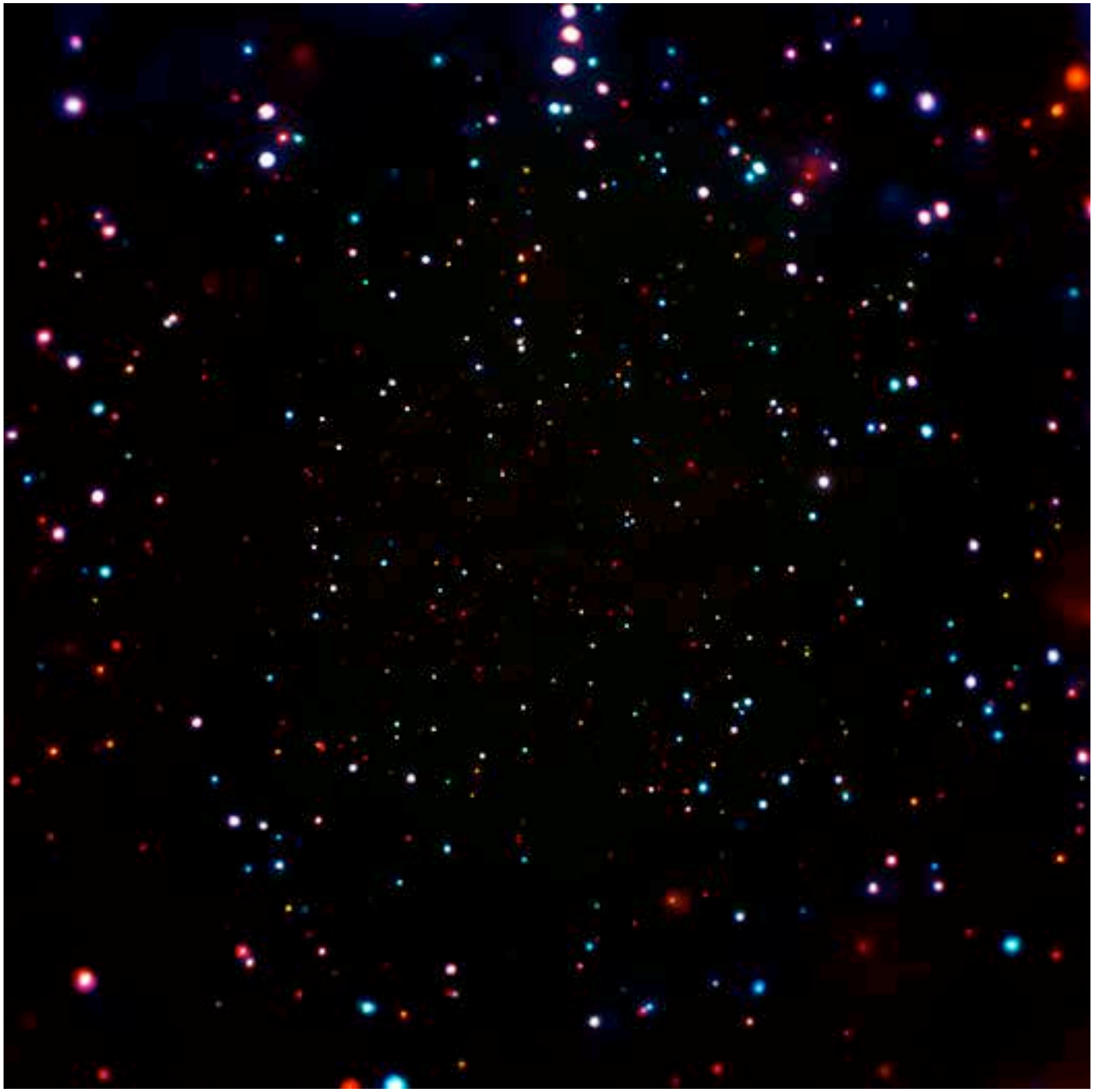
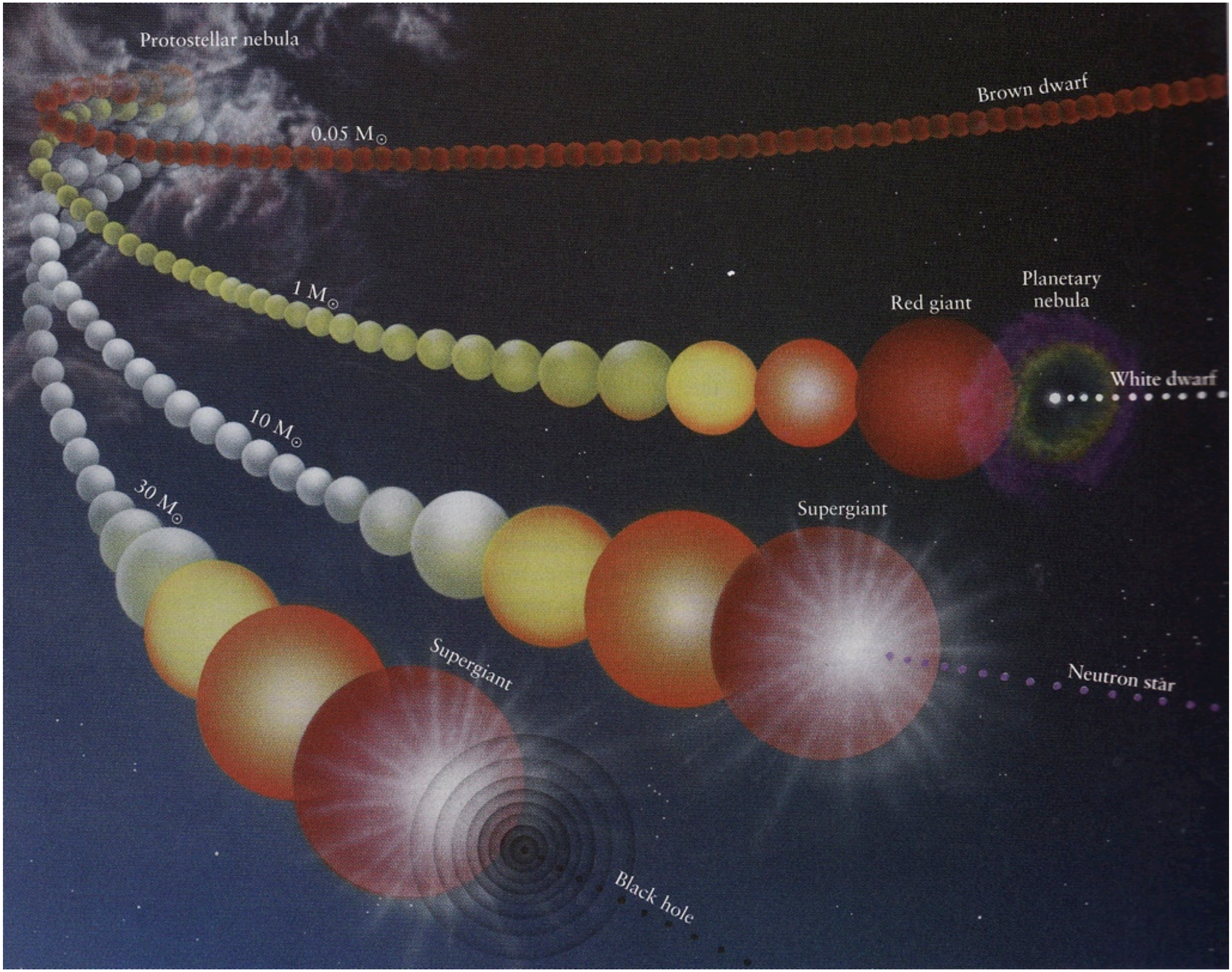
Inventory of Compact Objects in the Universe



