Universidad Industrial de Santander

GRUPO HALLEY DE ASTRONOMÍA Y CIENCIAS AEROESPACIALES

Astronomía Planetaria

Clase 21 – Objetos Compactos

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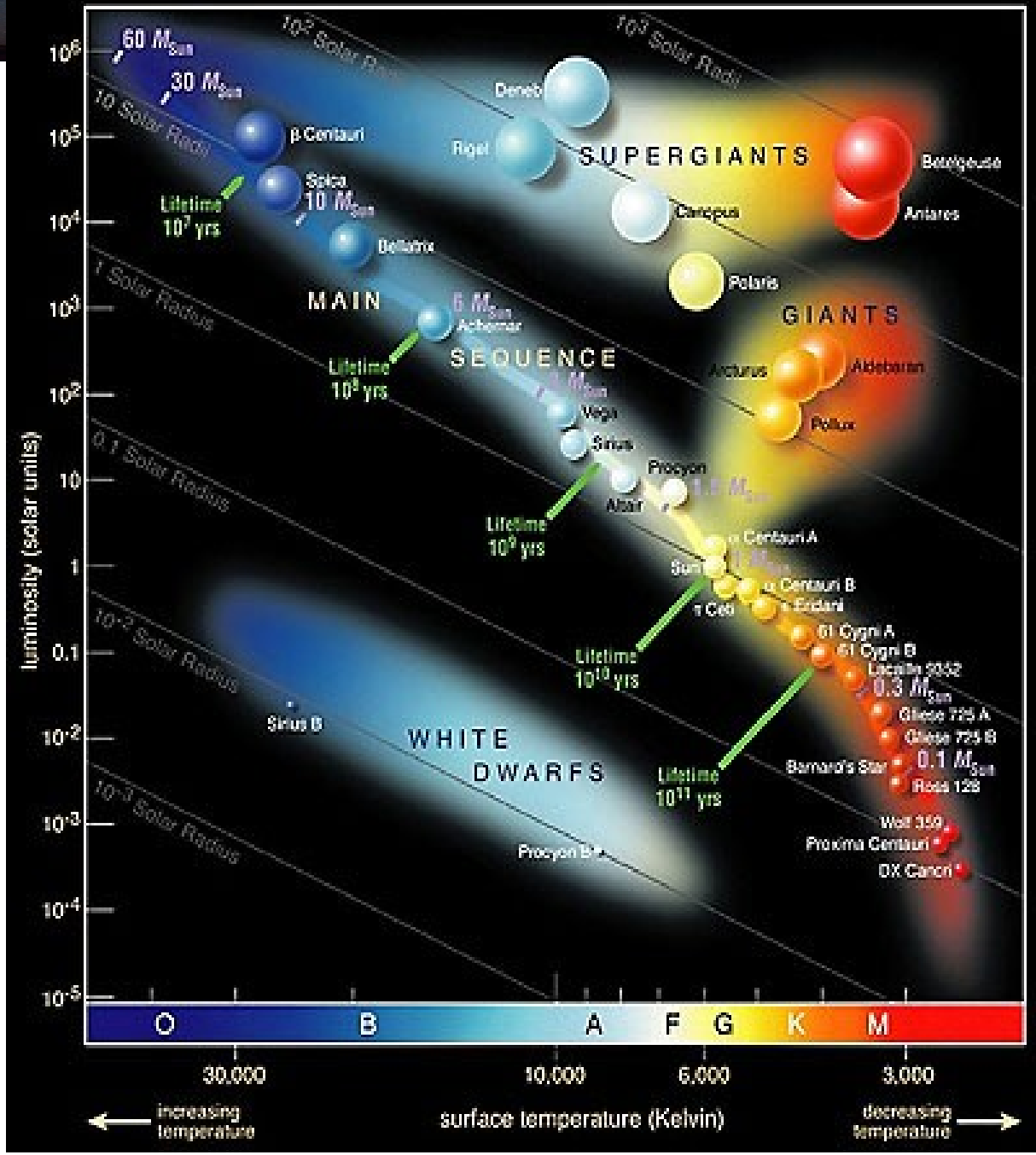
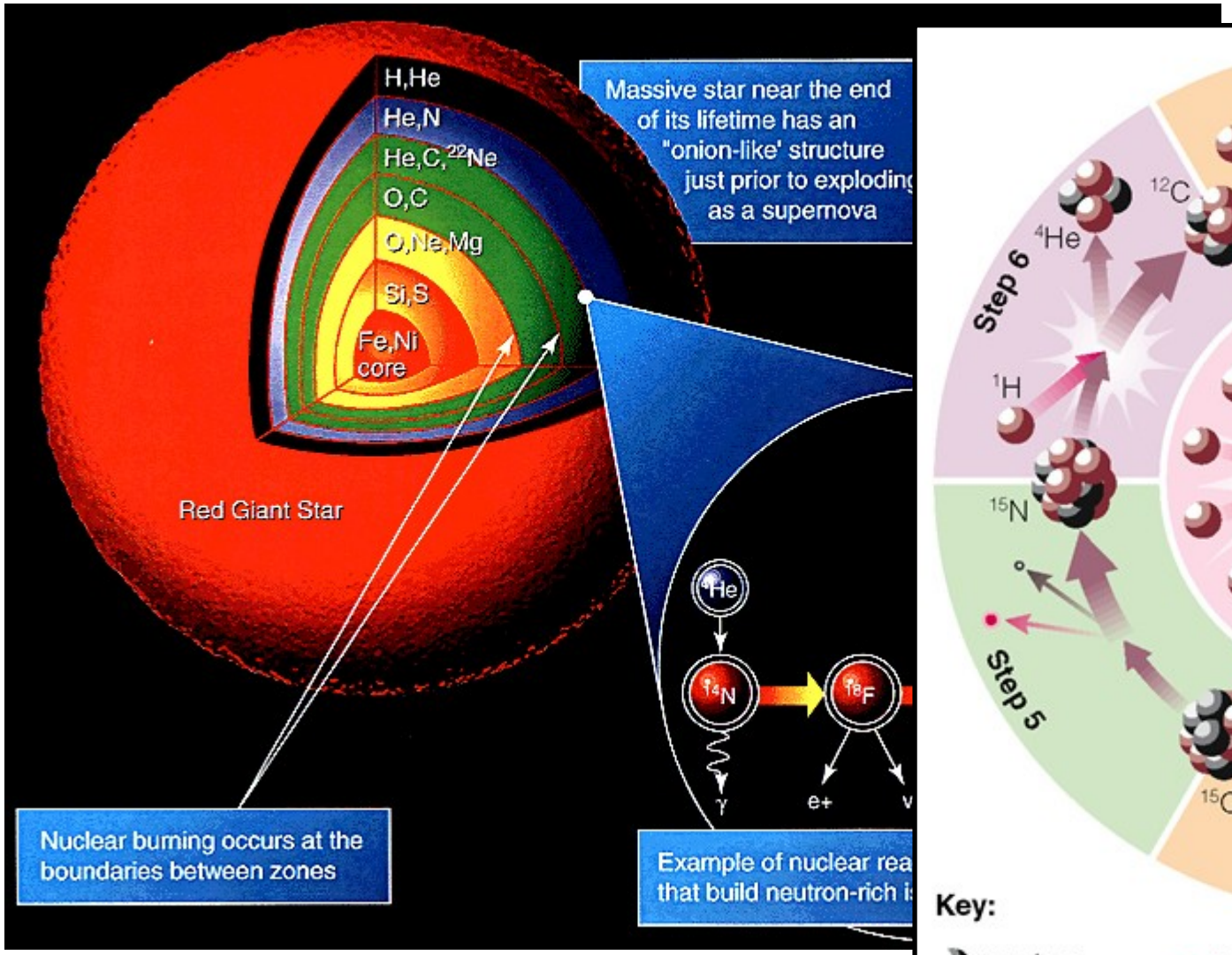
Escuela de Física
Grupo Halley de Astronomía y Ciencias Aeroespaciales
Universidad Industrial de Santander

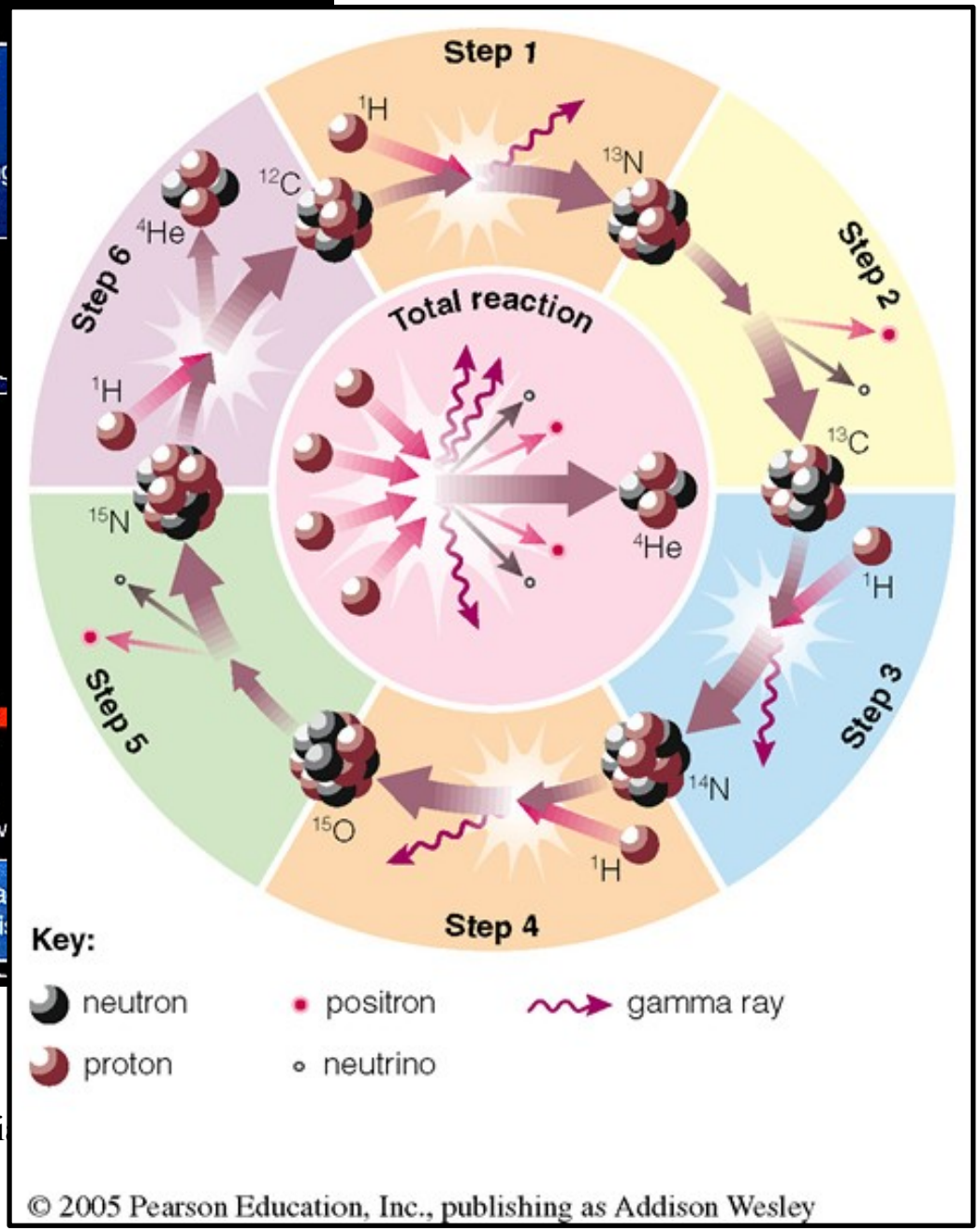
Bucaramanga, II semestre de 2013

En nuestro capitulo anterior



Clase	Temperatura	Color
O	30.000 – 60.000 K	Azul
B	10.000 – 30.000 K	Azul-Blanco
A	7.500 – 10.000 K	Blanco
F	6.000 – 7.500 K	Amarillo Blanco
G	5.000 – 6.000 K	Amarillo
K	3.000 – 5.000 K	Amarillo Naranja
M	2.000 – 3.500 K	Rojo


H,He
He,N
He,C,22Ne
O,C
O,Ne,Mg
Si,S
Fe,Ni core
Red Giant Star
Massive star near the end of its lifetime has an "onion-like' structure just prior to explodin as a supernova
Nuclear burning occurs at the boundaries between zones
Example of nuclear rea that build neutron-rich i
4He
14N
18F
γ
e+
ν


Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Total reaction
1H
12C
13N
4He
13C
15N
14N
15O
Key:
neutron
proton
positron
neutrino
gamma ray
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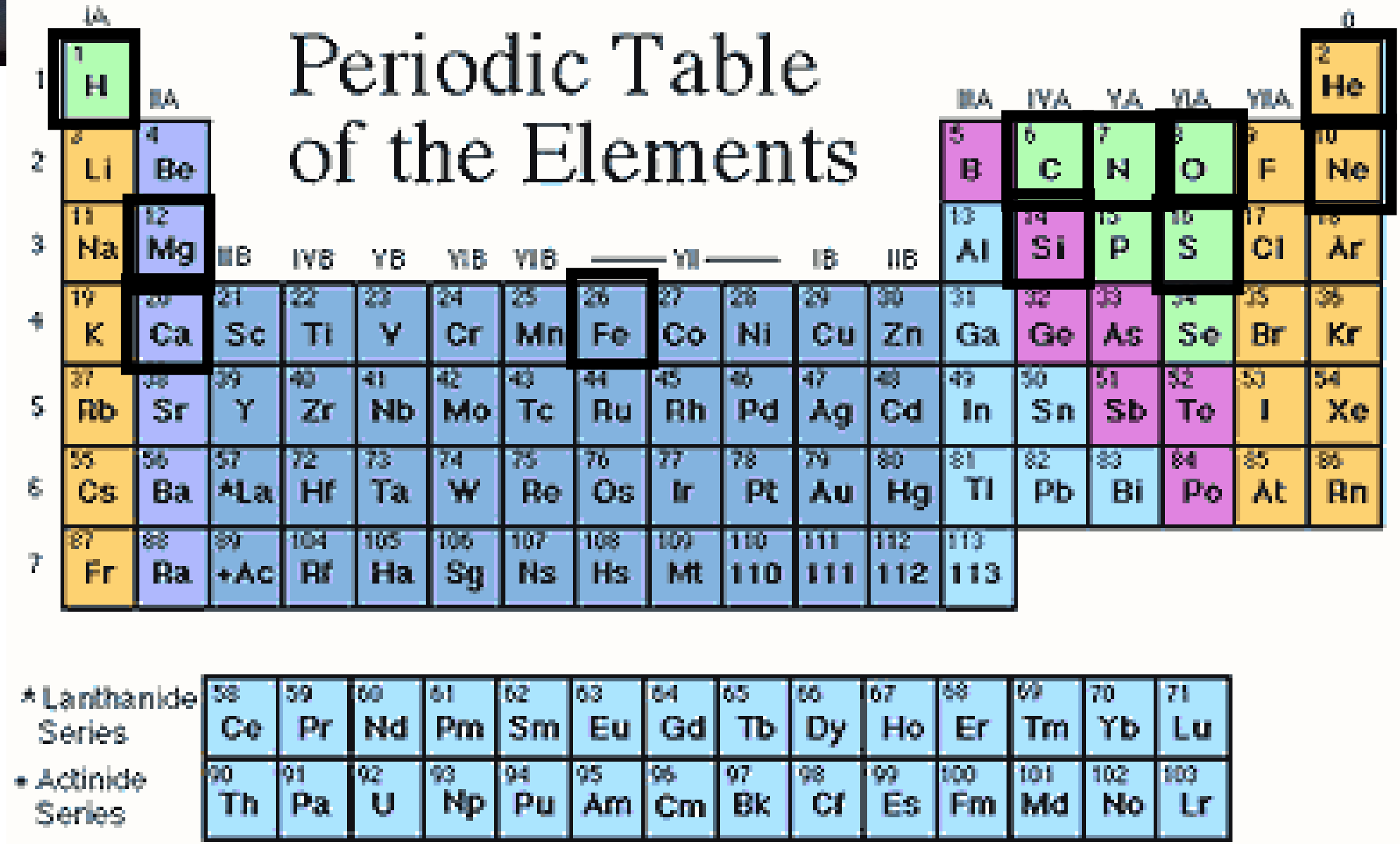
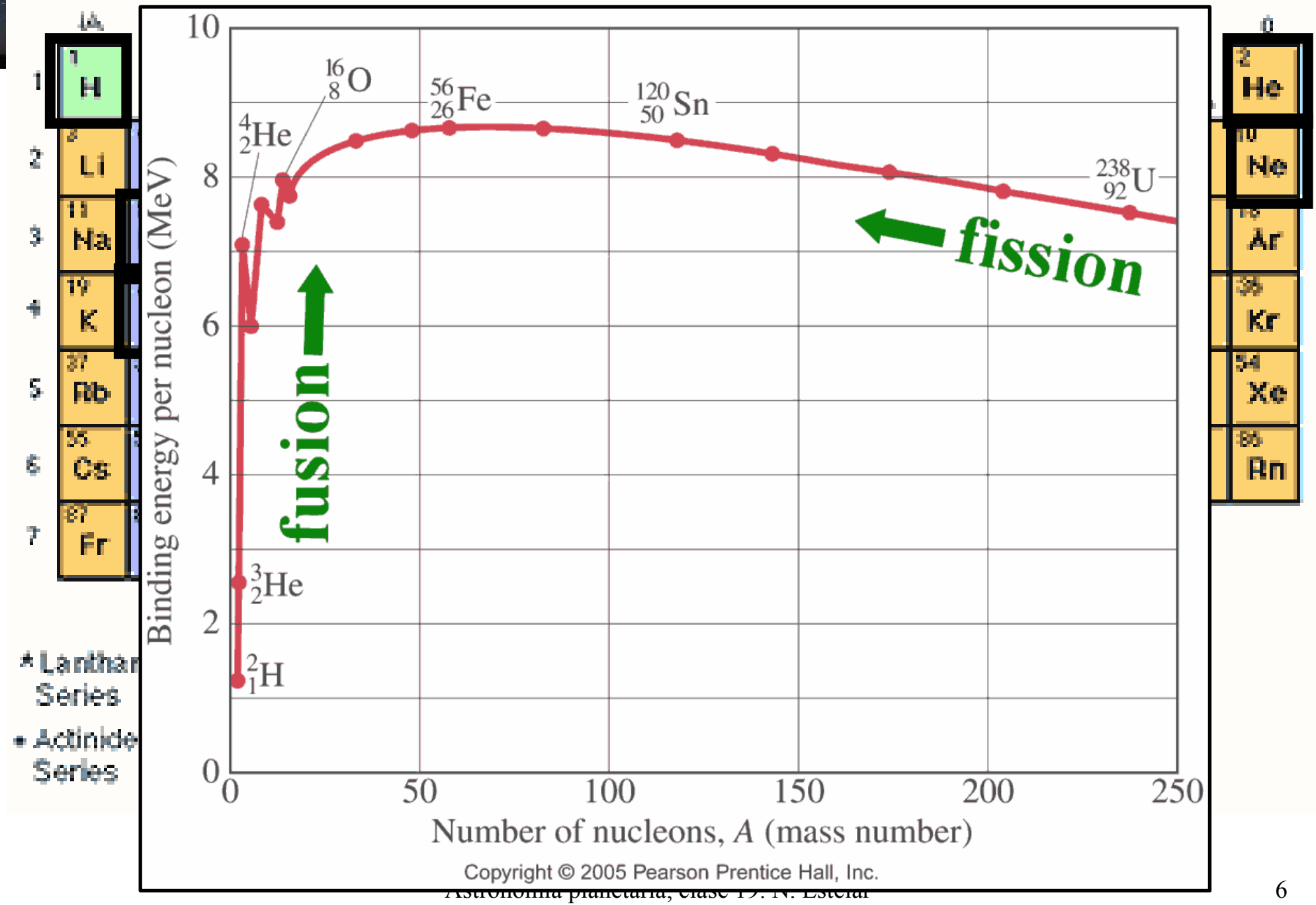

Periodic Table
of the Elements
IA
0
1 H
IIA
2 He
IIIA IVA VA VIA VIIA
2 Li 4 Be 5 B 6 C 7 N 8 O 9 F 10 Ne
3 Na 12 Mg IIIB IVB VB VIB VIIB VIII IB IIB 13 Al 14 Si 15 P 16 S 17 Cl 18 Ar
4 K 20 Ca 21 Sc 22 Ti 23 V 24 Cr 25 Mn 26 Fe 27 Co 28 Ni 29 Cu 30 Zn 31 Ga 32 Ge 33 As 34 Se 35 Br 36 Kr
5 37 Rb 38 Sr 39 Y 40 Zr 41 Nb 42 Mo 43 Tc 44 Ru 45 Rh 46 Pd 47 Ag 48 Cd 49 In 50 Sn 51 Sb 52 Te 53 I 54 Xe
6 55 Cs 56 Ba 57 *La 72 Hf 73 Ta 74 W 75 Re 76 Os 77 Ir 78 Pt 79 Au 80 Hg 81 Tl 82 Pb 83 Bi 84 Po 85 At 86 Rn
7 87 Fr 88 Ra 89 +Ac 104 Rf 105 Ha 106 Sg 107 Ns 108 Hs 109 Mt 110 110 111 111 112 112 113 113
* Lanthanide Series
58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Yb 71 Lu
+ Actinide Series
90 Th 91 Pa 92 U 93 Np 94 Pu 95 Am 96 Cm 97 Bk 98 Cf 99 Es 100 Fm 101 Md 102 No 103 Lr


Binding energy per nucleon (MeV)
Number of nucleons, A (mass number)
0
2
4
6
8
10
0
50
100
150
200
250
$^{2}_{1}H$
$^{3}_{2}He$
$^{4}_{2}He$
$^{16}_{8}O$
$^{56}_{26}Fe$
$^{120}_{50}Sn$
$^{238}_{92}U$
fusion
fission
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Objetivos

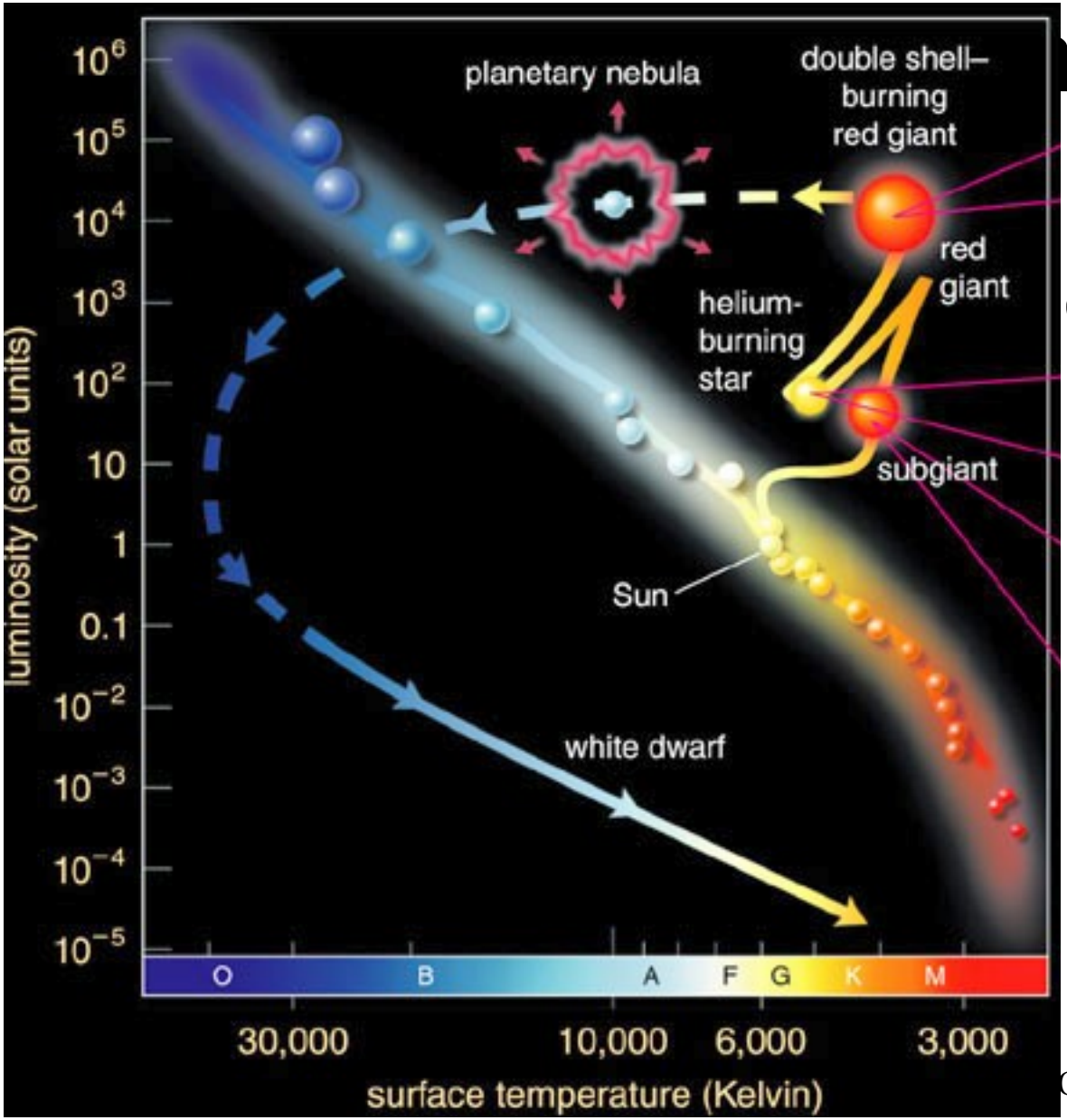
- Definir qué son objetos compactos y sus principales características

