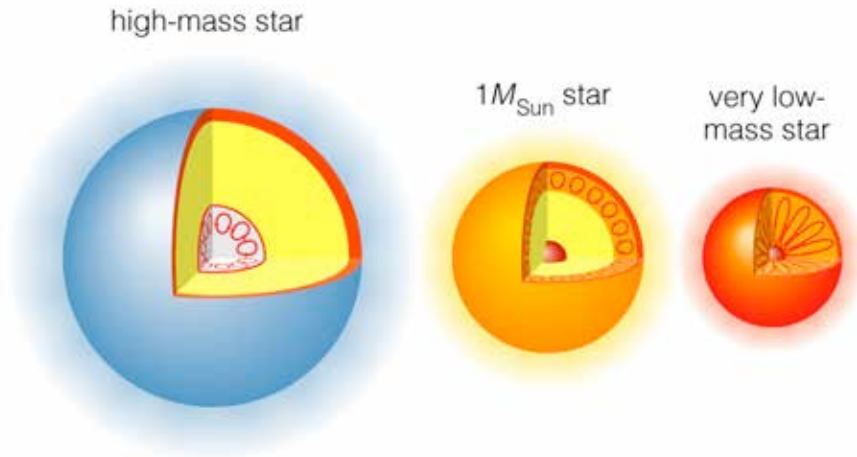
structures: compact objects



structures: compact objects



stellar evolution: initial mass function



$$dN/dM \propto M^{-2.35} \text{ in the range } M \in 0.4 - 100M_{\odot}.$$

The Milky Way Galaxy



$\approx 10^{11}$ *stars*

Compact Objects in our Galaxy

Find the fraction of stars formed with $M > 8M_{\odot}$. How many NS and BHs should there be in the galaxy?

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The total number of compact objects, is thus

$$N_8 \times N_{\text{galaxies}} \approx 2 \times 10^{19}$$

Supernovae in our Galaxy

Find the supernova rate in our galaxy.



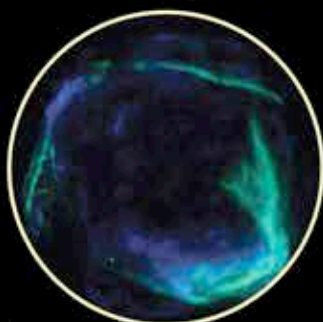
The Milky Way has formed stars at a rate of about

$$\mathcal{R} \approx 1M_{\odot}/\text{yr}$$

implying a rate of compact objects of about

$$f_8 \mathcal{R} \approx 10^{-2} \text{yr}^{-1}$$

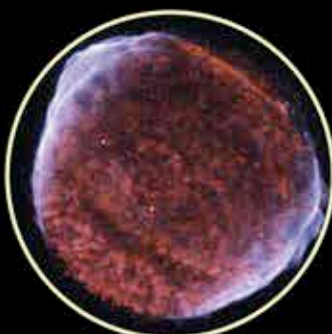
Supernovae in the Galaxy



A.D. 185

RCW 86

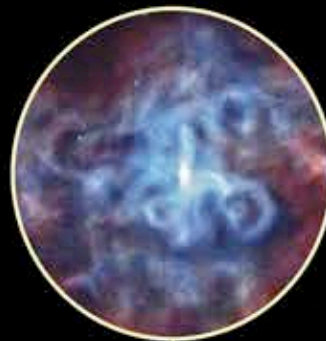
Historical Observers: Chinese
Likelihood of Identification: Possible
Distance Estimate: 8,200 light years
Type: Core collapse of massive star



A.D. 393

SN 1006

Historical Observers: Chinese, Japanese, Arabic, European
Likelihood of Identification: Definite
Distance Estimate: 7,000 light years
Type: Thermonuclear explosion of white dwarf



A.D. 1054

3C58

Historical Observers: Chinese, Japanese
Likelihood of Identification: Possible
Distance Estimate: 10,000 light years
Type: Core collapse of massive star



A.D. 1680

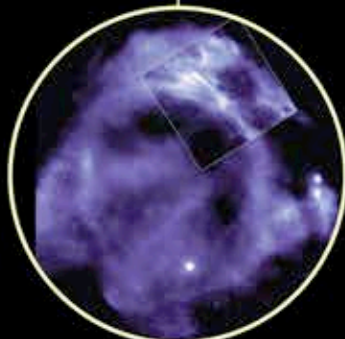
Cassiopeia A

Historical Observers: European?
Likelihood of Identification: Unlikely
Distance Estimate: 10,000 light years
Type: Core collapse of massive star