structures: compact objects



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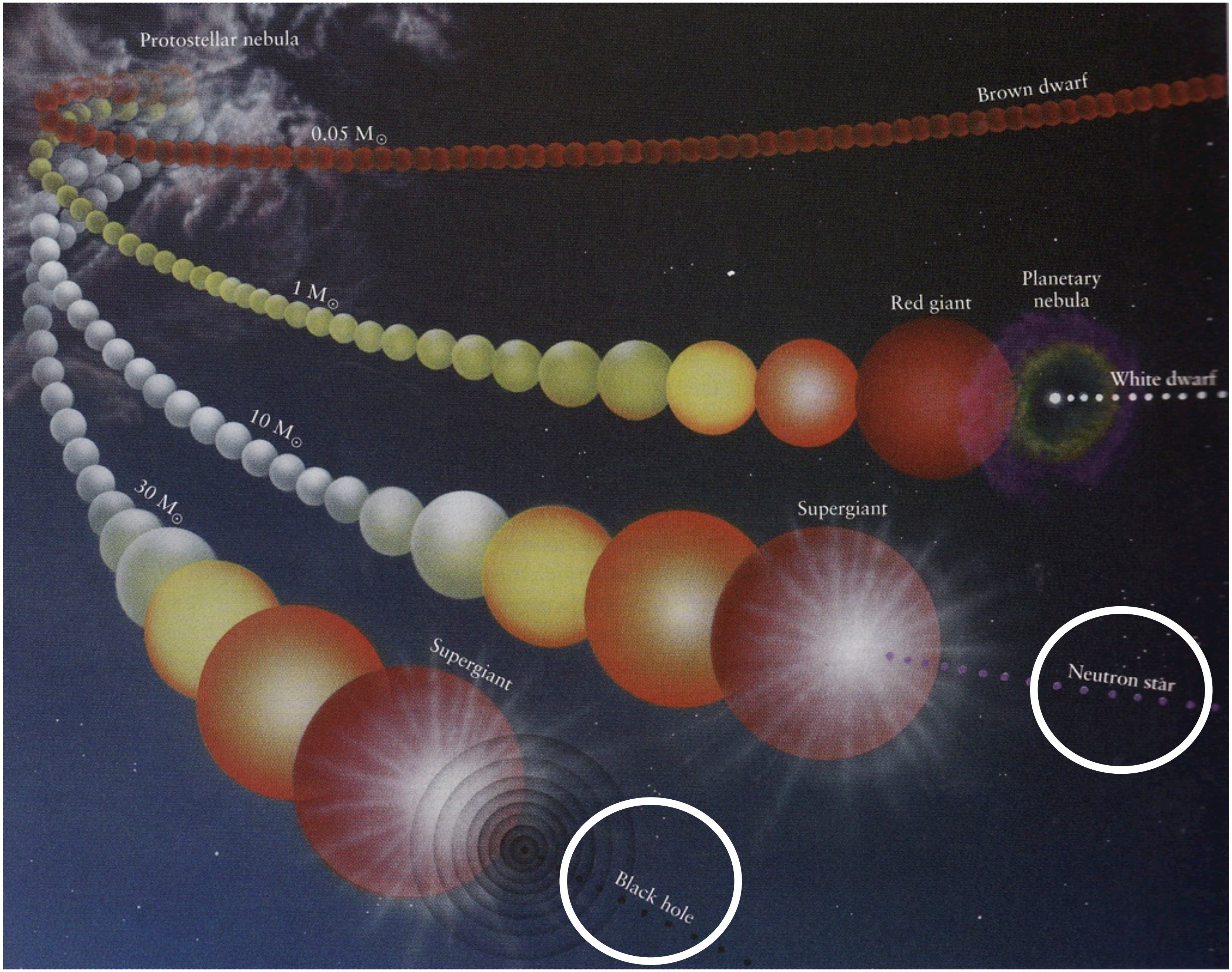