Enanas Blancas

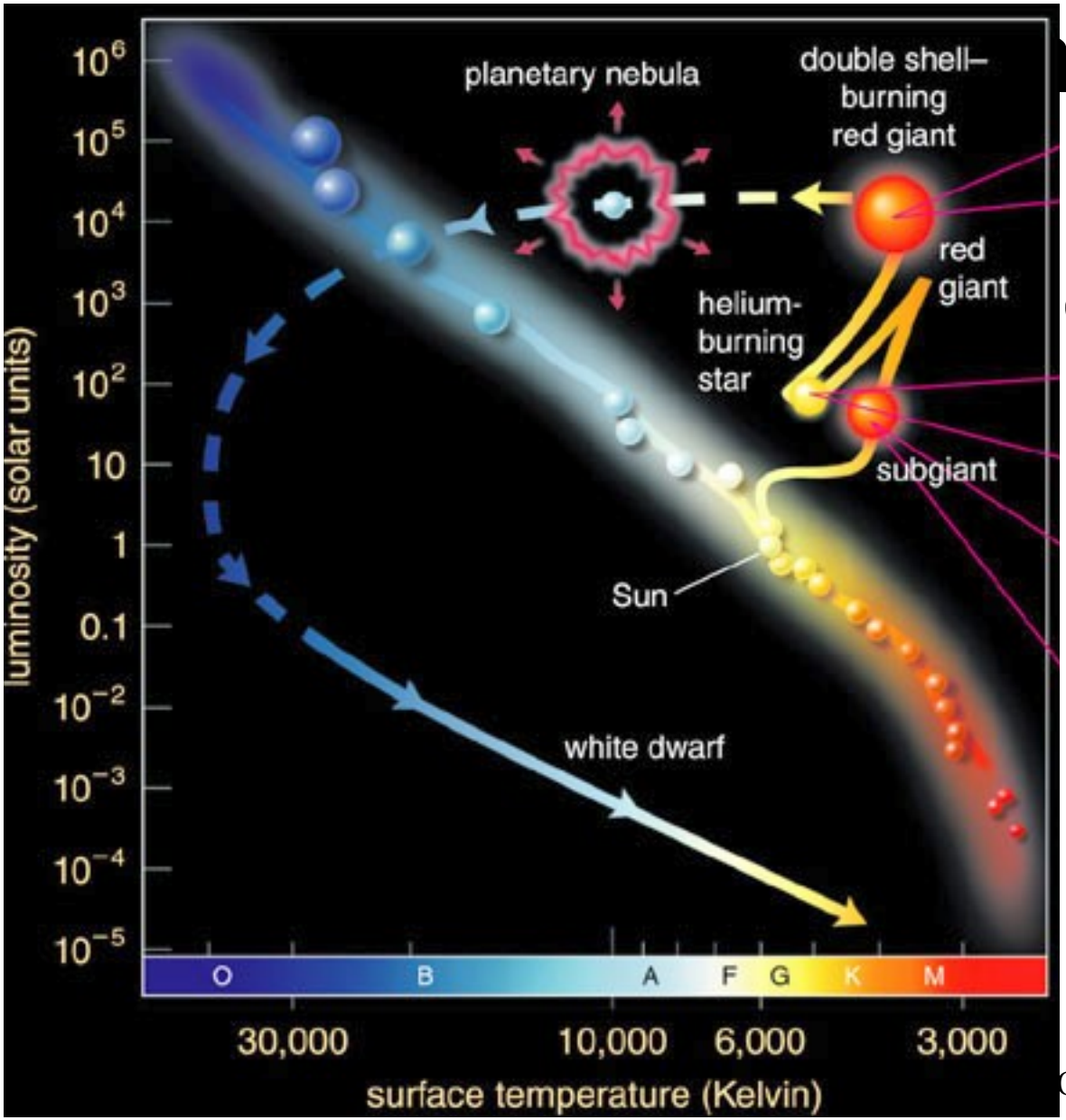
- ¿Qué es una Enana Blanca (EB)?

ncas

ca (EB)?


planetary nebula
double shell–
burning
red giant
red
giant
helium-
burning
star
subgiant
Sun
white dwarf
luminosity (solar units)
10^6
10^5
10^4
10^3
10^2
10
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
O
B
A
F
G
K
M
30,000
10,000
6,000
3,000
surface temperature (Kelvin)

ncas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10^5
10^4
10^3
10^2
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1
0.1
10^{-2}
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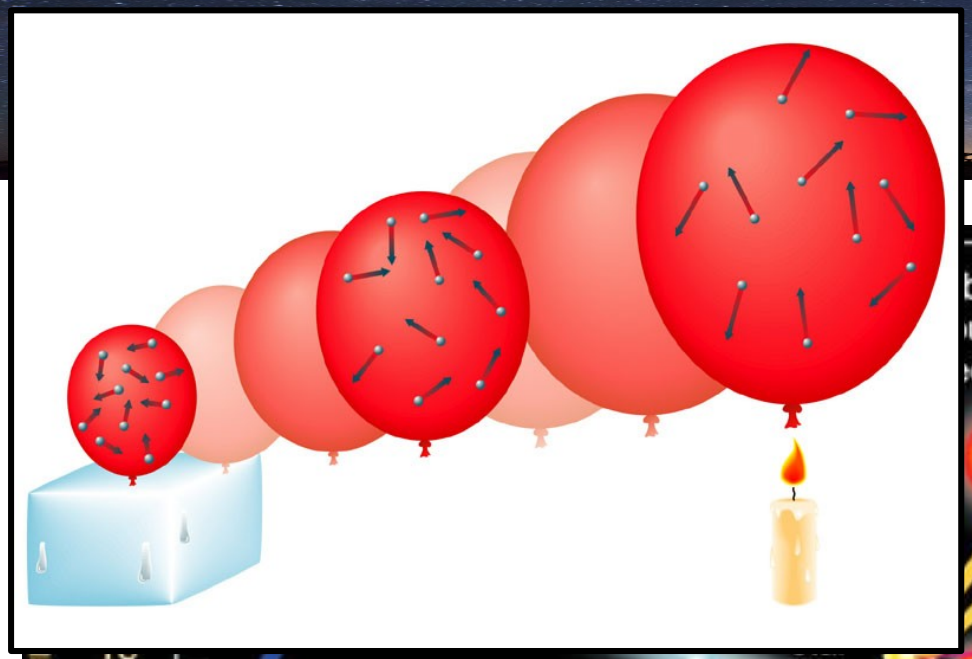
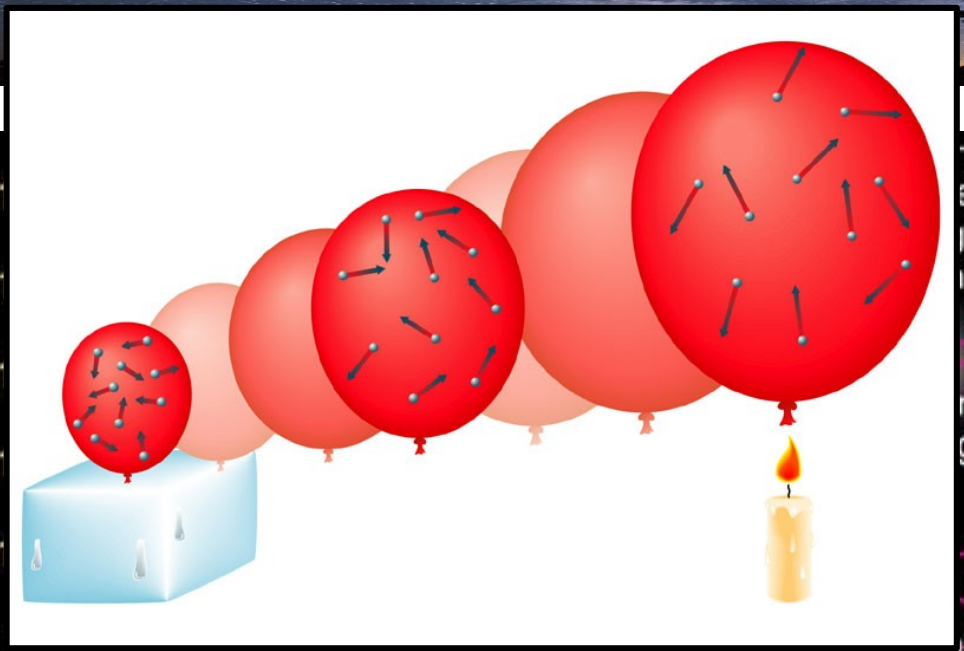
10^{-4}
10^{-5}
O
B
A
F
G
K
M
30,000
10,000
6,000
3,000
surface temperature (Kelvin)

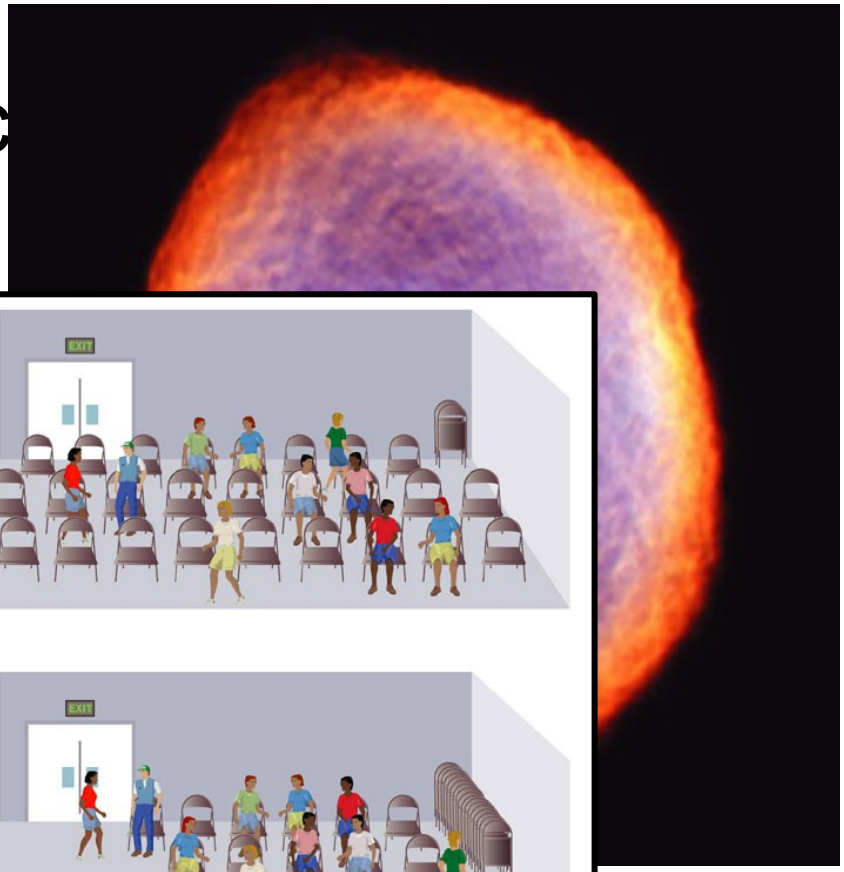
ncas



ble shell–
urning
d giant
red
giant
subgiant
Sun
white dwarf
luminosity (solar u
10
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
O
B
A
F
G
K
M
30,000
10,000
6,000
3,000
surface temperature (Kelvin)

ncas

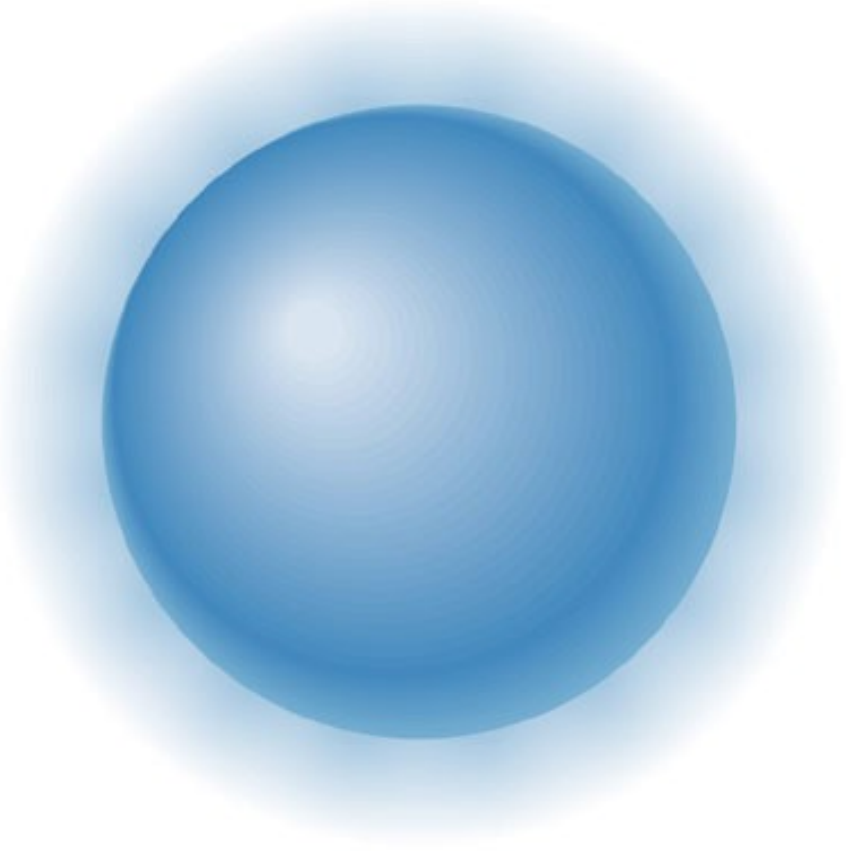




luminosity (solar units)
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
Sun
white dwarf
O
B
A
F
G
K
M
30,000
10,000
6,000
3,00
surface temperature (Kelvin)

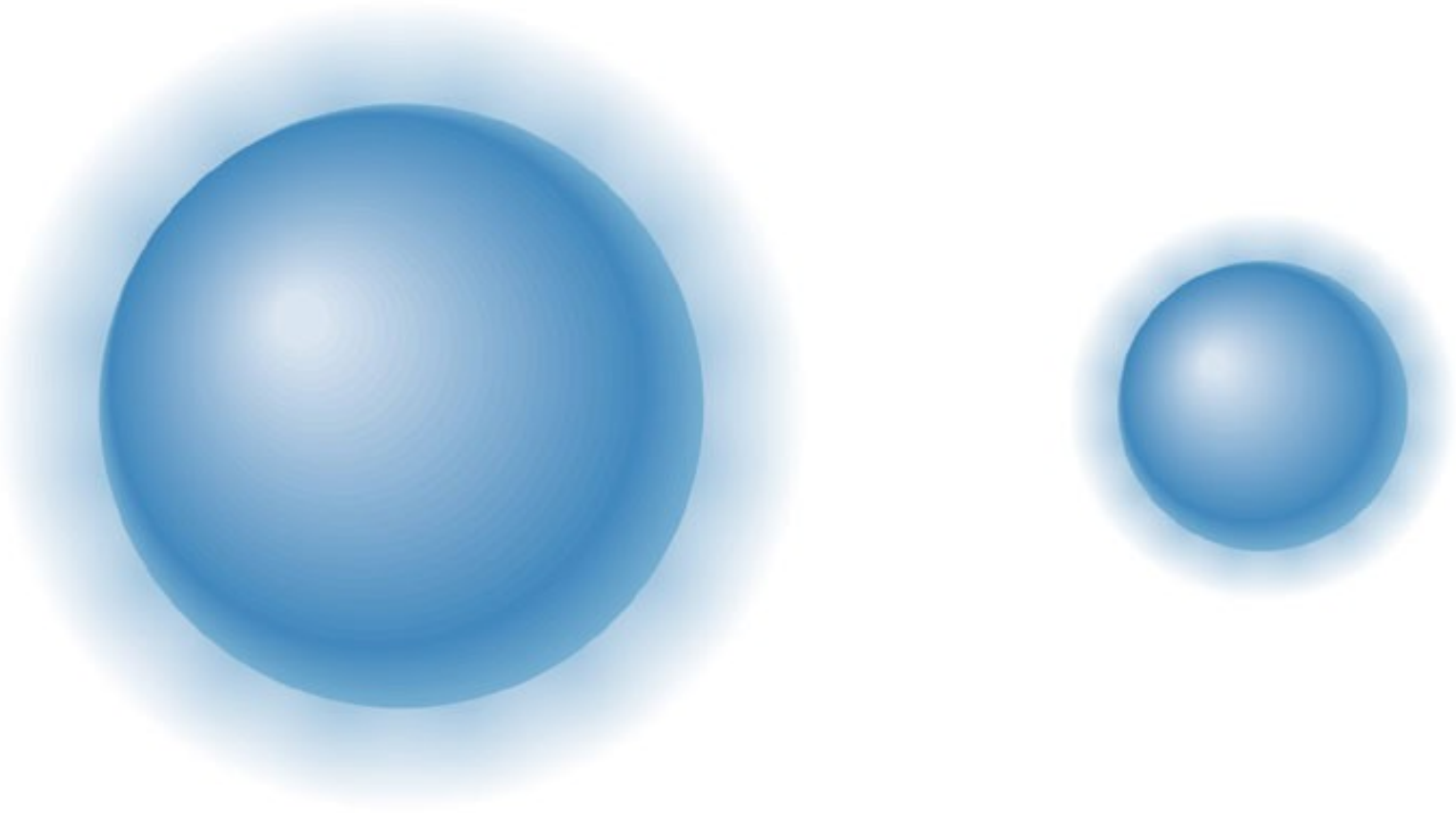
EXIT
EXIT

$1.0 M_{Sun}$ white dwarf



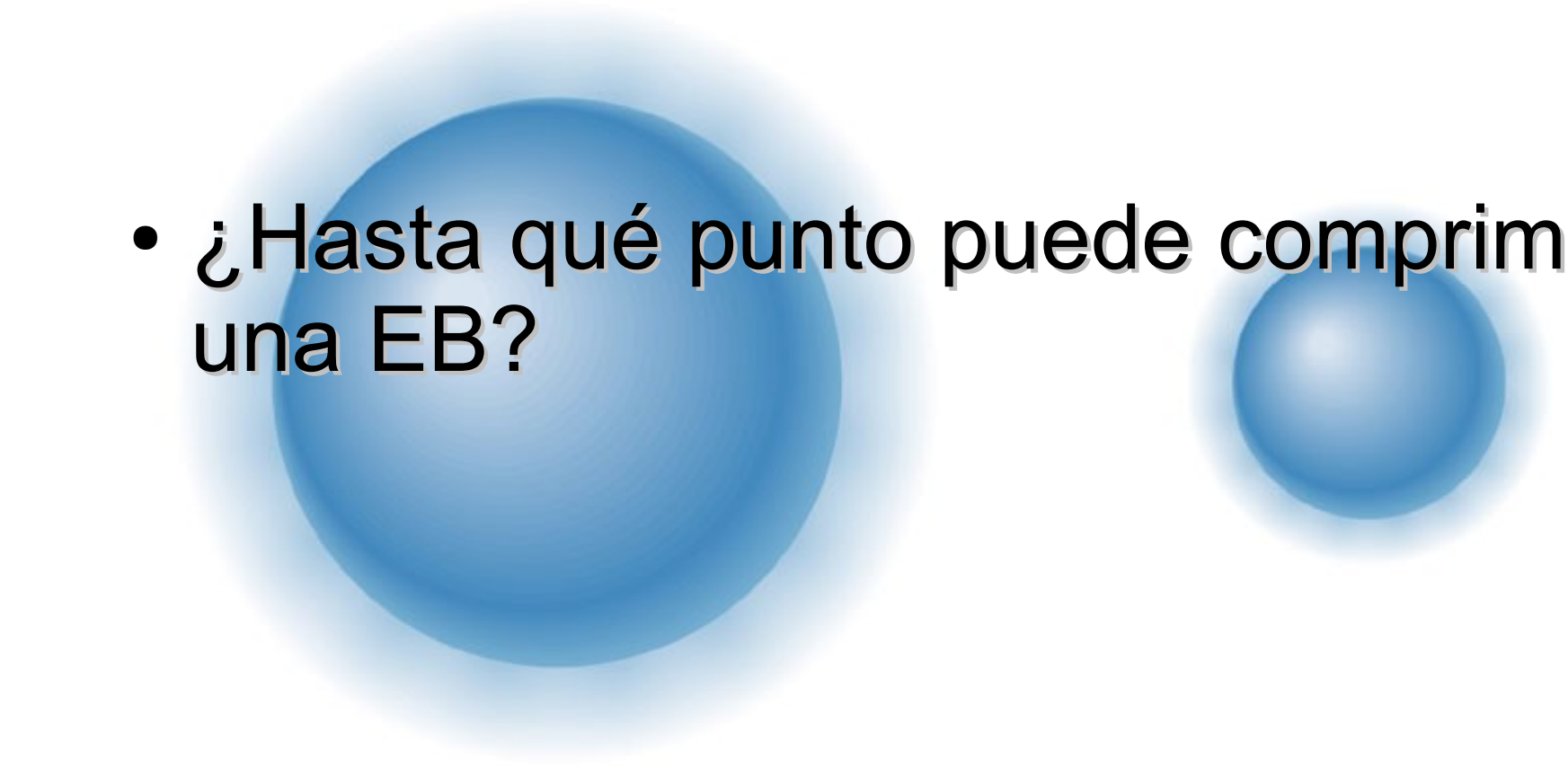
$1.0M_{Sun}$ white dwarf

$1.3M_{Sun}$ white dwarf



$1.0M_{Sun}$ white dwarf

$1.3M_{Sun}$ white dwarf



- ¿Hasta qué punto puede comprimirse una EB?