A.D. 386

G347.3-0.5

Historical Observers: Chinese
Likelihood of Identification: Possible
Distance Estimate: 3,000 light years
Type: Core collapse of massive star



A.D. 1006



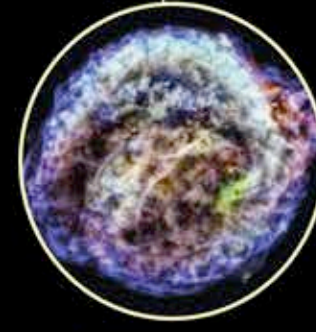
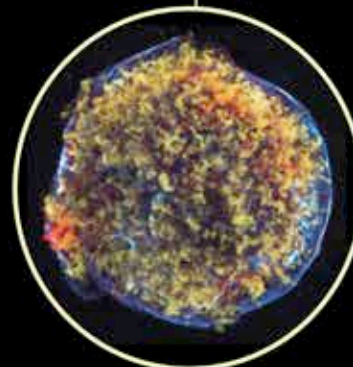
Crab Nebula

Historical Observers: Chinese, Japanese, Arabic, Native American
Likelihood of Identification: Definite
Distance Estimate: 6,000 light years
Type: Core collapse of massive star

A.D. 1572

Tycho's SNR

Historical Observers: European, Chinese, Korean
Likelihood of Identification: Definite
Distance Estimate: 7,500 light years
Type: Thermonuclear explosion of white dwarf



