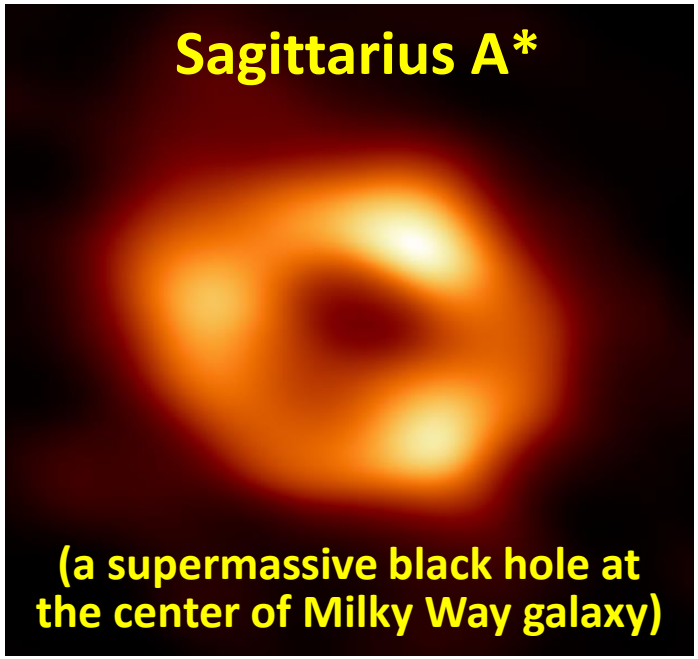
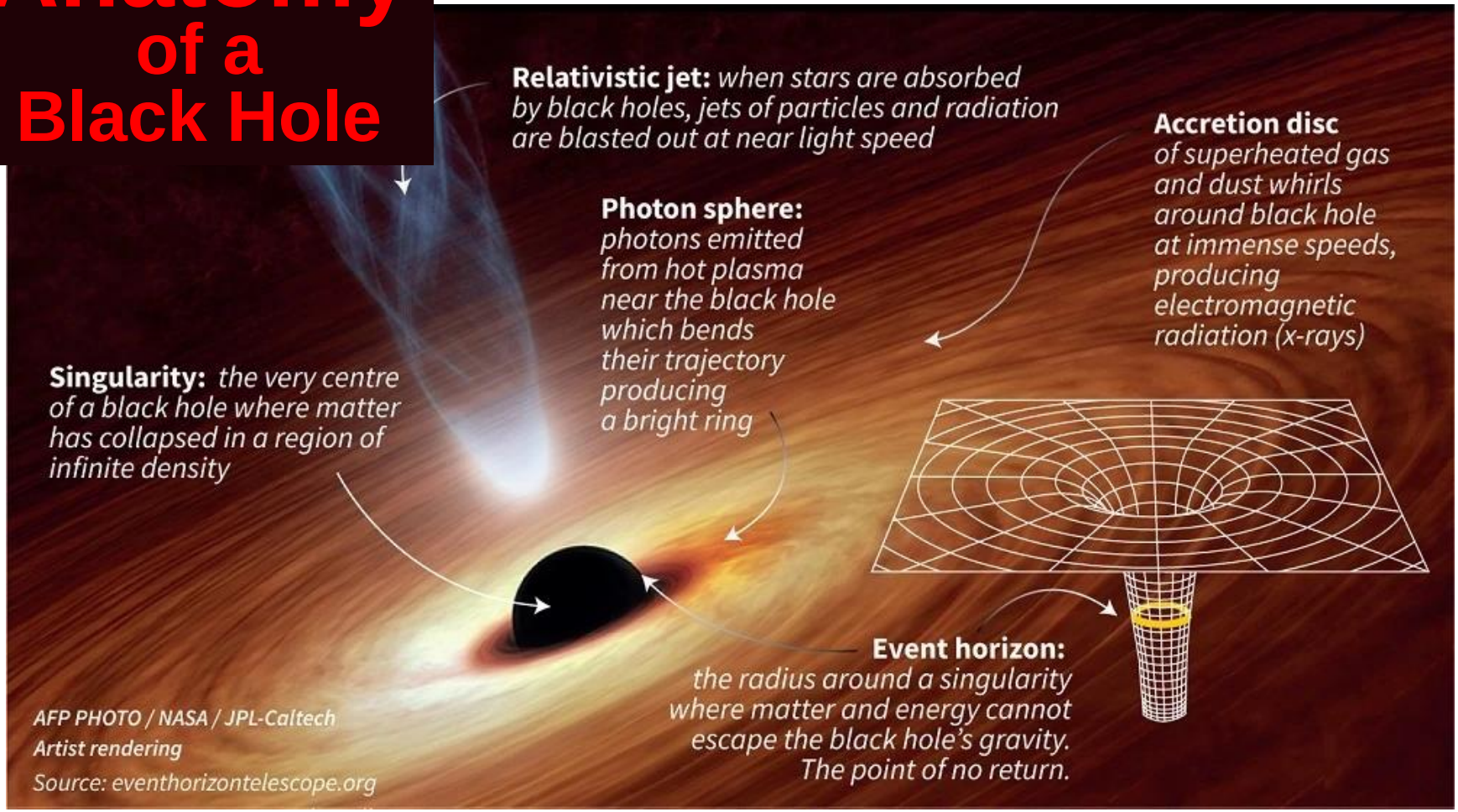
Black Holes