$1.0M_{Sun}$ white dwarf

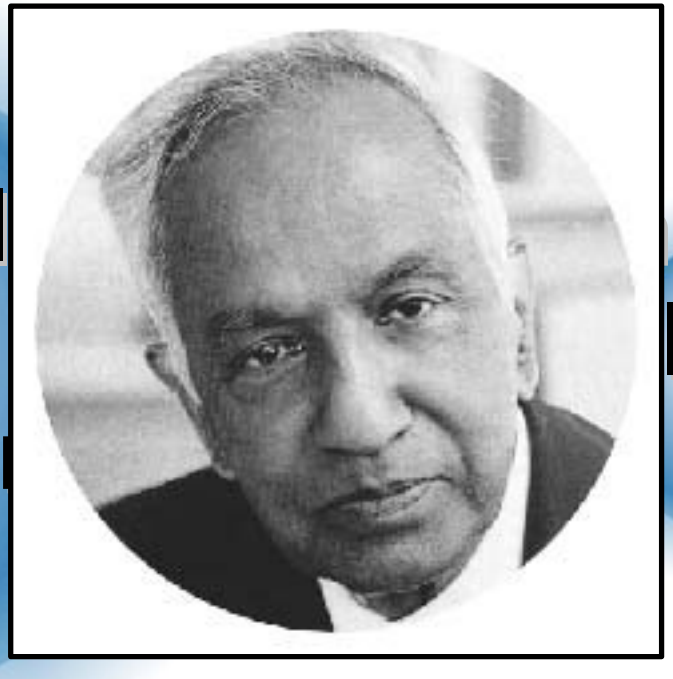
$1.3M_{Sun}$ white dwarf

- Cuando los electrones logran velocidades cercanas a *c*, la presión de degeneración no puede soportar el colapso.

$1.0M_{Sun}$ white dwarf

$1.3M_{Sun}$ white dwarf

- Cuando l es logran velocidades la presión de degeneració soportar el colapso.

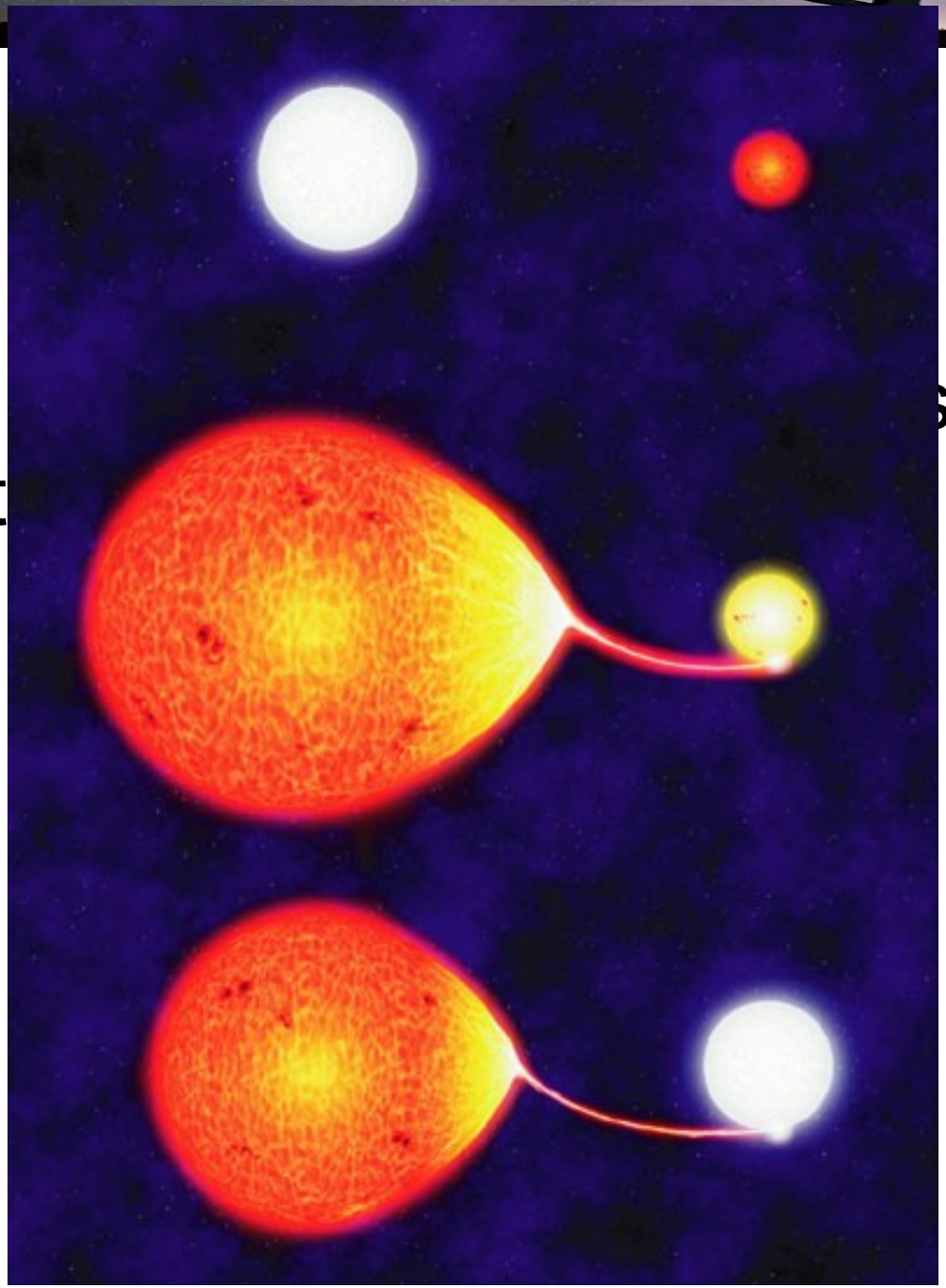


S. Chandrasekhar

Enanas Blancas

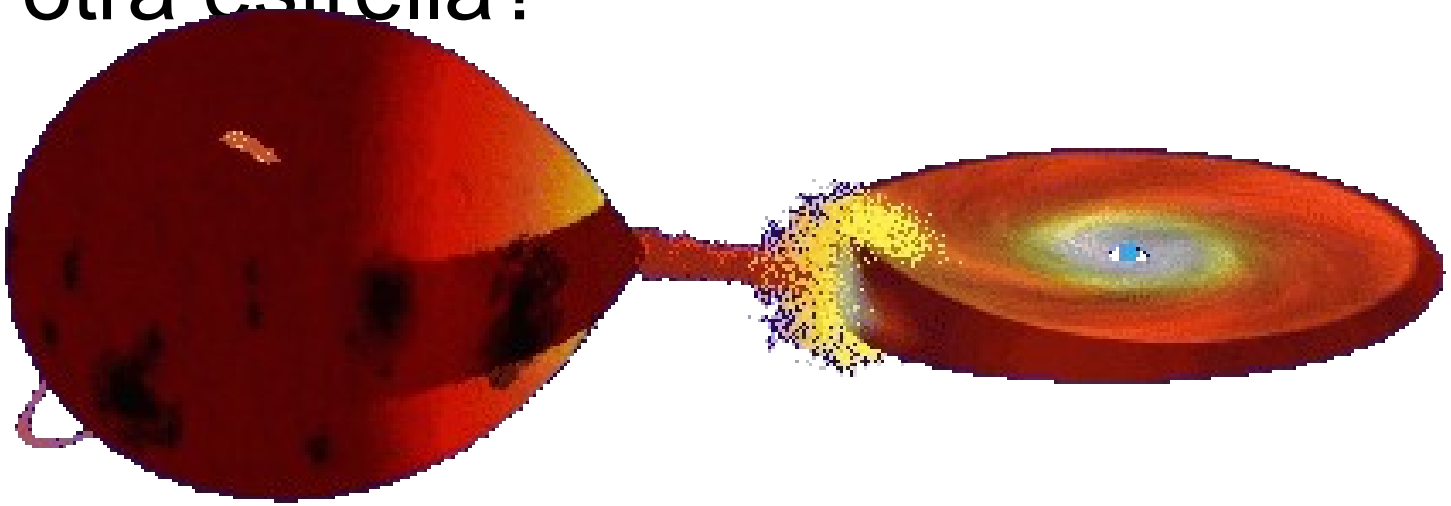
- ¿Qué sucede cuando una EB esta cerca de otra estrella?

- ¿Qué s sta cerca de otra est

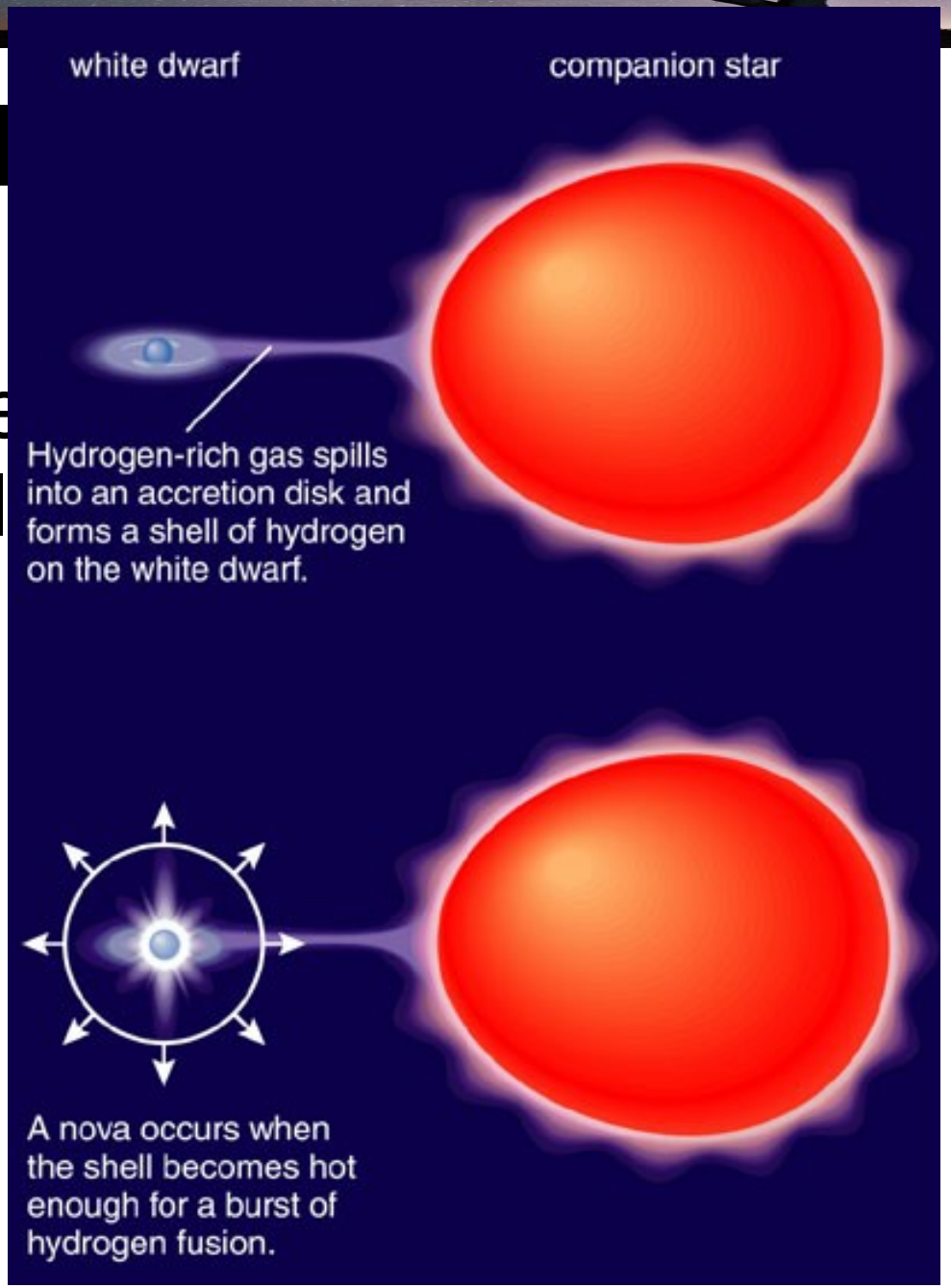


Enanas Blancas

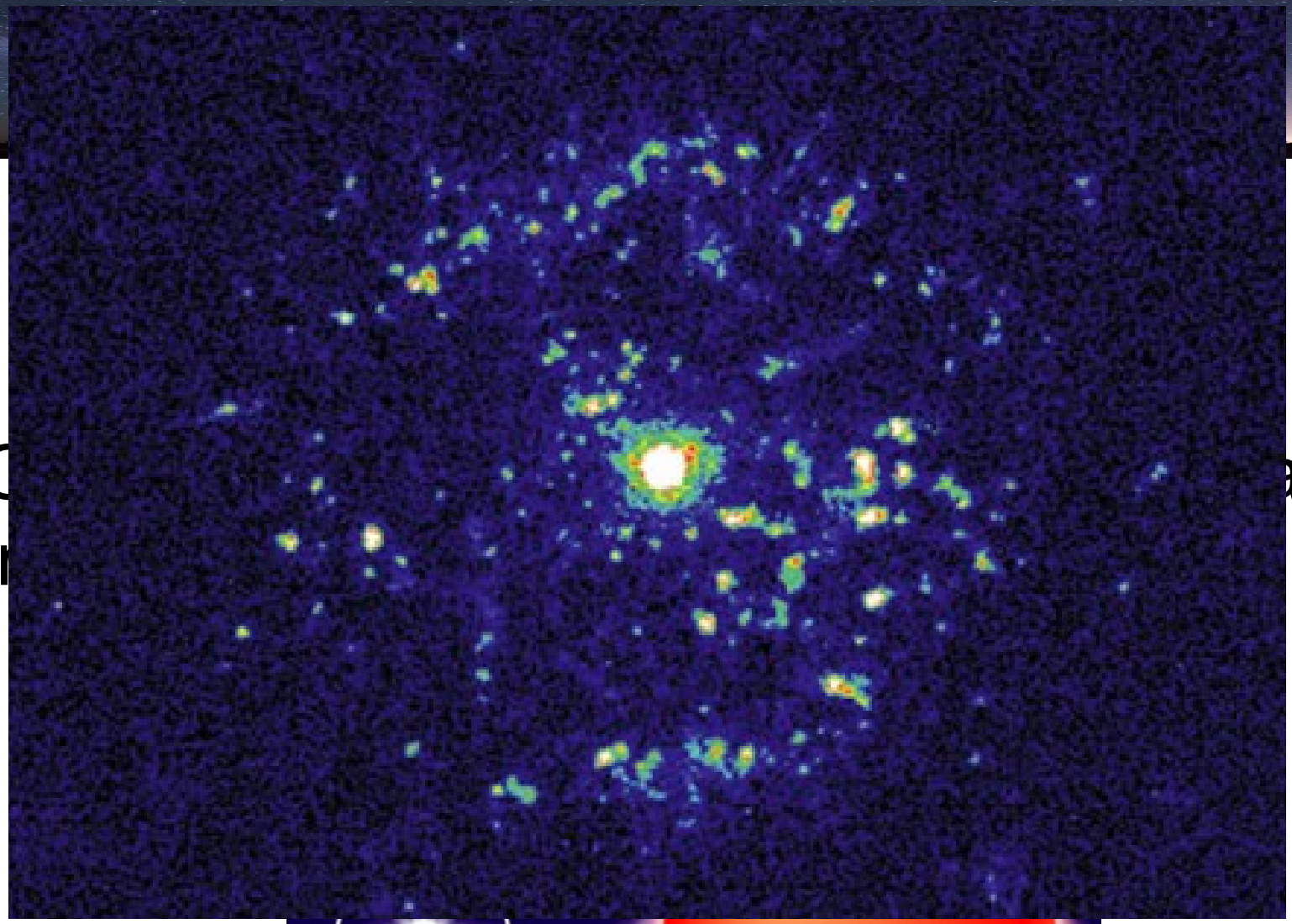
- ¿Qué sucede cuando una EB esta cerca de otra estrella?



- ¿Qué suce cerca de otra estrell



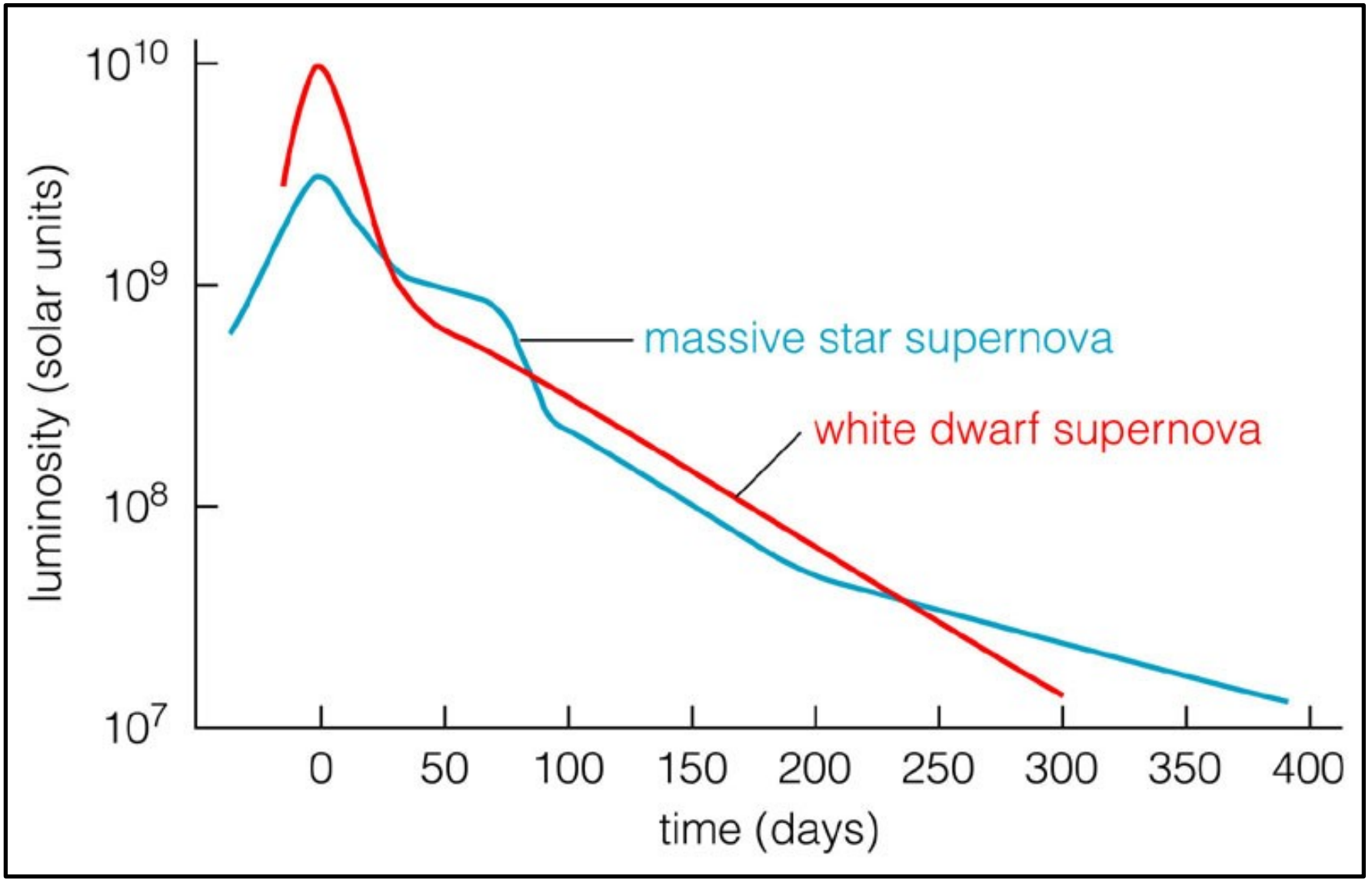
- ¿C a de otr




A nova occurs when the shell becomes hot enough for a burst of hydrogen fusion.

Enanas Blancas

- Dos tipos de Supernova:
  - Supernova de estrellas masivas
  - Supernova de EB


luminosity (solar units)
10^{10}
10^{9}
10^{8}
10^{7}
massive star supernova
white dwarf supernova
0
50
100
150
200
250
300
350
400
time (days)

¿Nova o Supernova?

- Supernovae (Supernova tipo II): son del orden de 10 millones de veces más luminosas

- Nova: Fusión de H a He de las capas superiores del núcleo permanece intacta

- Supernova (Supernova tipo I): Explosión completa de una EB, no queda nada.

Estrellas de Neutrones

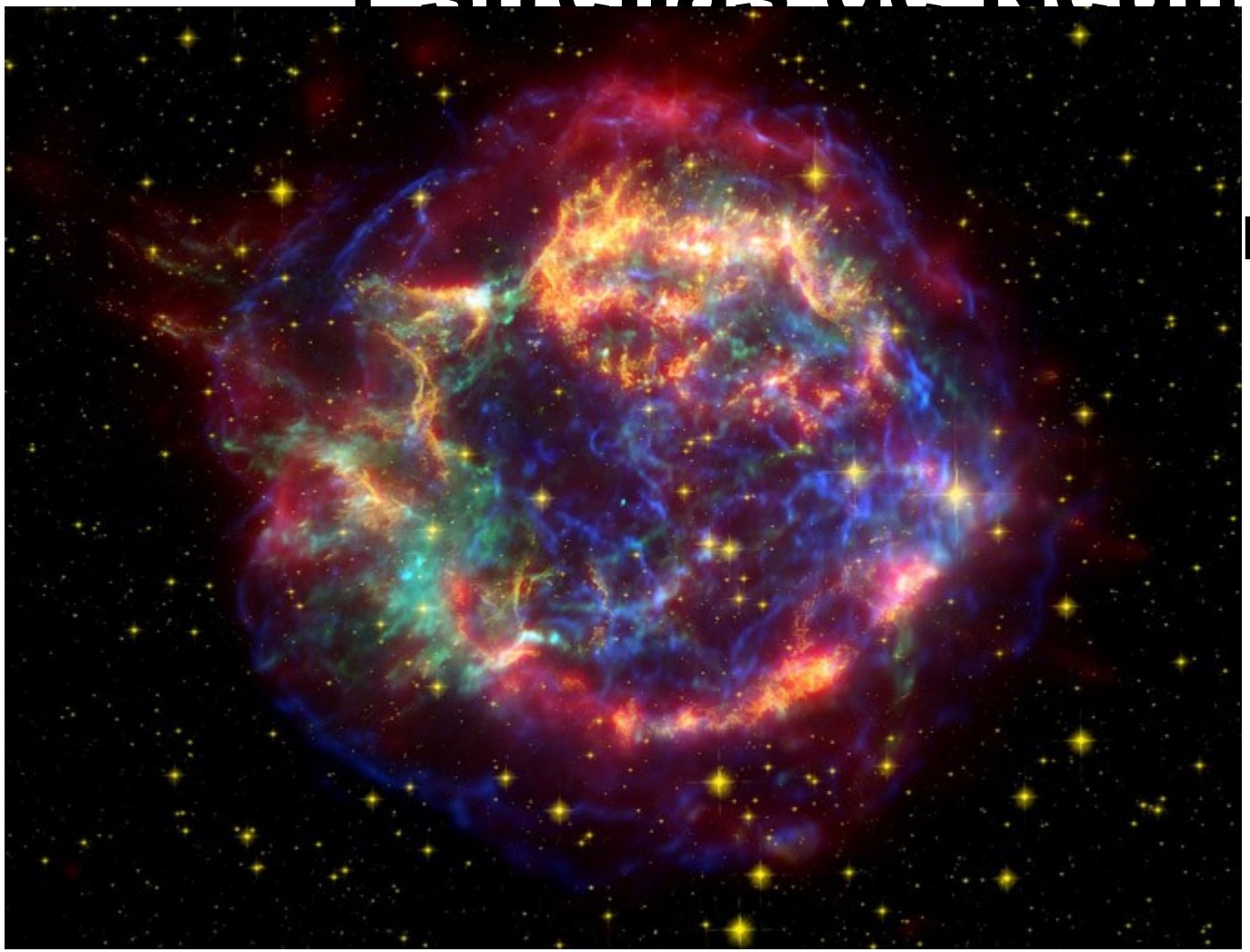
- ¿Qué es una Estrella de Neutrones (EN)?

- ¿Qué le sucede a una estrella cuando esta en un sistema binario?