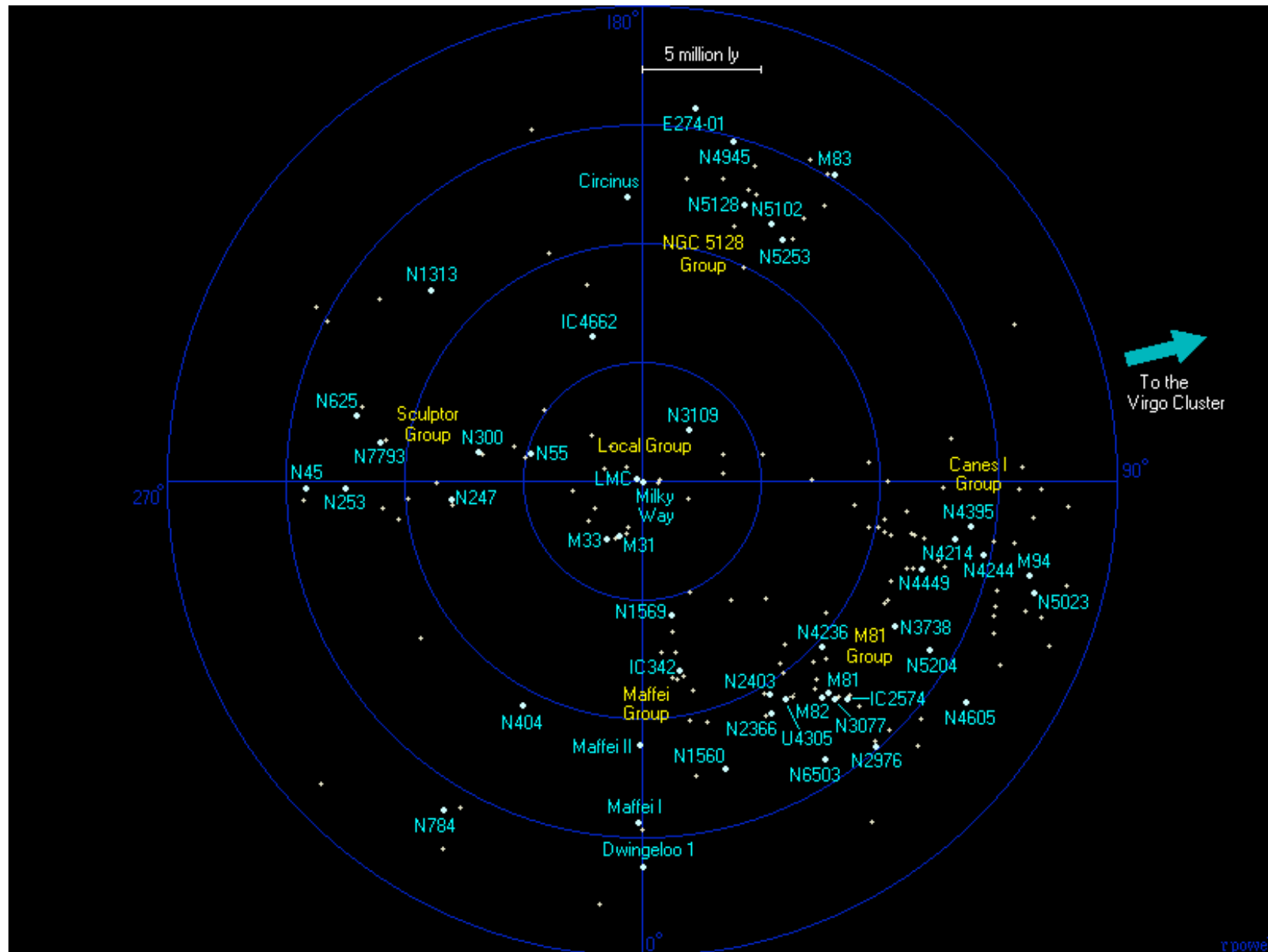
A.D. 1604

Kepler's SNR

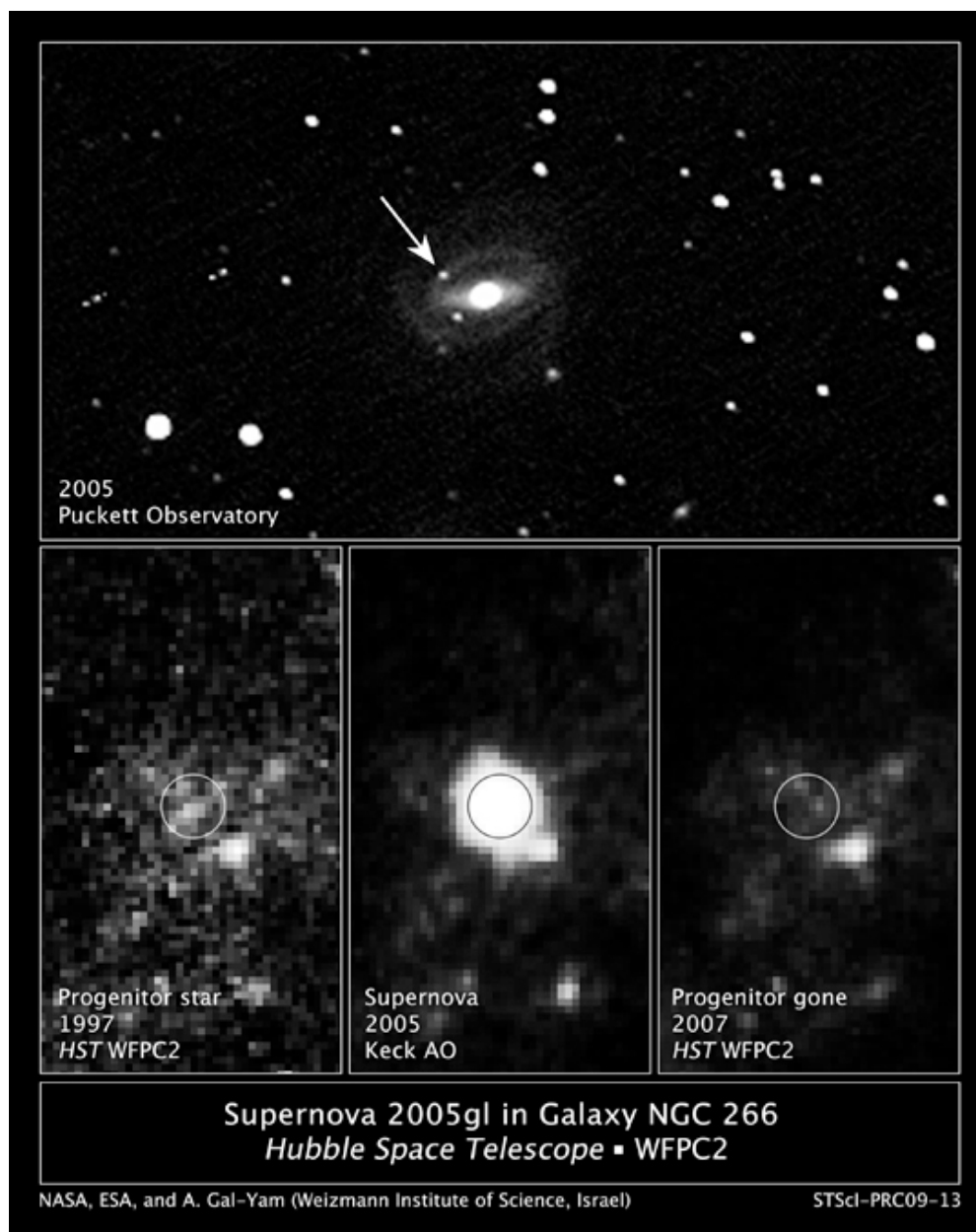
Historical Observers: European, Chinese, Korean
Likelihood of Identification: Definite
Distance Estimate: 13,000 light years
Type: Thermonuclear explosion of white dwarf?

