



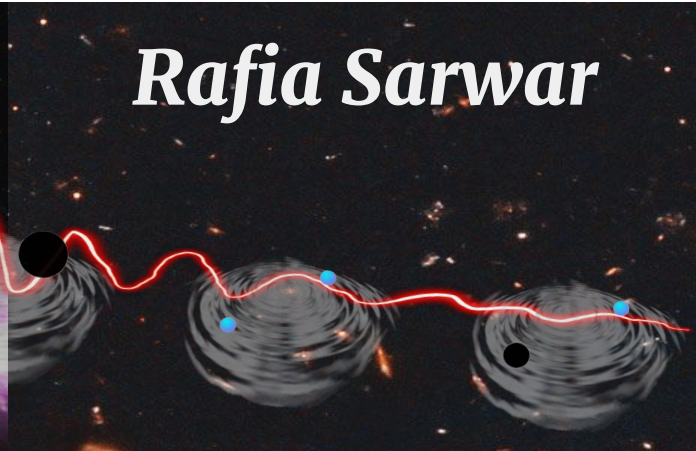
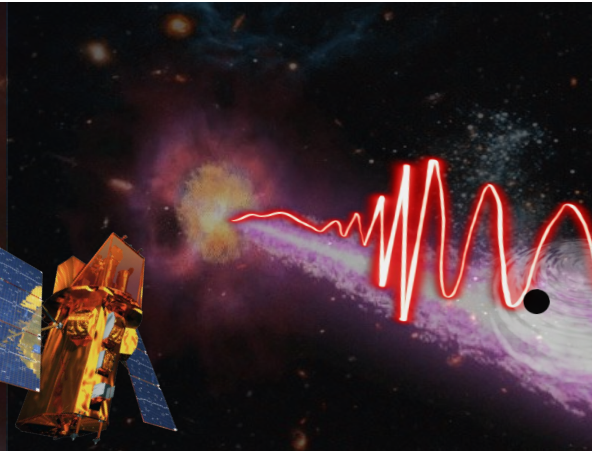
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From Stars to Galaxies



Rafia Sarwar



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Figure Credit: NASA



What have we learned so far...



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How many stars are there in the night sky...

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How many stars are there in the night sky...

10^{11} stars in the Milky Way



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Do these stars change with time...

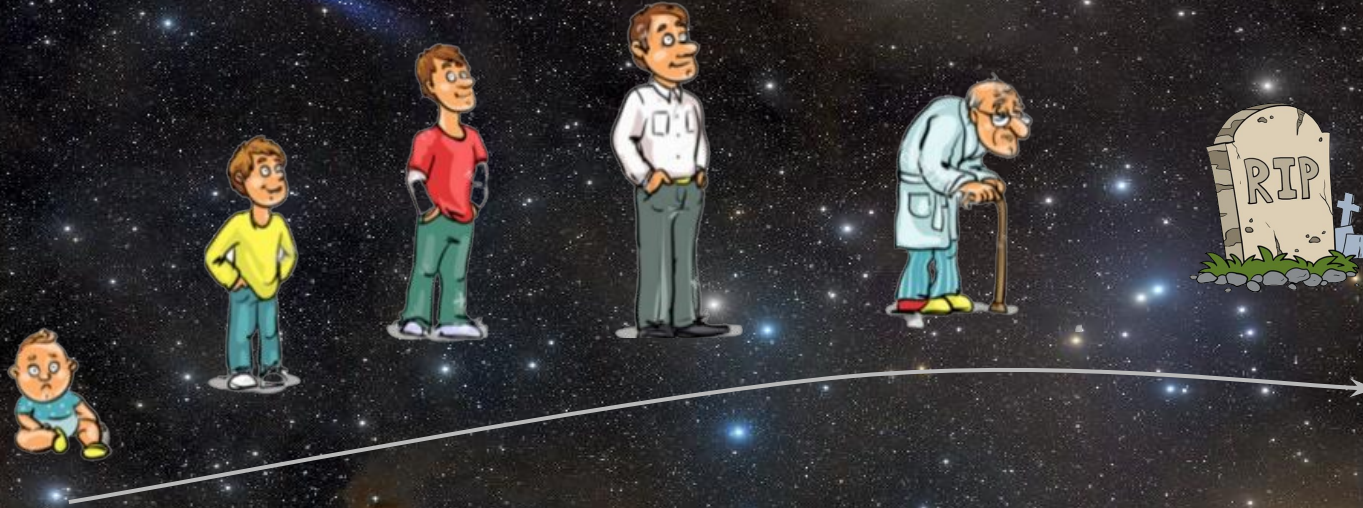
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Figure Credit: NASA

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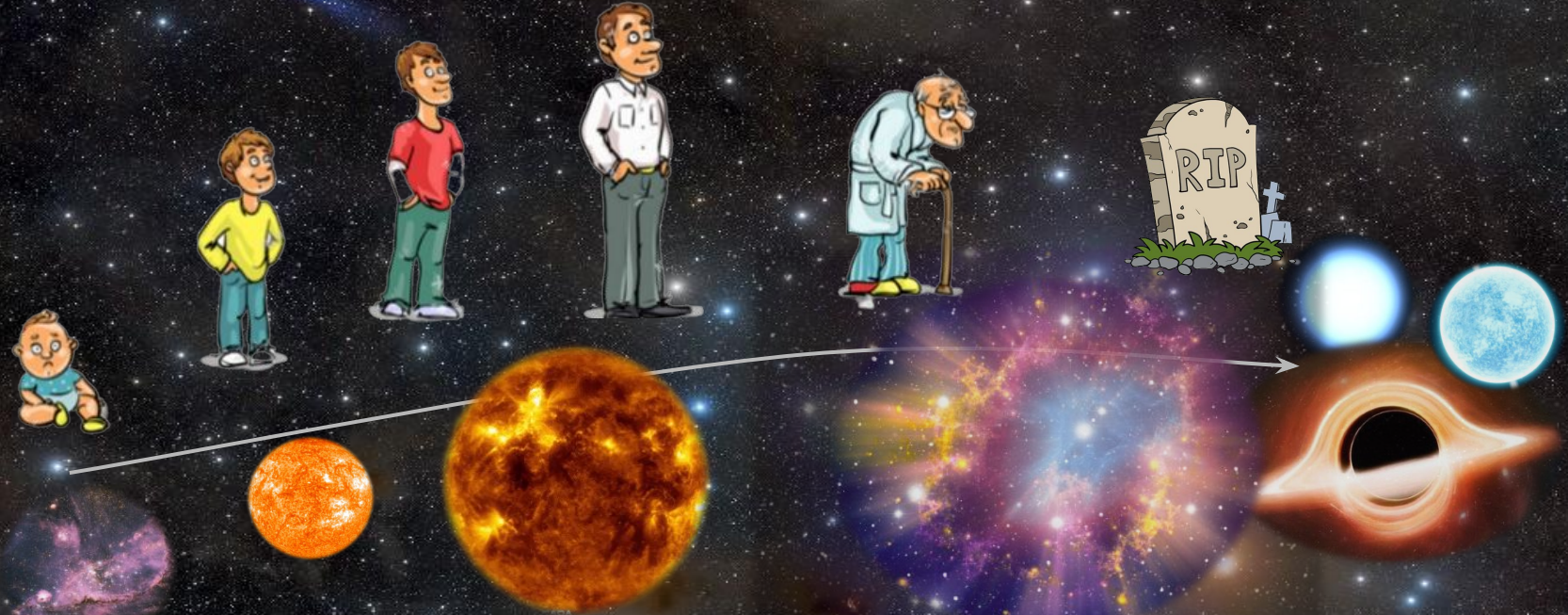
Stars live and die just like humans...