Estrellas de Neutrones

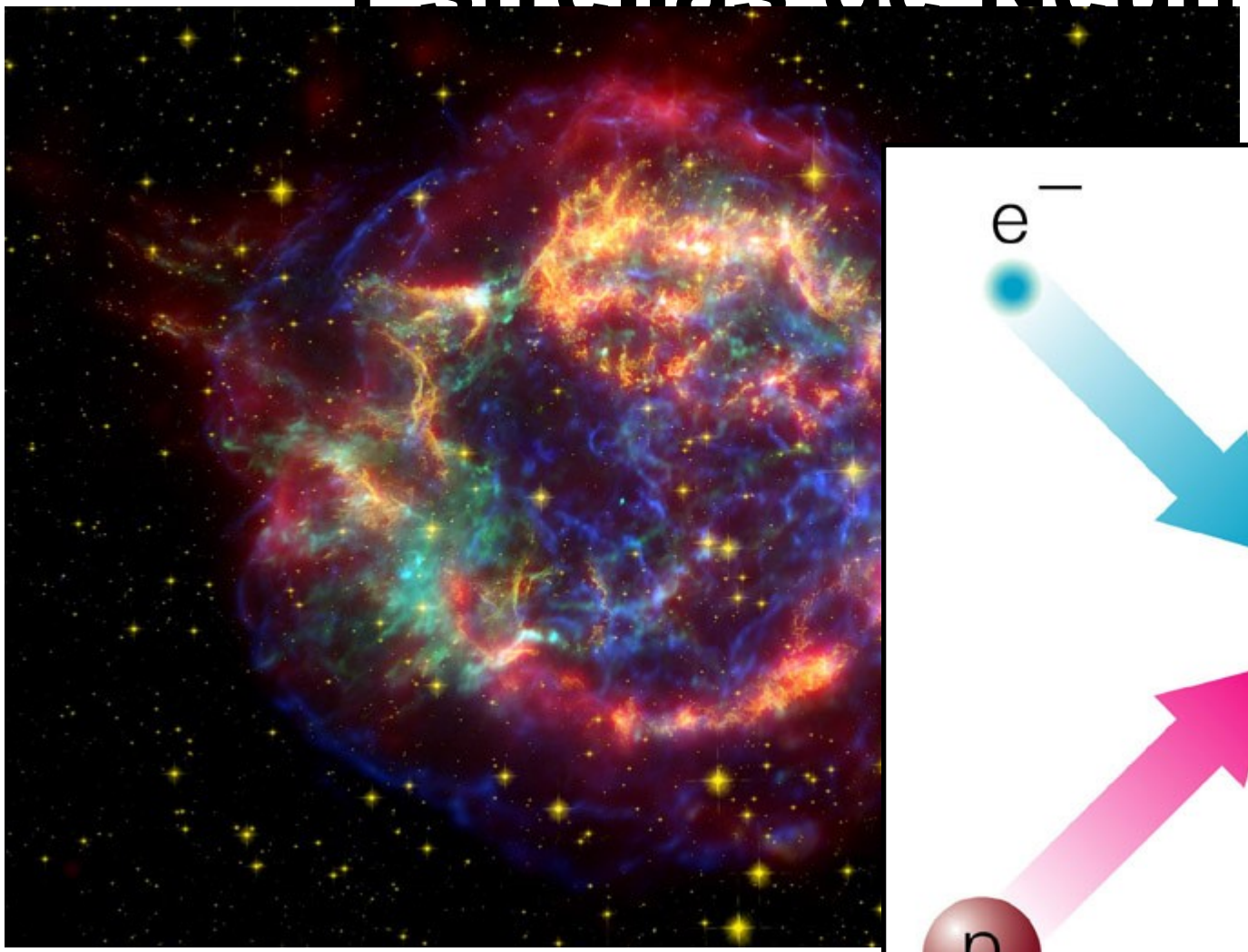
- ¿Qué es una Estrella de Neutrones (EN)?

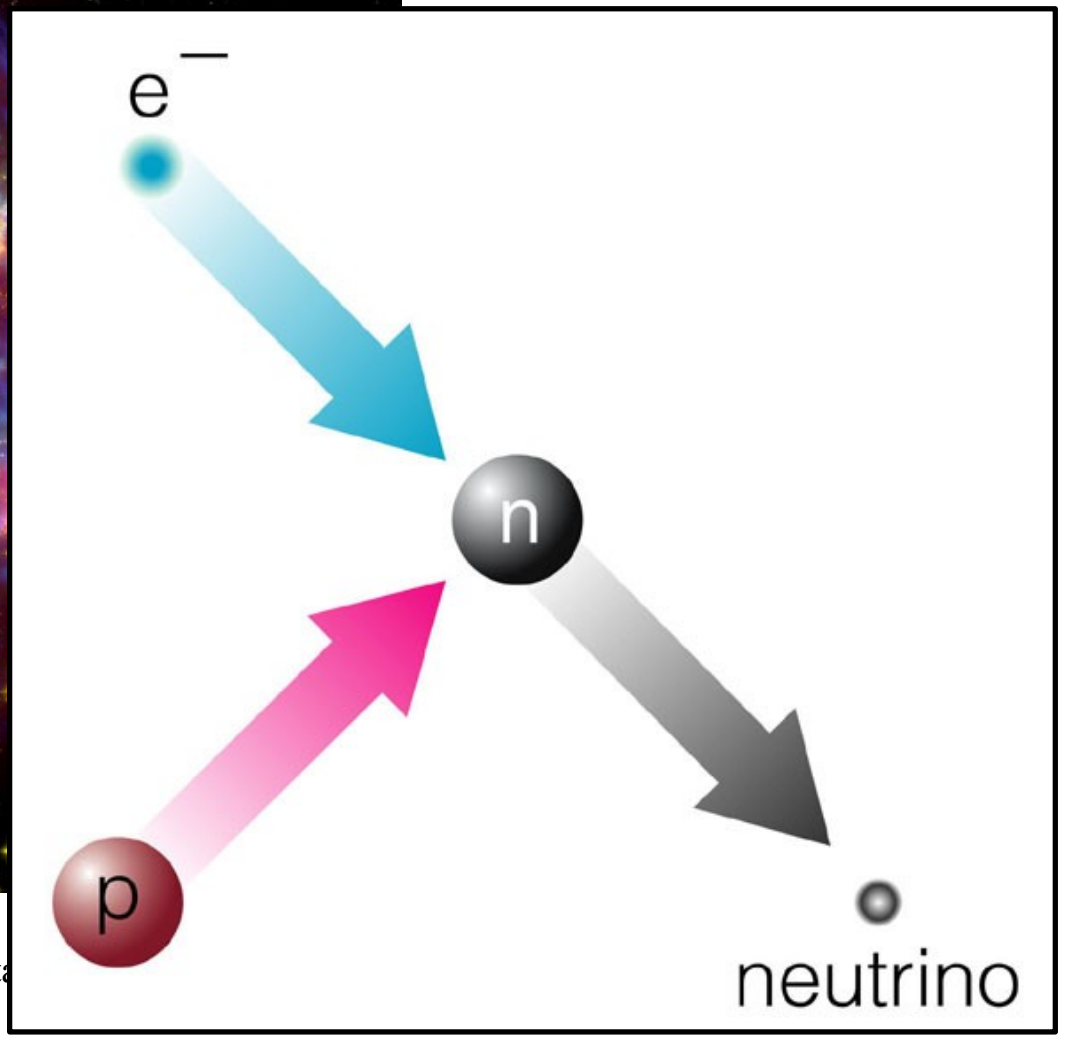
Estrellas de Neutrones



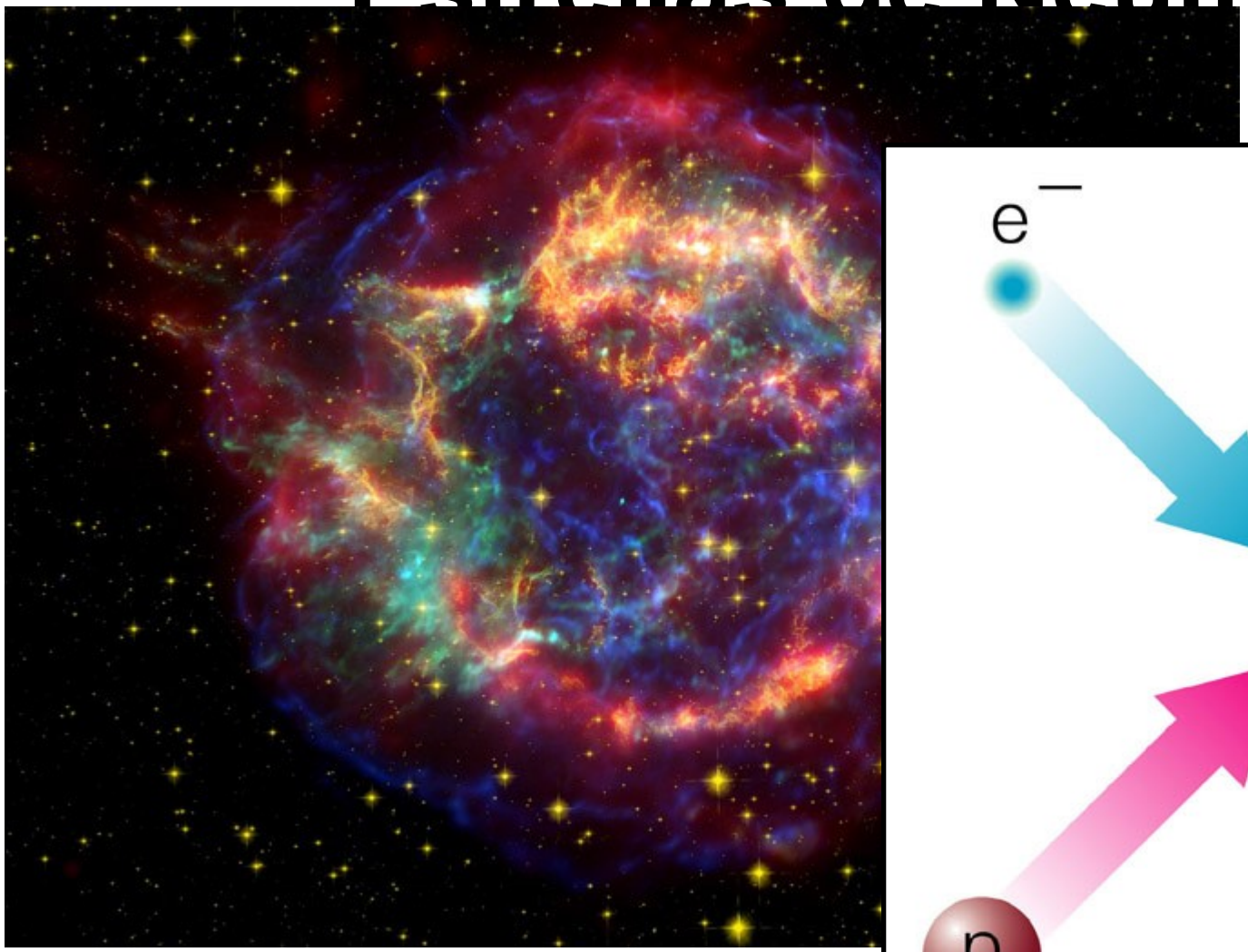
rones (EN)?

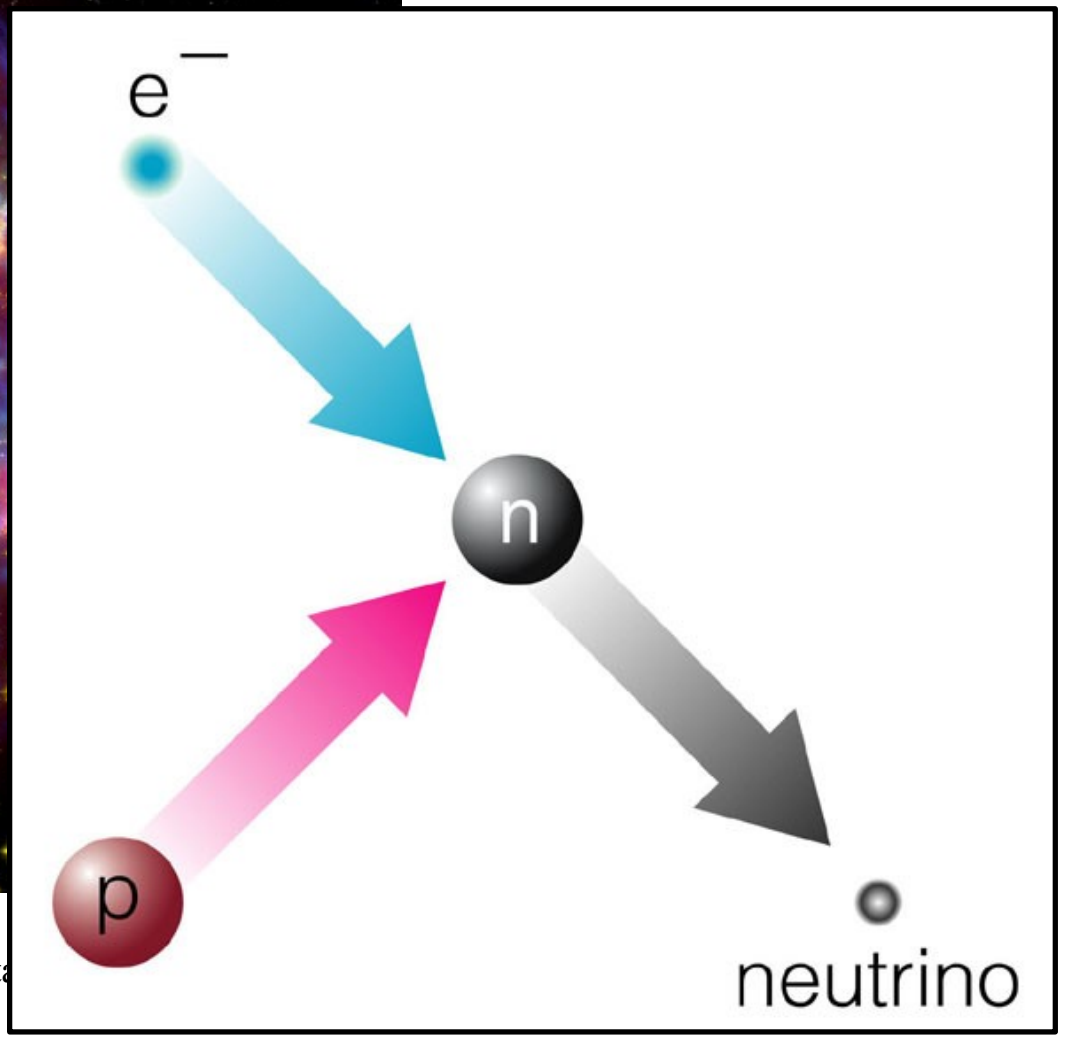
Estrellas de Neutrones

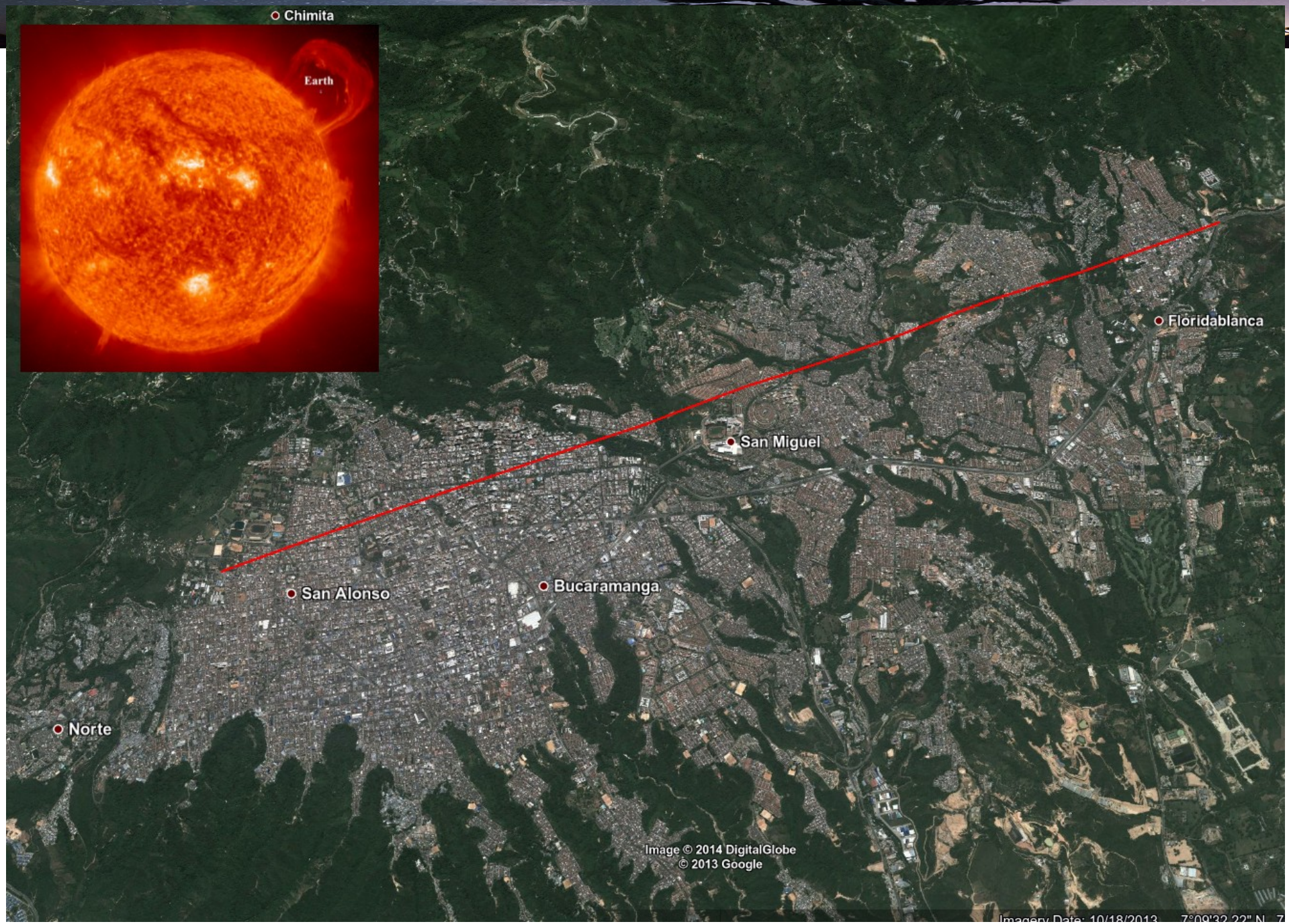




Estrellas de Neutrones






Chimita
Earth
Floridablanca
San Miguel
San Alonso
Bucaramanga
Norte
Image © 2014 DigitalGlobe
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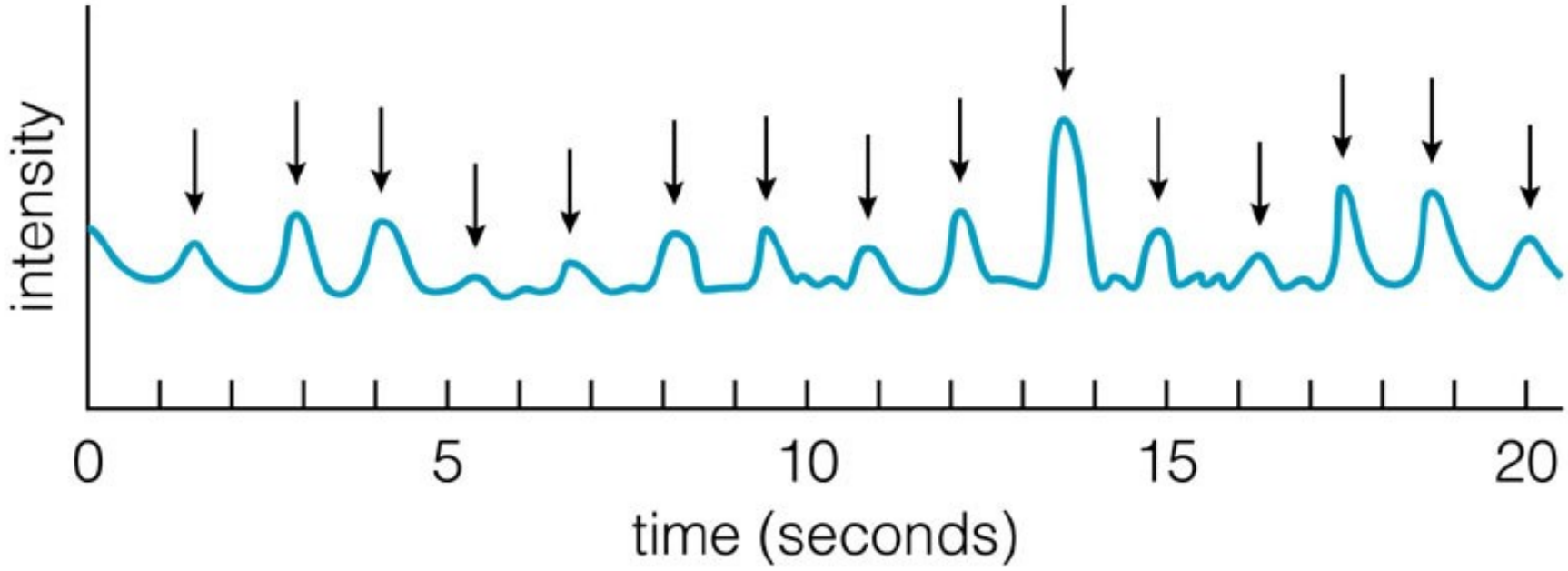
Estrellas de Neutrones

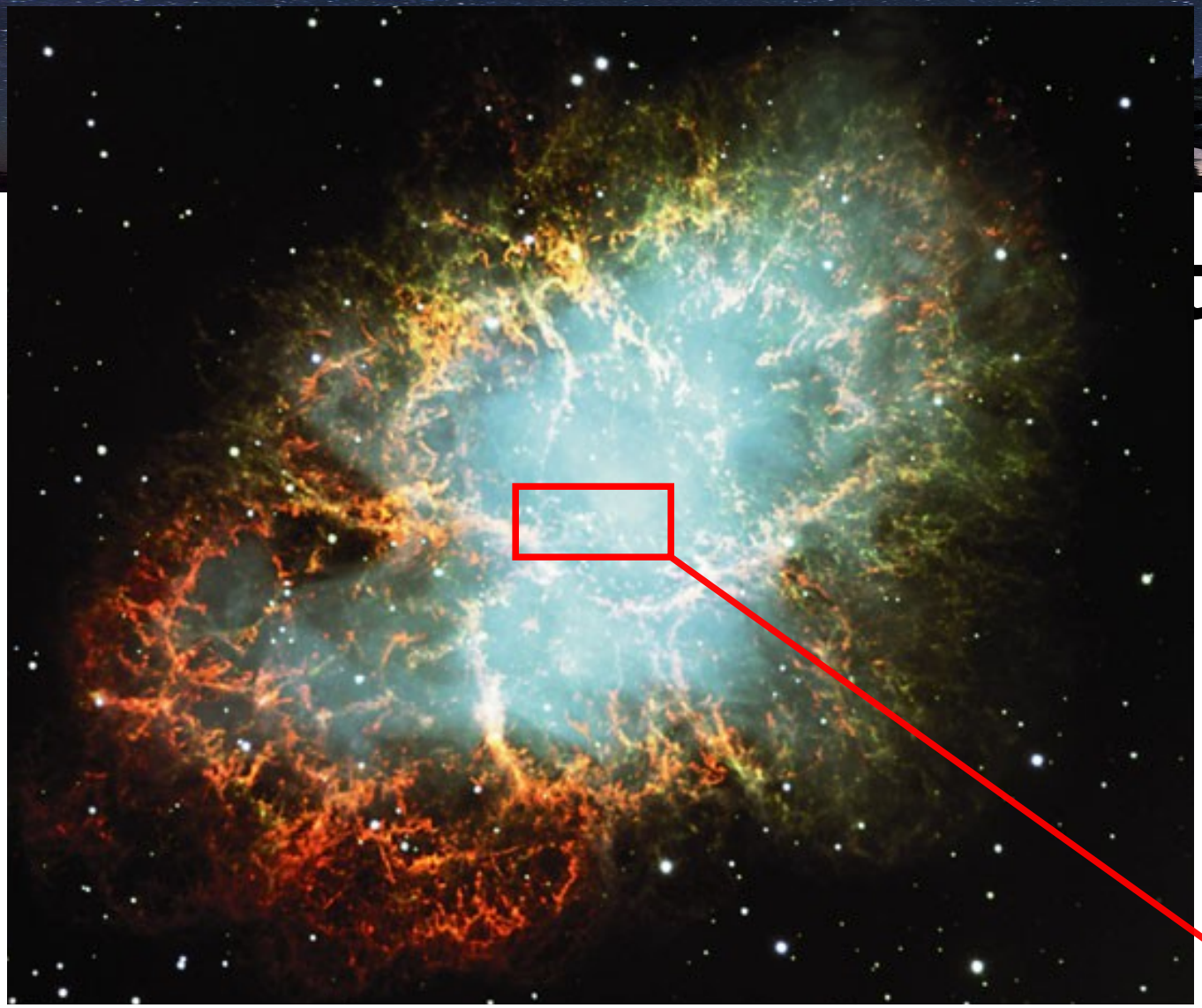
- Fueron descubiertas en 1967 por Bell Burnell, usando un radio telescopio.