Black holes are volumes of space where gravity is extreme enough to prevent the escape of even the fastest moving particles – light photons!



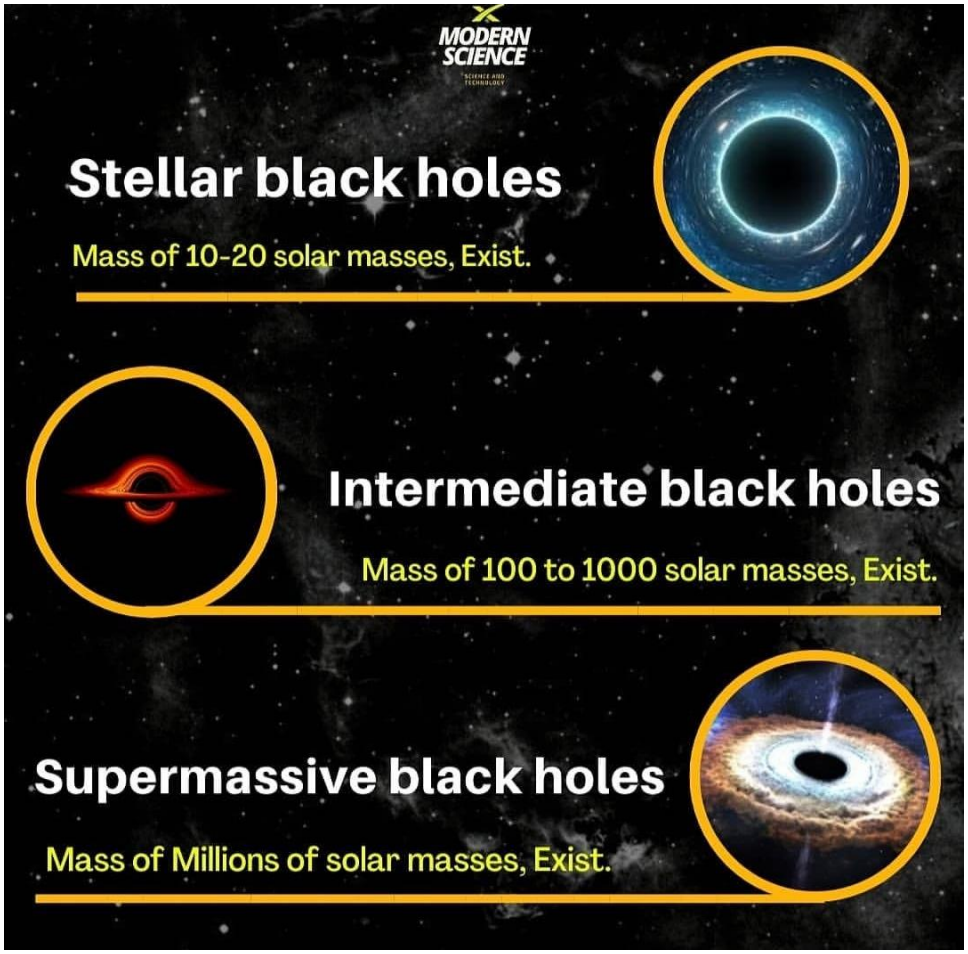
- **The first black holes are thought to have begun to emerge ~13.5 billion years ago resulting from deaths of short-lived massive stars.**
- **After a black hole has formed, it can continue to slowly grow by absorbing mass (**like gas or other stars**) from its surroundings and merging with other black holes.**

