Black hole!!!

கருந்துளை

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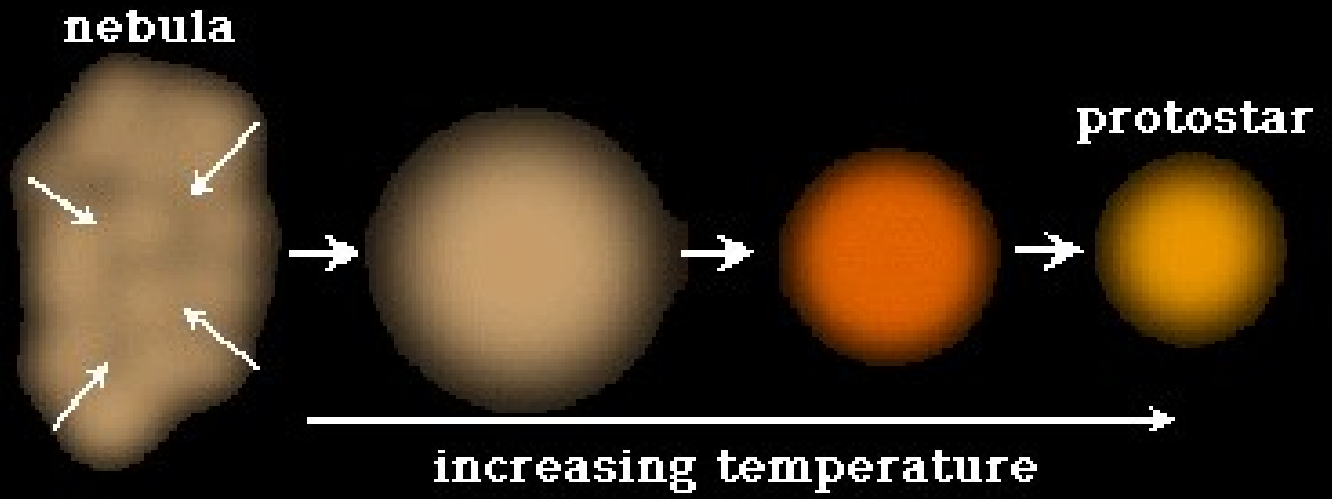
How star forms?

.....Clouds of gas and dust (largely of Hydrogen)

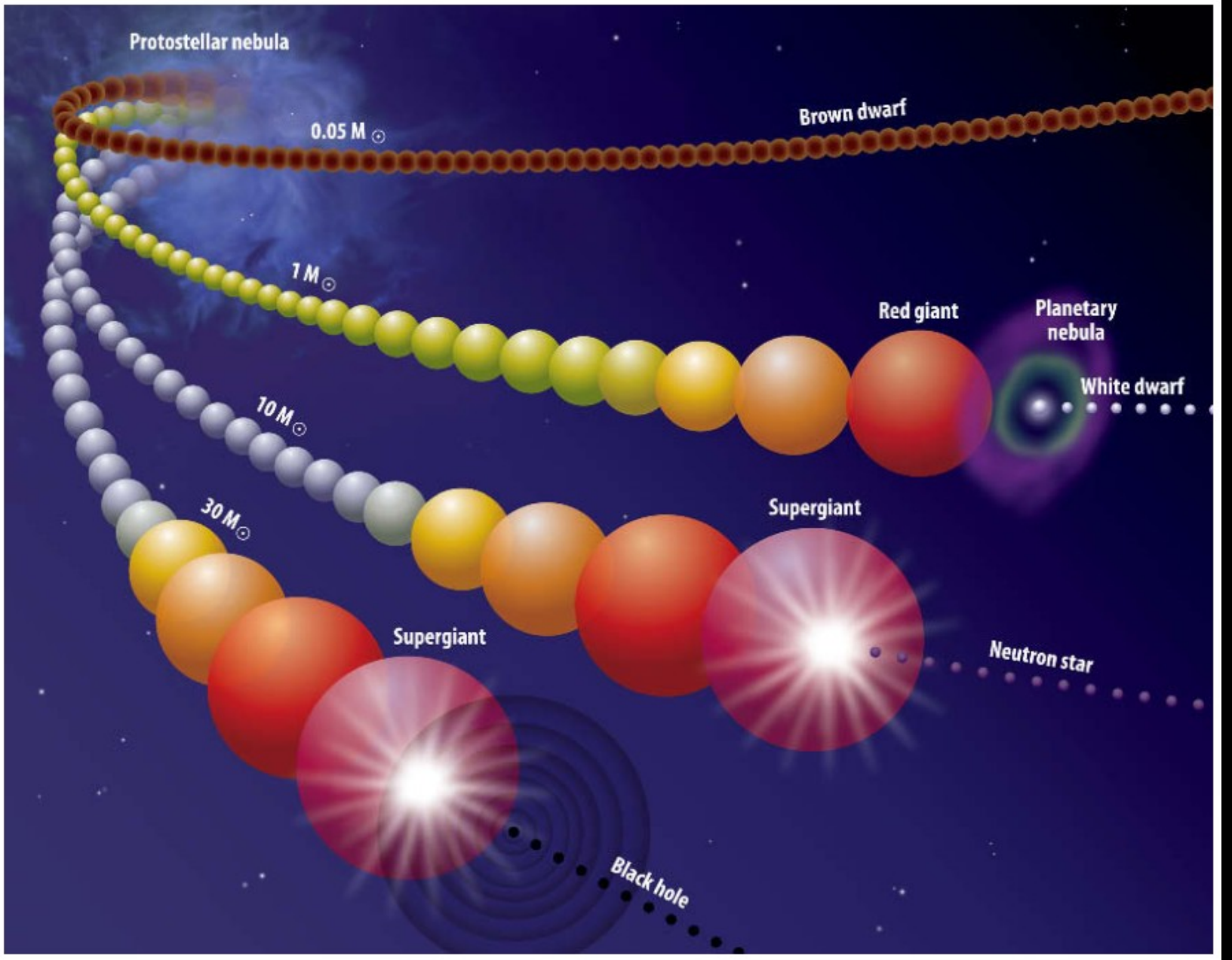
How do star forms?

Temperature increases...
Internal pressure build up....
Proto star formed....

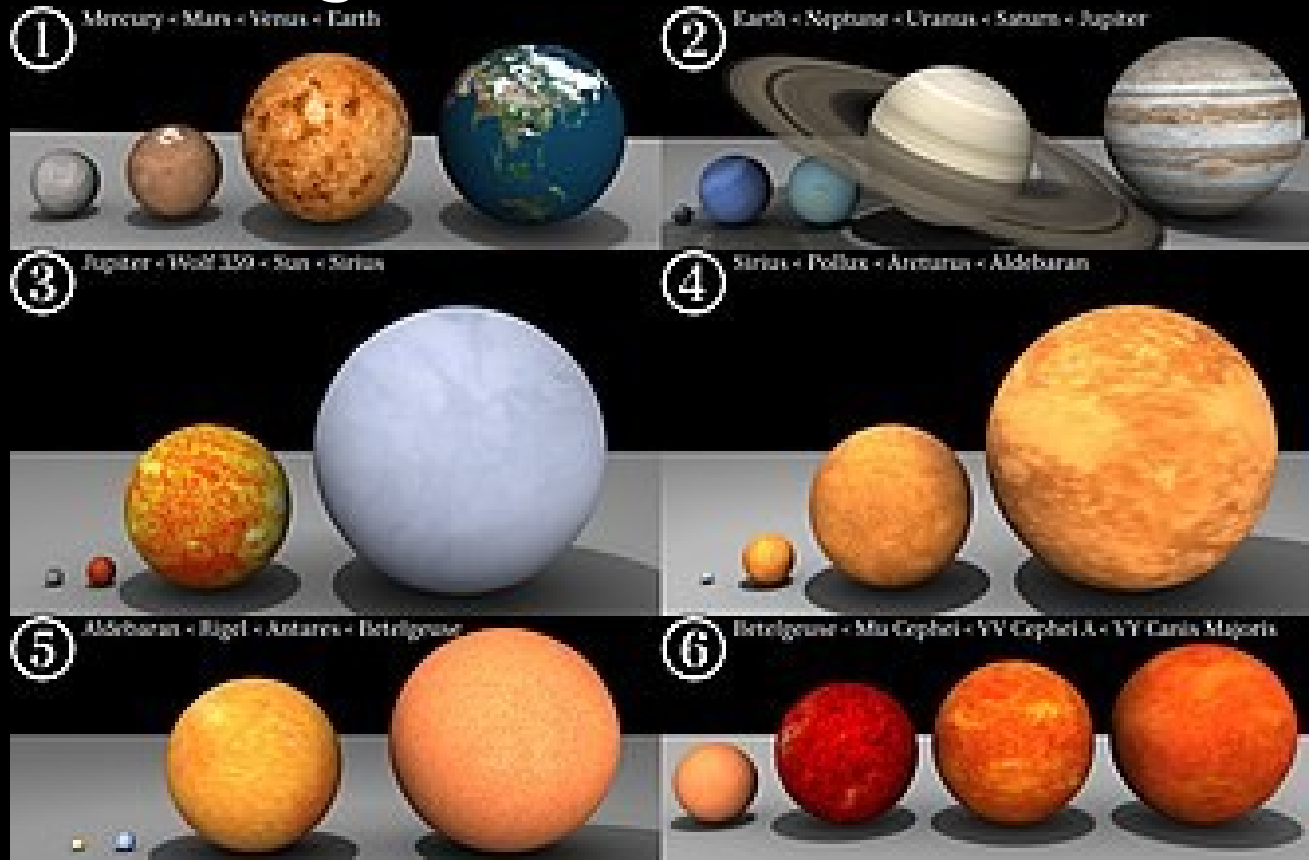


Nuclear Fusion starts....

- Star is born
- Main sequence star...
- Sun is a main sequence star...


Protostellar nebula
0.05 M ⊙
Brown dwarf
1 M ⊙
Red giant
Planetary nebula
White dwarf
10 M ⊙
Supergiant
30 M ⊙
Supergiant
Neutron star
Black hole

- Red giant ---- Nova
- Super red gaint ----- Supernova (Bettelgeuse, Antares)



Supernova explosion –
1. Core – Collapse Supernova explosion

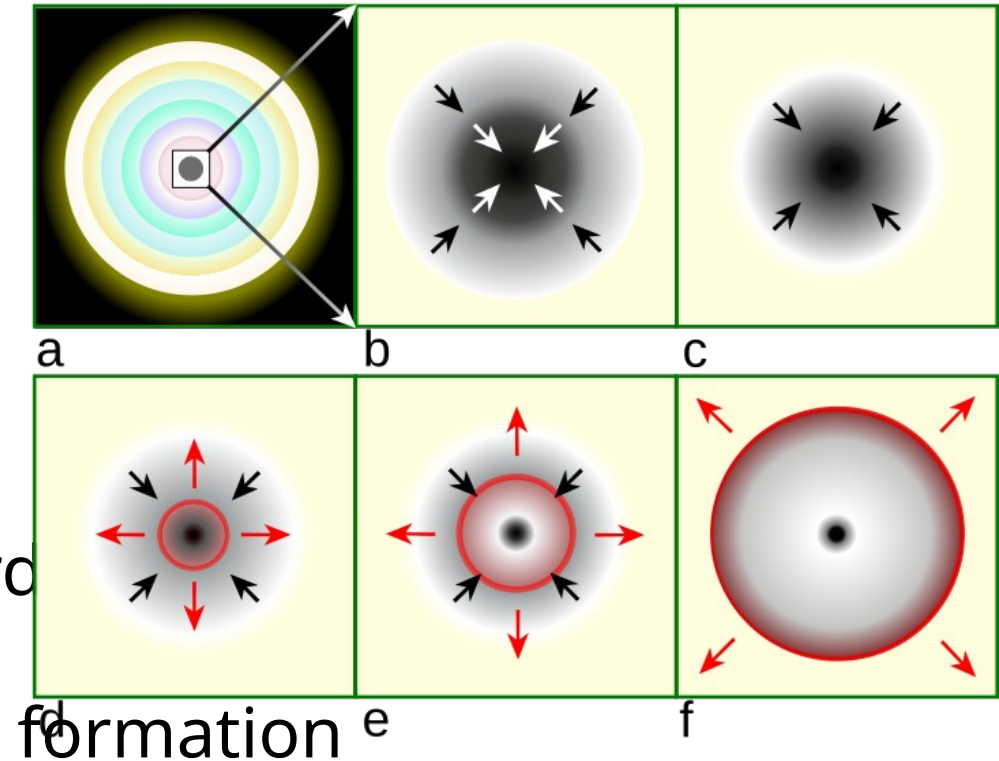
- Masses > 8 solar mass
- Electron degeneracy pressure not