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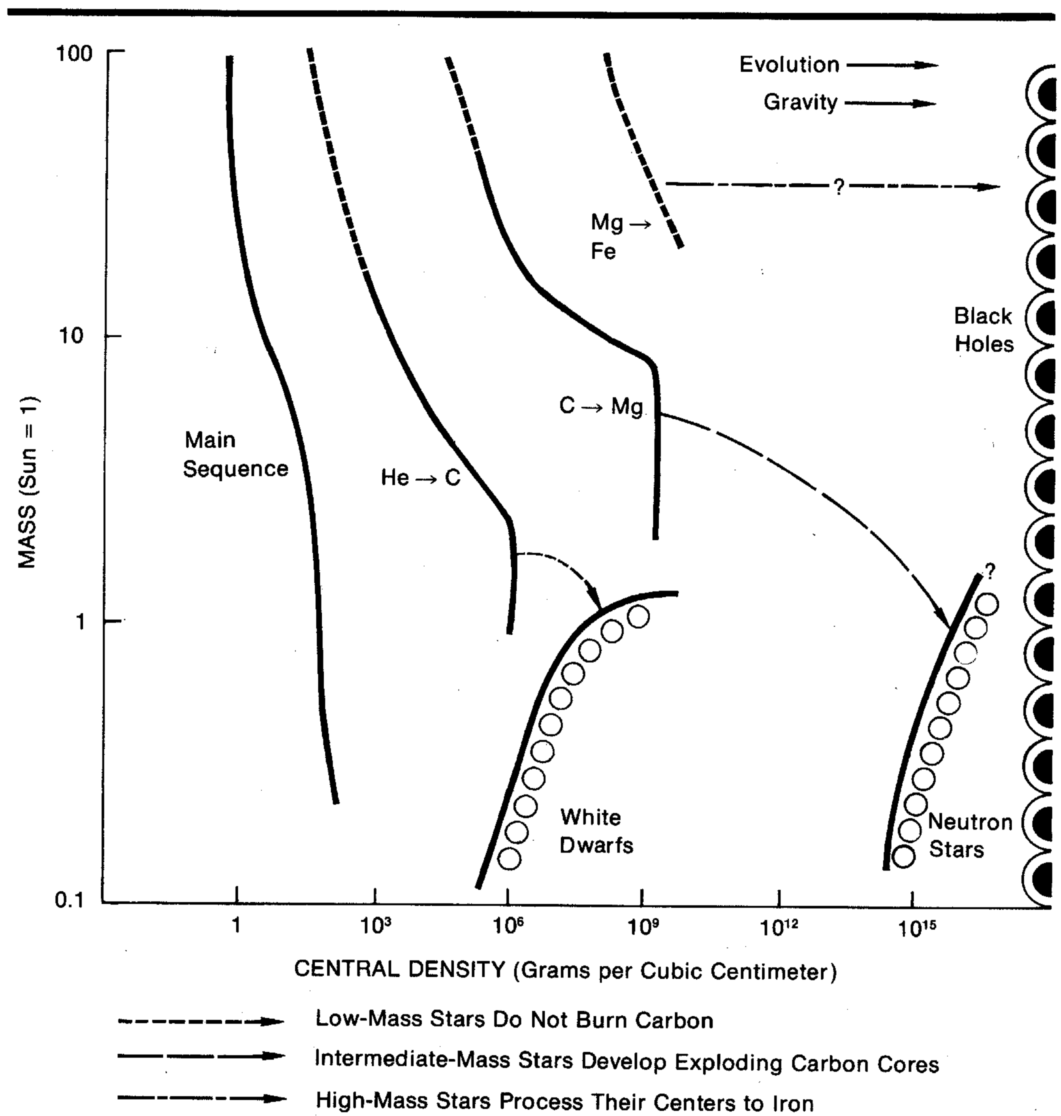
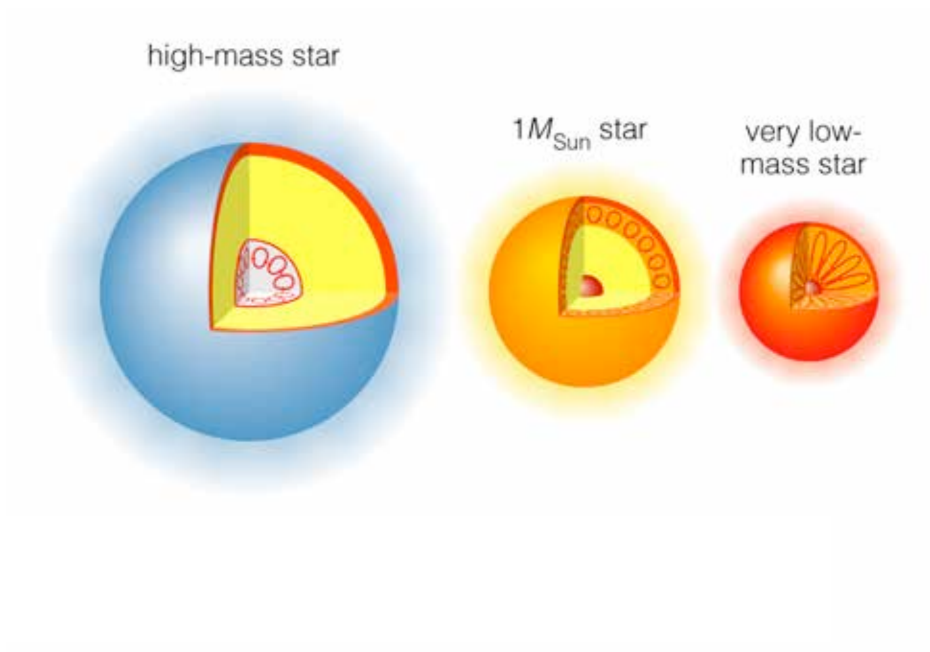
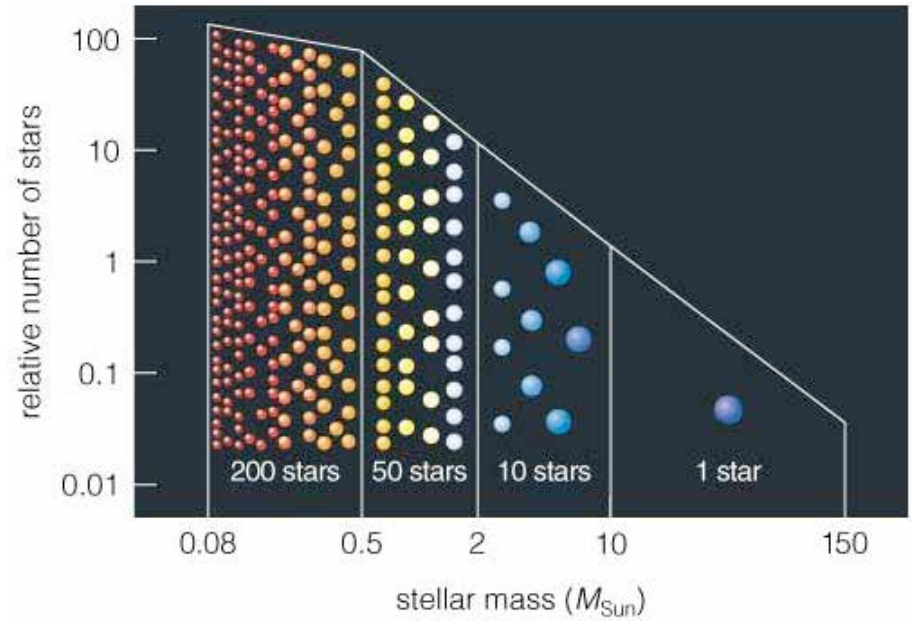