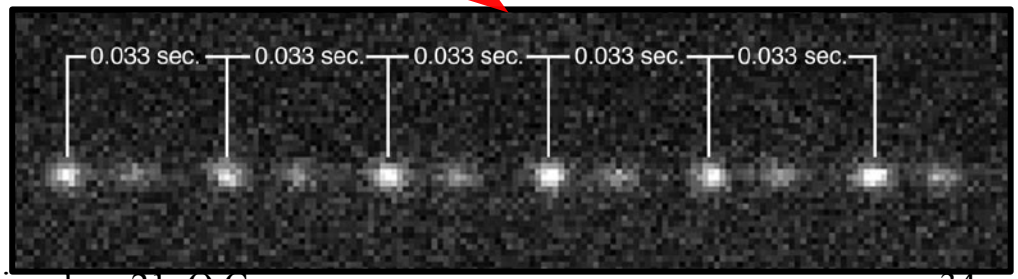
Estrellas de Neutrones

- Fueron descubiertas en 1967 por Bell Burnell, usando un radio telescopio.

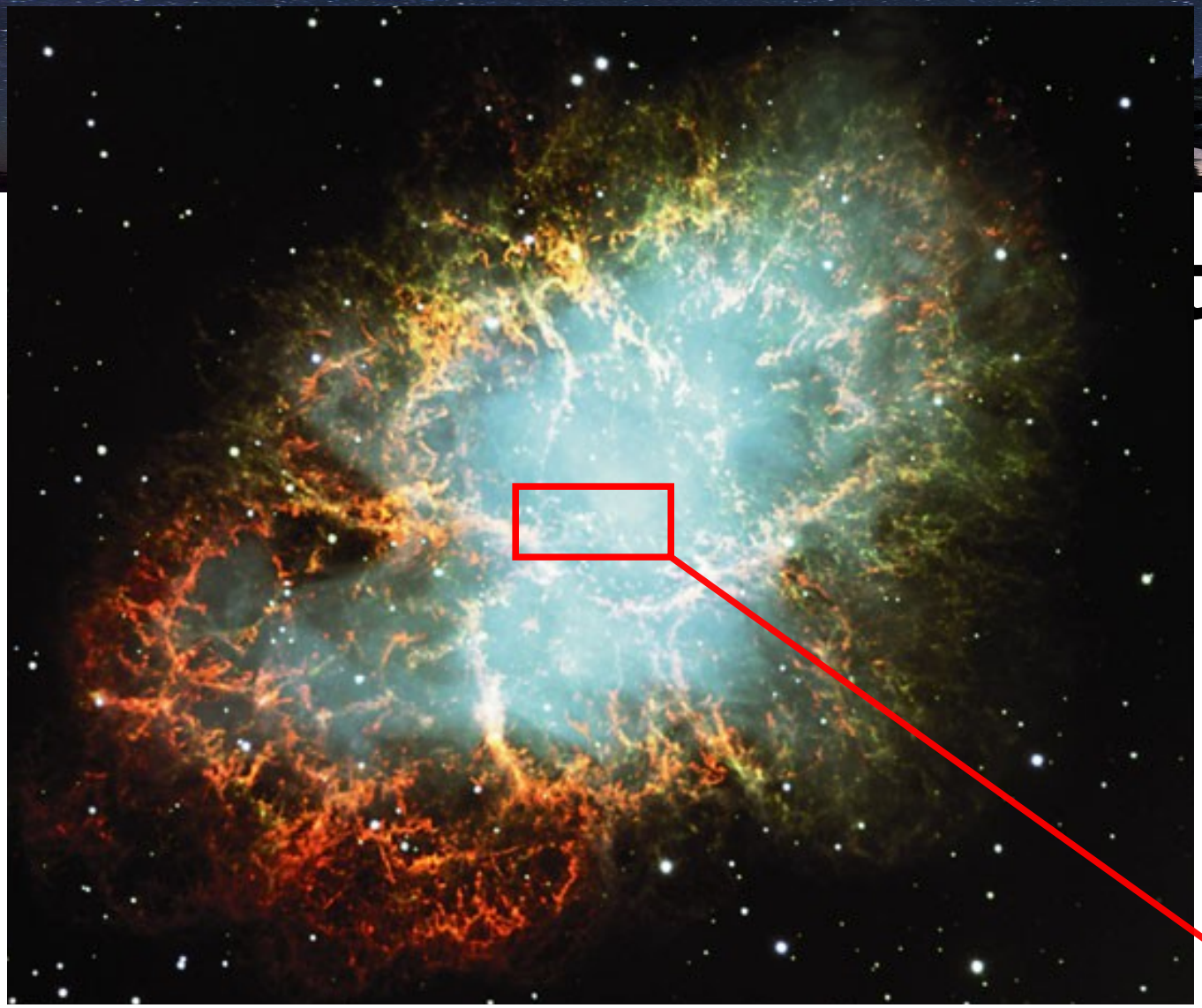


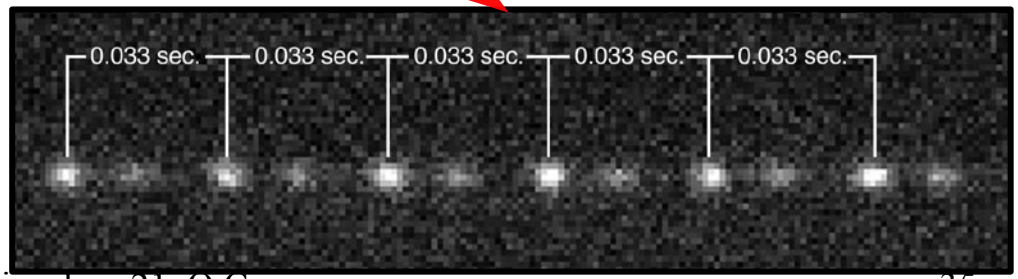
trones



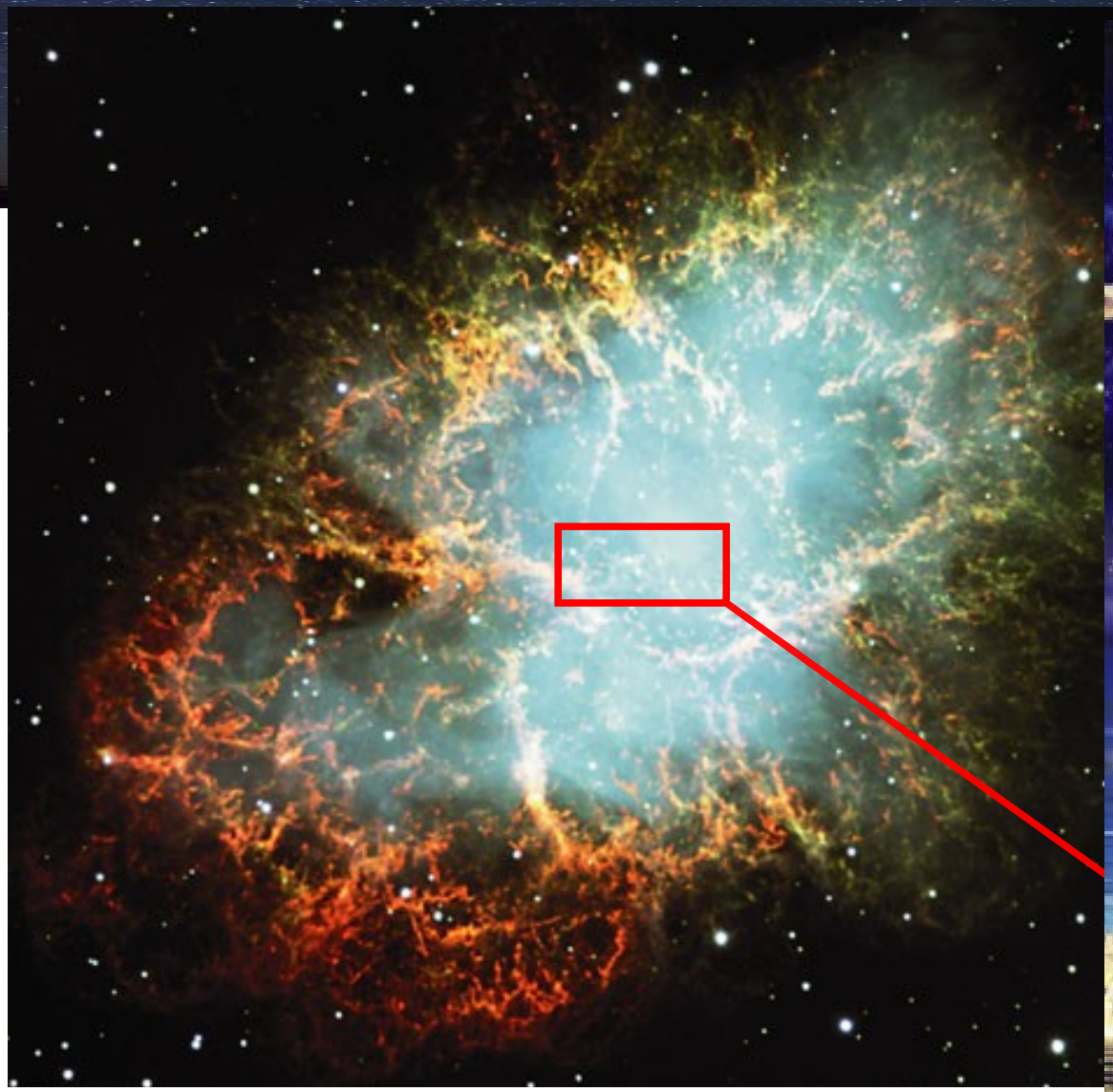


trones

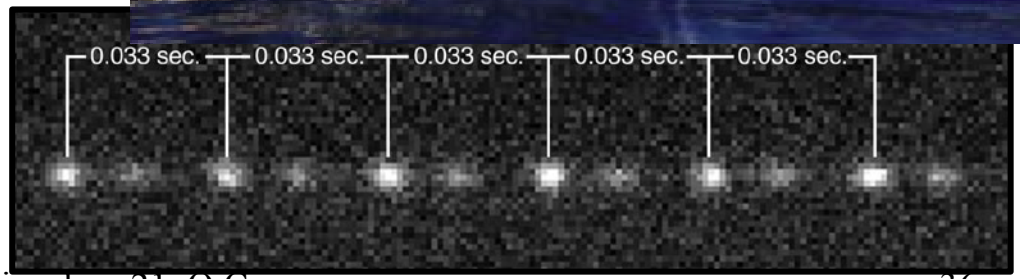


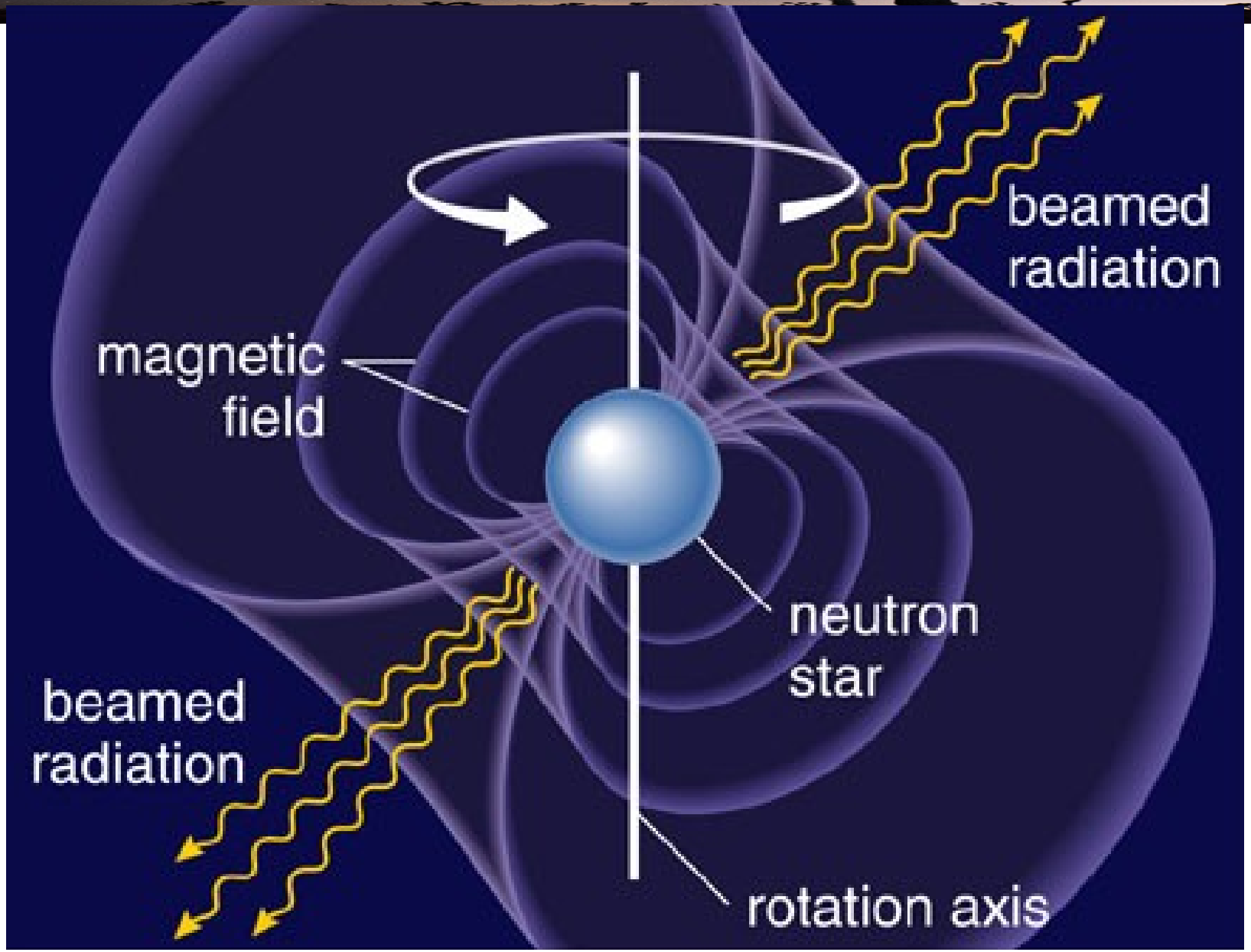


- 30 hz

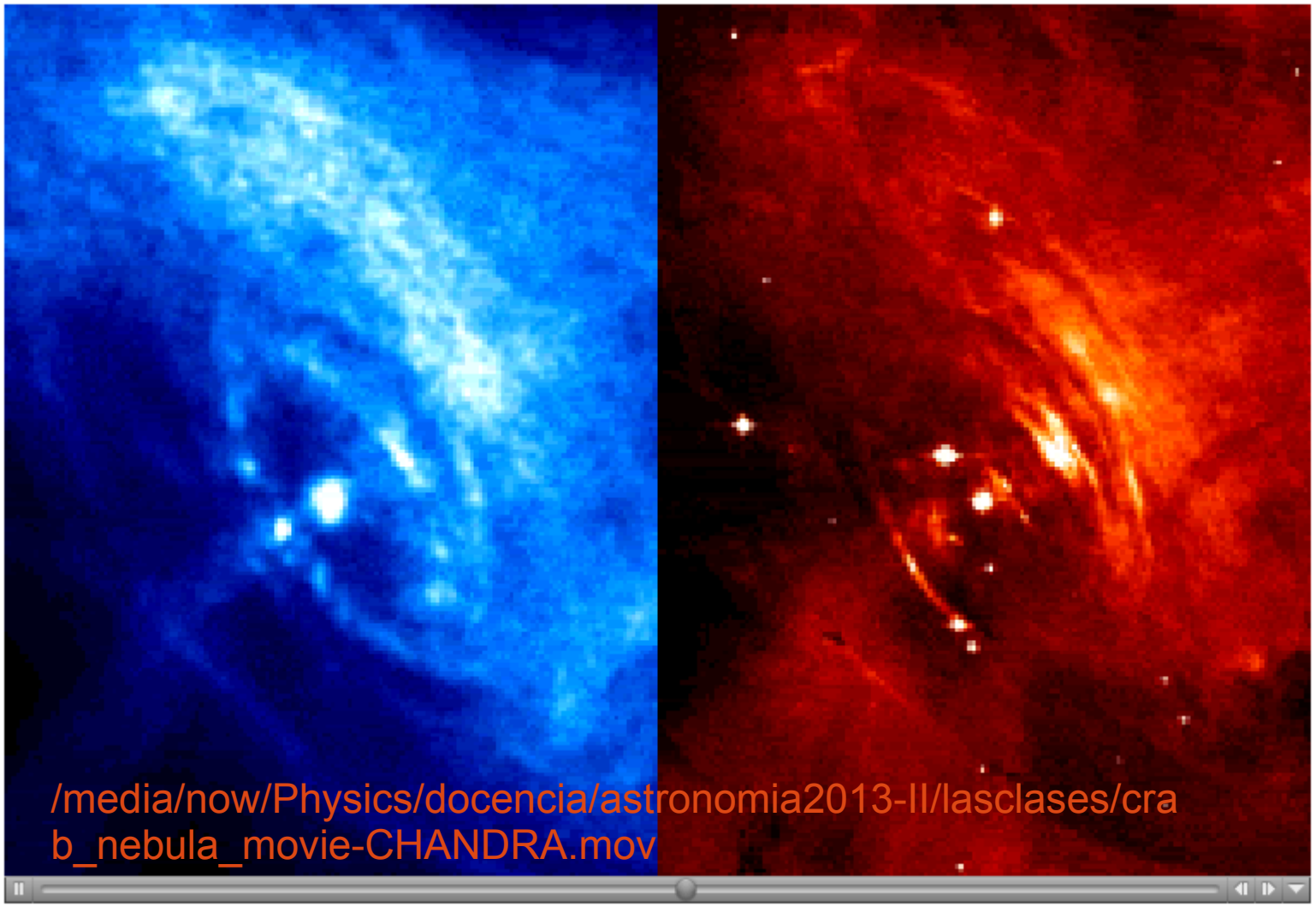


- 30 hz




beamed
radiation
magnetic
field
neutron
star
beamed
radiation
rotation axis

Estrellas de Neutrones

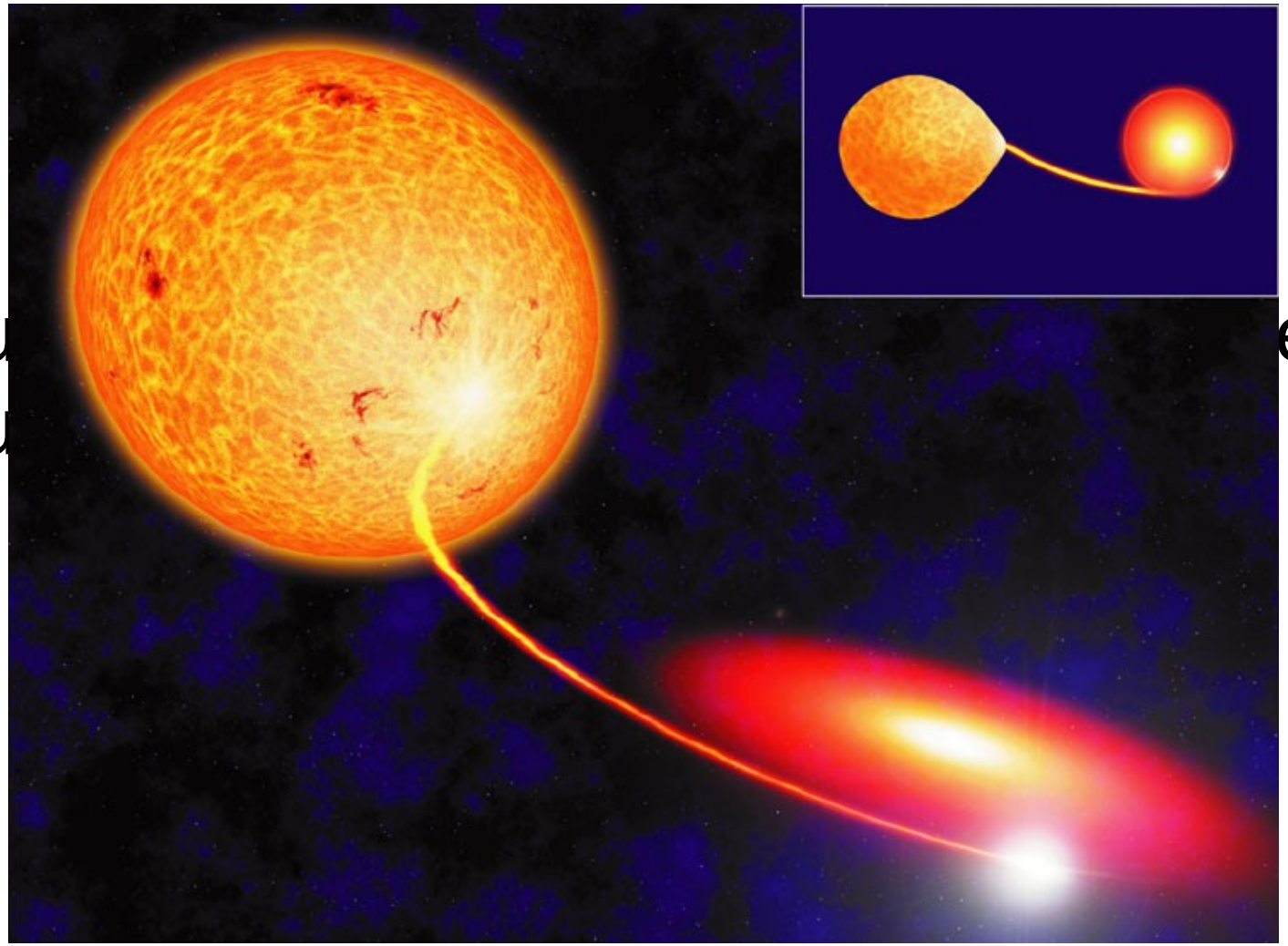


Estrellas de Neutrones

- Velocidad de rotación: ~1000/s
- Velocidad de rotación superficial: ~60000 km/s
- ~20% de la velocidad luz

Estrellas de Neutrones

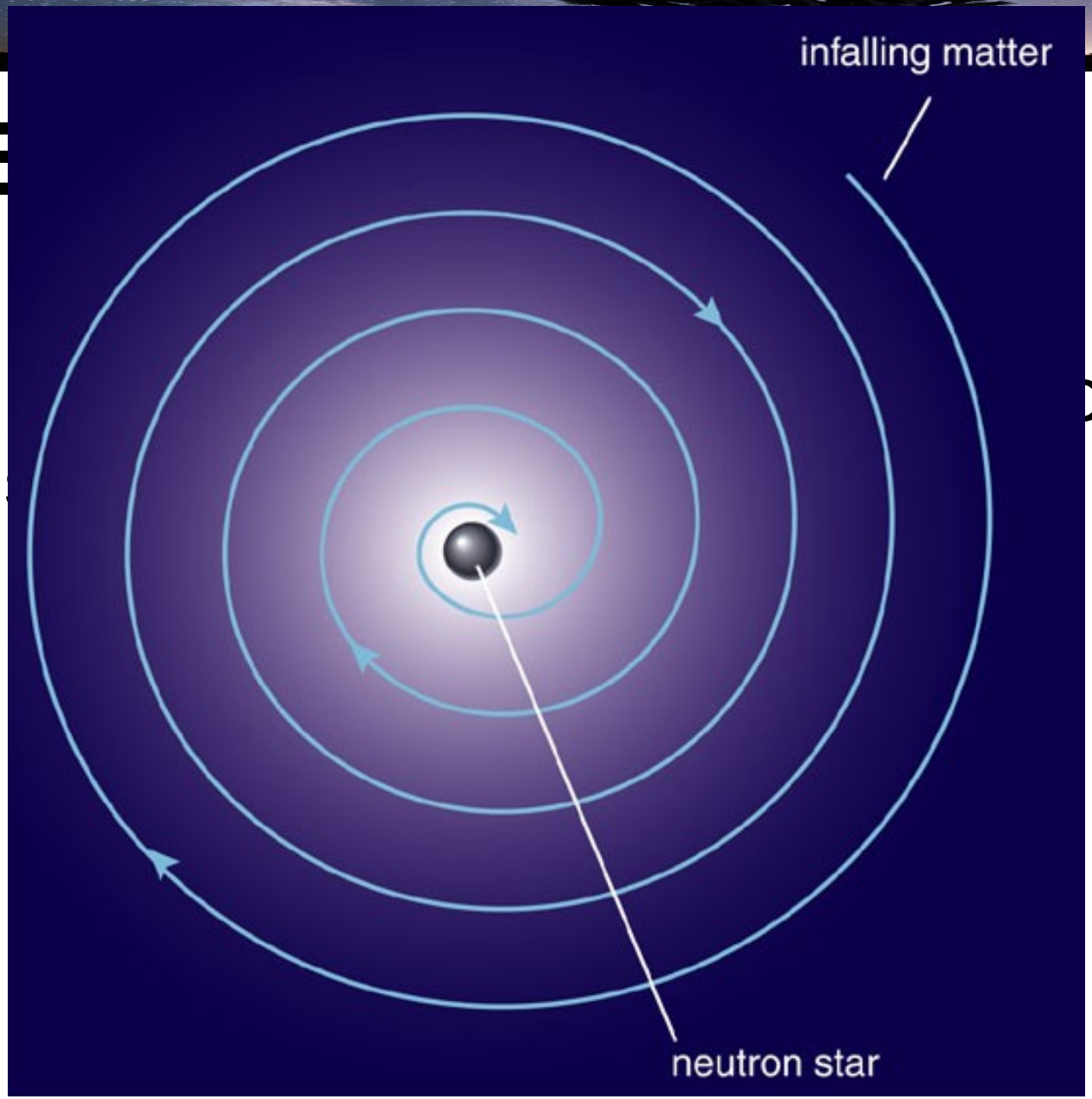
- ¿Qué le sucede a una estrella cuando esta en un sistema binario?