Sufficient, then iron core starts to collapse

- p+e → n + neutrino
- Neutron gives pressure to support inward

Pull

- Supernova explosion and heavy element formation
- Energy release is so fast
- Neutron star or black hole

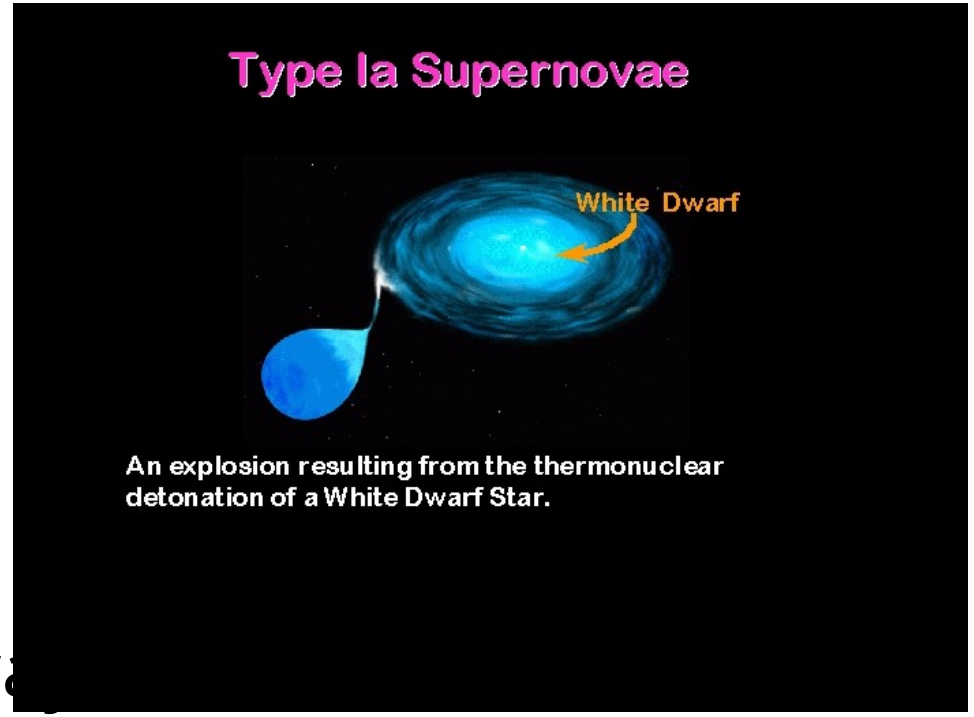


2.Thermonuclear Supernova explosion

- White dwarf with binary

Companion (red giant)

- Mass < 8 solar mass
- Mostly carbon and oxygen
- Start to pull mass from it companion
- Temperature rise and thermal runaw
- Leaves no remnant

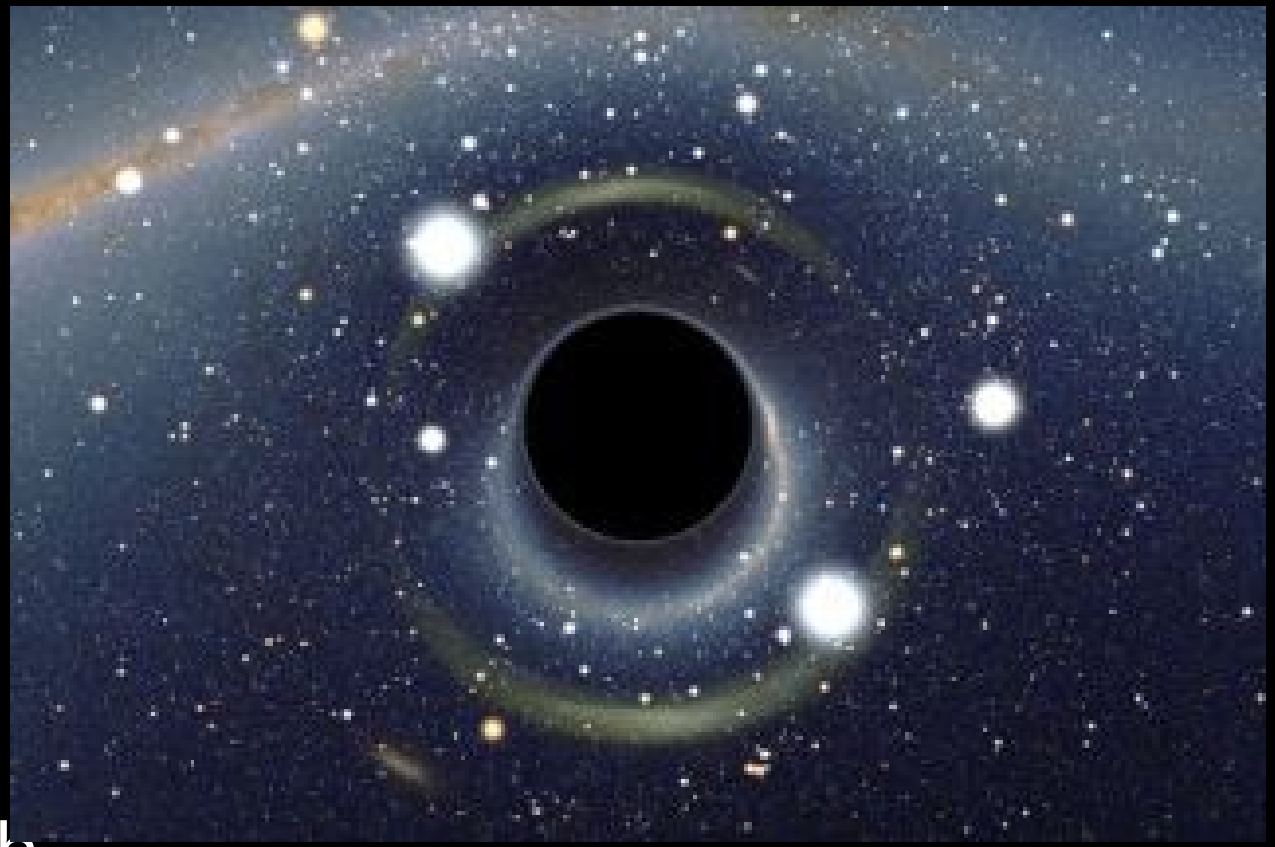


The core mass after supernova M

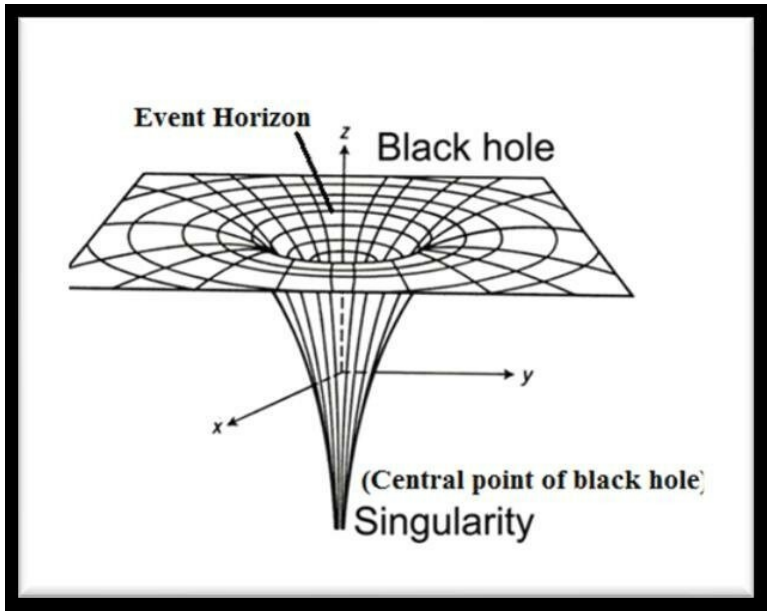
- Red giant becomes White dwarf (M<1.4 Mass of the sun)
- Super red giant becomes Neutron star (1.4 <M<8 Mass of the sun)
- What will happen if mass is greater than 8 times mass of the sun?

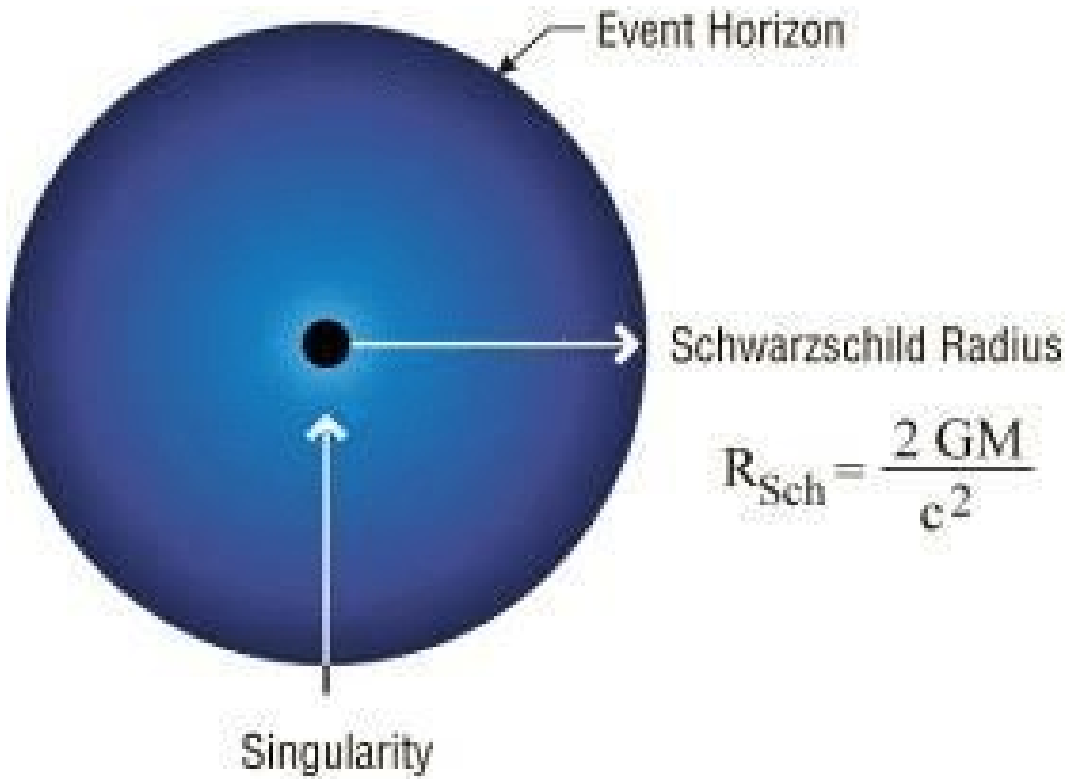
Black hole

- Strongest gravity place
- Light cannot escape
- Singularity
- Event horizon
- Space – time curved much



- John Mitchell – 1783 – (Newton theory)
- General theory of relativity – Solution of Field equation
- 1968 – John Wheeler coined the term “black hole”
- Before that, it was called “Schwarzschild singularities”