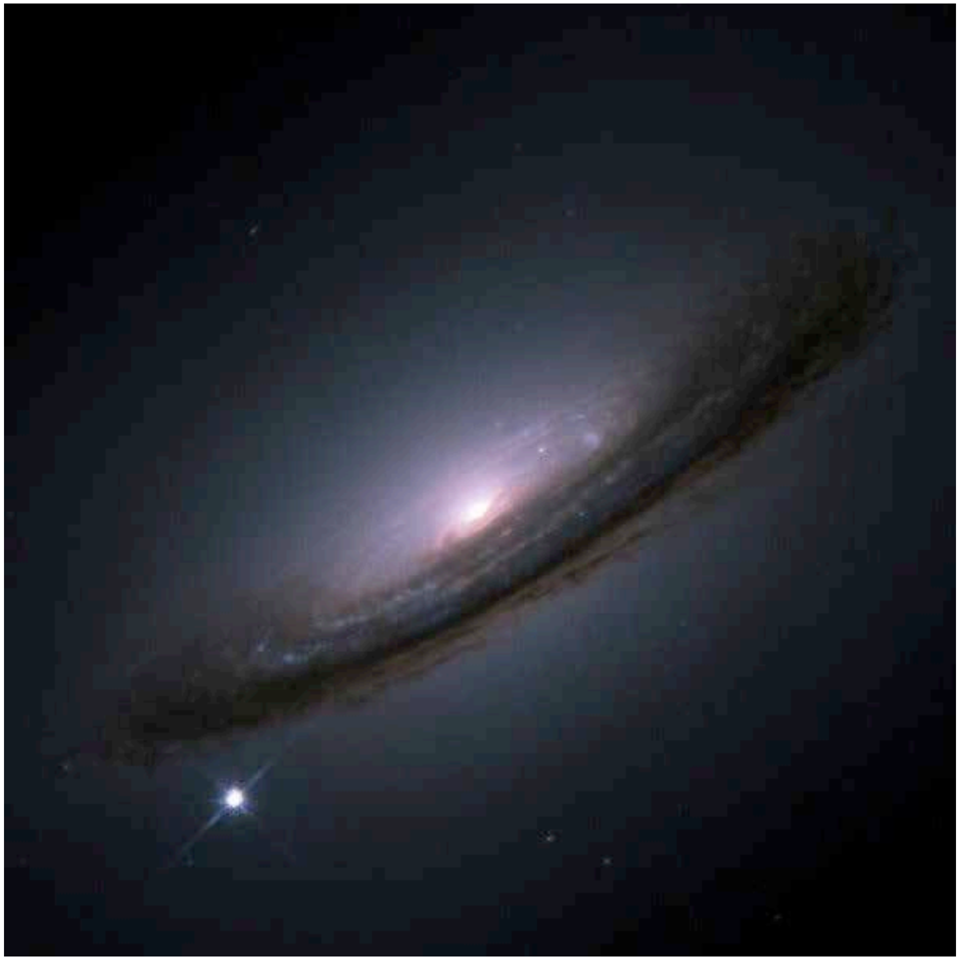
stellar evolution: initial mass function





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

The Milky Way Galaxy



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

Compact Objects in our Galaxy

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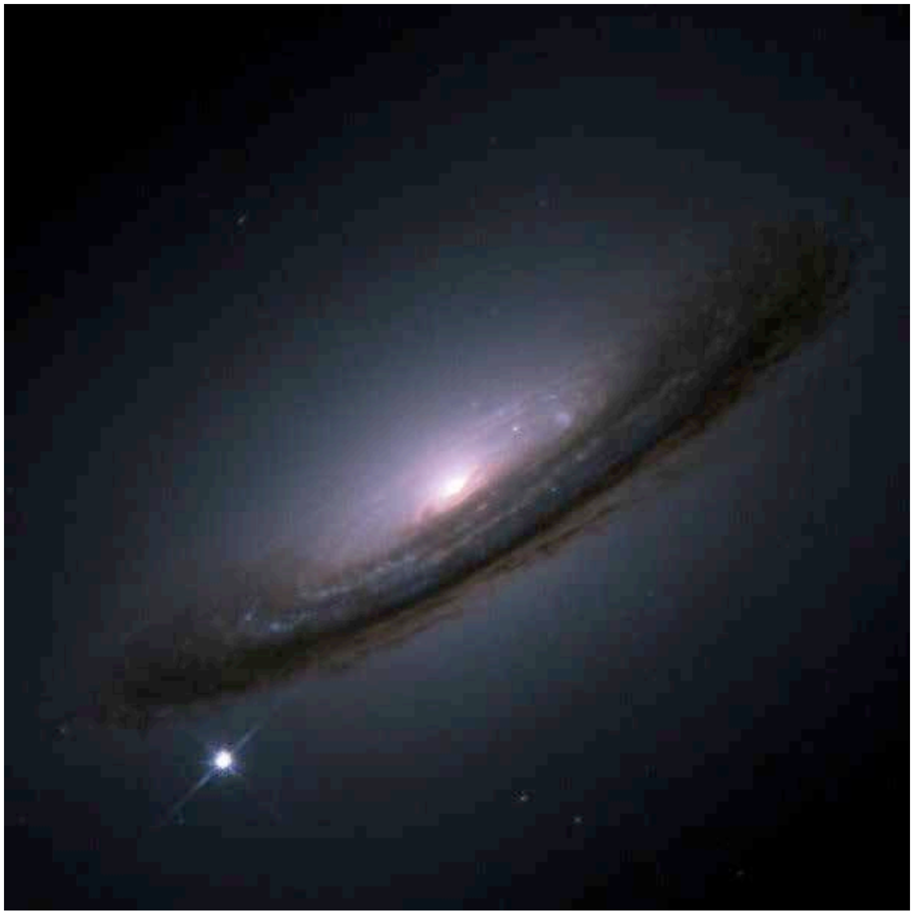
The total number of compact objects, is thus