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Stars live and die just like humans...

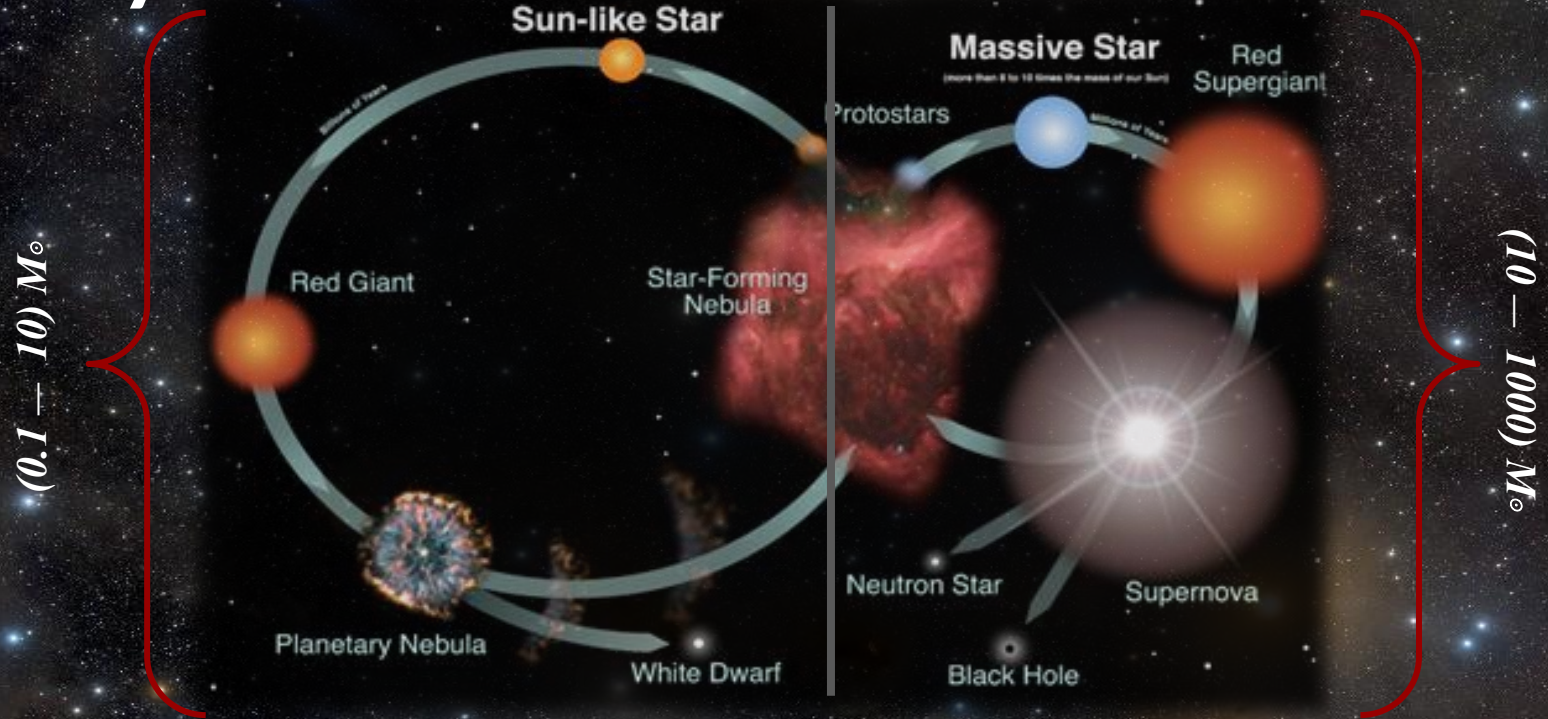


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Figure Credit: NASA



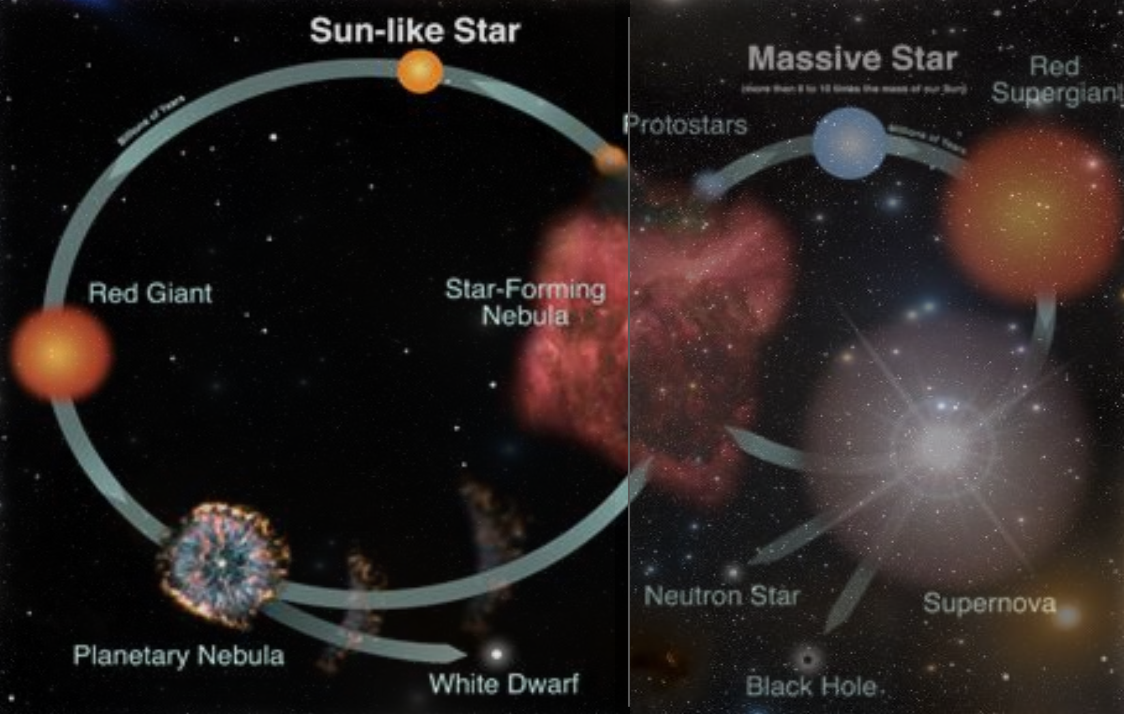
Life cycle of stars