Event Horizon
Black hole
z
y
x
(Central point of black hole)
Singularity


Event Horizon
Schwarzschild Radius
$R_{Sch} = \frac{2GM}{c^2}$
Singularity

Two types of classification

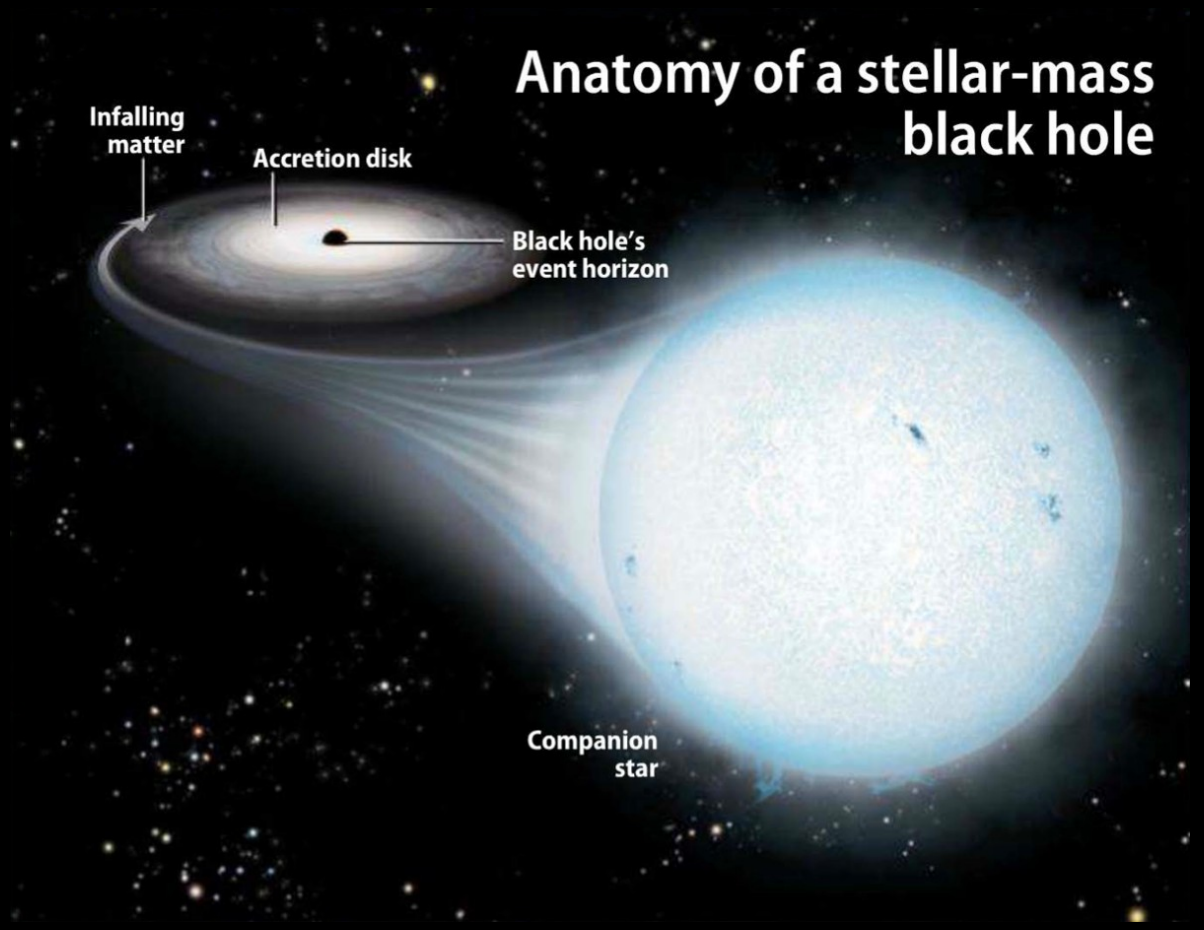
- 1. Schwarzschild blackhole – Only mass, no spin, no charge
- 2. Reissner – Nordstorm blackhole – mass and charge but no spin
- 3. Kerr-Black hole – Mass, spin but no charge

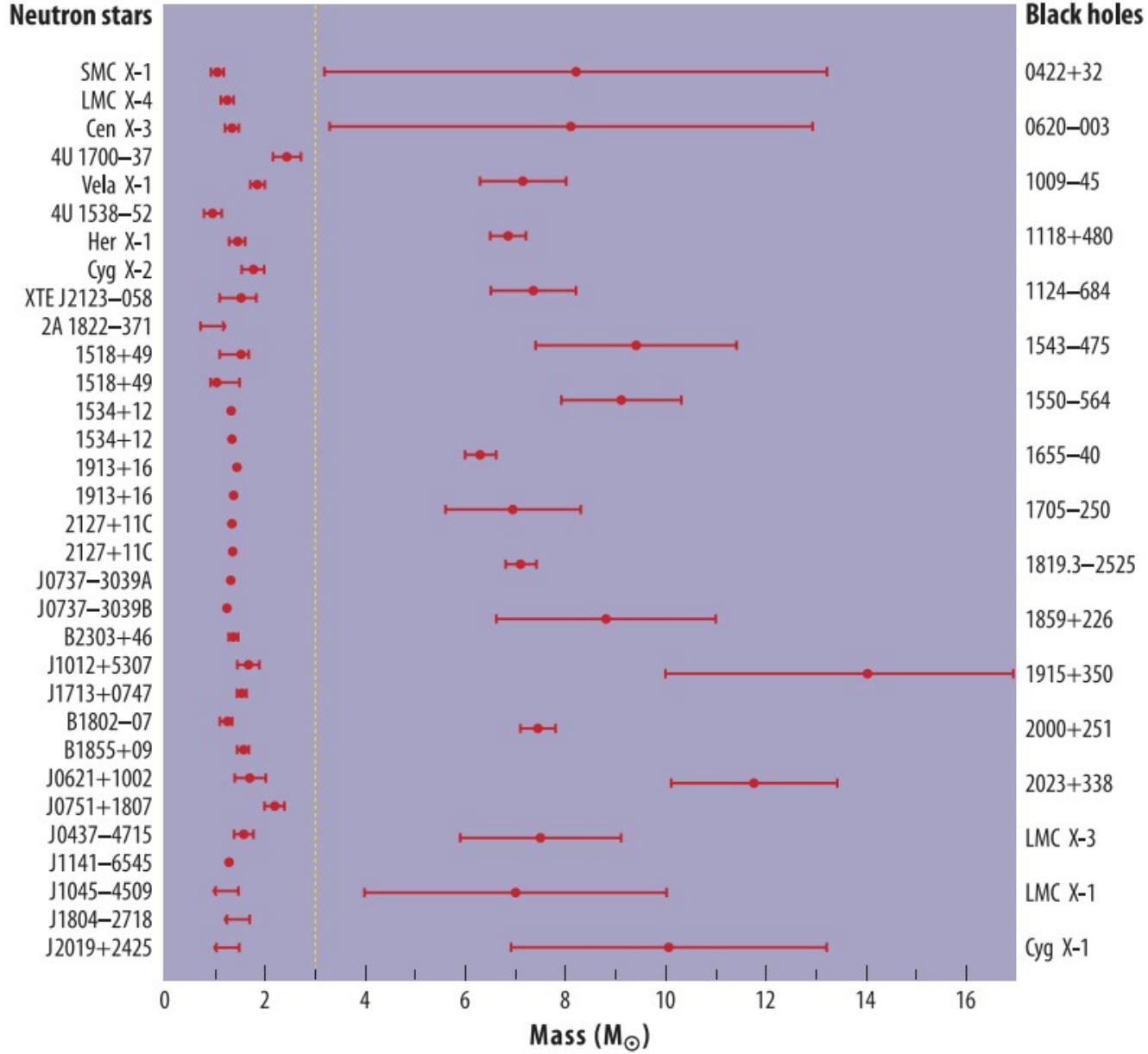
Classification based on observation

- Stellar black holes (3 M to 100 M)
- Intermediate black holes (100 M to 100000M)
- Super massive black holes (million to billion times of the mass of the sun)

Stellar black hole

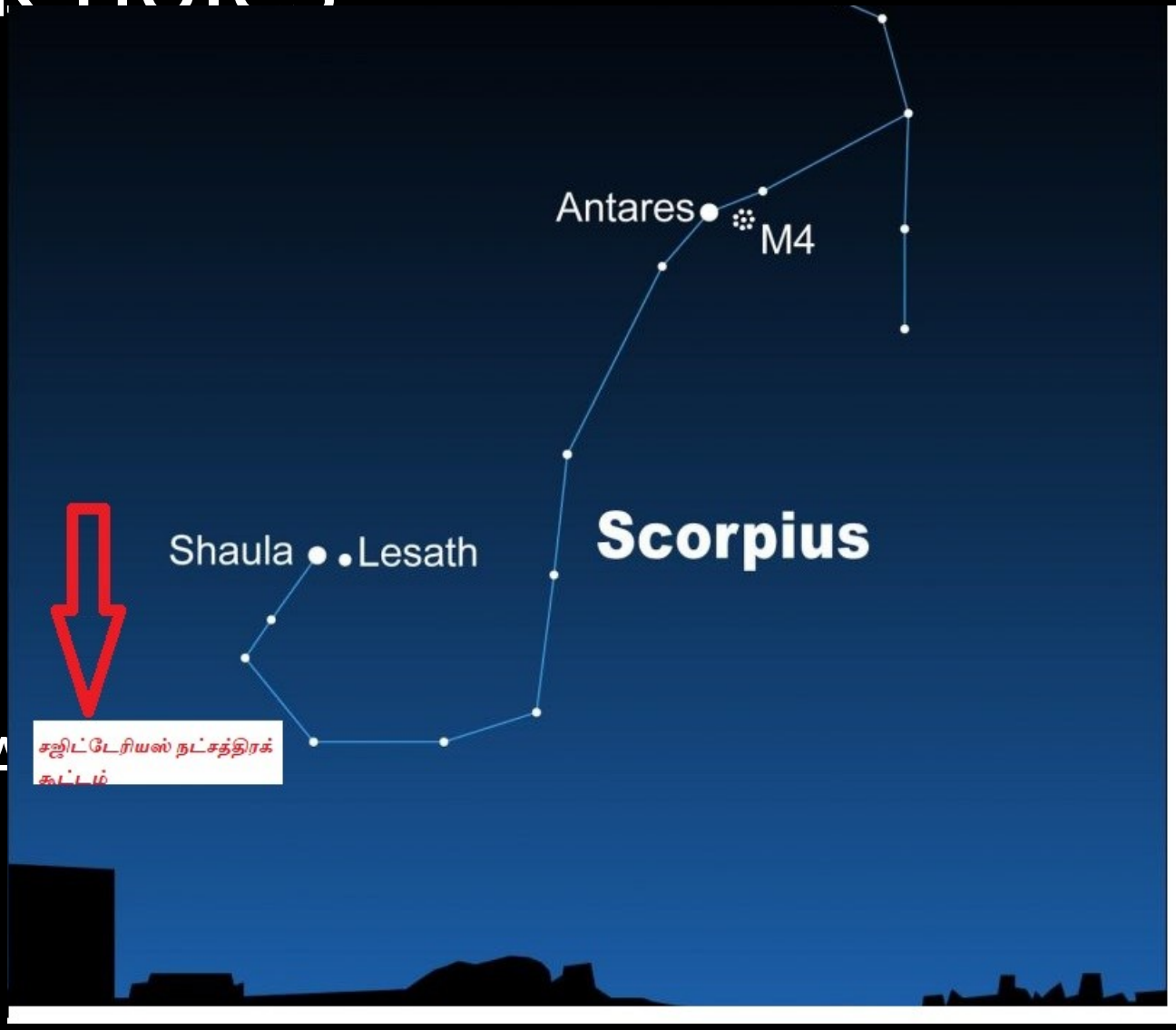
- Mostly from binary star
- Cygnus X-1 (1965)