Anatomy of a Black Hole



- **Black holes have infinitely dense core ("singularity").**
- **Their "size" is defined by the event horizon - the boundary of the region from which no escape is possible.**

Black Hole Types

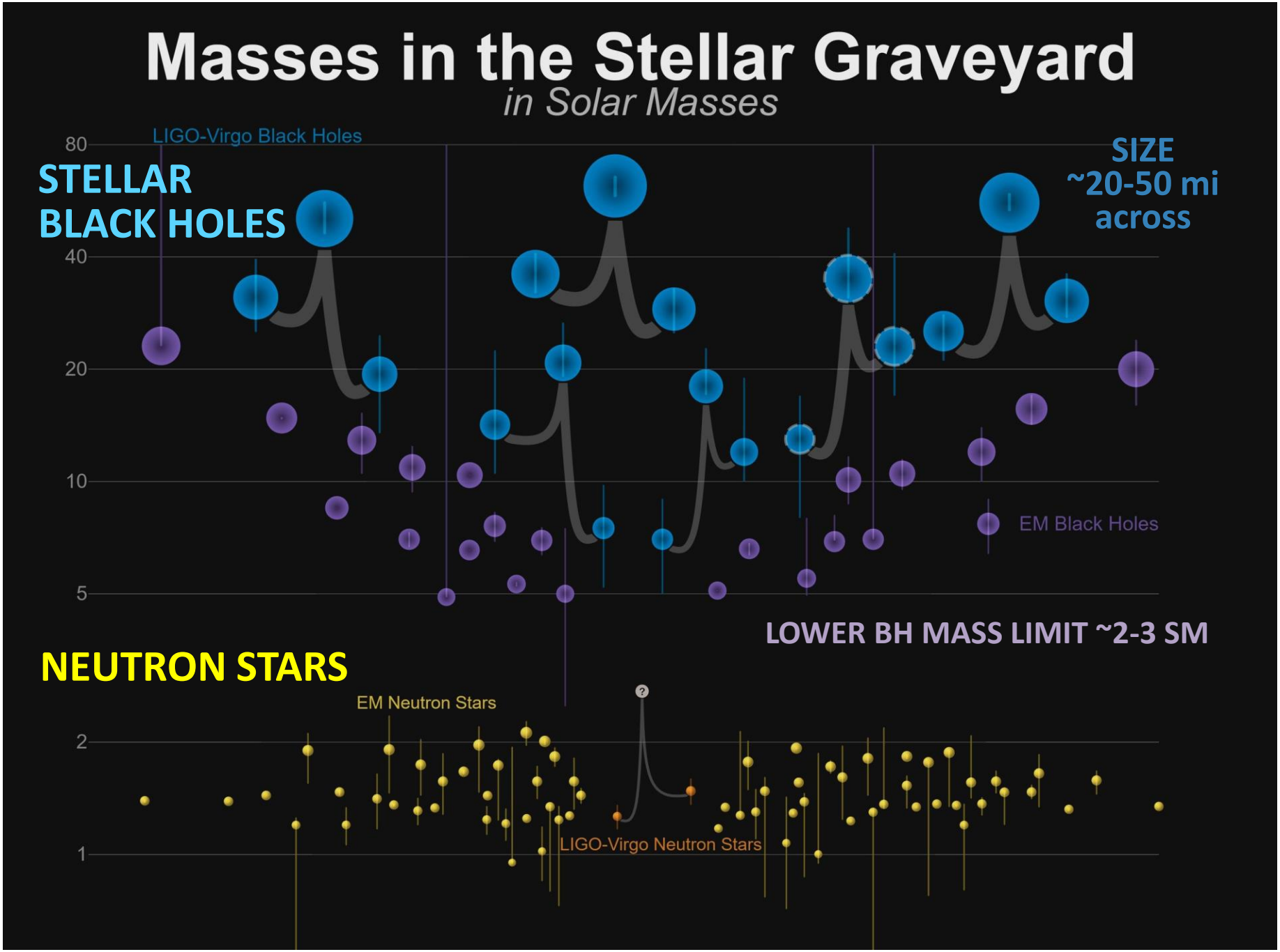


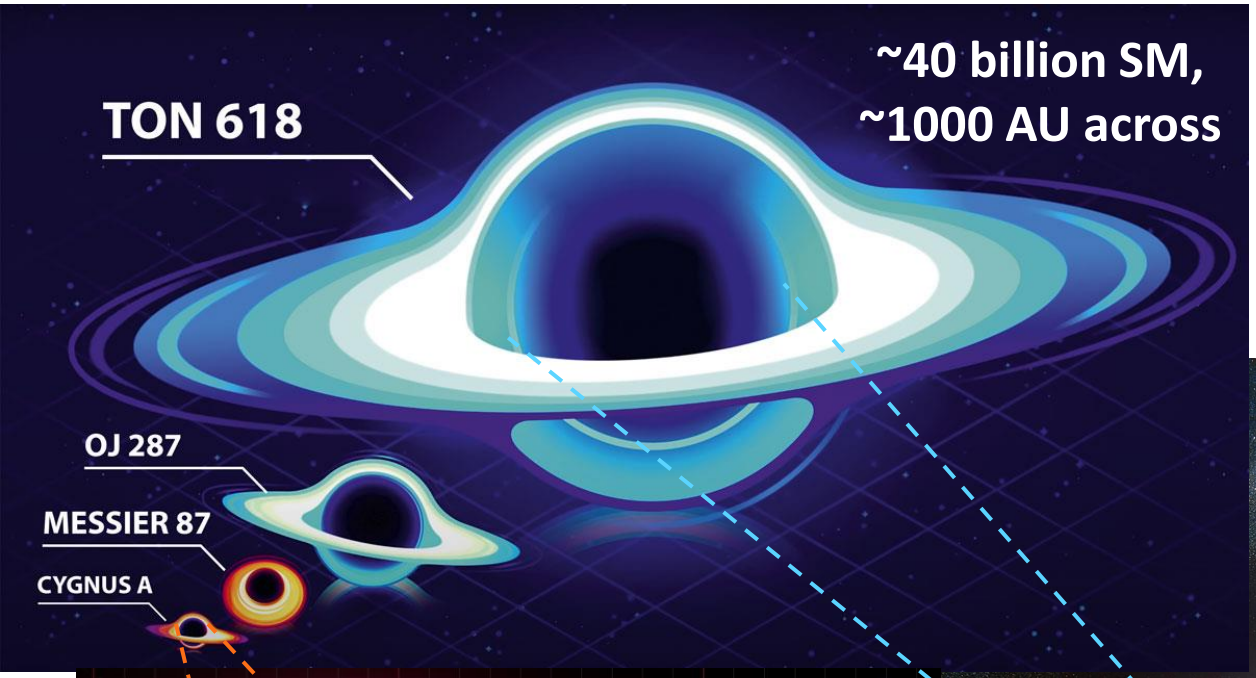
← **STELLAR**
formed by the gravitational collapse of a star following a supernova explosion

← **INTERMEDIATE**
poorly understood; may be found at the centers of globular clusters or within low-luminosity galaxies

← **SUPERMASSIVE**
found at the centers of all large galaxies; formation?