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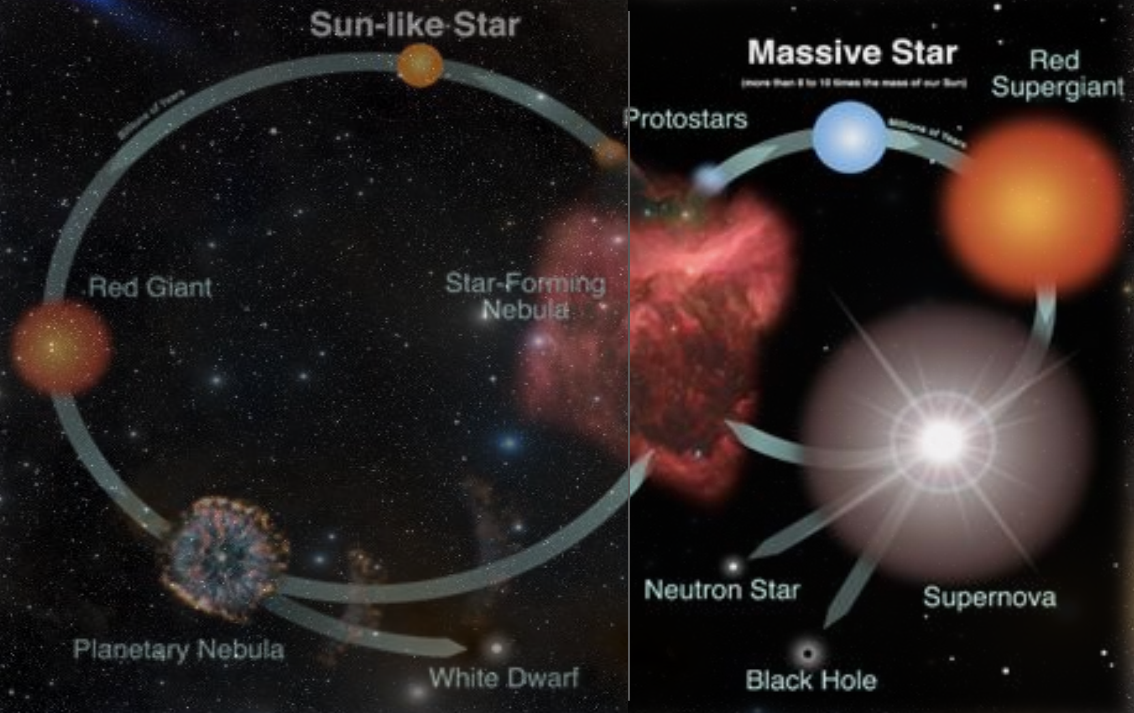
Sun-like stars



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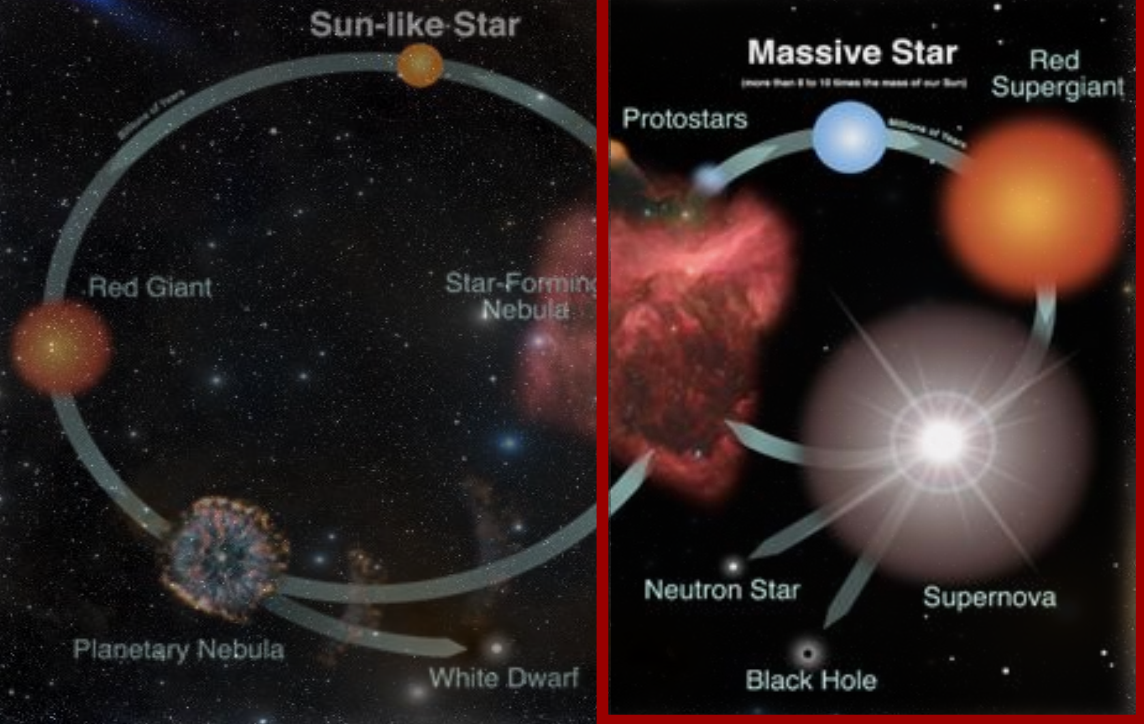
Massive stars



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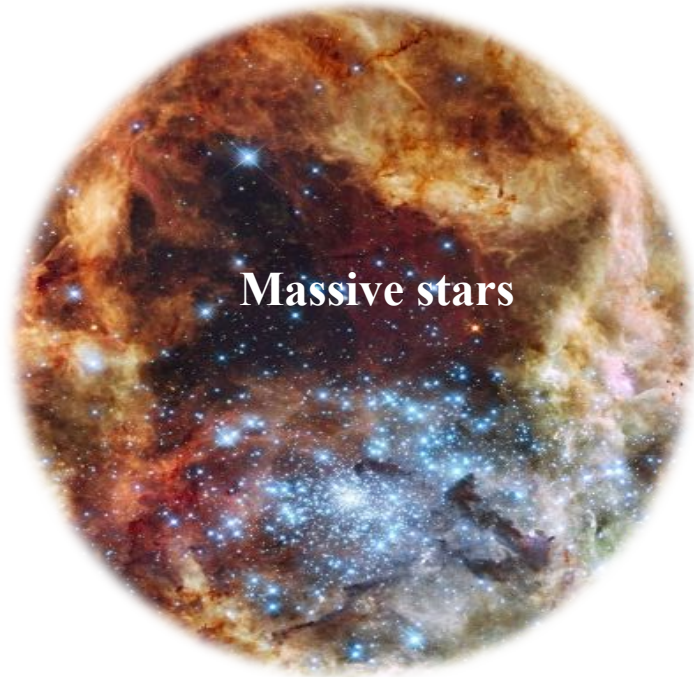