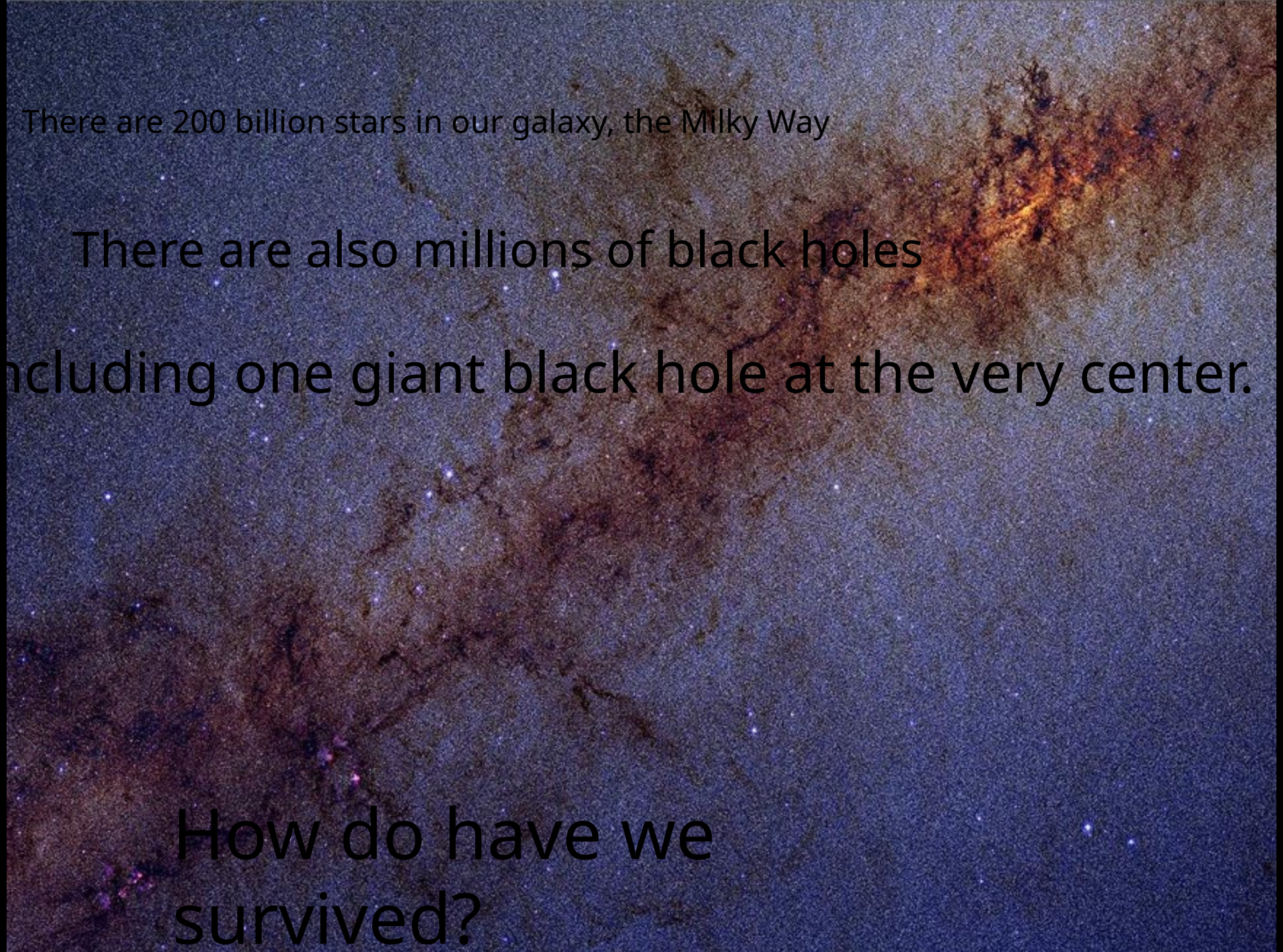



Neutron stars
SMC X-1
LMC X-4
Cen X-3
4U 1700–37
Vela X-1
4U 1538–52
Her X-1
Cyg X-2
XTE J2123–058
2A 1822–371
1518+49
1518+49
1534+12
1534+12
1913+16
1913+16
2127+11C
2127+11C
J0737–3039A
J0737–3039B
B2303+46
J1012+5307
J1713+0747
B1802–07
B1855+09
J0621+1002
J0751+1807
J0437–4715
J1141–6545
J1045–4509
J1804–2718
J2019+2425
Black holes
0422+32
0620–003
1009–45
1118+480
1124–684
1543–475
1550–564
1655–40
1705–250
1819.3–2525
1859+226
1915+350
2000+251
2023+338
LMC X-3
LMC X-1
Cyg X-1
0
2
4
6
8
10
12
14
16
Mass ($M_\odot$)

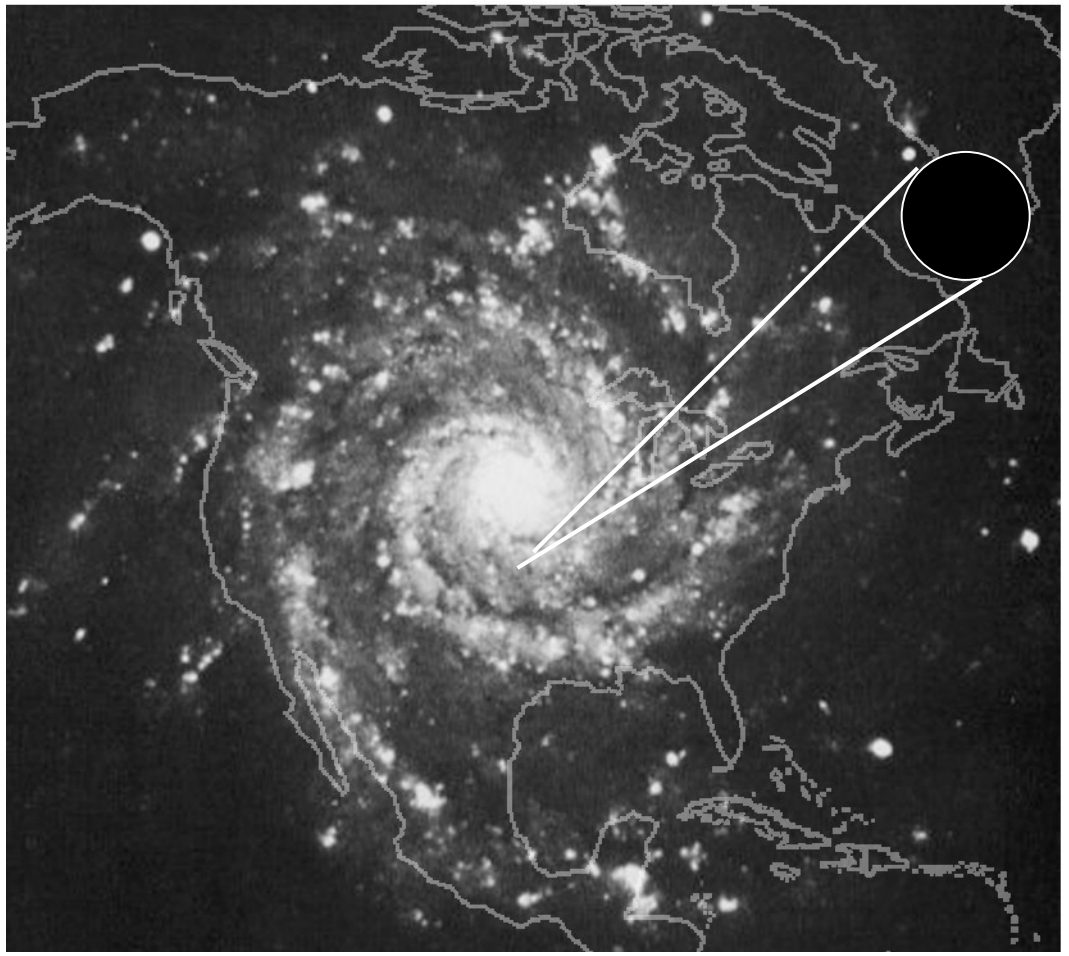
Super massive black holes

- Center of almost all galaxies
- Messier galaxy M87*
- Milky way galaxy Sagittarius A




There are 200 billion stars in our galaxy, the Milky Way
There are also millions of black holes
ncluding one giant black hole at the very center.
How do have we survived?

So how do we survive amid all these Black Holes?



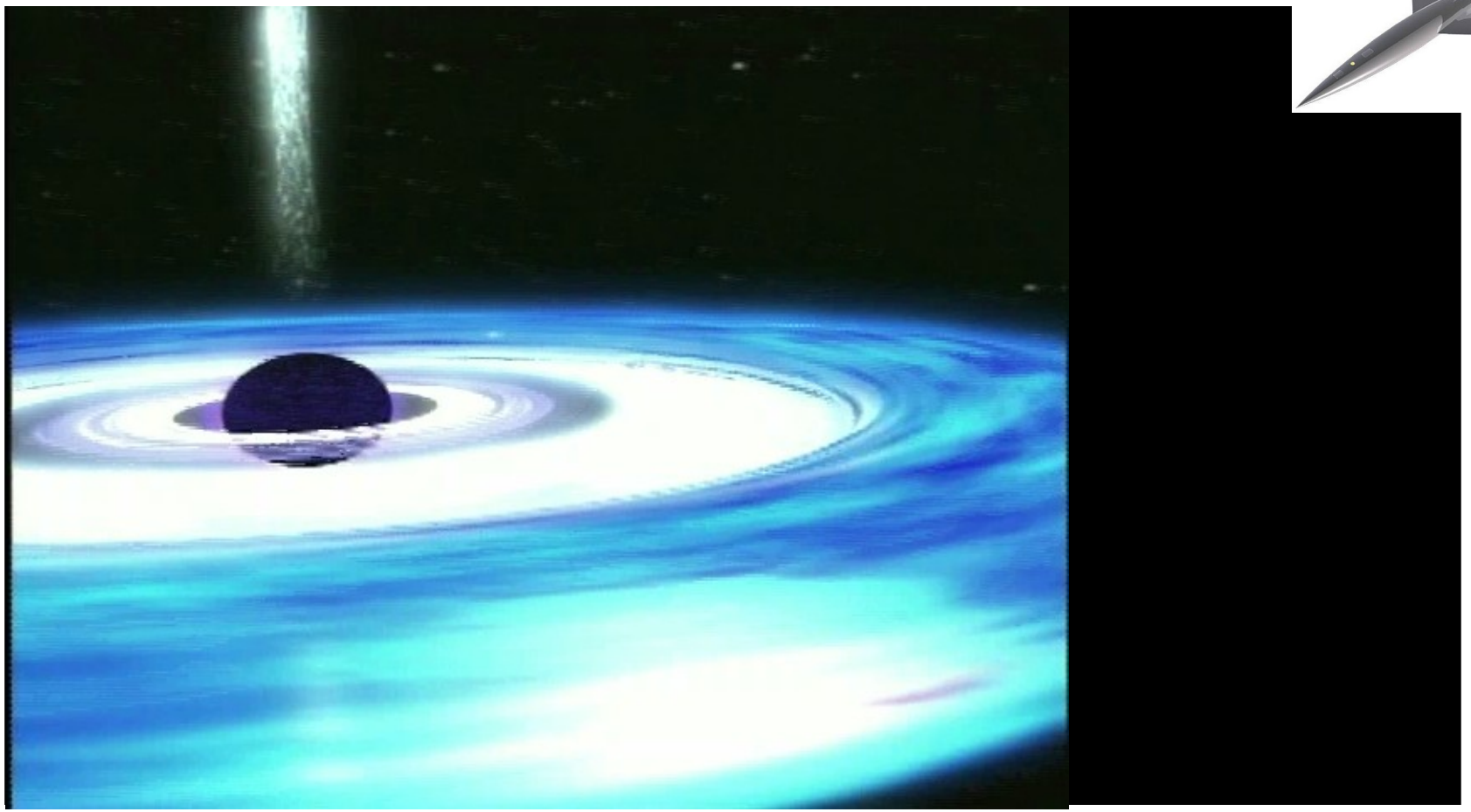
M74 Photo Credit: NOAO/AURA/NSF

Great distances between the stars!

What do you think?