* LIGHT YEAR: the distance that light, moving at a constant speed of 300,000 km/s, travels in one year. One light year is just under 10 trillion kilometers.

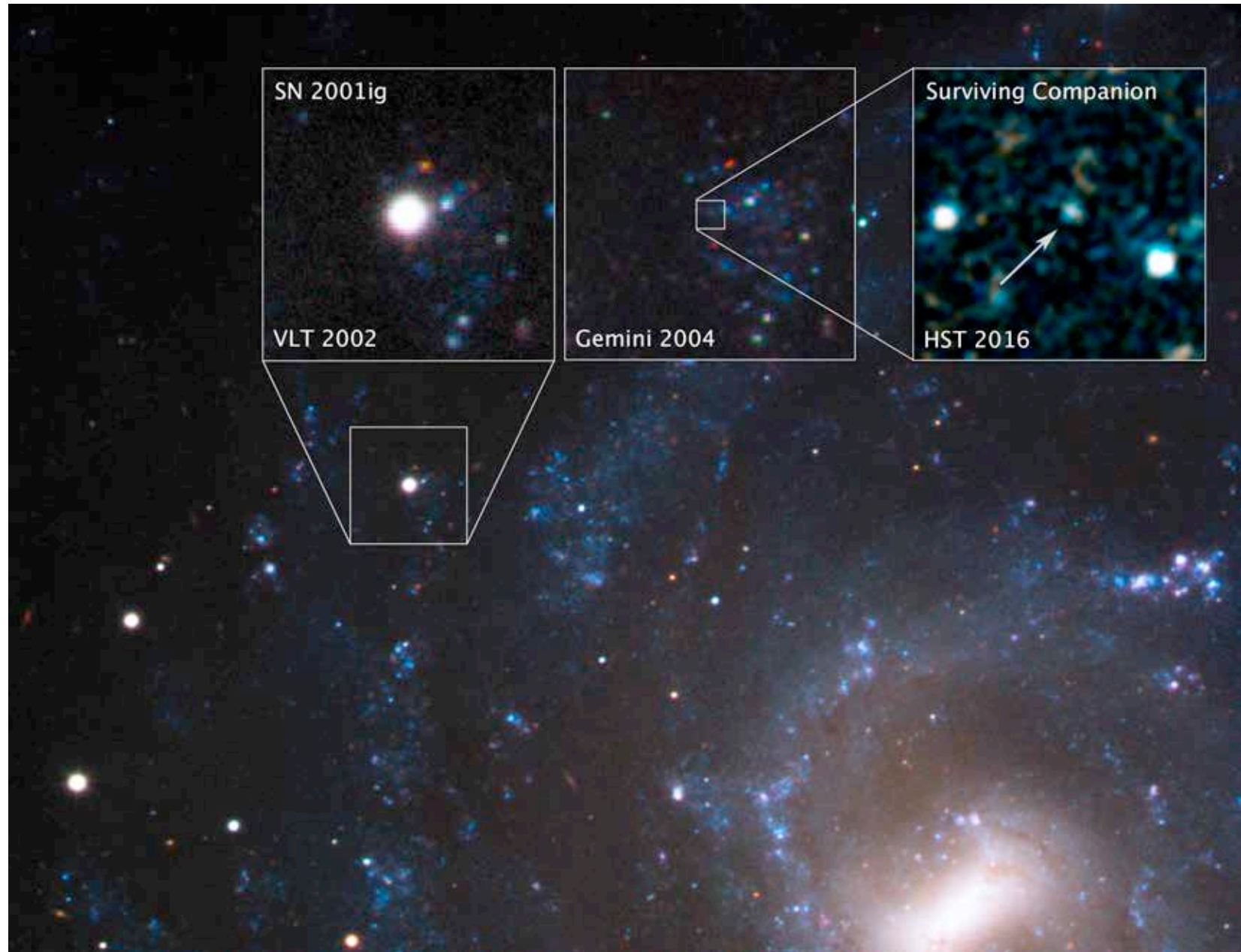
Supernovae in the Nearby Universe



Supernovae in the Nearby Universe



Supernovae in the Nearby Universe



Iron Production in the Milky Way

Assume that every stellar core collapse distributed $0.05M_{\odot}$ of iron into the interstellar medium. If the MW started with $5 \times 10^{10}M_{\odot}$ of gas, what is the mean interstellar mass abundance of iron in the Galaxy?

Description	Solar value