Massive stars



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Why massive stars

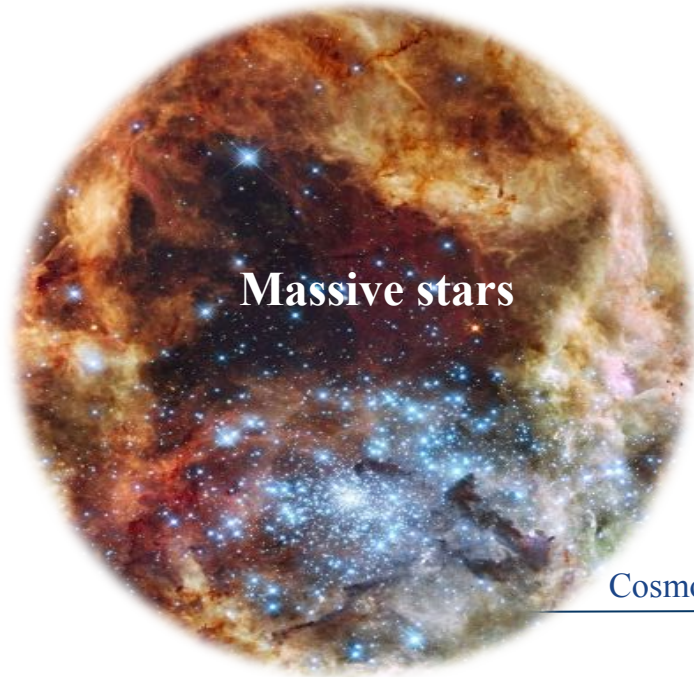


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Figure Credit: NASA

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Why massive stars



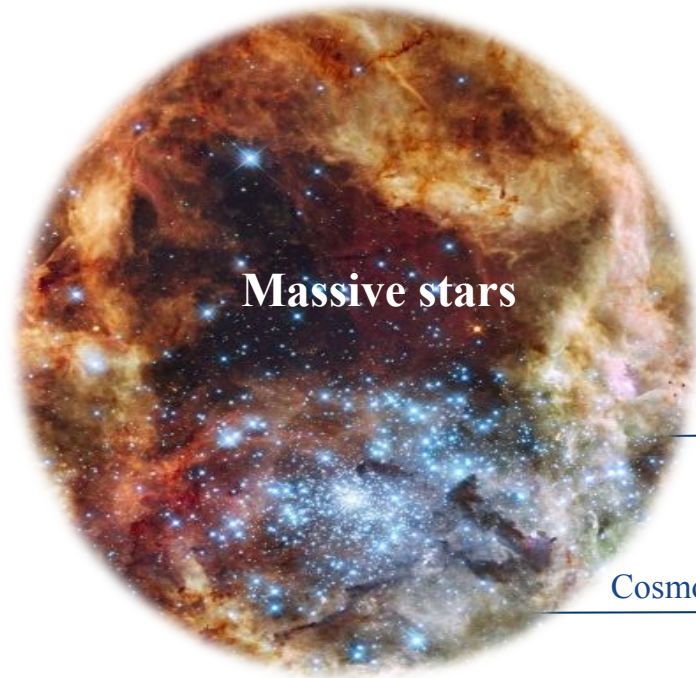
Cosmological impact by the feedback processes



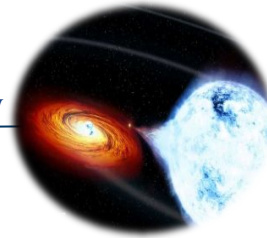
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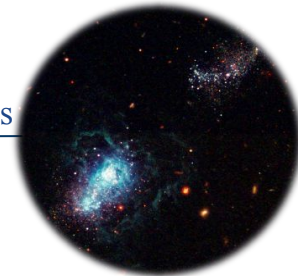
Why massive stars



Physics of binary
stars



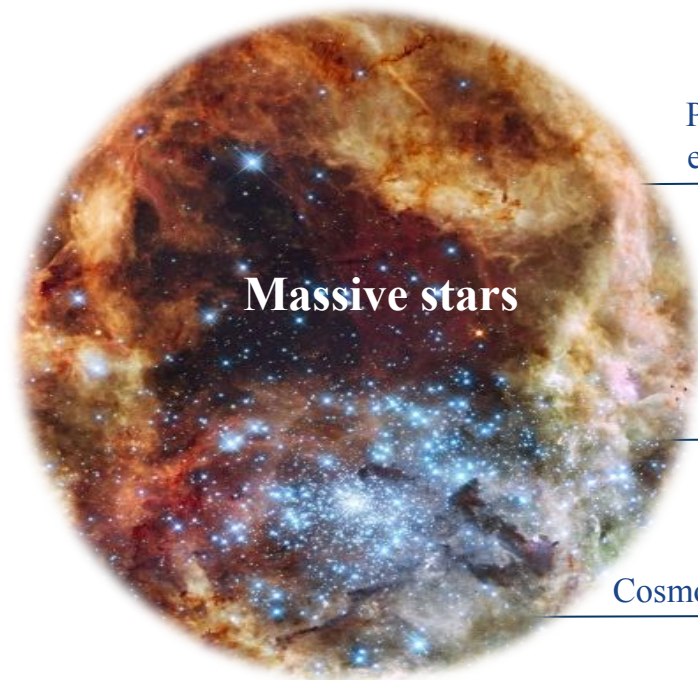
Cosmological impact by the feedback processes