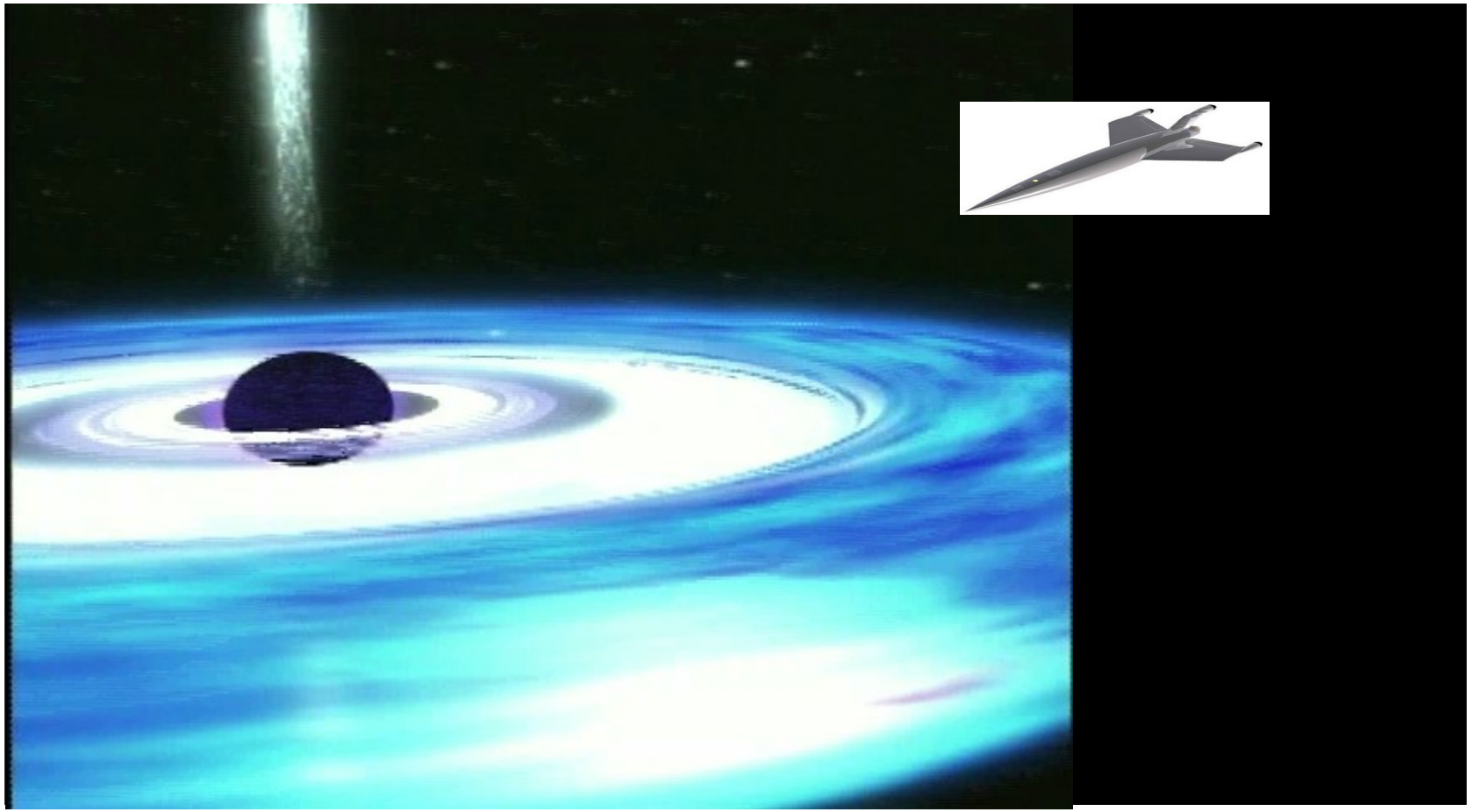
1. What happens to a spaceship that falls into a black hole?
2. Will the black holes in our Galaxy eventually suck up everything in it - a cosmic vacuum cleaner?
3. What would happen to Earth if the Sun was replaced by a black hole of the same mass?
4. If we can’t see black holes, how do we know they are there?