- ¿Qu esta en u

E

- ¿Qué … o esta en un …

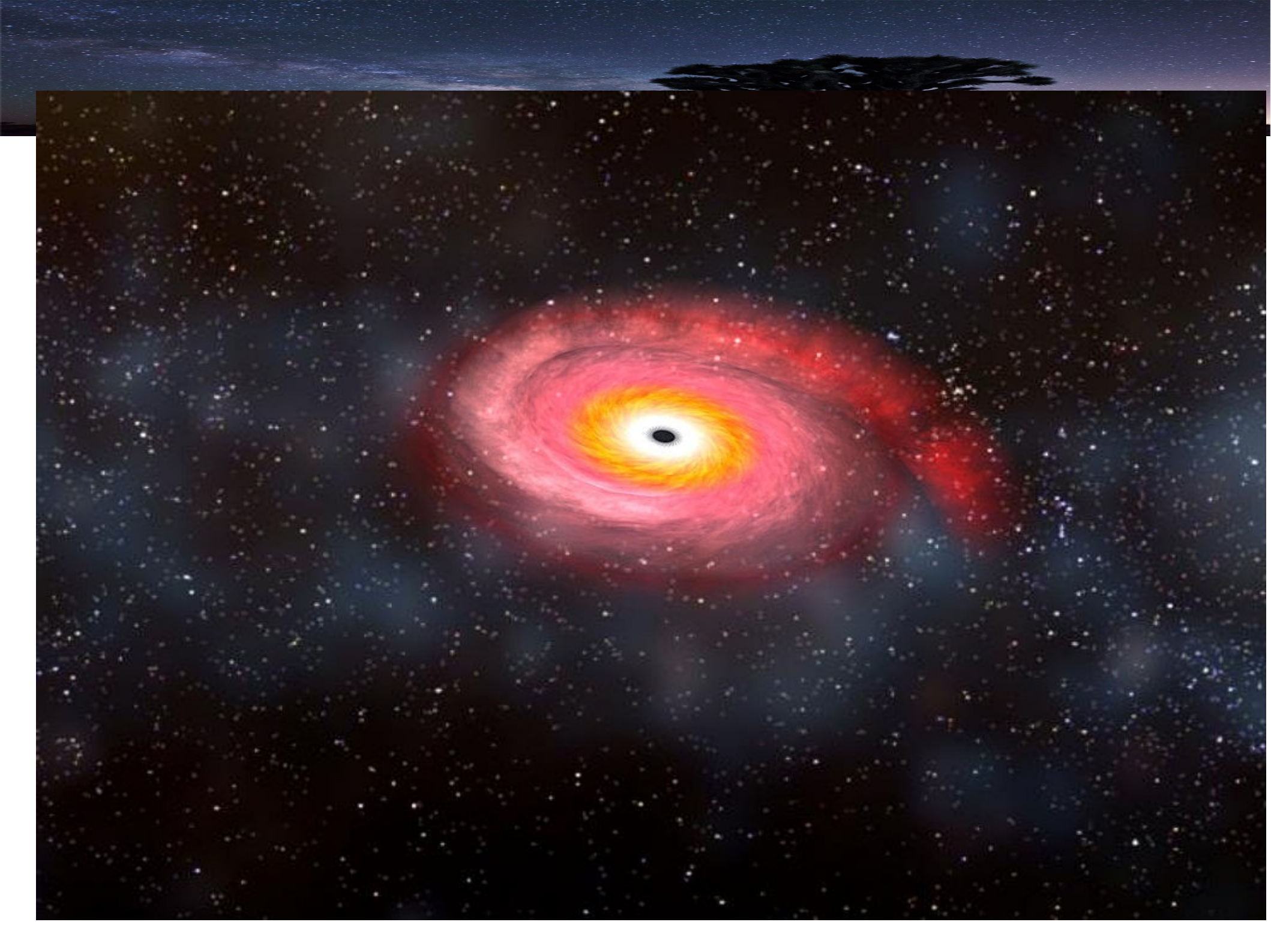


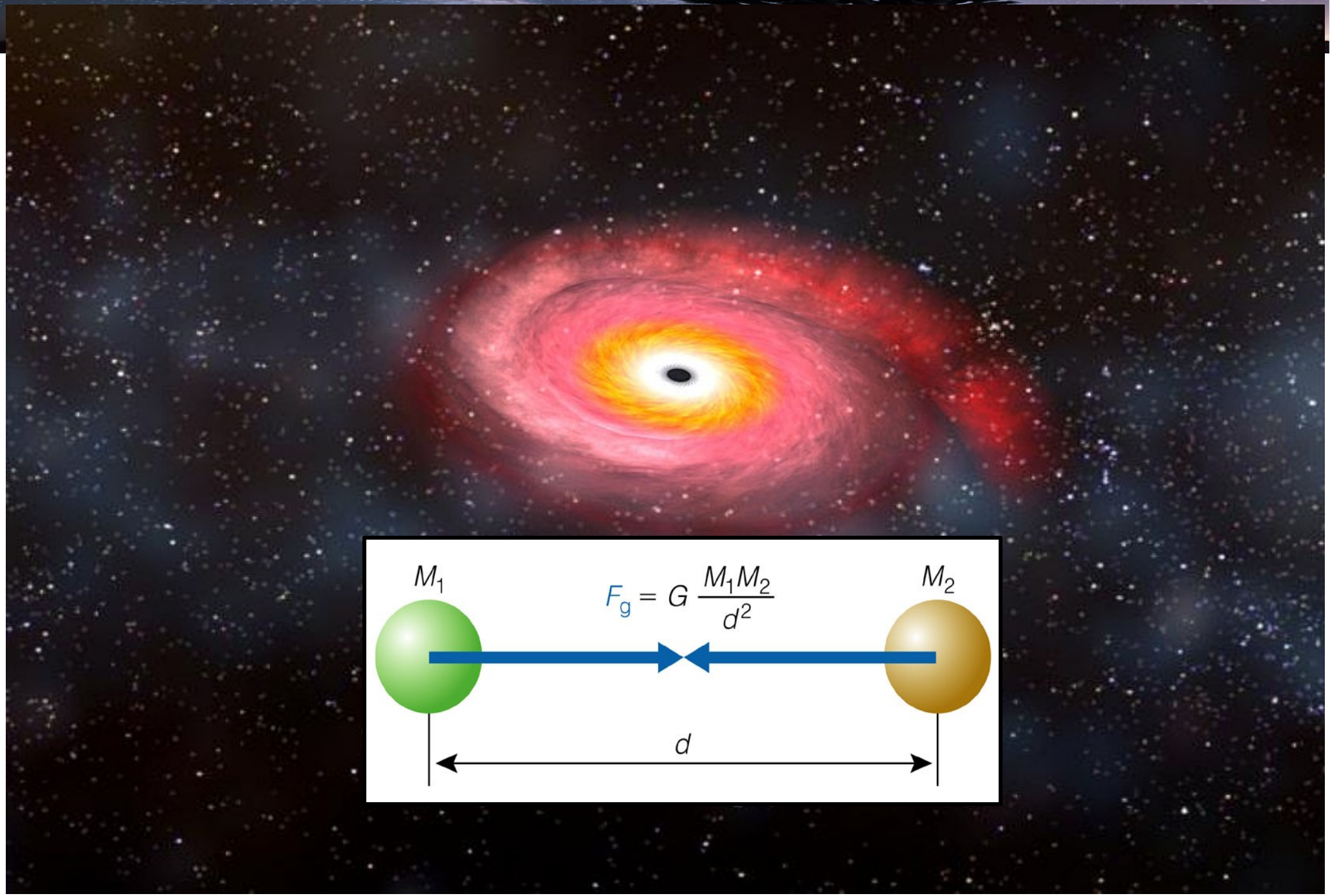
Agujeros Negros

- ¿Qué es un Agujero Negro (AN)?
- ¿Existen los agujeros negros?

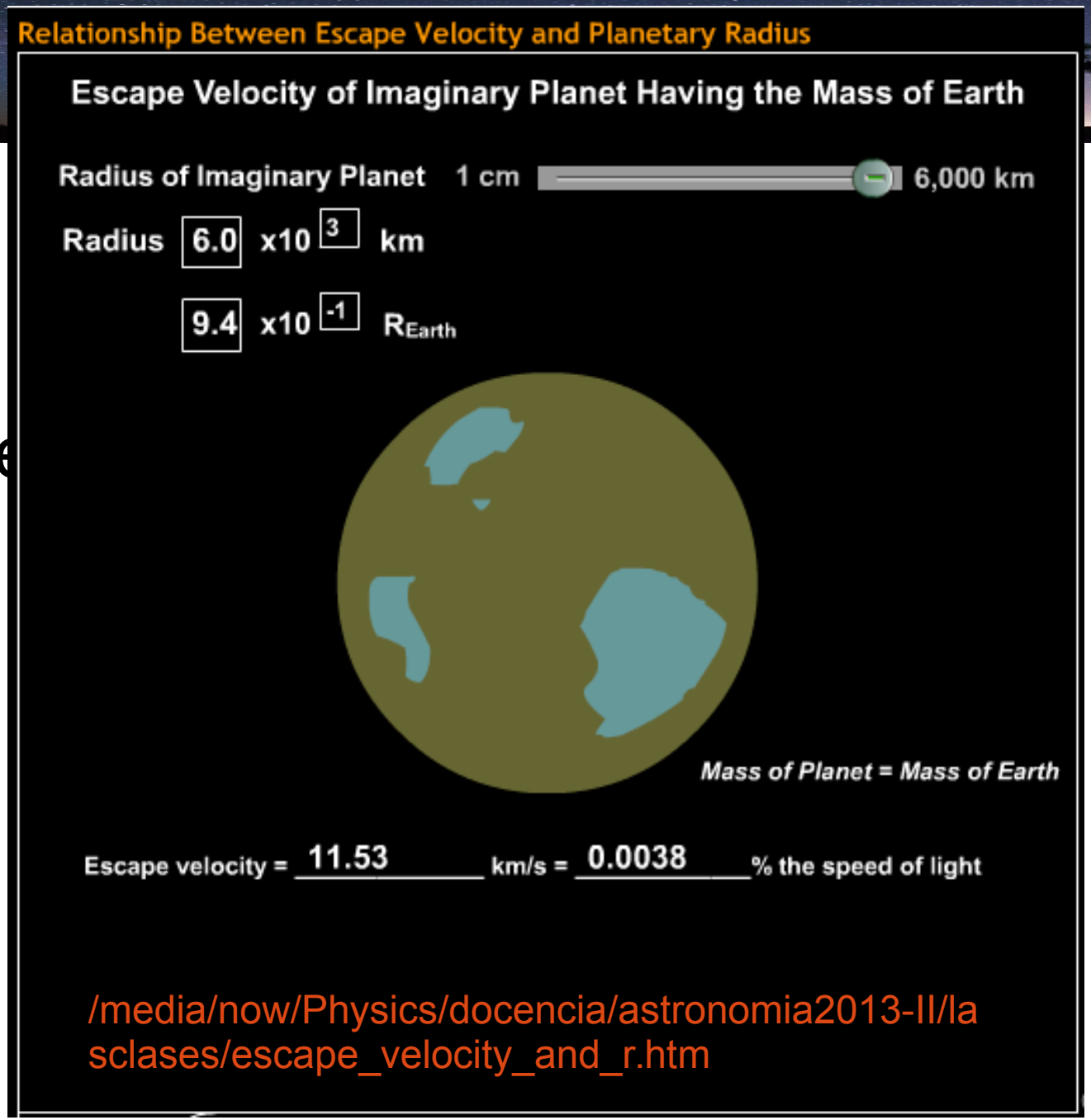
Agujeros Negros

- ¿Qué es un Agujero Negro (AN)?



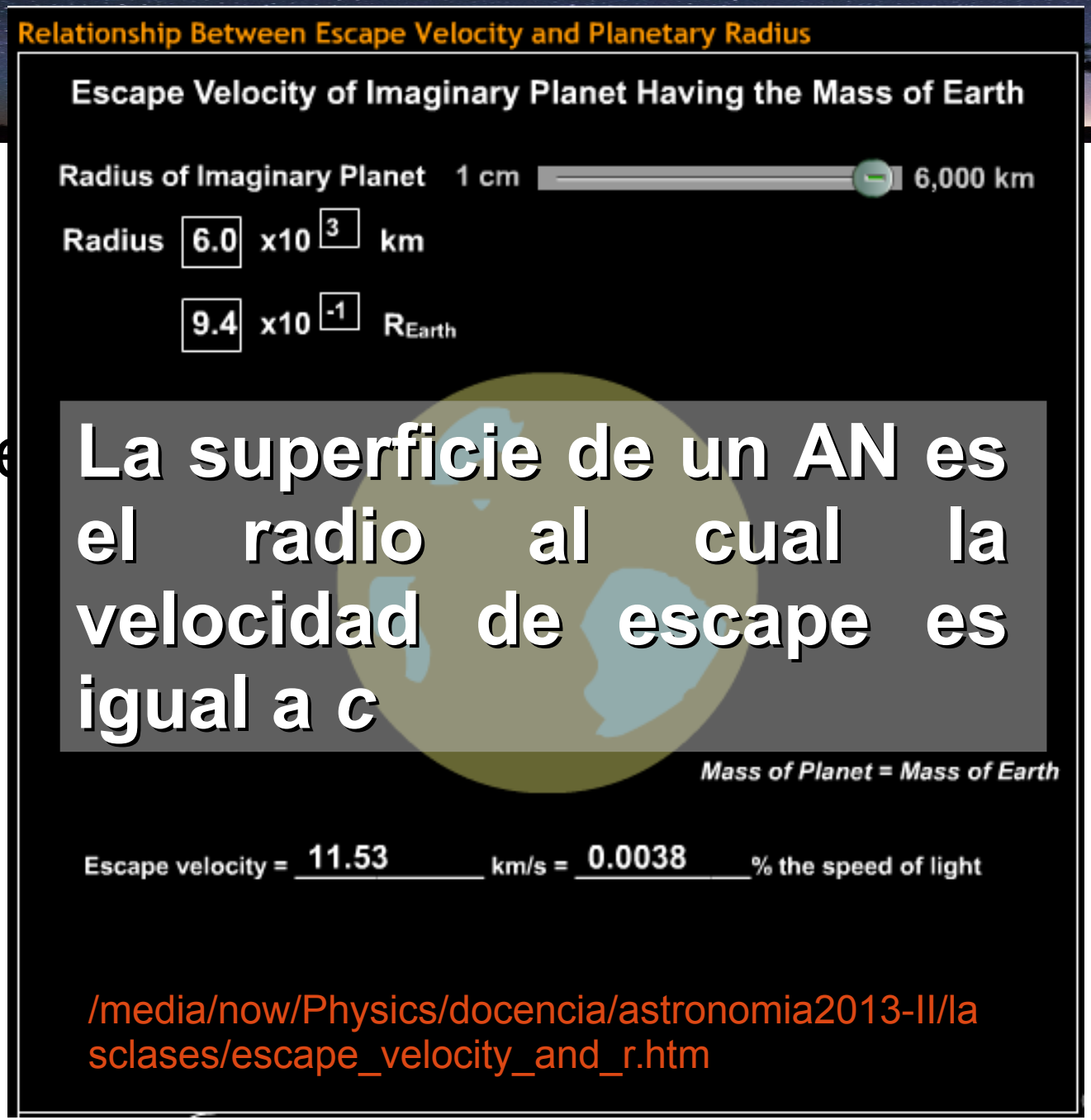

M_1
$F_g = G \frac{M_1 M_2}{d^2}$
M_2
d

- ¿Que



/media/now/Physics/docencia/astronomia2013-II/lasclases/escape_velocity_and_r.htm

- ¿Que

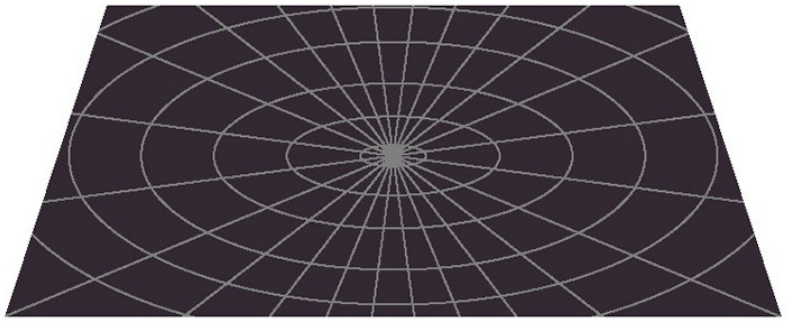

Relationship Between Escape Velocity and Planetary Radius
Escape Velocity of Imaginary Planet Having the Mass of Earth
Radius of Imaginary Planet 1 cm 6,000 km
Radius 6.0 x10 3 km
9.4 x10 -1 REarth
La superficie de un AN es el radio al cual la velocidad de escape es igual a c
Mass of Planet = Mass of Earth
Escape velocity = 11.53 km/s = 0.0038 % the speed of light
/media/now/Physics/docencia/astronomia2013-II/lasclases/escape_velocity_and_r.htm

- ¿Que

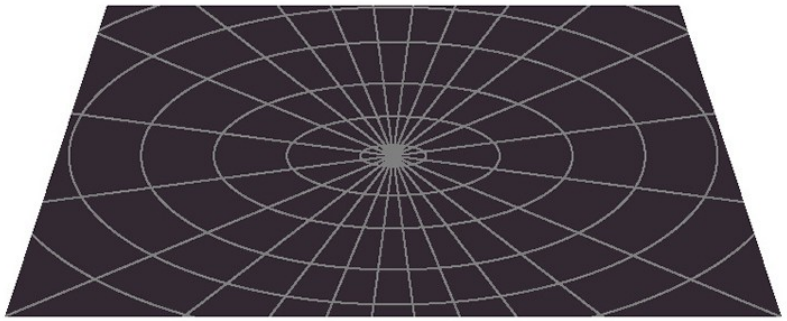
La superficie de un AN es el radio al cual la velocidad de escape es igual a *c*.

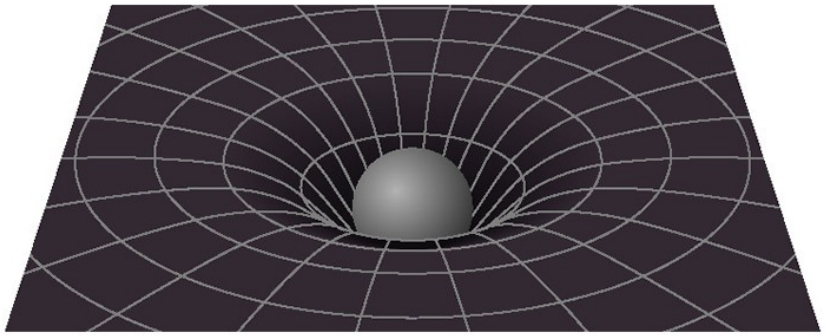
Radio de horizonte de eventos => Radio de Schwarzchild.