Hydrogen mass fraction	$X_{\text{sun}} = 0.7381$
Helium mass fraction	$Y_{\text{sun}} = 0.2485$
Metallicity	$Z_{\text{sun}} = 0.0134$

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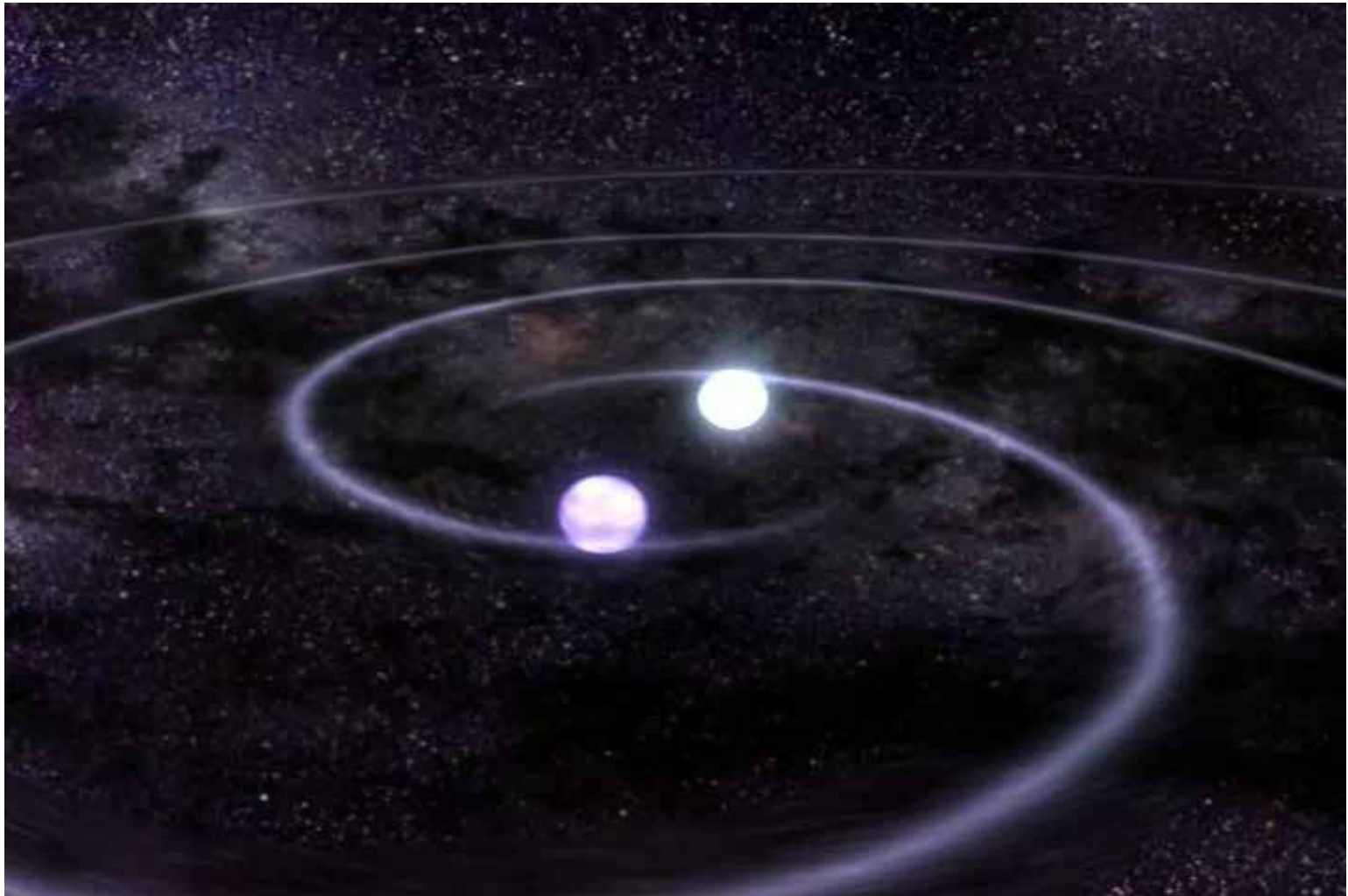
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From the previous problem, we can expect the number of supernovae to have been about 2×10^9 , distributing a total of $M_{Fe} \approx 10^8M_{\odot}$. Comparing this with the total initial amount of gas, yields a primordial mass abundance of $Z_{Fe} \approx 0.002$. This abundance is only slightly greater than that of the sun.