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Why massive stars

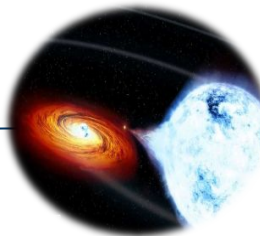


Massive stars

Parents of supernova
events & gamma ray
bursts



Physics of binary
stars



Cosmological impact by the feedback processes

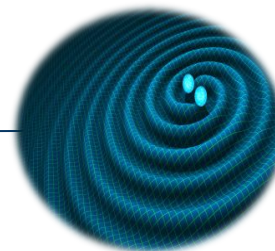


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Why massive stars

Binary stars as progenitors of gravitational waves

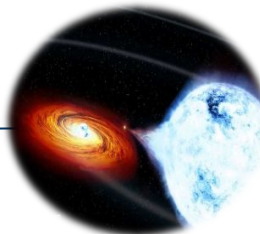


Parents of supernova
events & gamma ray
bursts



Massive stars

Physics of binary
stars



Cosmological impact by the feedback processes

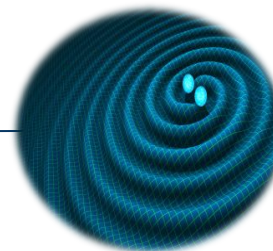


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Why massive stars

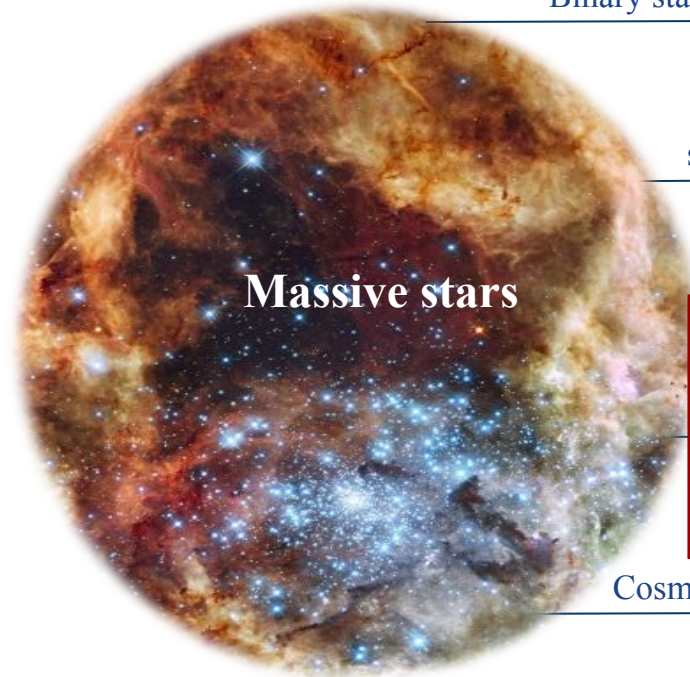
Binary stars as progenitors of gravitational waves



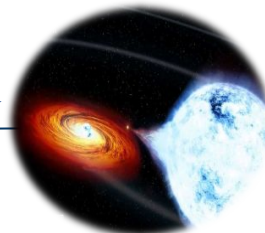
Progenitors of
supernova & gamma
ray bursts



Massive stars



Physics of binary
stars



Cosmological impact by the feedback processes



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Any questions so far...



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Figure Credit: NASA



Binary stars



Binary System

=

a system of two objects in space (usually stars), which are so close that their **gravitational** interaction causes them to **orbit** around their common center of mass.



According to this definition, almost **all stars are binaries** (or multiples). The Sun is one of the exceptions.

Evolution of massive binary stars

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Evolution of massive binary stars

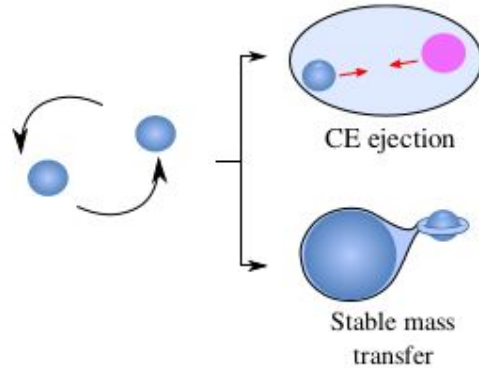


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Figure Credit: Pablo Marchant

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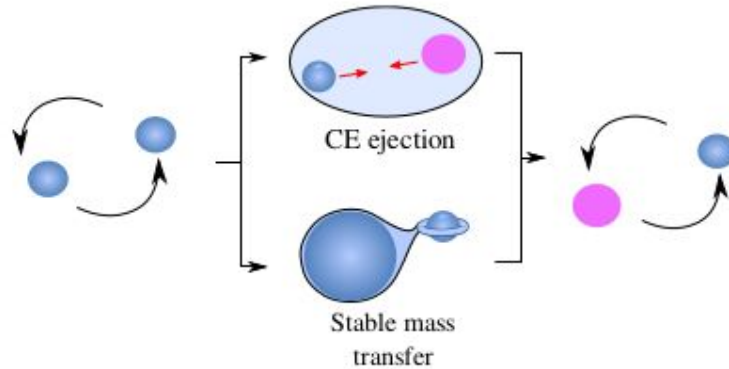
Evolution of massive binary stars



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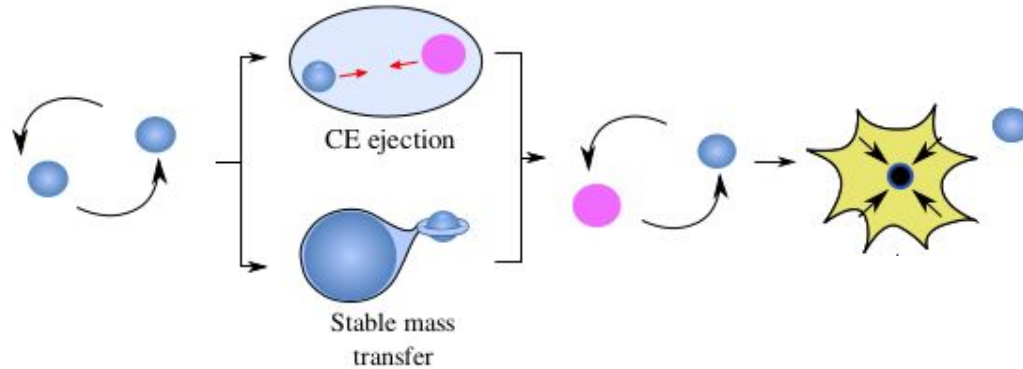
Evolution of massive binary stars



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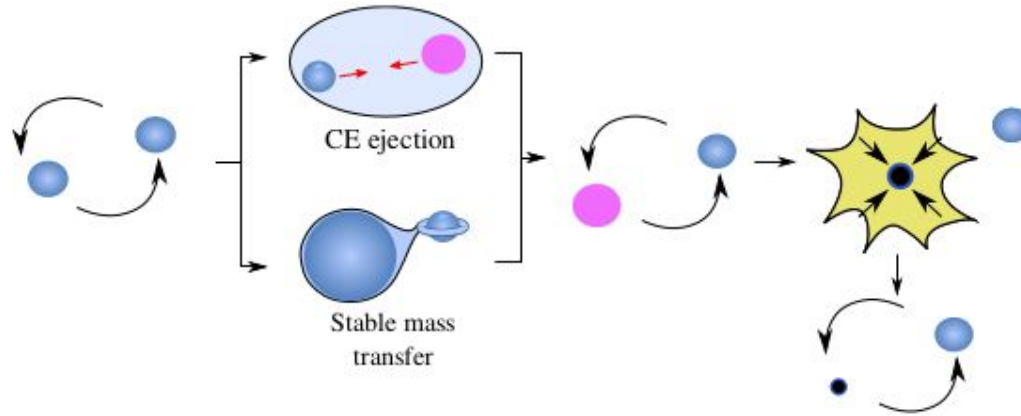
Evolution of massive binary stars