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

Supernovae in our Galaxy

Find the supernova rate in our galaxy.



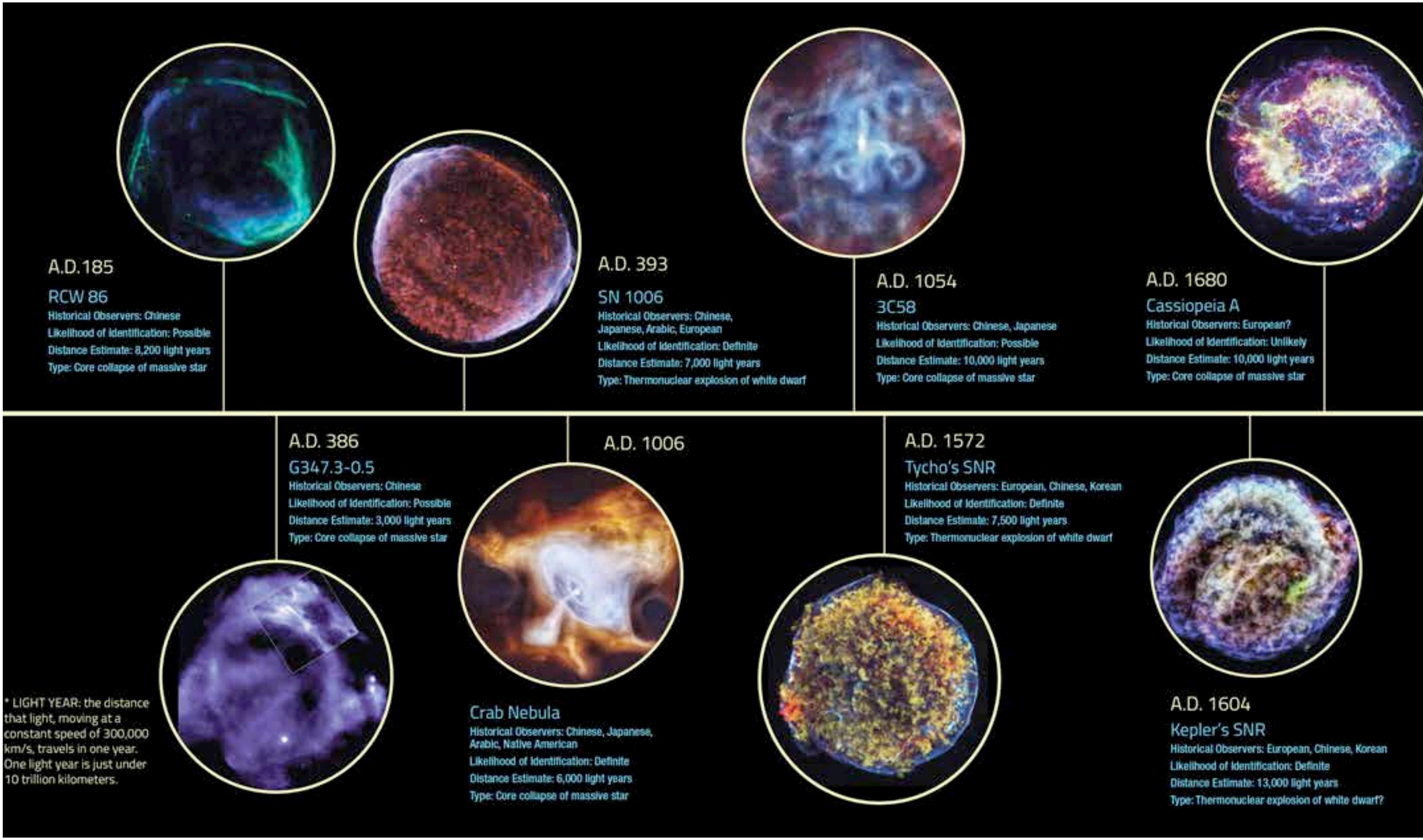
The Milky Way has formed stars at a rate of about