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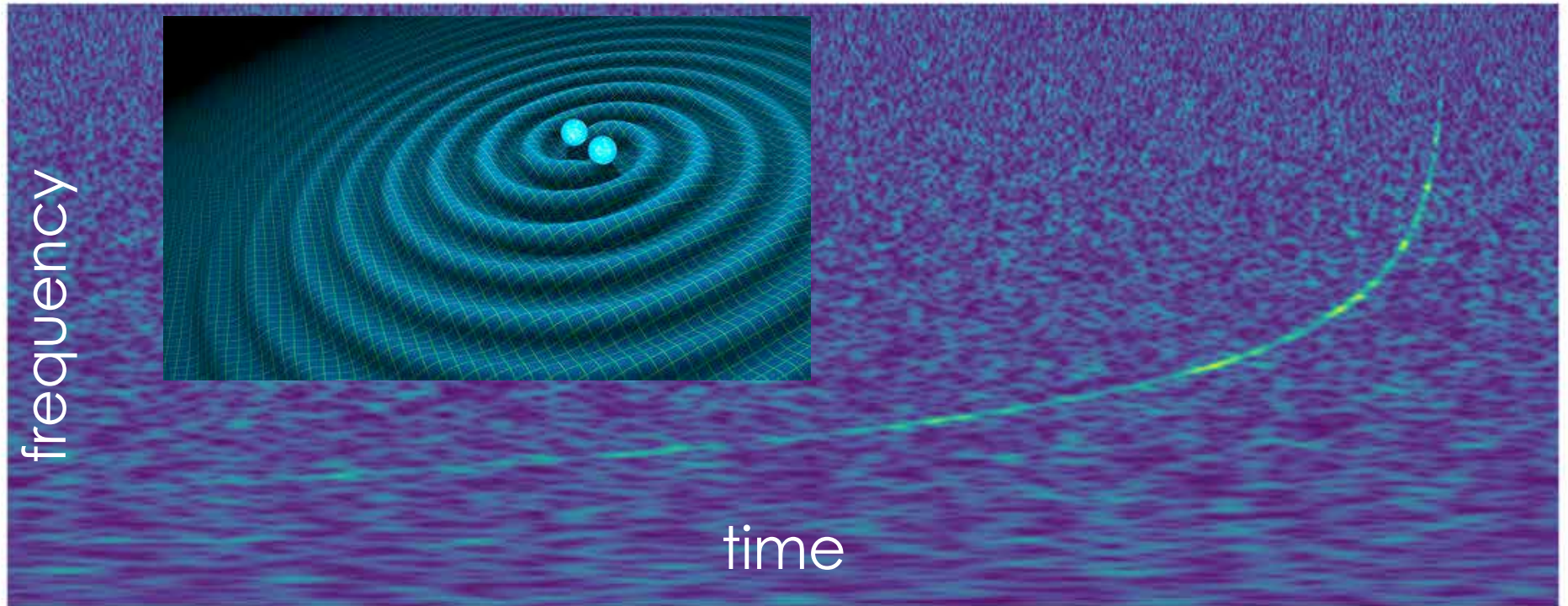
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This suggests that there may be about 7×10^6 NS-NS, NS-BH and BH-BH binaries in the galaxy.

Merging Compact Objects

The number of LIGO NS-NS binaries is derived to be 10^{-5}yr^{-1} per galaxy



This implies that about 1/70 of all the binaries we estimate to exist in the galaxy will merge