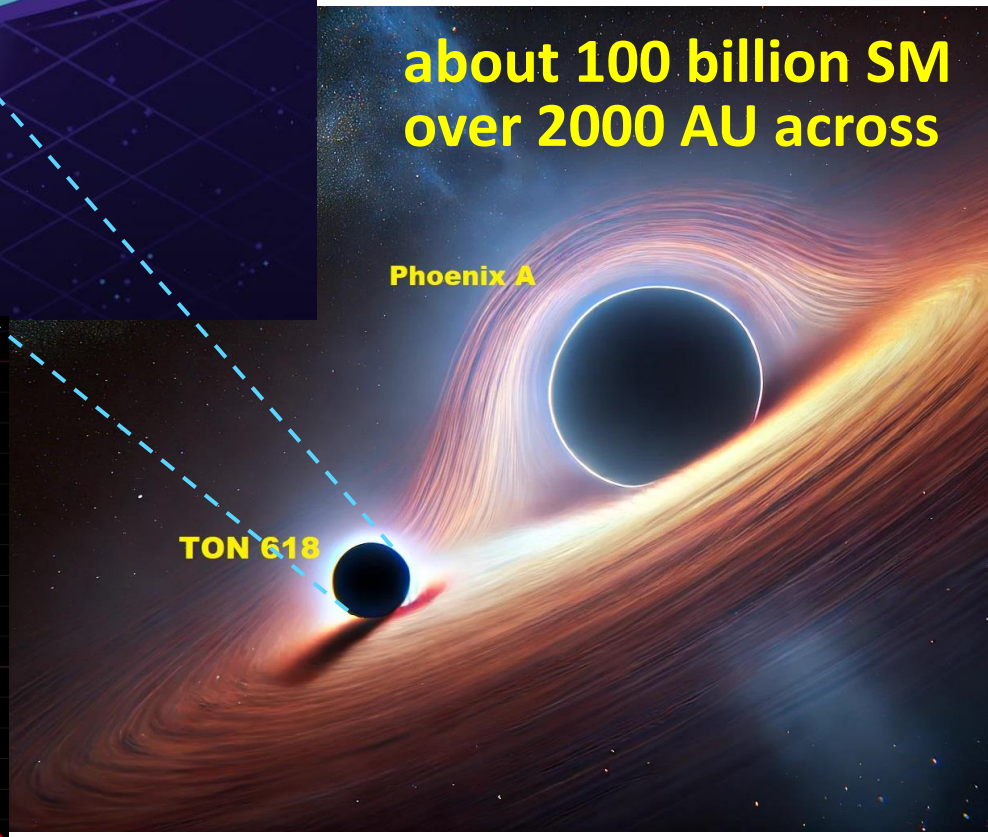
\+ **Theoretical Primordial Black Holes**, formed soon after the Big Bang by gravitational collapse of extremely dense pockets of subatomic matter – can be ANY mass! – is THIS "dark matter"?