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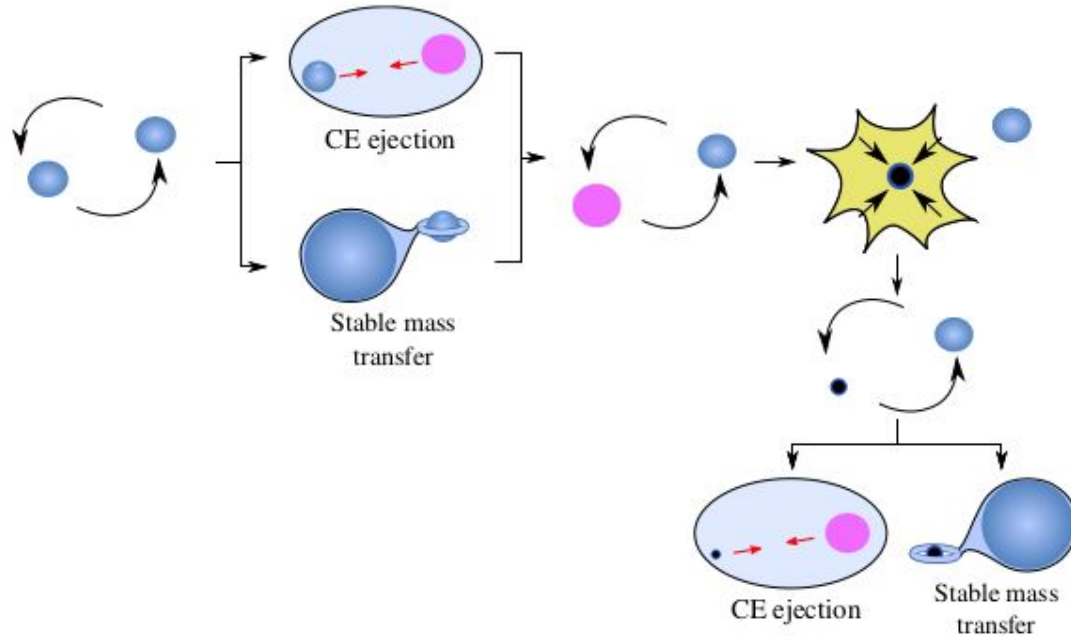
Evolution of massive binary stars



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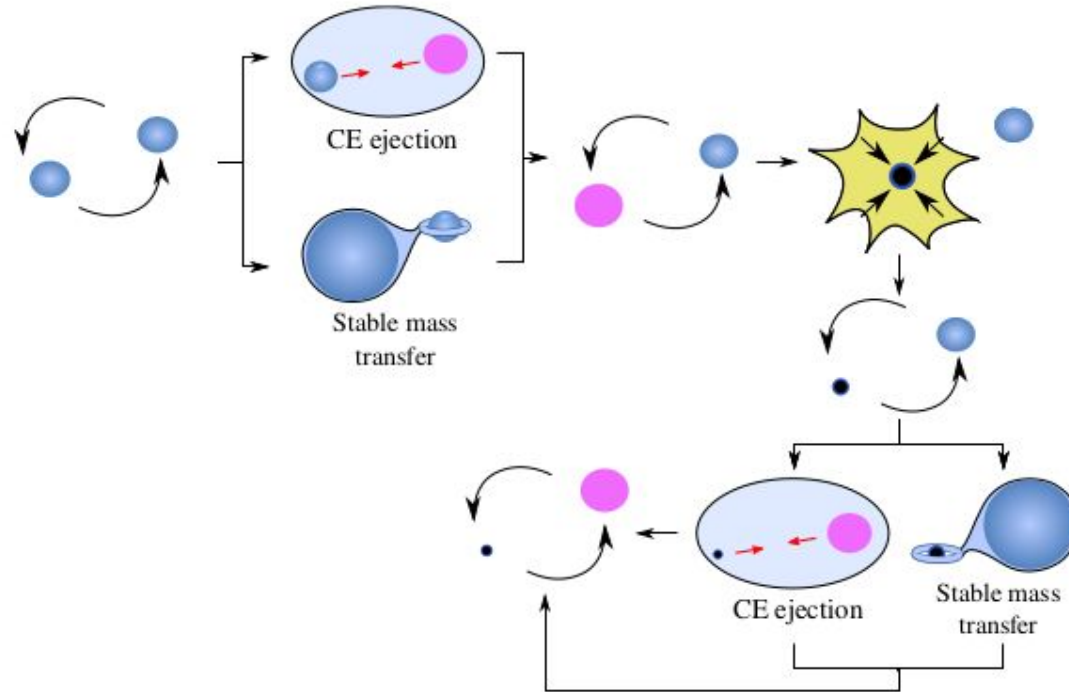
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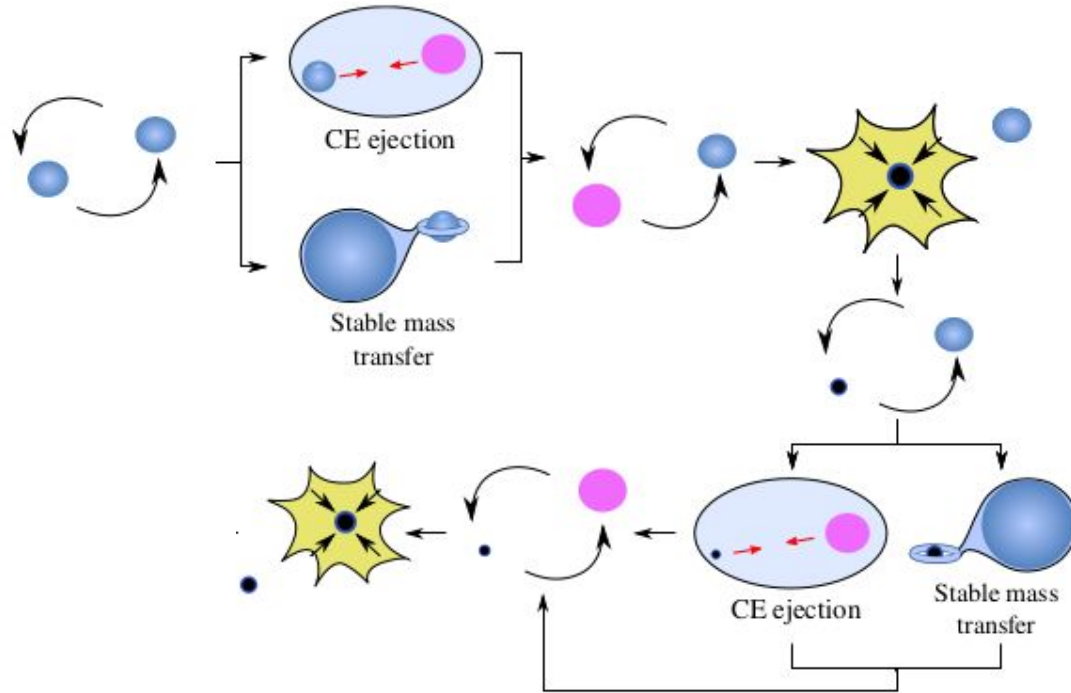
Evolution of massive binary stars