/media/now/Physics/docencia/astronomia2013-II/lasclases/escape_velocity_and_r.htm



os Negros





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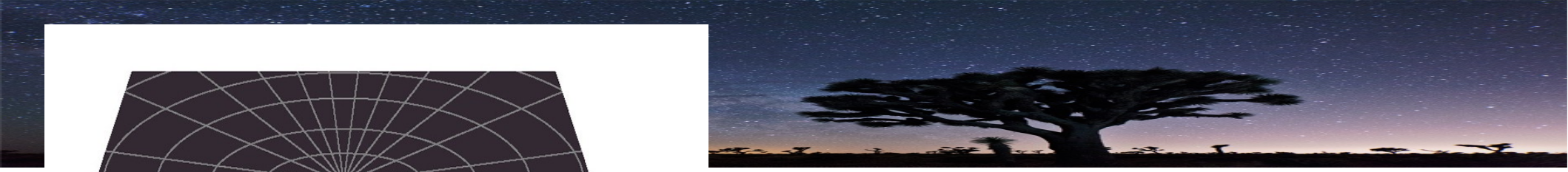

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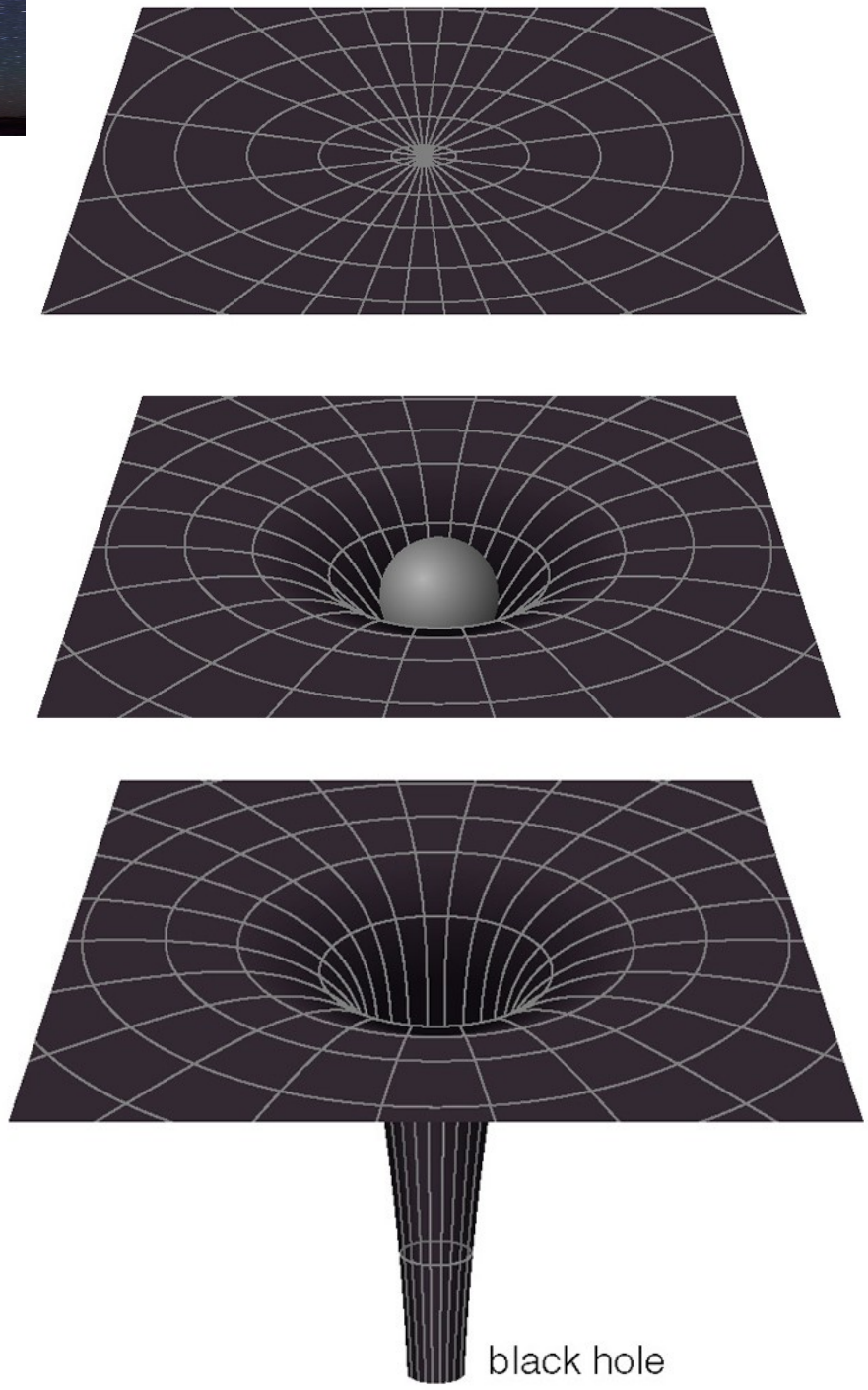

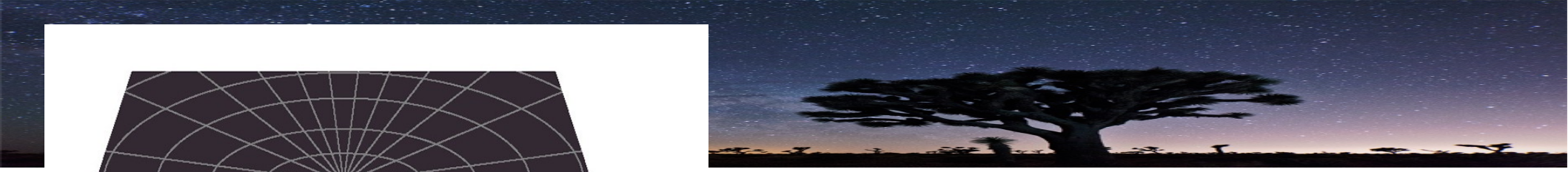

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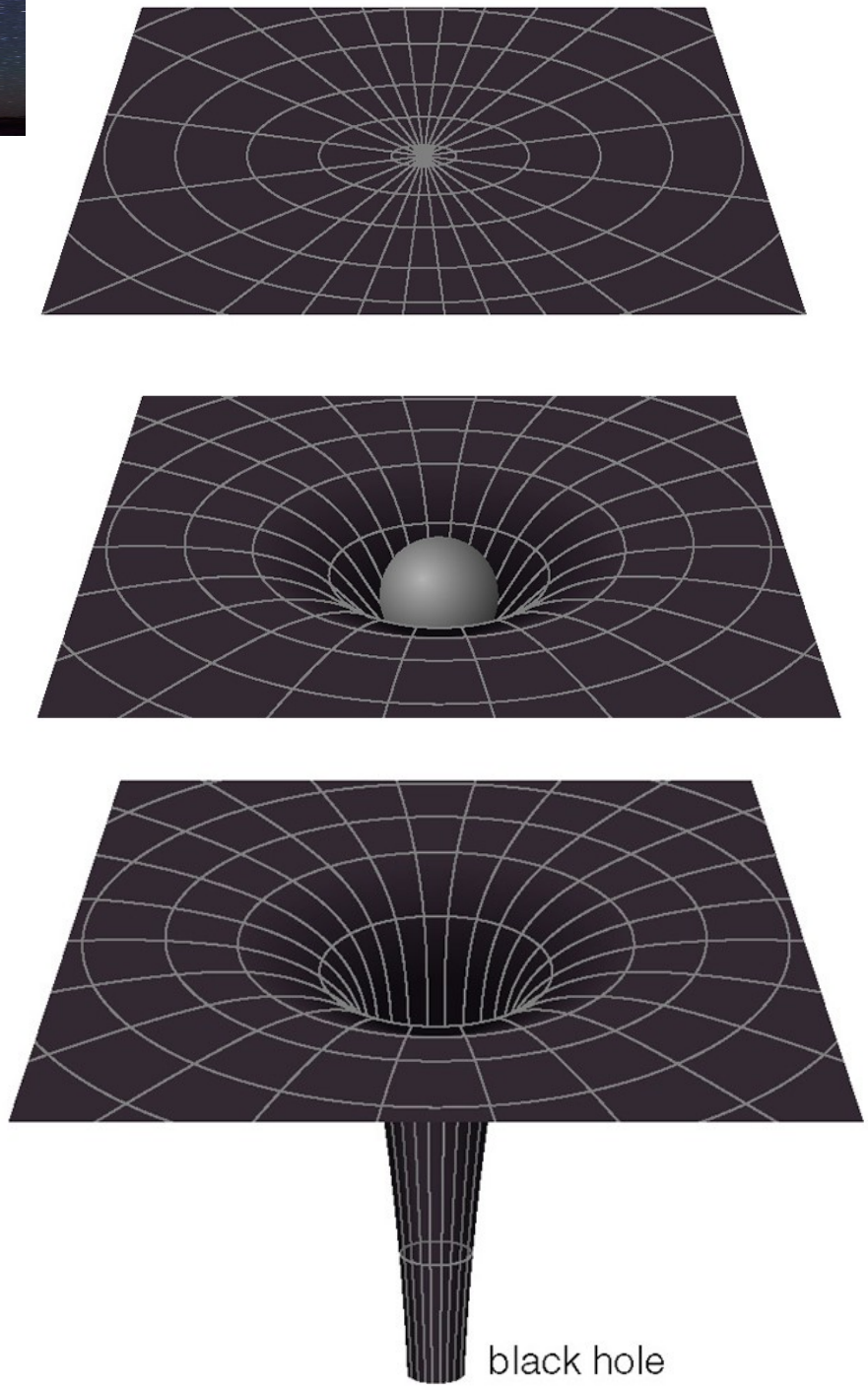
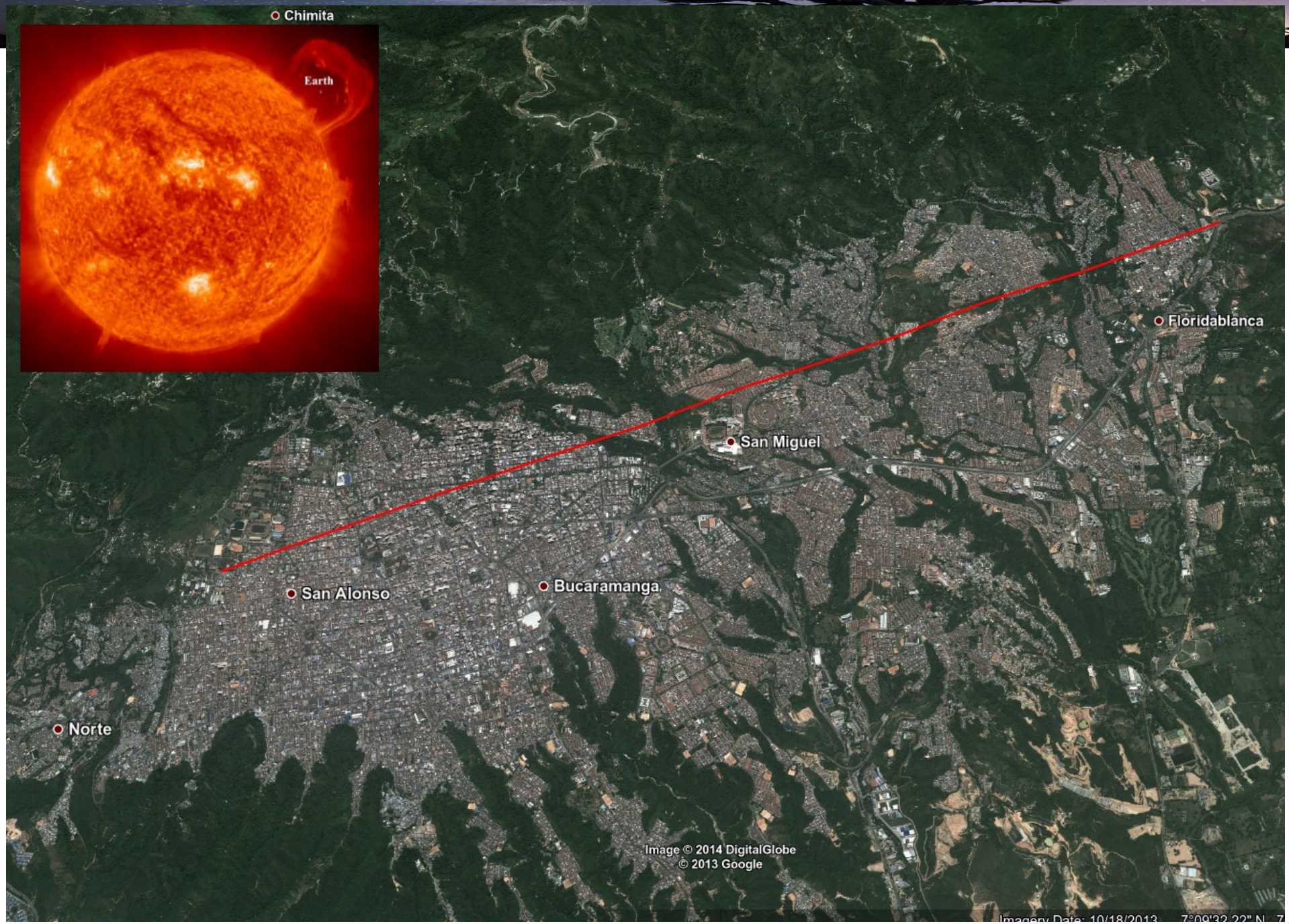
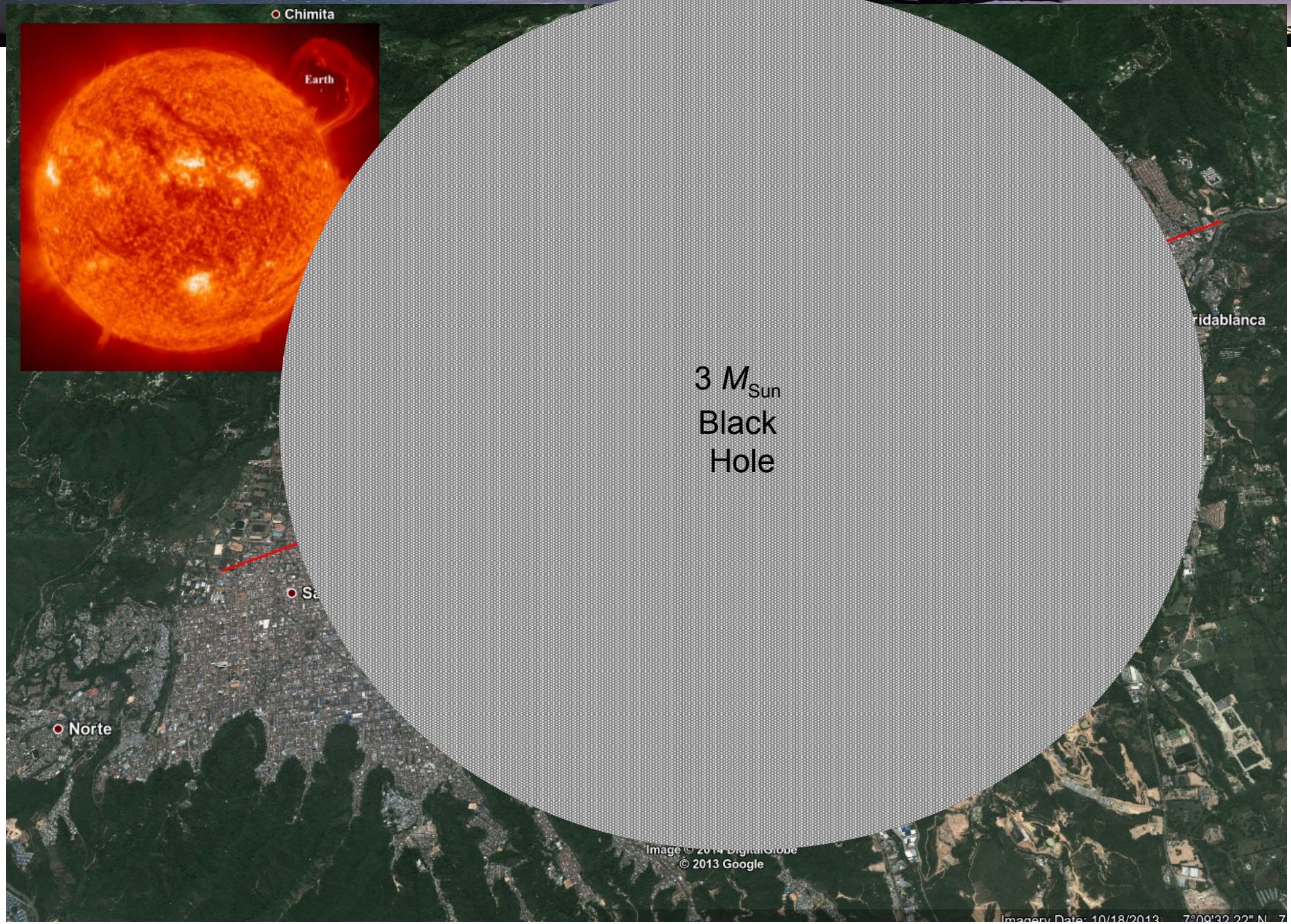


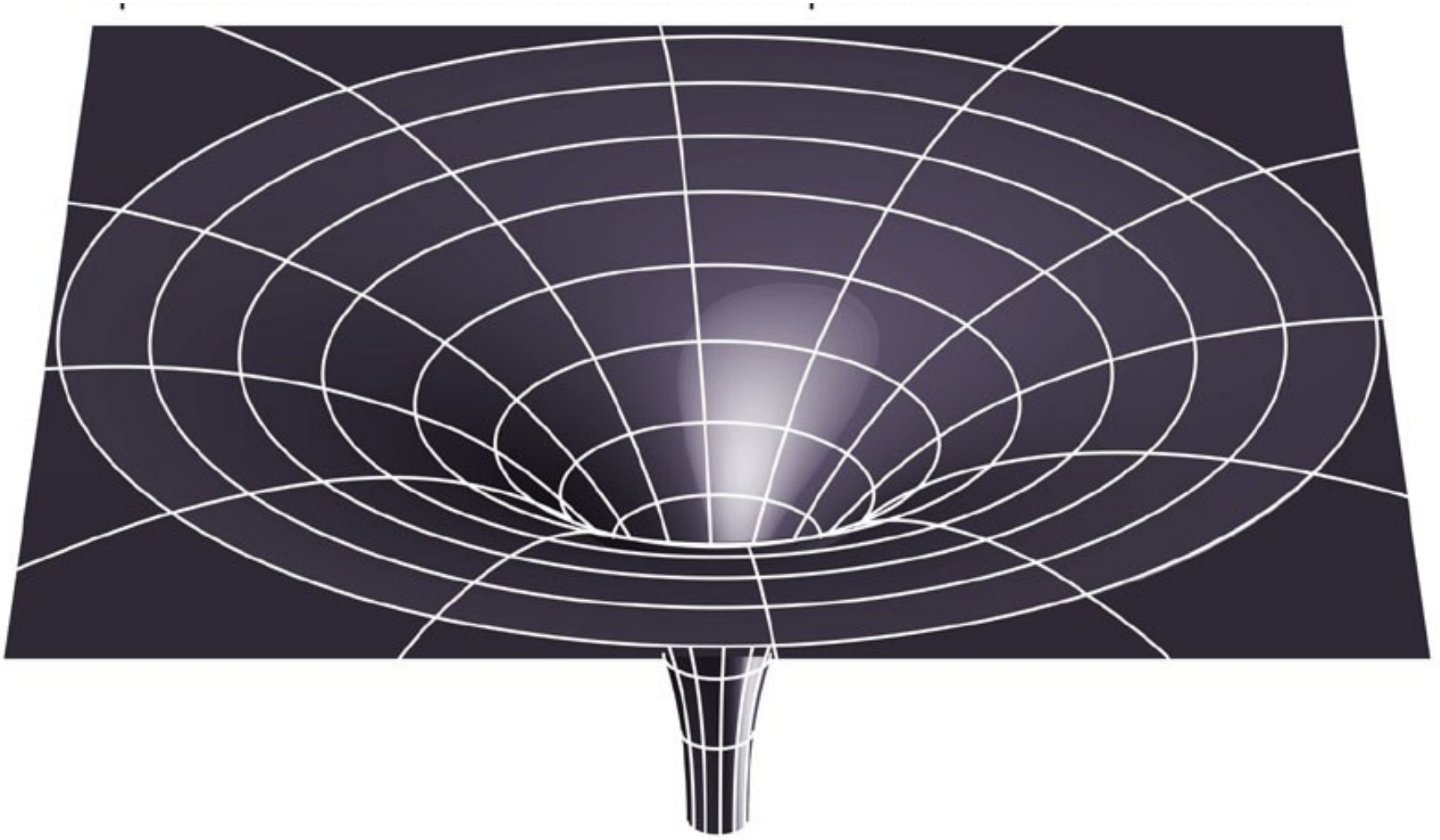
El límite de la presión de degeneración para que una EN pueda soportar el colapso gravitacional es ~ 3 masas solares.

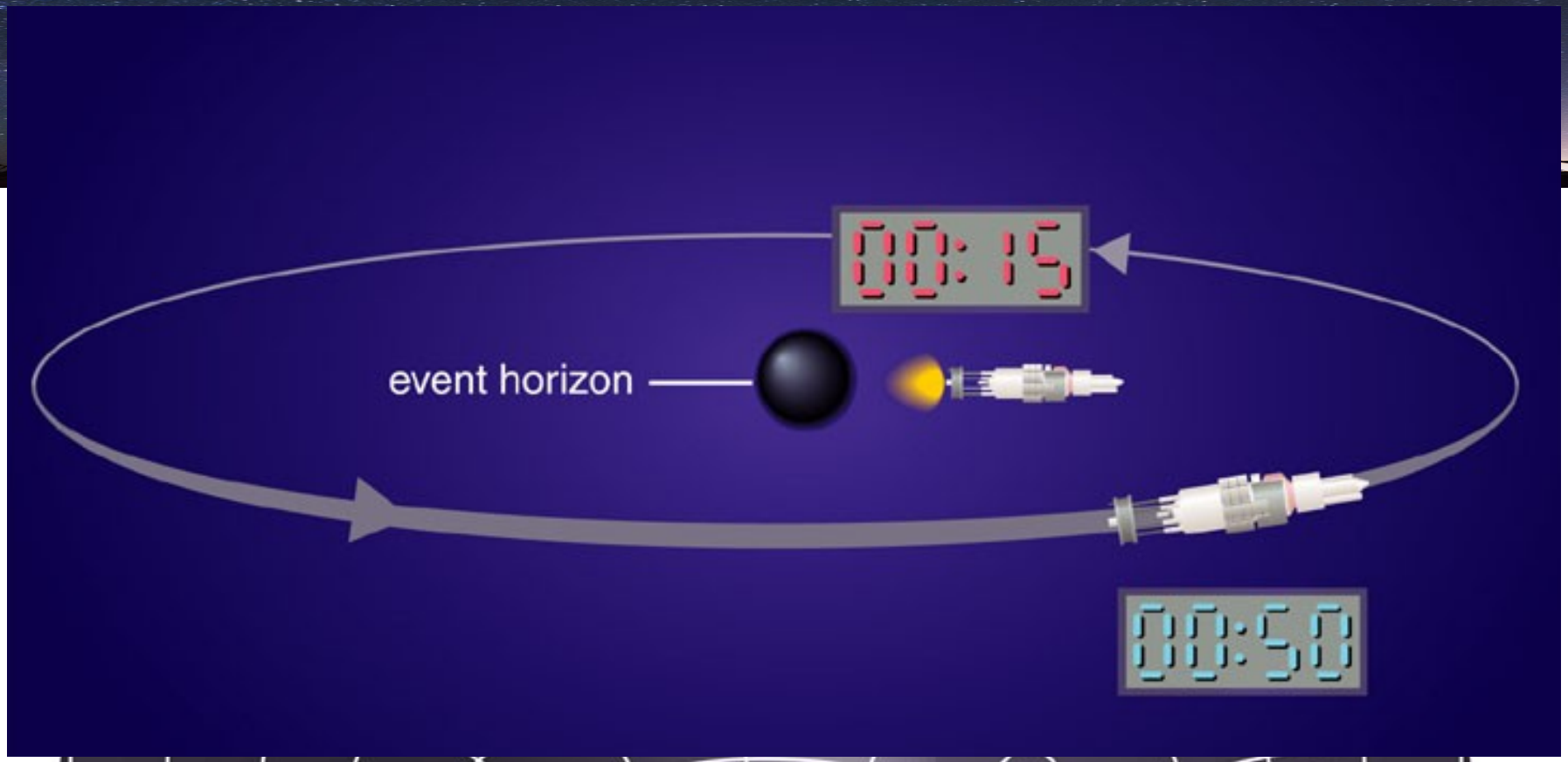

Chimita
Earth
Floridablanca
San Miguel
San Alonso
Bucaramanga
Norte
Image © 2014 DigitalGlobe
© 2013 Google