Falling into a Black Hole



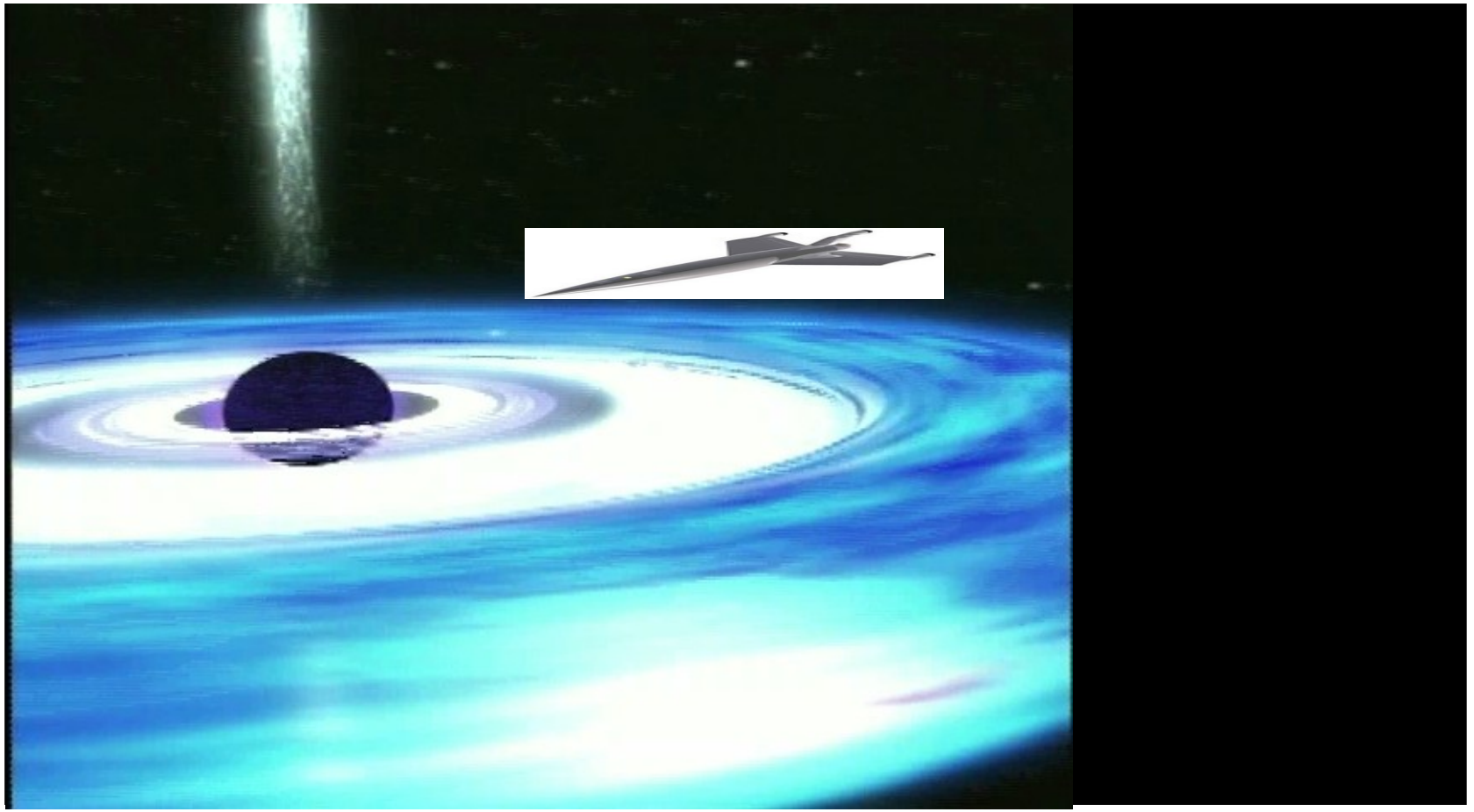
Not to Scale

Falling into a Black Hole



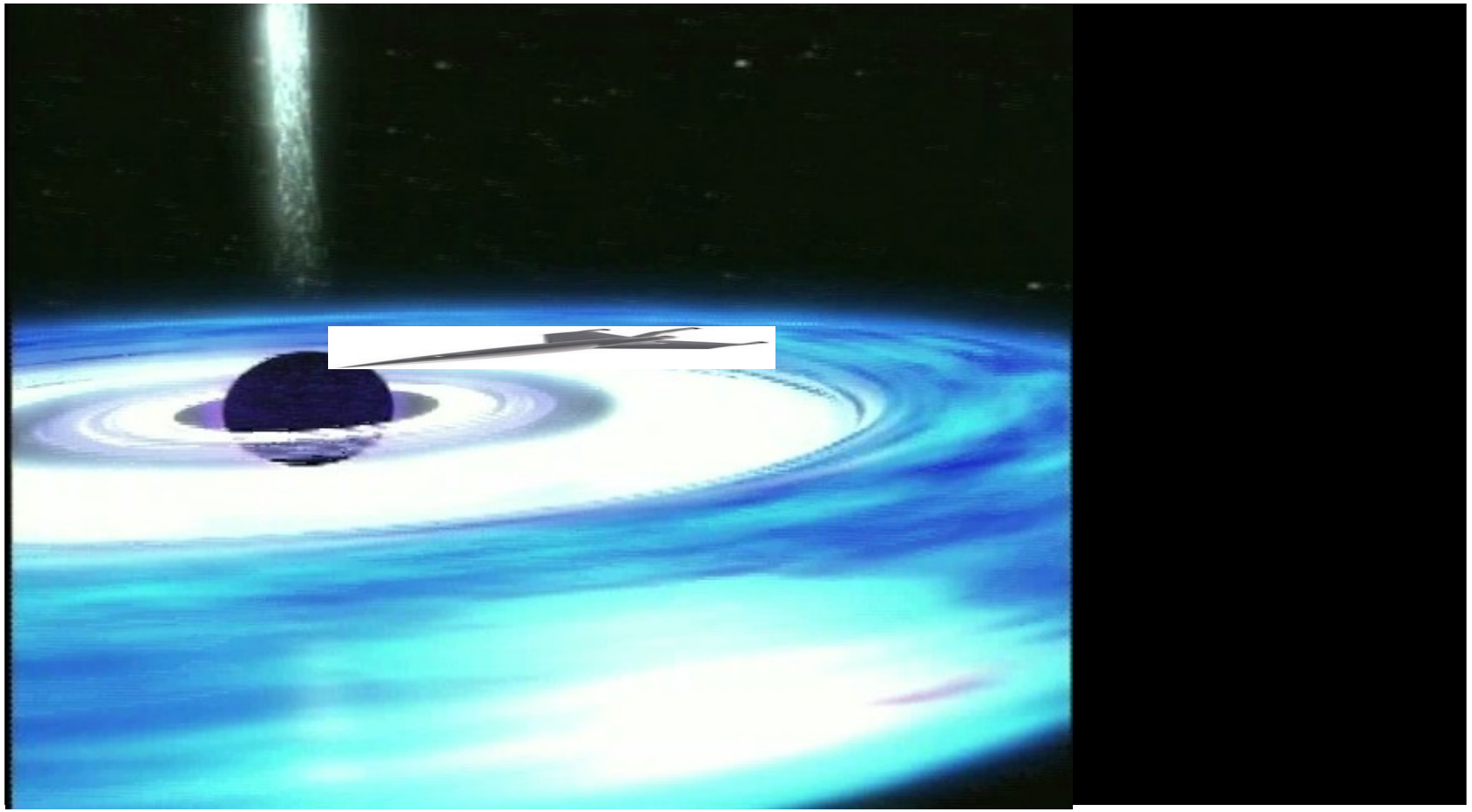
Not to Scale

Falling into a Black Hole



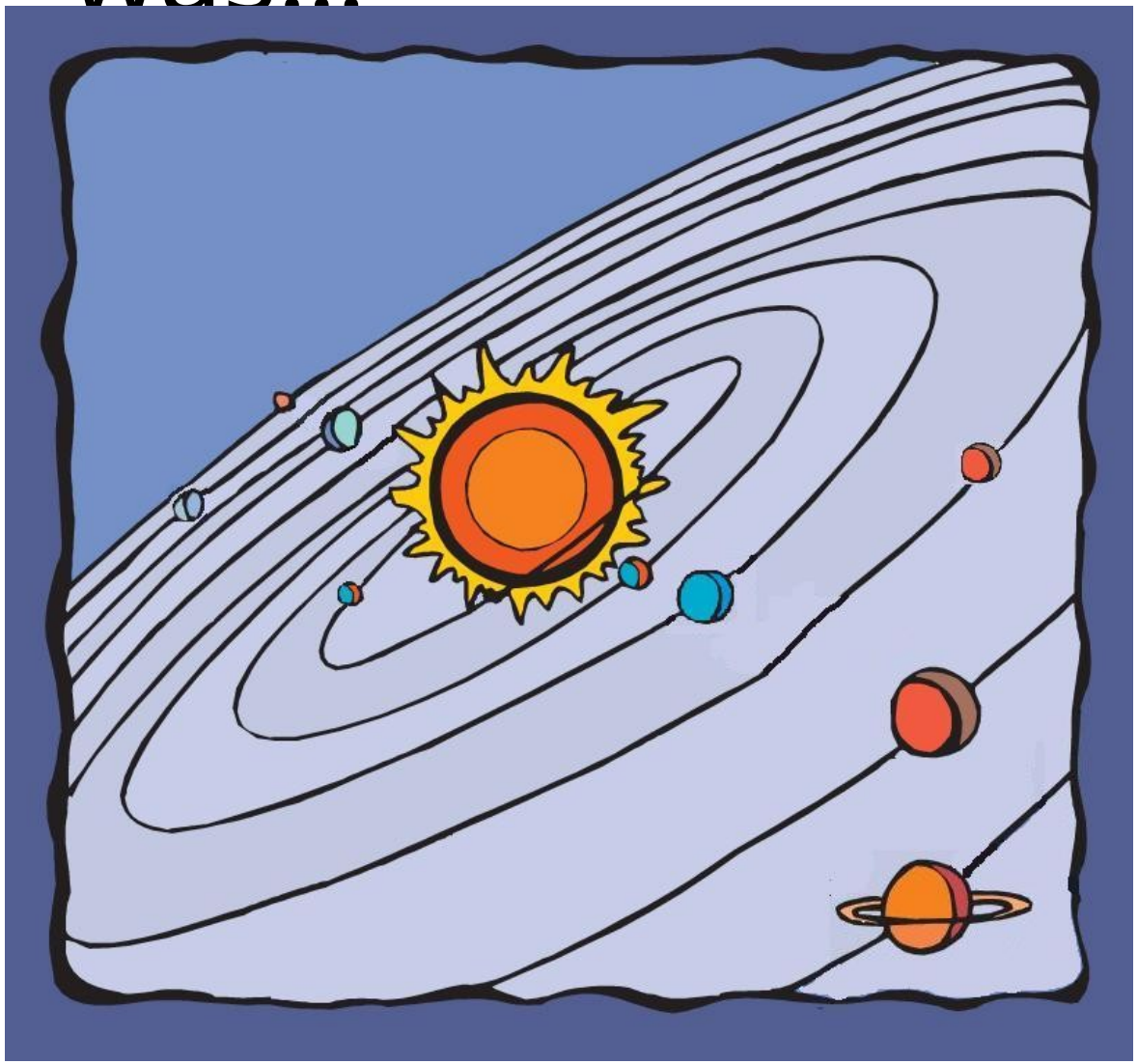
Not to Scale

Falling into a Black Hole



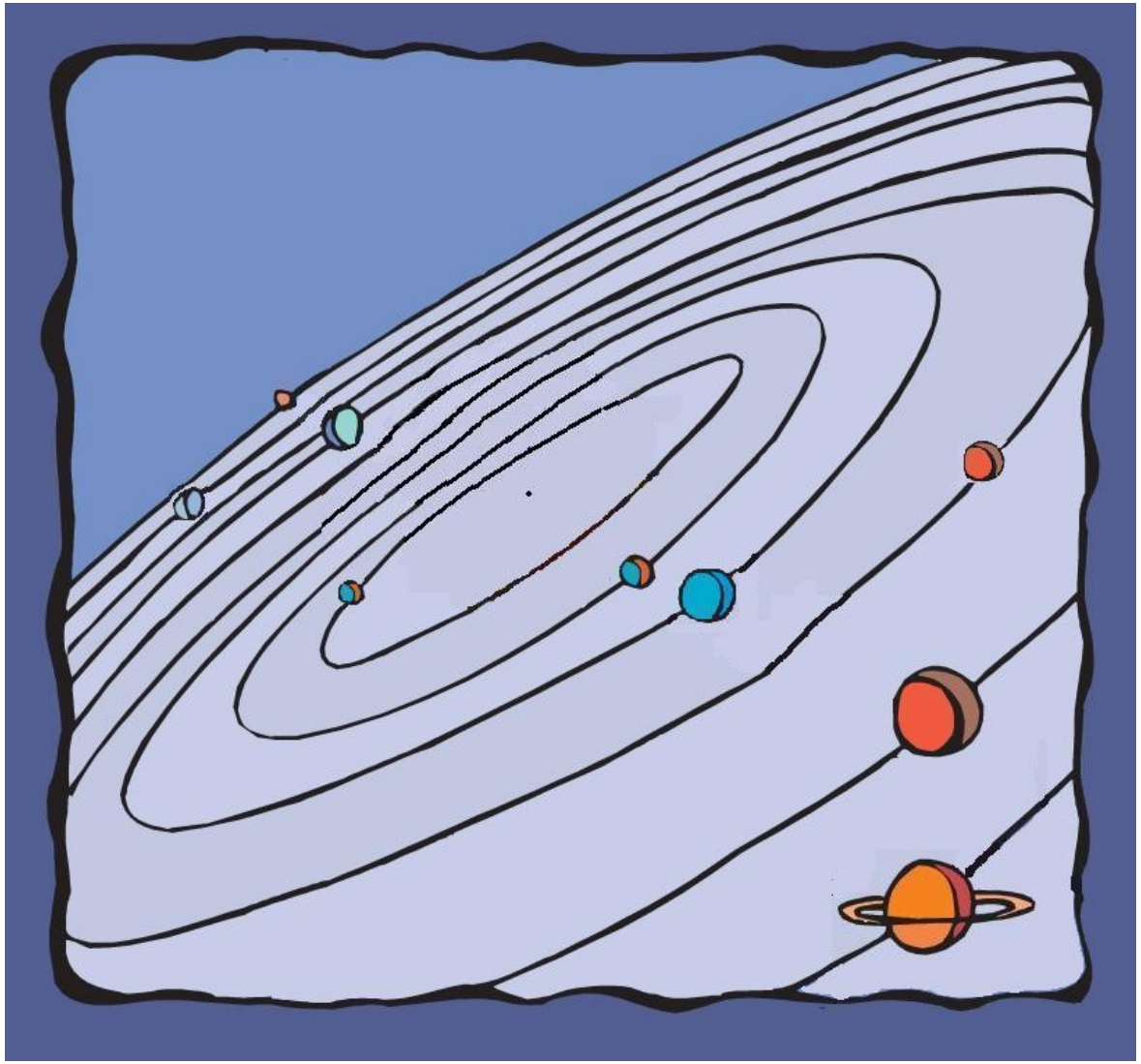
Not to Scale

What would happen if the Sun was...



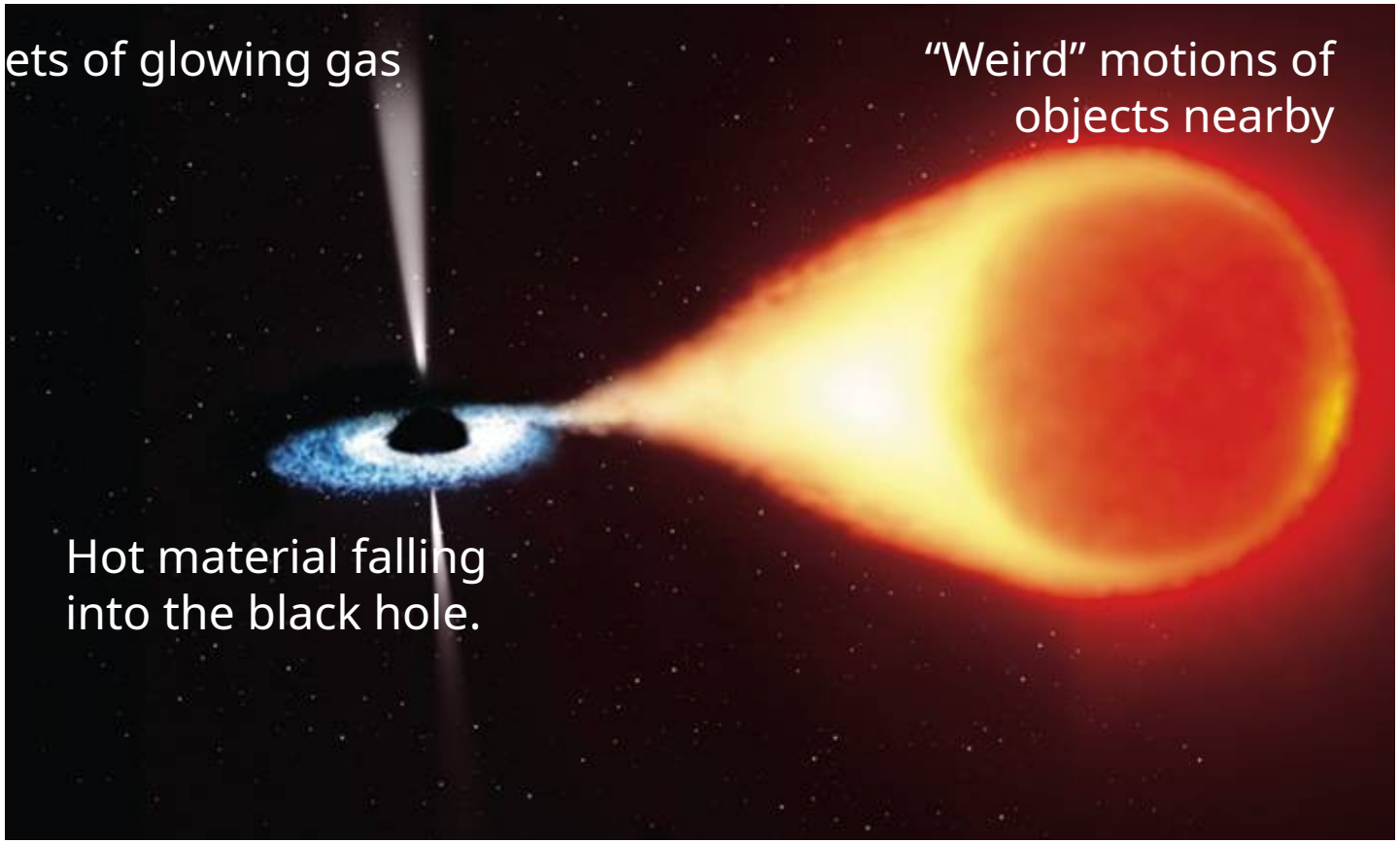
Not to Scale

… changed into a Black Hole?



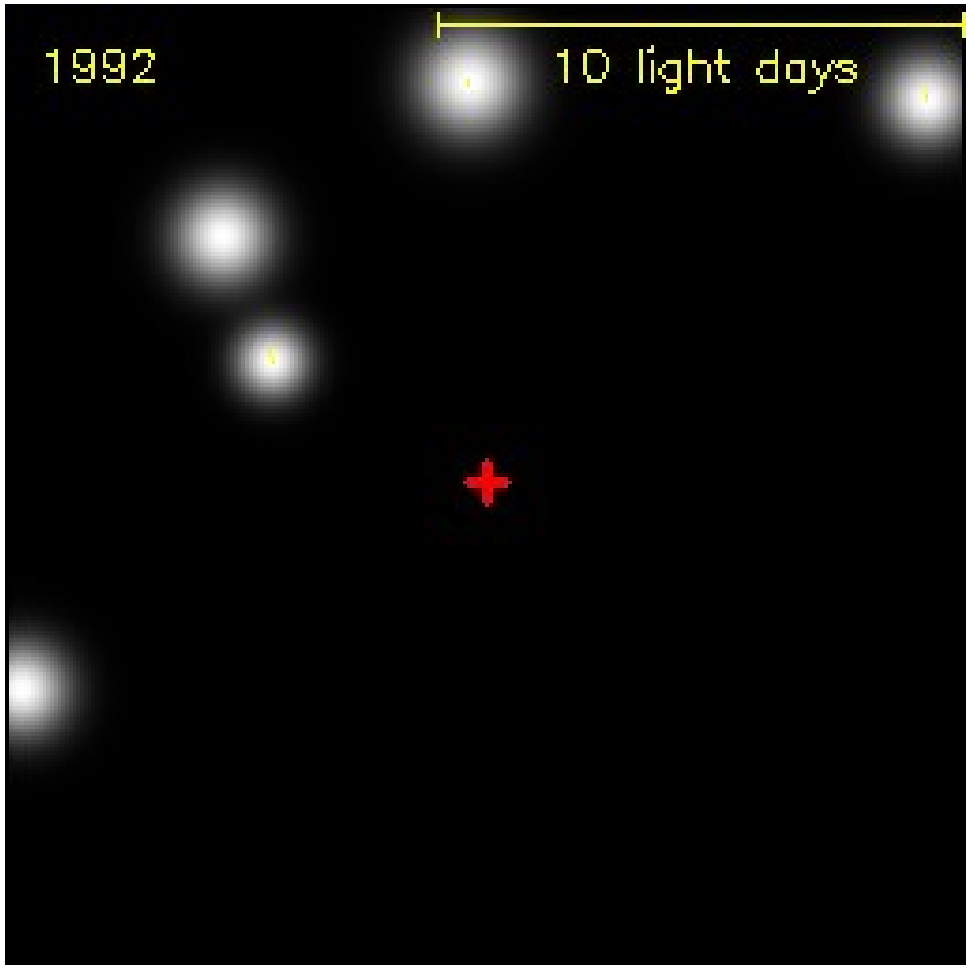
Not to Scale

How do we know it’s there?