$$\Re \approx 1 M_{\odot}/\mathrm{yr}$$

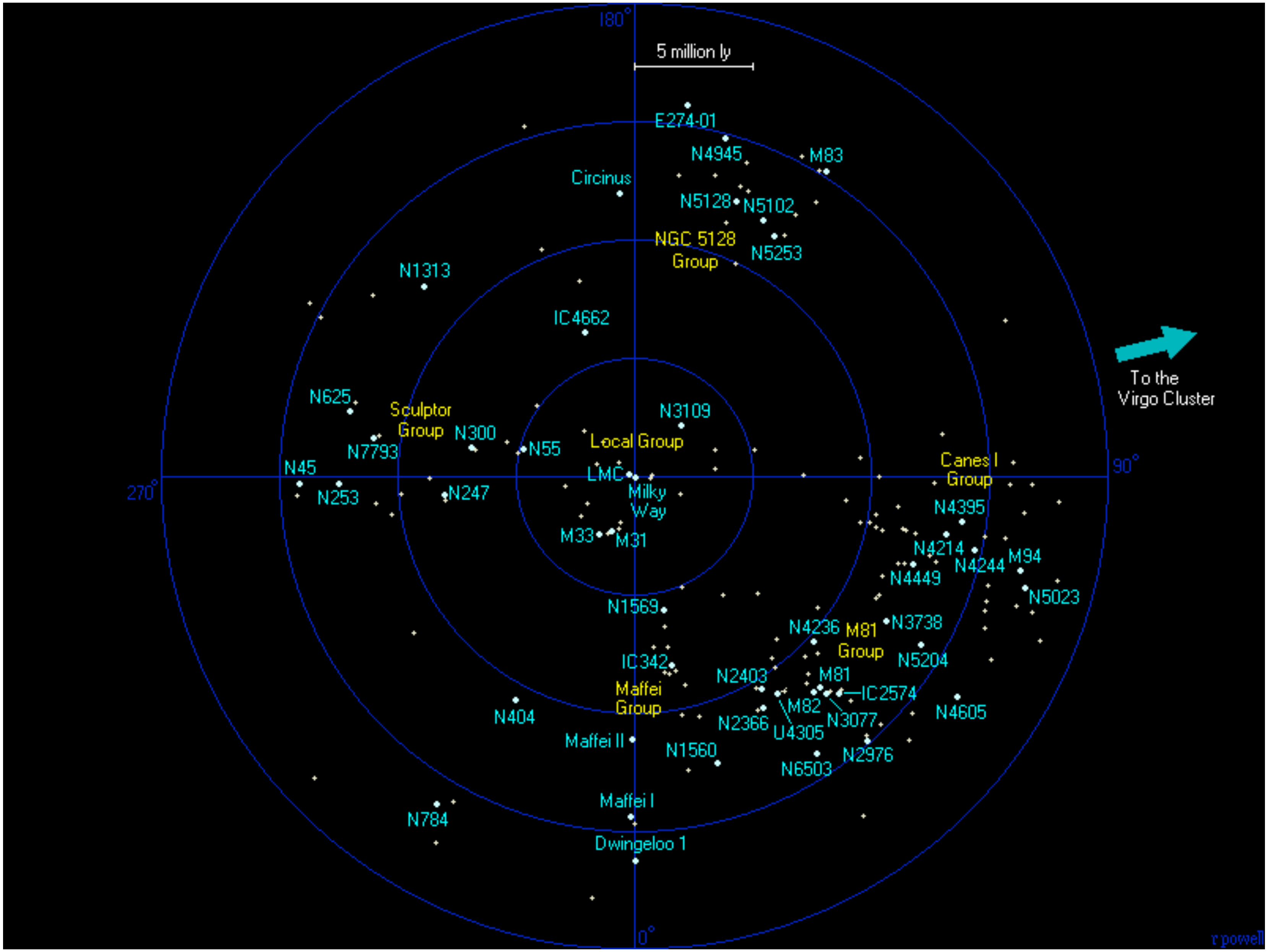
implying a rate of compact objects of about

$$f_8 \Re \approx 10^{-2} \mathrm{yr}^{-1}$$

Supernovae in the Galaxy



Supernovae in the Nearby Universe



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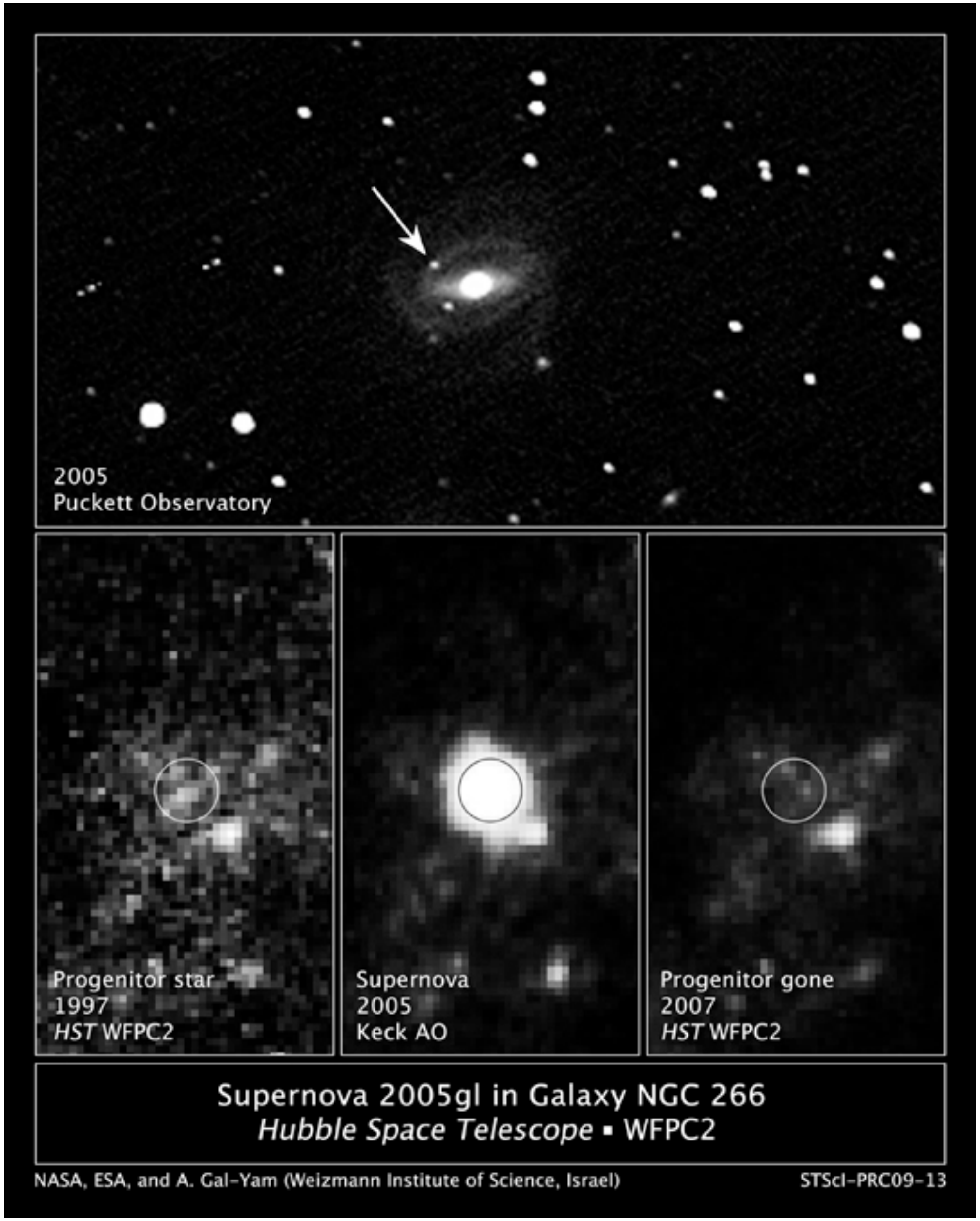