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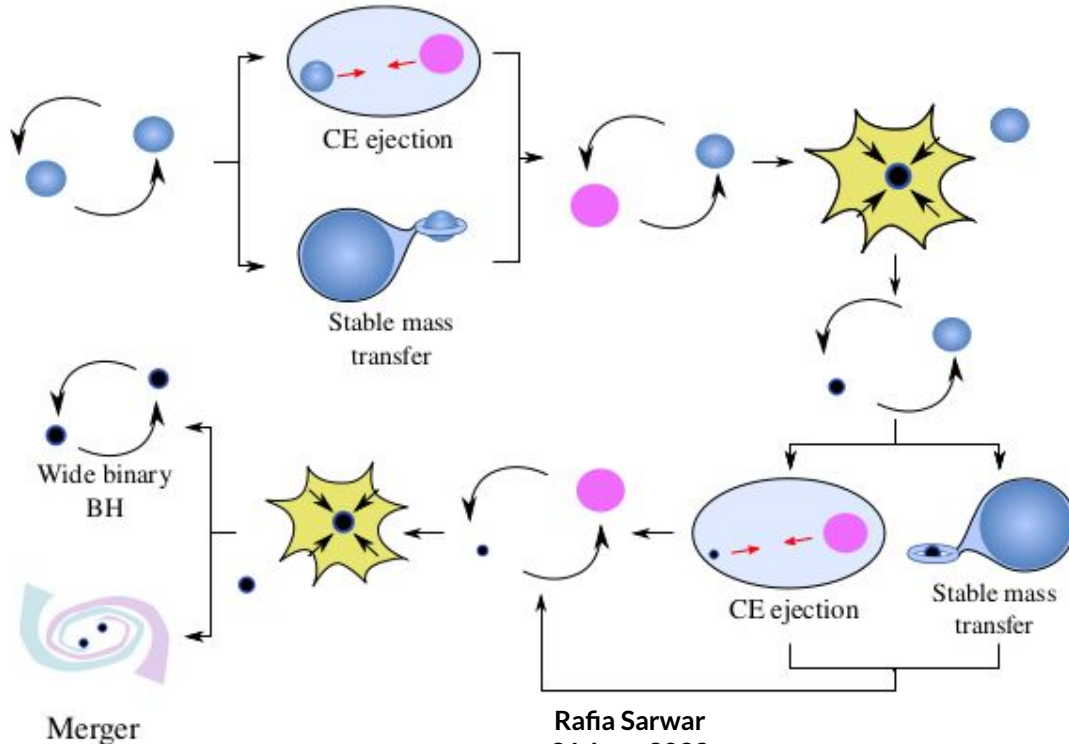
Evolution of massive binary stars



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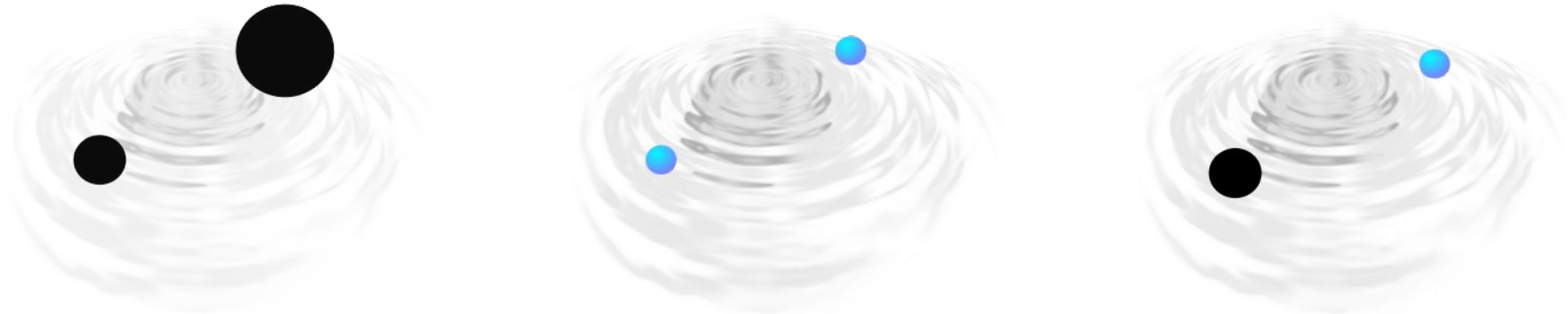
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Evolution of massive binary stars



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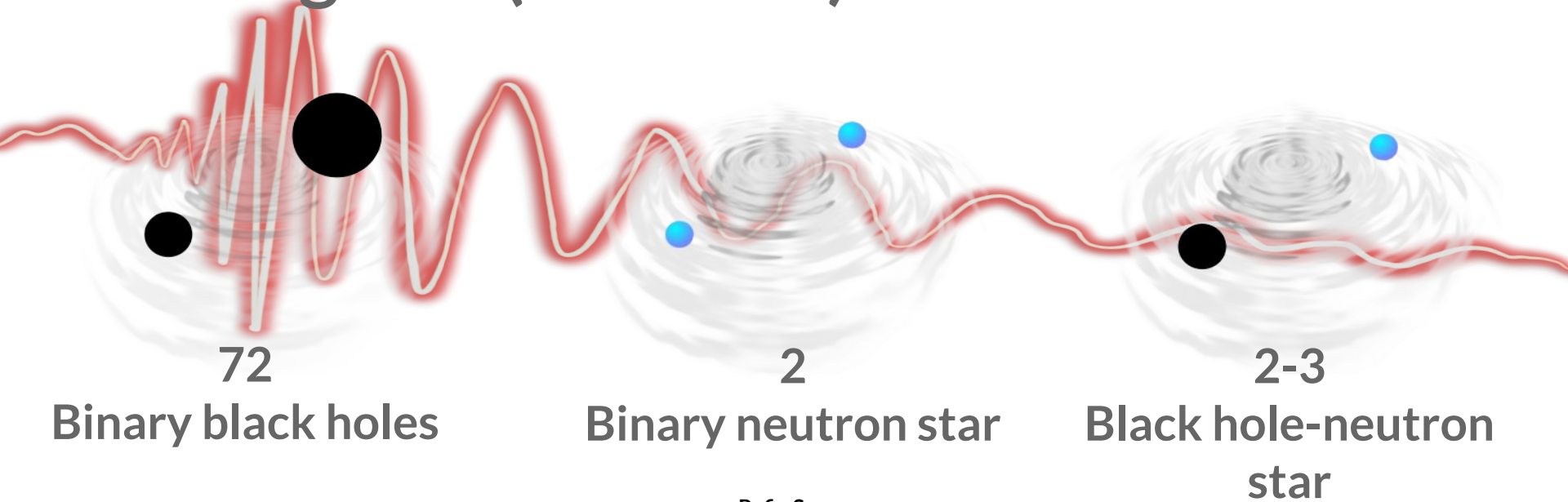
The Gravitational-Wave Transient Catalogue 3 (GWTC-3)