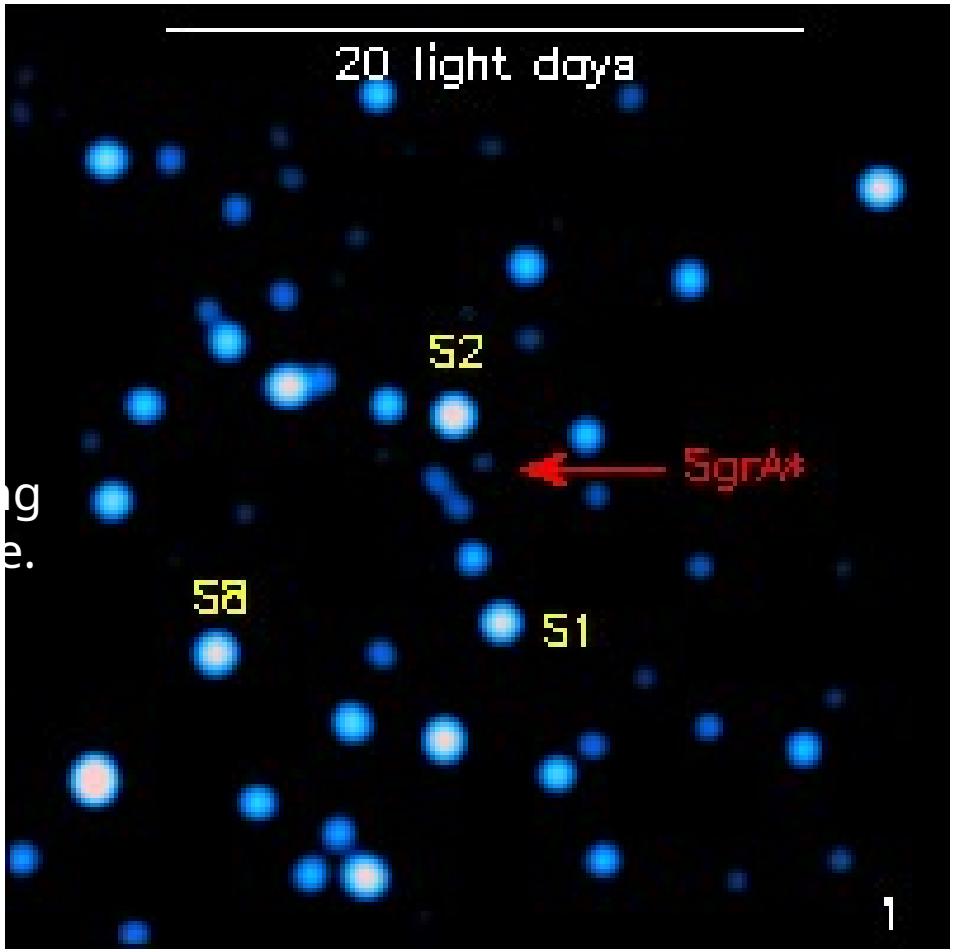


How do we know it’s there?

Years

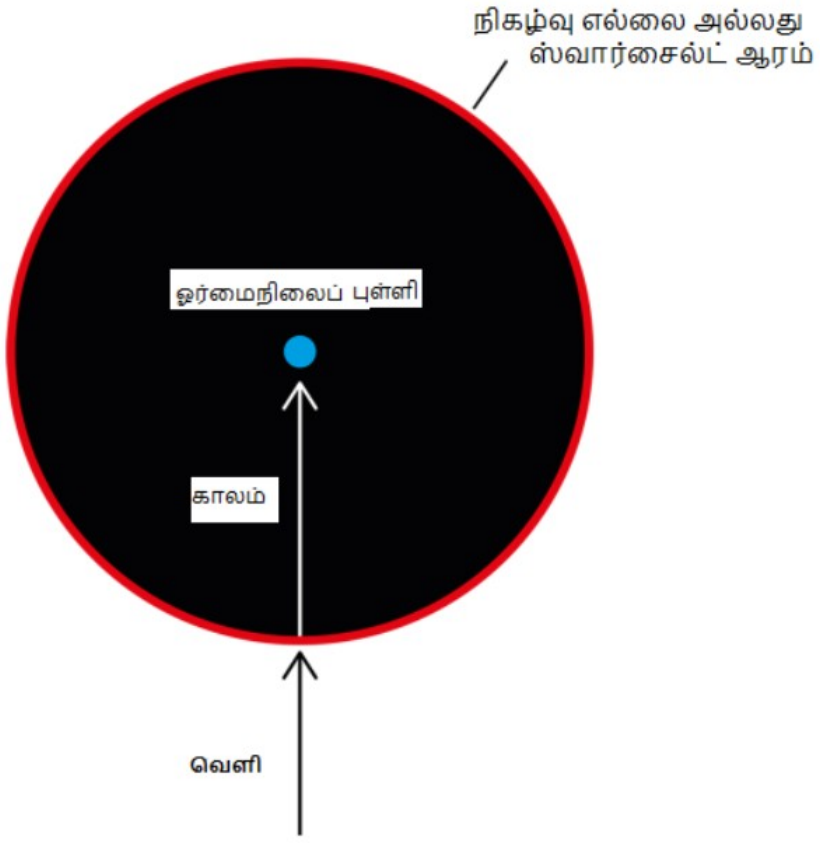


How do we know it’s there?

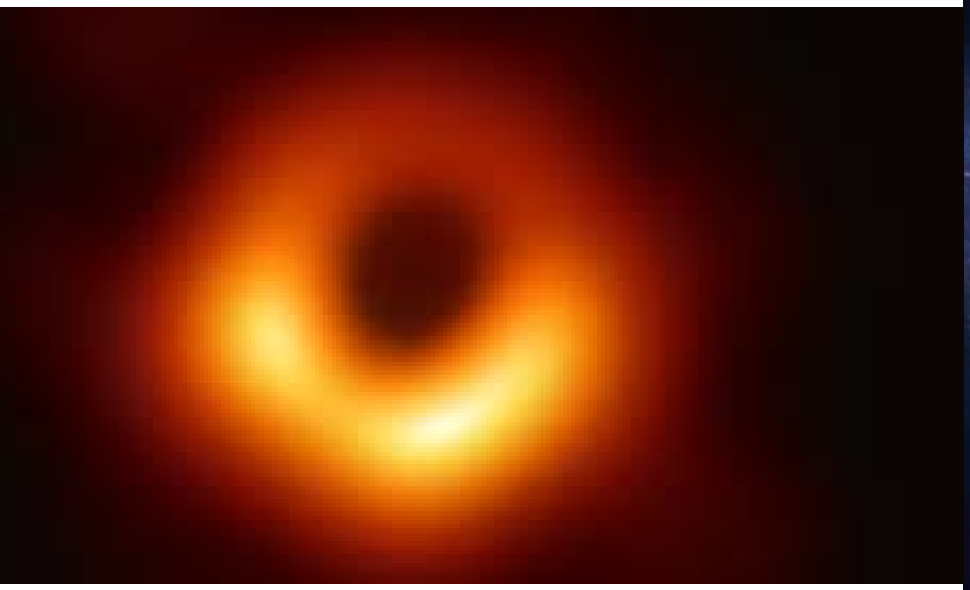


2020 Physics Noble Prize

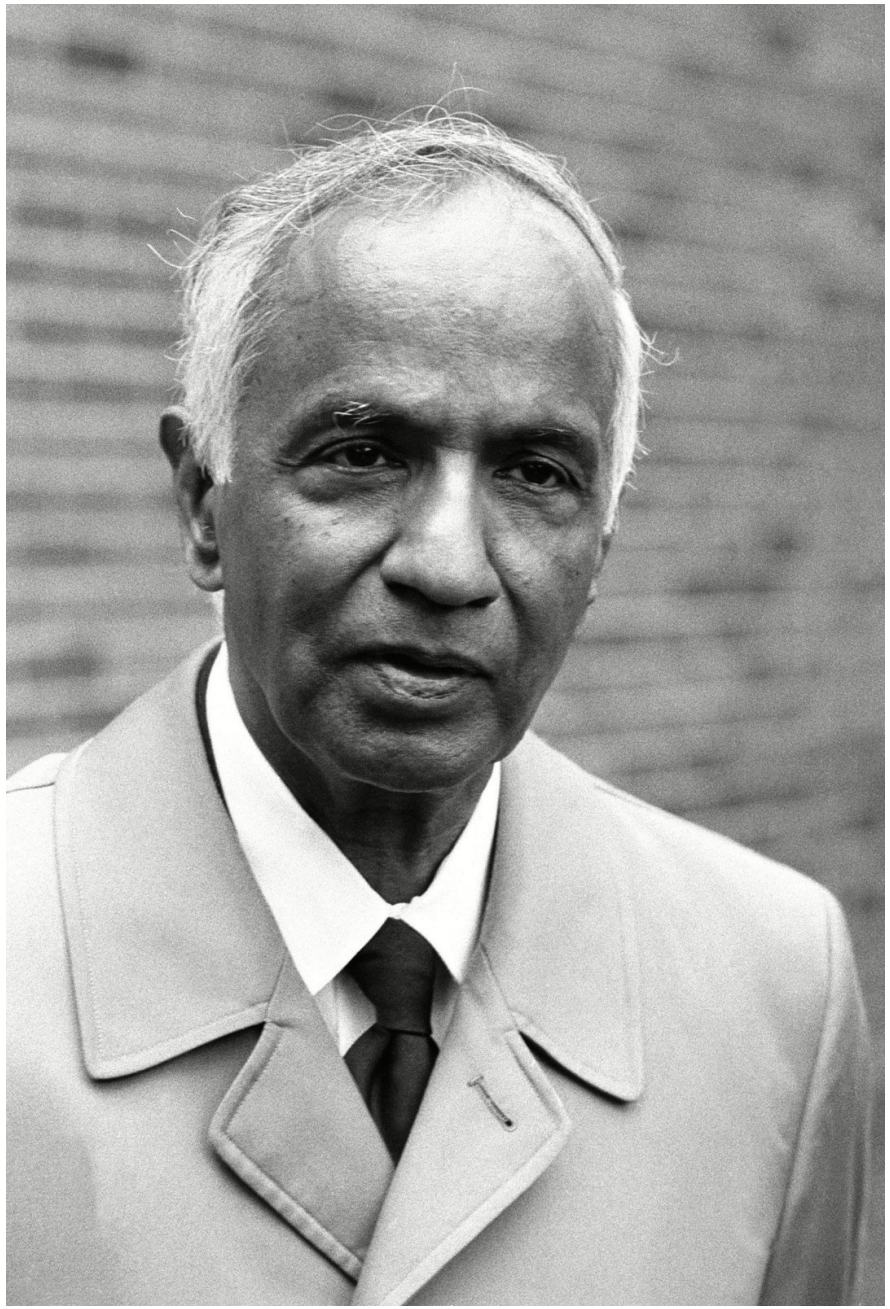
கருந்துளைக்குள் இருப்பது வெறும் காலம் மட்டுமே.