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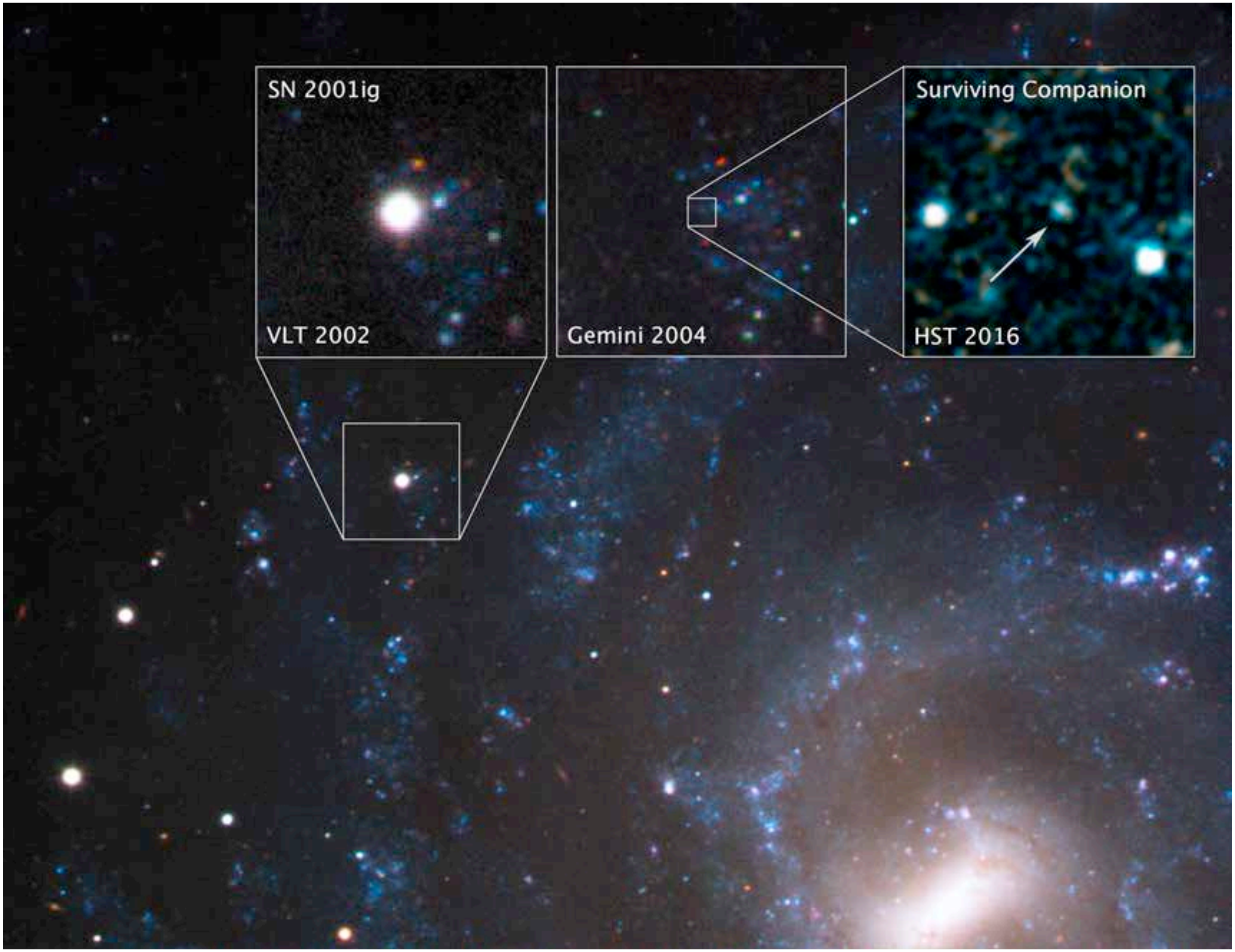

Iron Production in the Milky Way

Assume that every stellar core collapse distributed $0.05 M_\odot$ 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	$X_{\rm sun} = 0.7381$
Helium mass fraction	$Y_{\rm sun} = 0.2485$
Metallicity	$Z_{\rm sun} = 0.0134$

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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 $M_{Fe} \approx 10^8 M_\odot$. Comparing this with the total initial amount of gas, yields a primordial mass abundance of $Z_{\mathrm{Fe}} \approx 0.002.$ This abundance is only slightly greater than that of the sun.