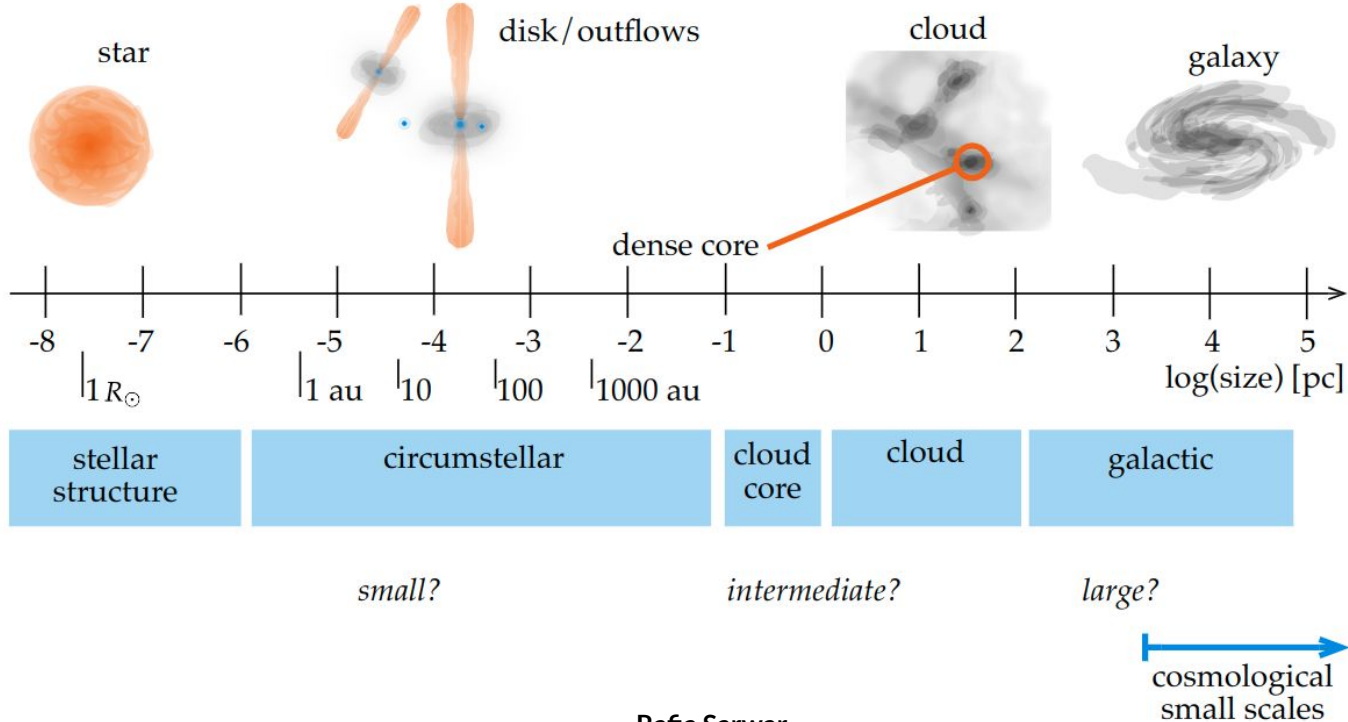
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Figure Credit: Tassos Fragos

The Gravitational-Wave Transient Catalogue 3 (GWTC-3)



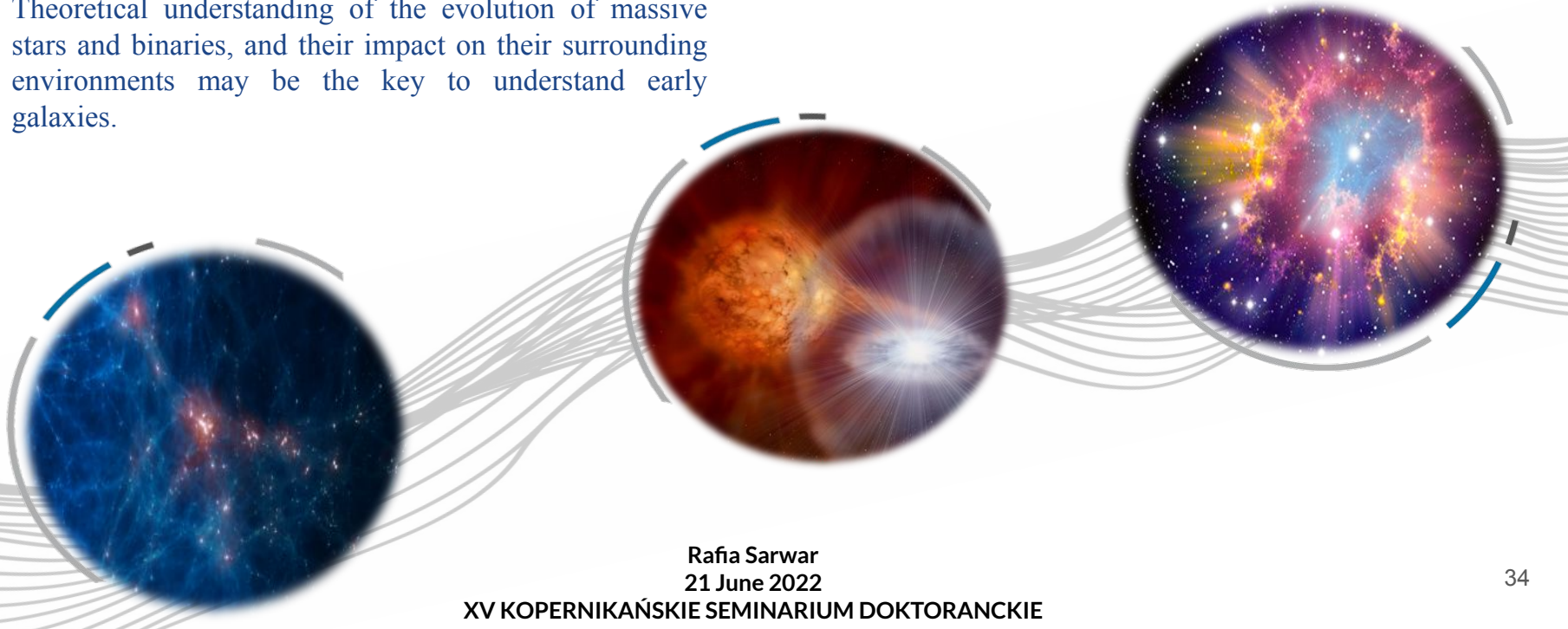
Sizes in the Universe



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Take home message

Theoretical understanding of the evolution of massive stars and binaries, and their impact on their surrounding environments may be the key to understand early galaxies.



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Thank you...

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Figure Credit: NASA