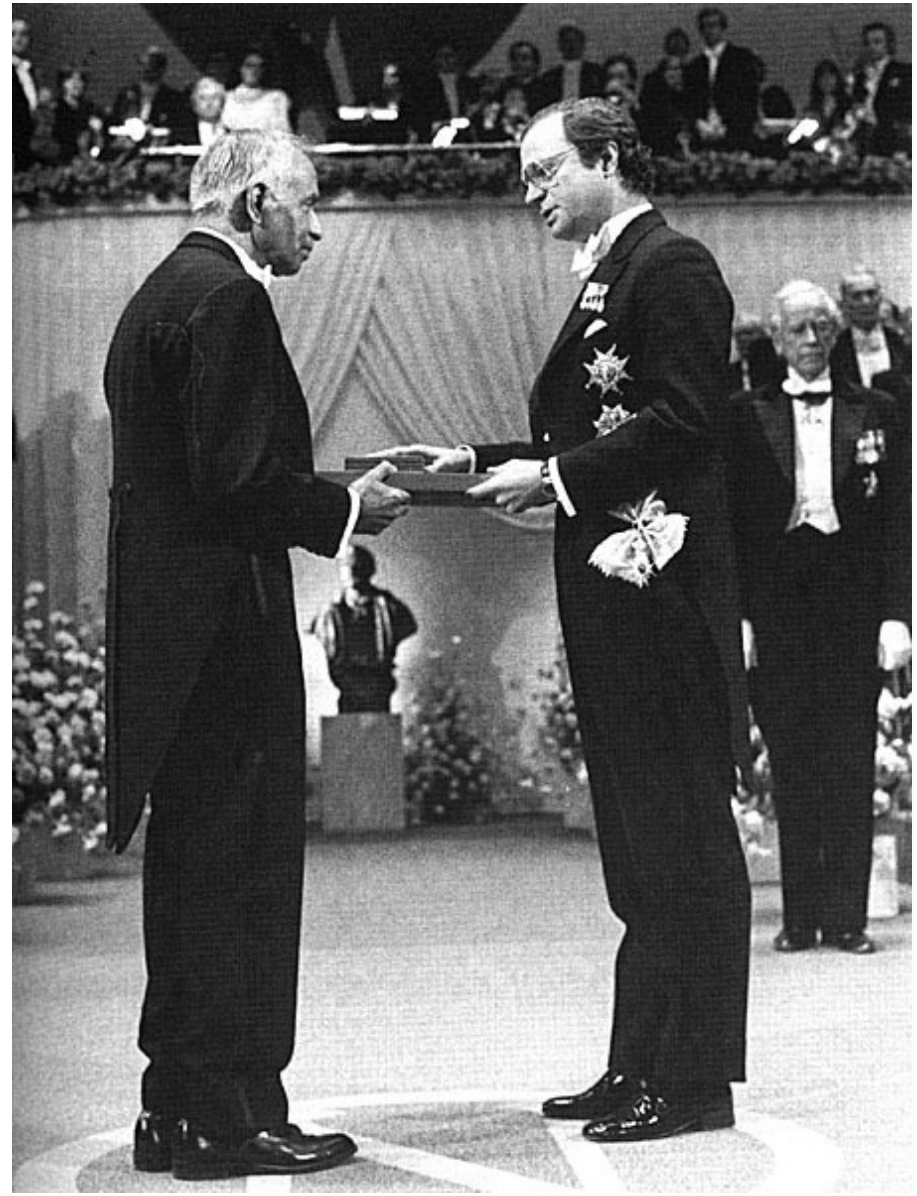


M87* and Sag A*

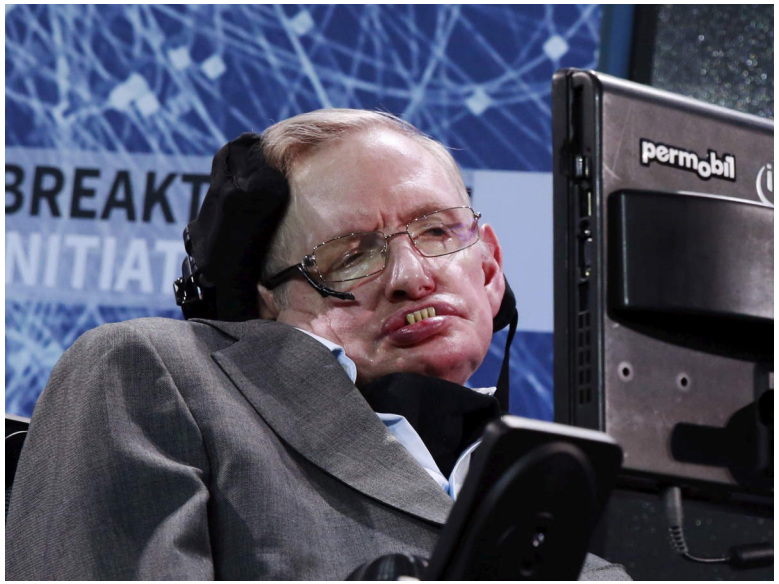


Event Horizon telescopes



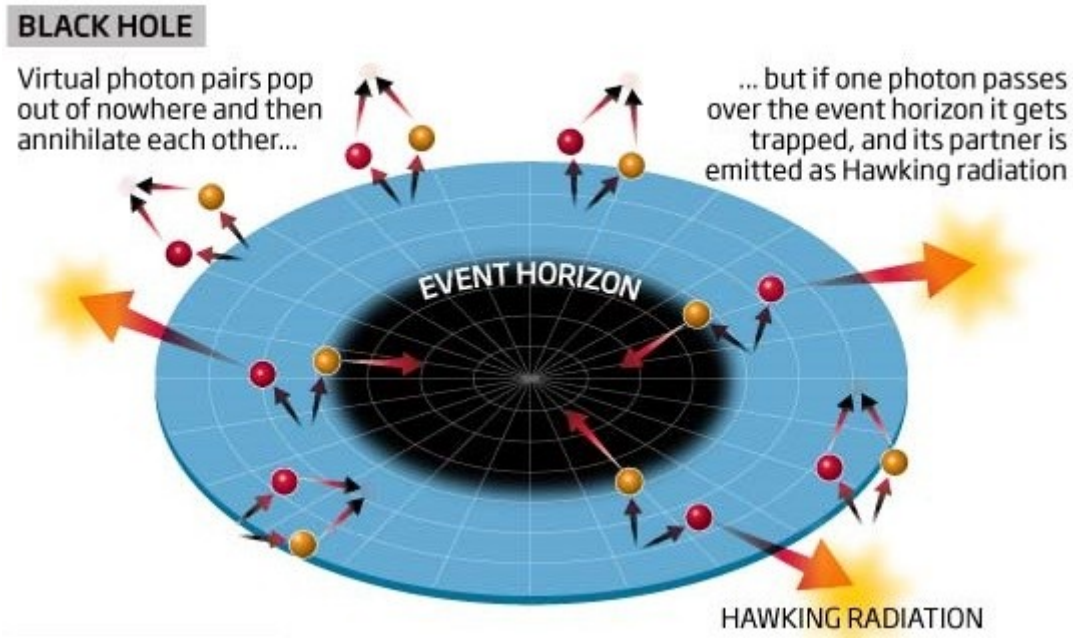


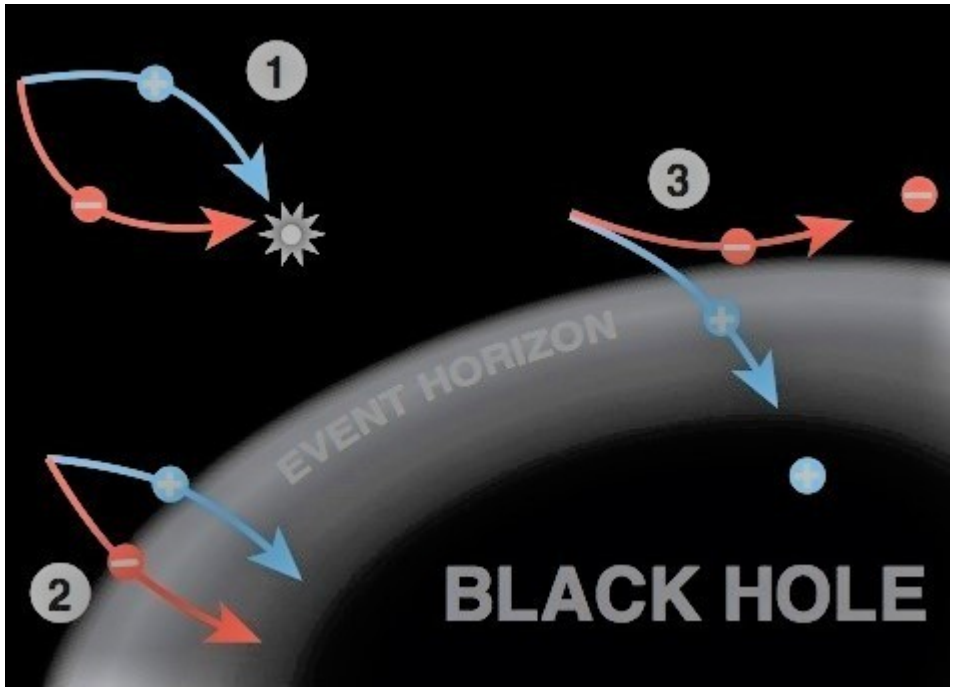
Stephen Hawking - Black hole



Hawking radiation

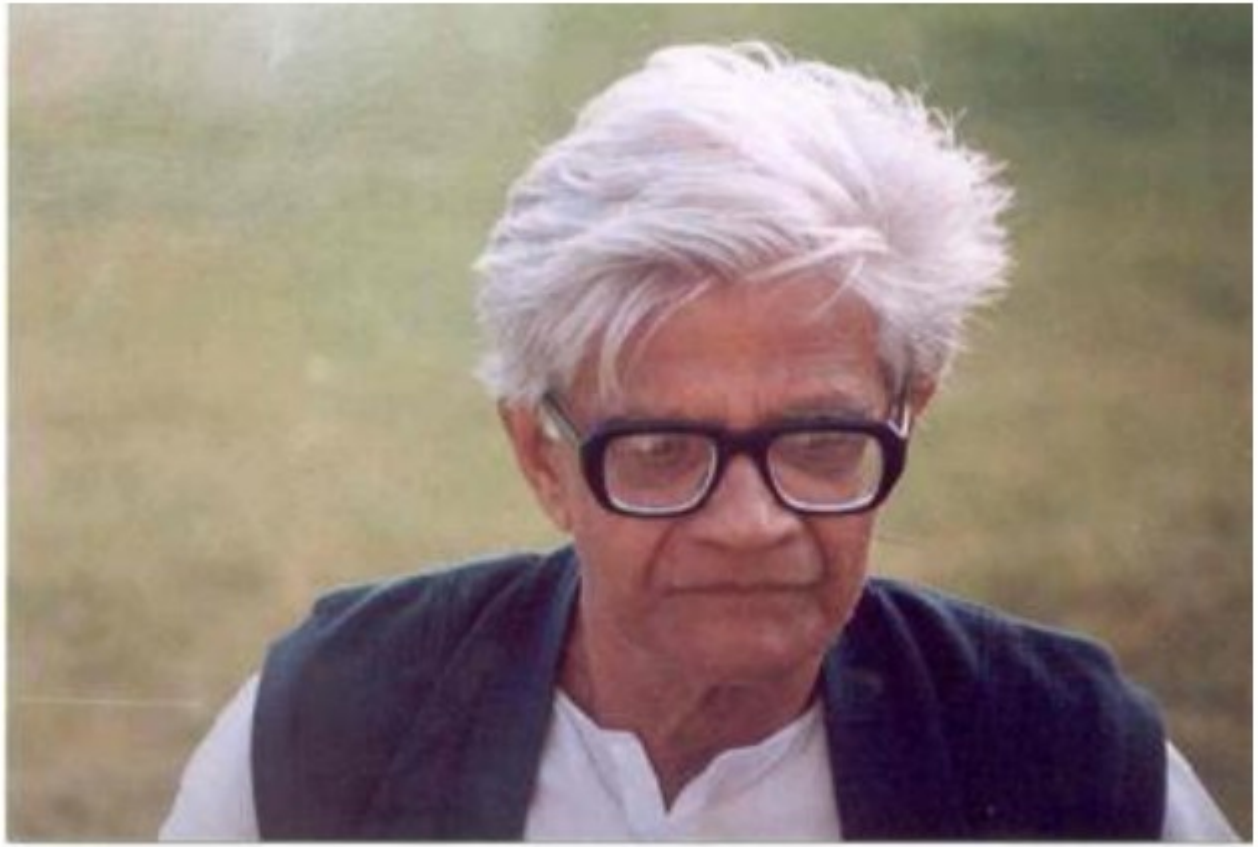
- General relativity + Quantum mechanics





- Hawking radiation – no observable evidence so far
- The energy of radiation is inversely proportional to its mass
- Slowly the blackhole evaporate (prediction!!!!)

அமல் ரே சவுத்ரி



Priyamvada Natarajan – Yale University

- She born in Coiambatore, Tamilnadu

Thank you all !!!!