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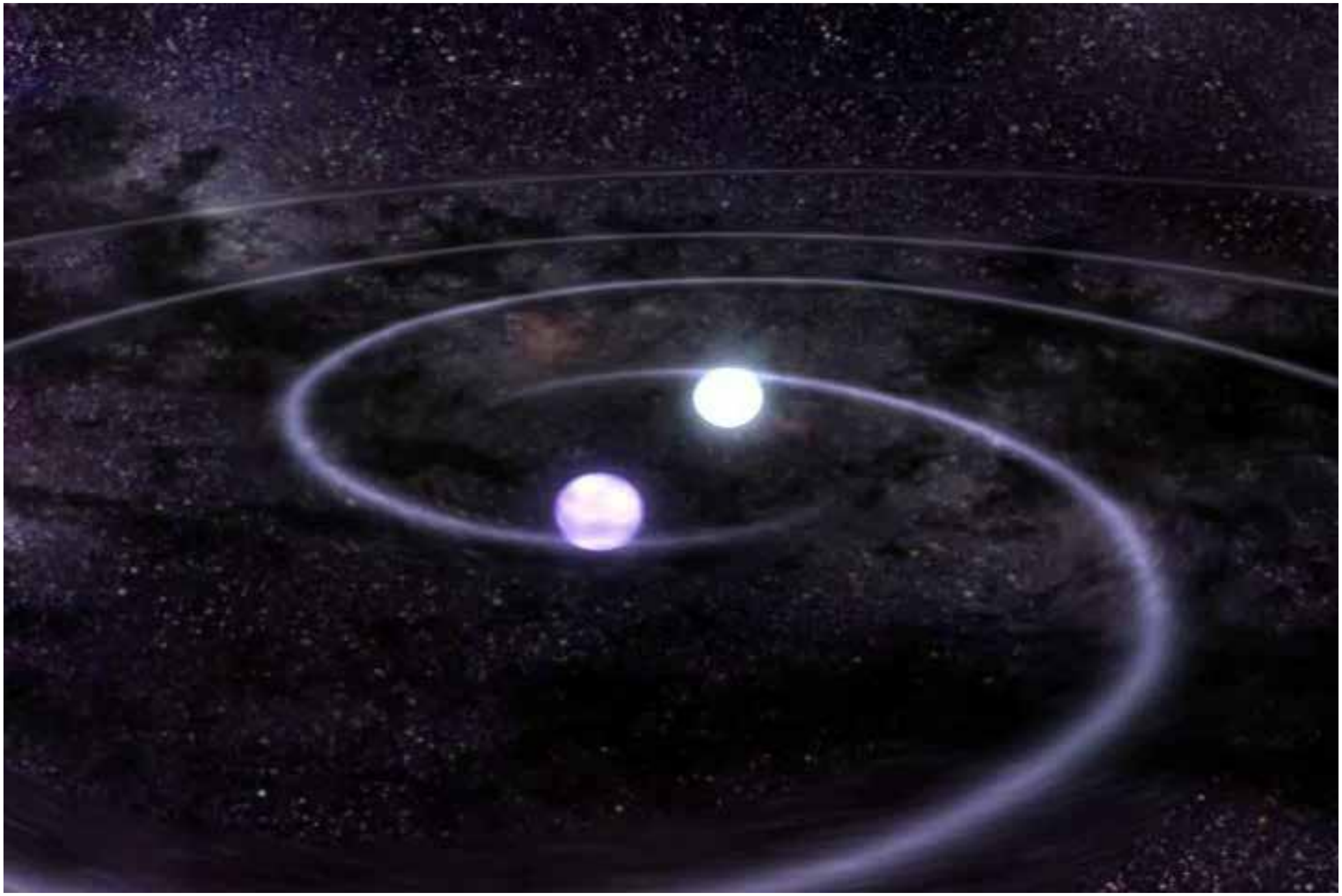
Pairs of Compact Objects

How many pairs of stars in the MW were formed in which both companions were more massive than $8M_\odot$?



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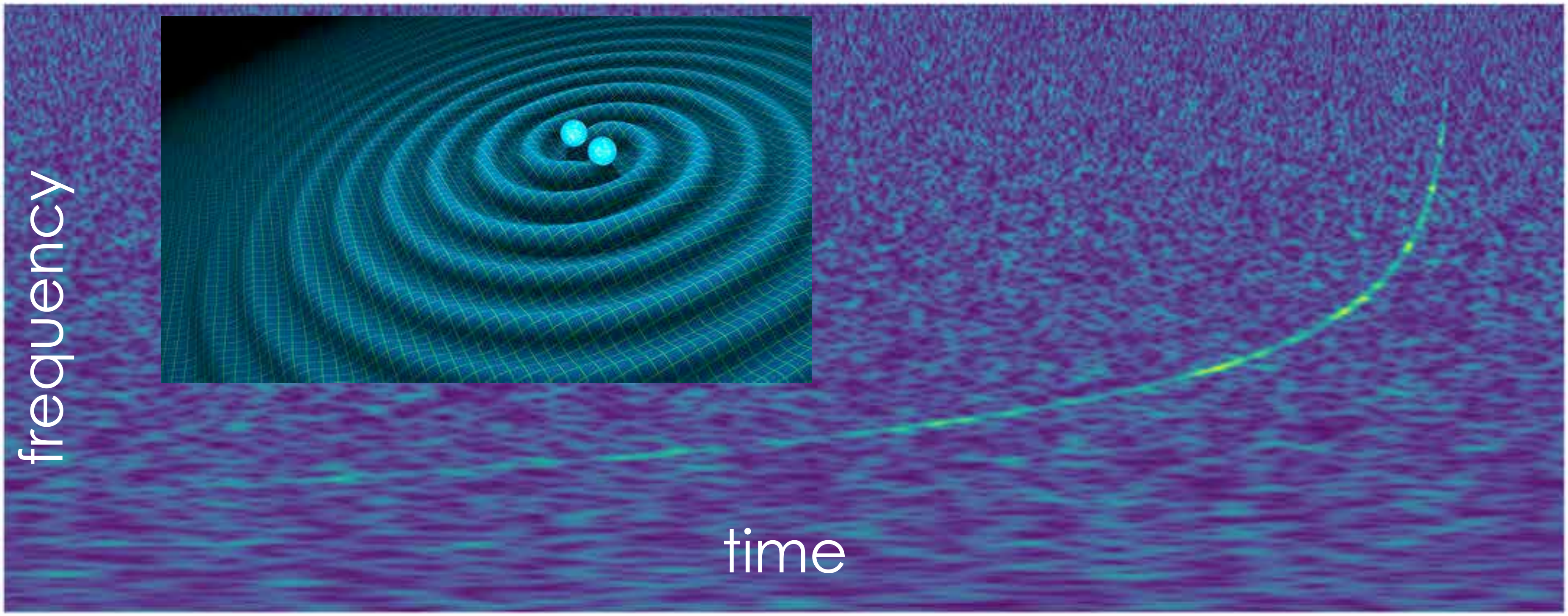
This suggests that there may be about 7×10^6 NS-NS, NS-BH and BH-BH binaries in the galaxy.

Merging Compact Objects

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



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