Chimita
Earth
3 M_{Sun}
Black
Hole
Norte
© 2013 Google

Visitando Agujeros Negros

Visitando Agujeros Negros

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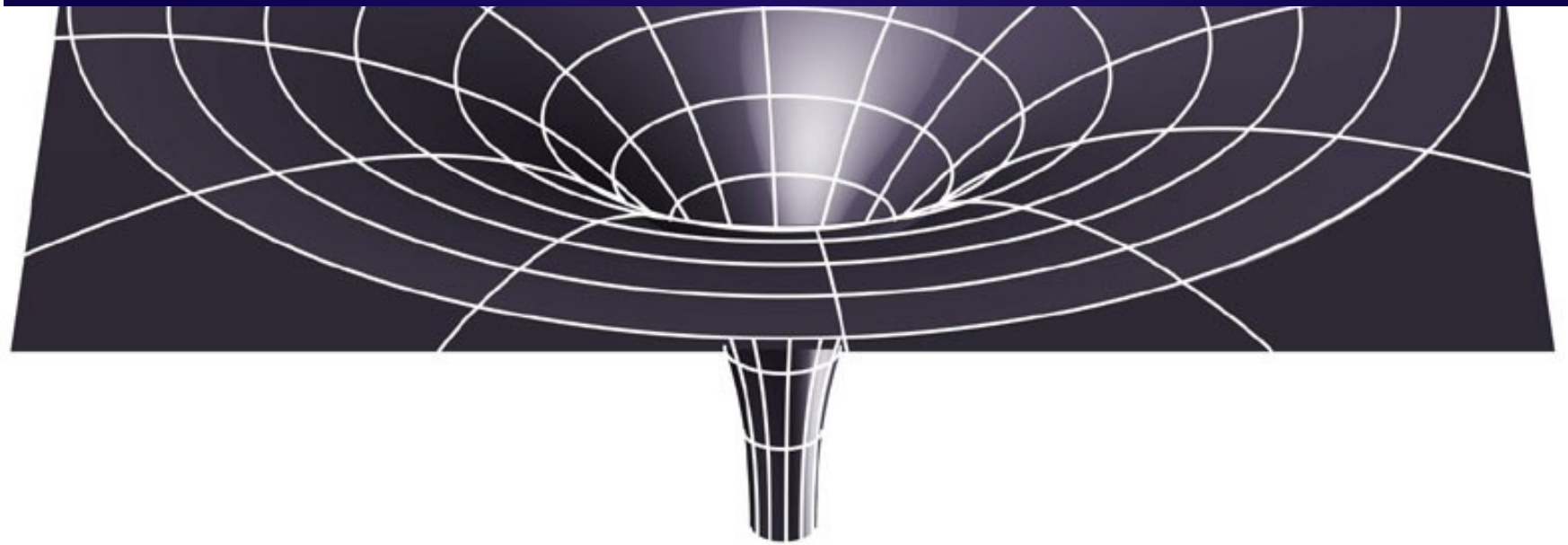
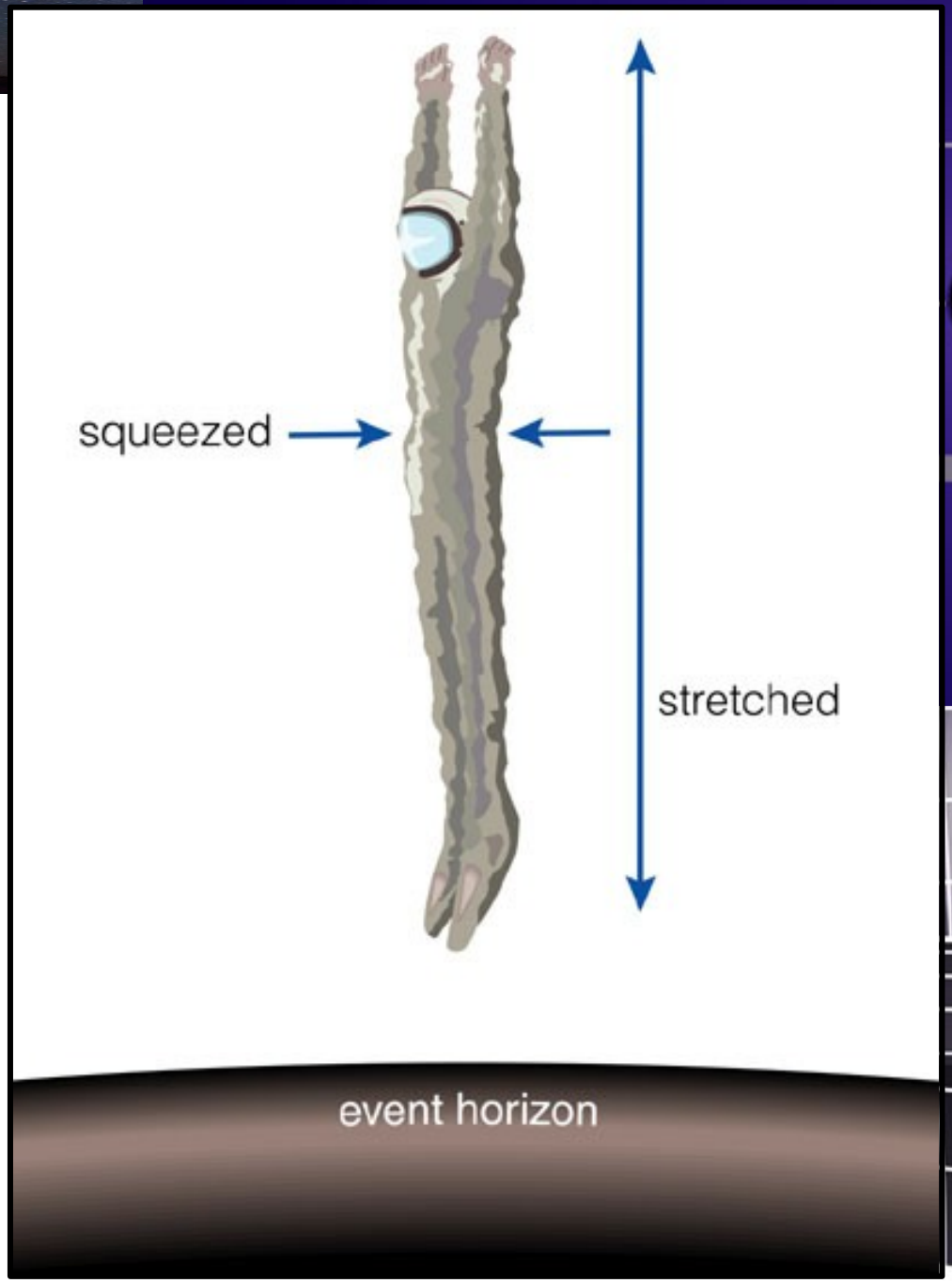
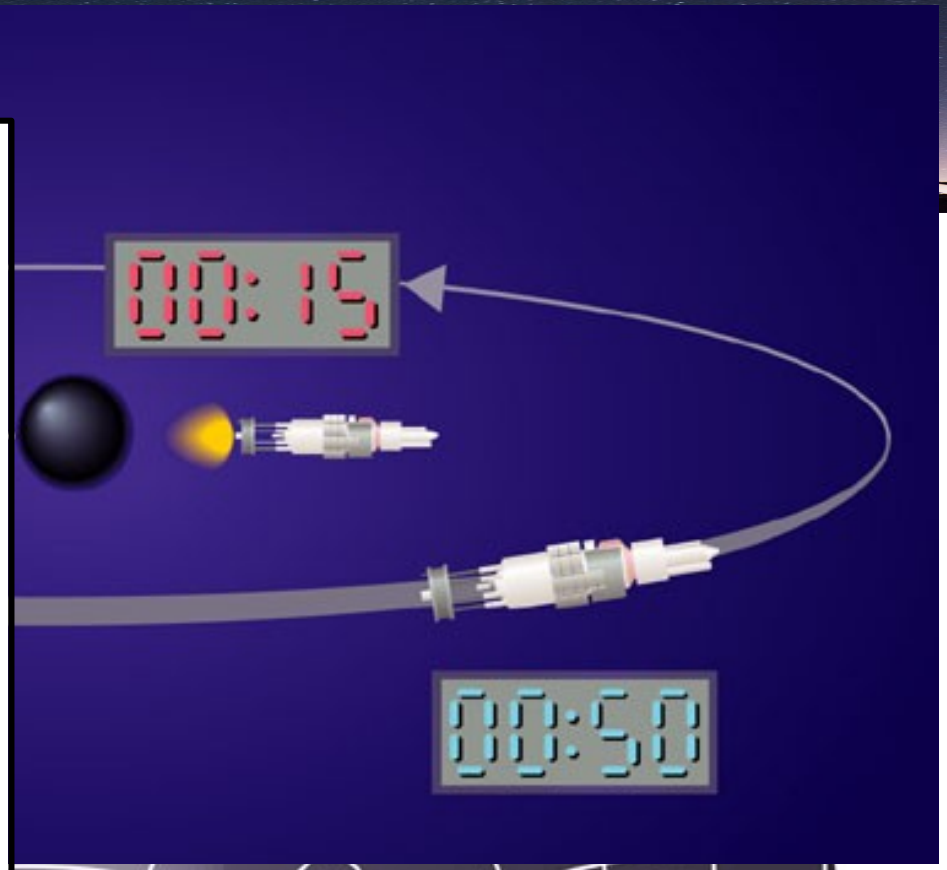
event horizon
00:50




squeezed
stretched
event horizon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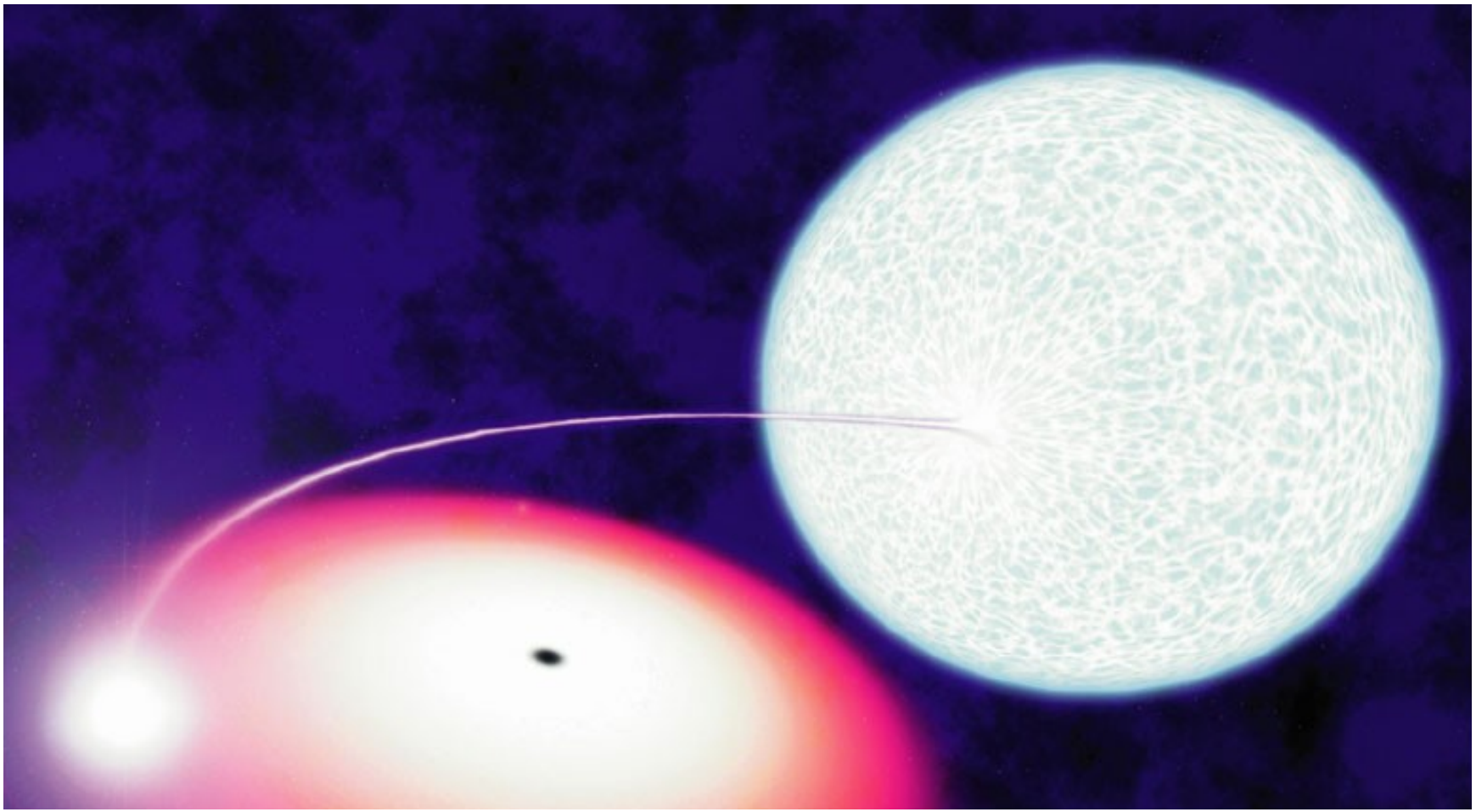
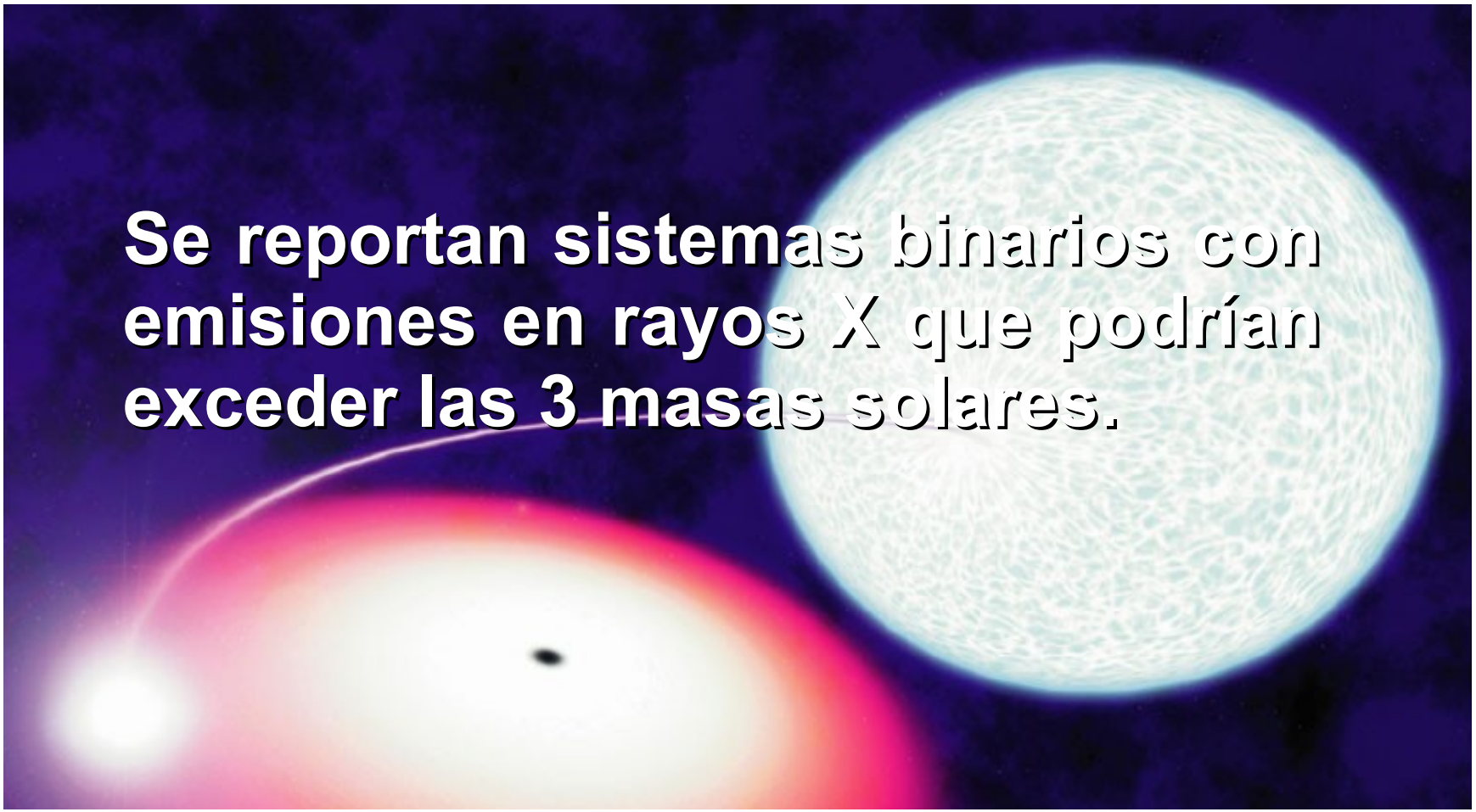
Agujeros Negros

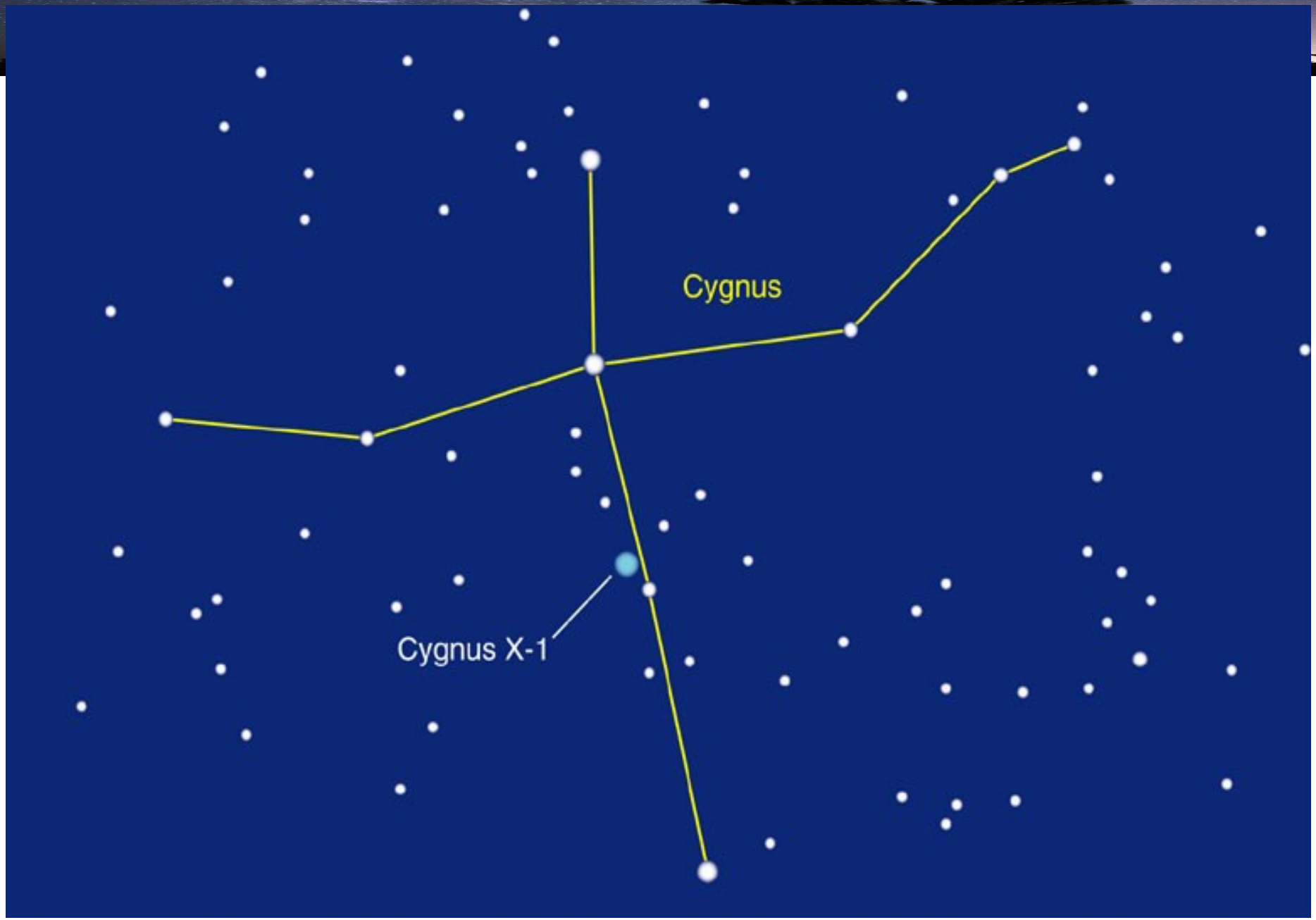
- ¿Existen los agujeros negros?

Agujeros Negros

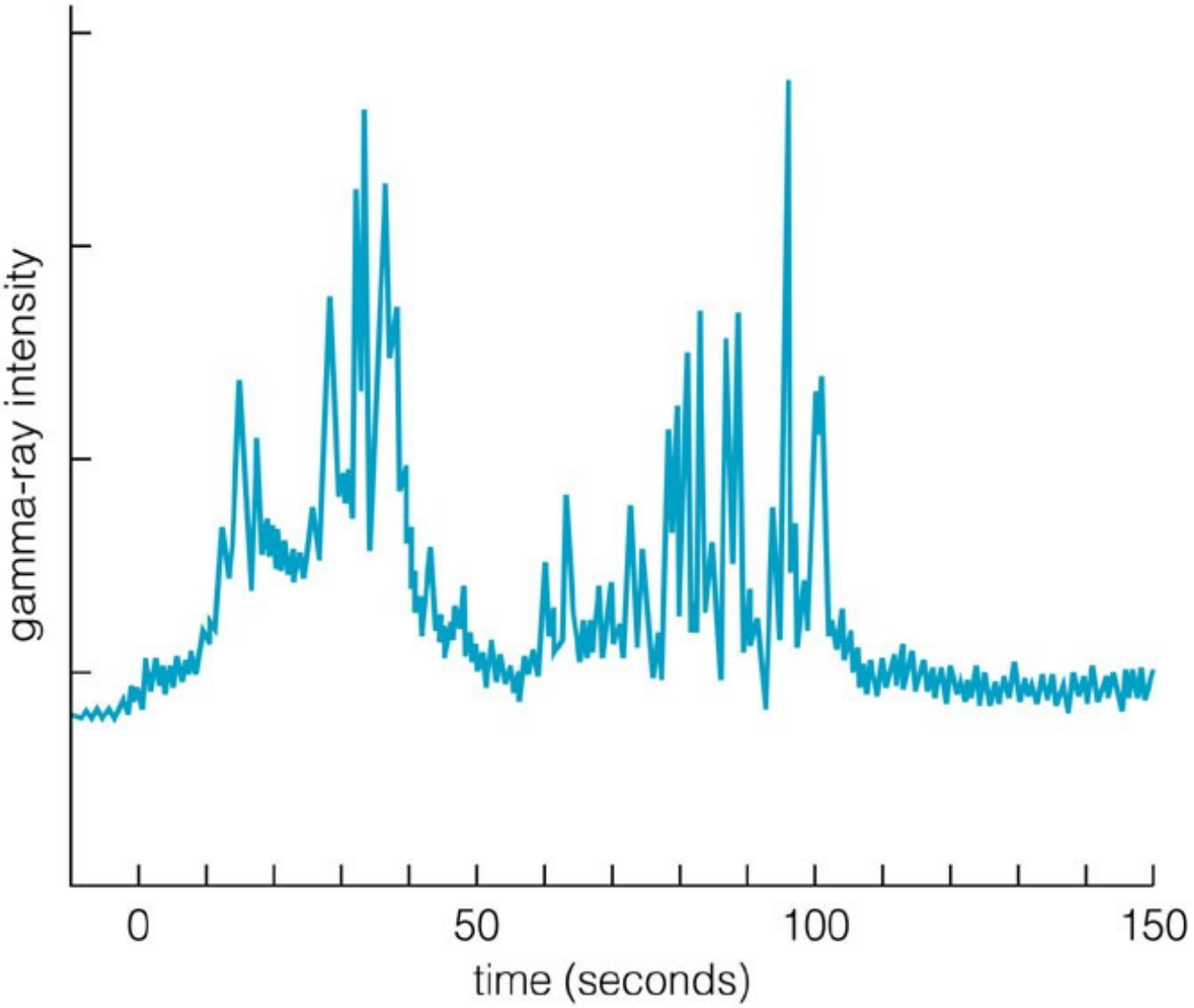


Agujeros Negros




Cygnus
Cygnus X-1

Destellos de Rayos Gamma



Destellos de Rayos Gamma