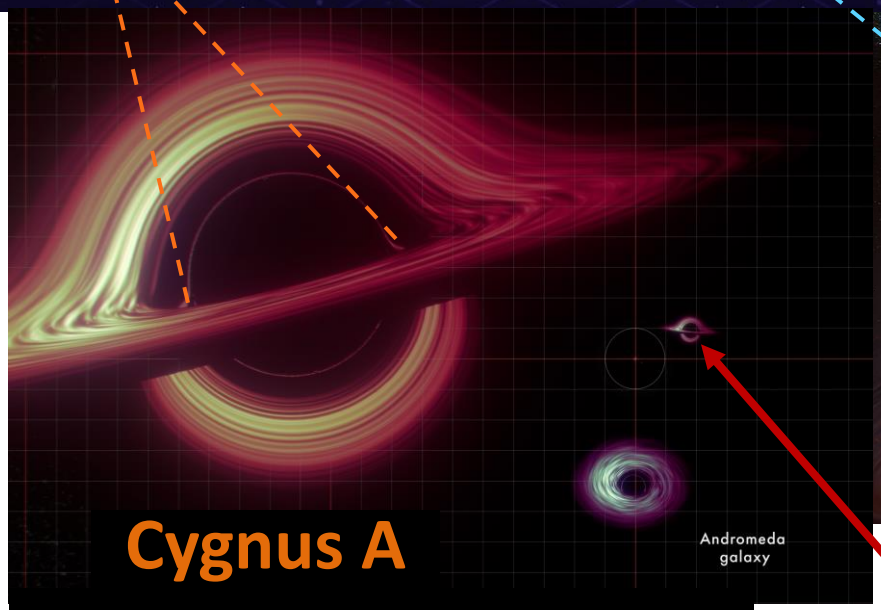

Masses in the Stellar Graveyard
in Solar Masses
LIGO-Virgo Black Holes
STELLAR BLACK HOLES
SIZE ~20-50 mi across
80
40
20
10
5
EM Black Holes
LOWER BH MASS LIMIT ~2-3 SM
NEUTRON STARS
EM Neutron Stars
2
1
LIGO-Virgo Neutron Stars



Largest
SMBH Detected

↓ PHOENIX A*





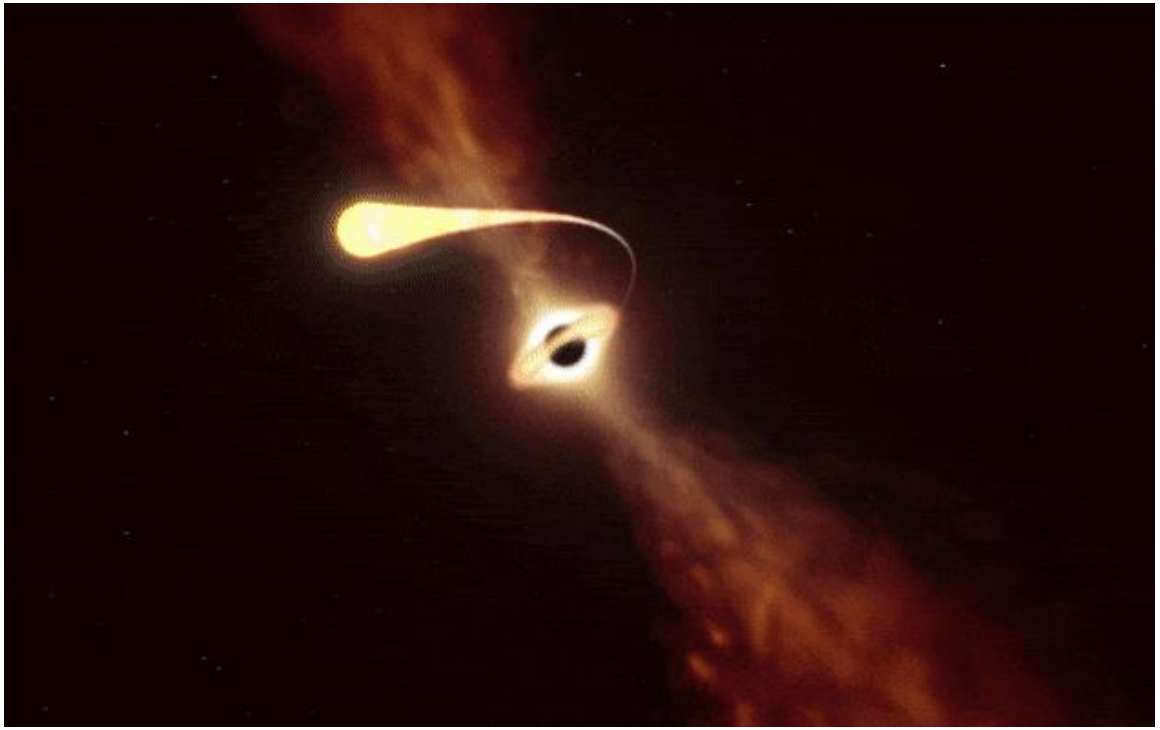
Cygnus A
~2.5 billion SM, ~25 AU across

SAGITTARIUS A* (Milky Way)
~4 million SM, ~0.1 AU

What happens when matter gets too close to a black hole?

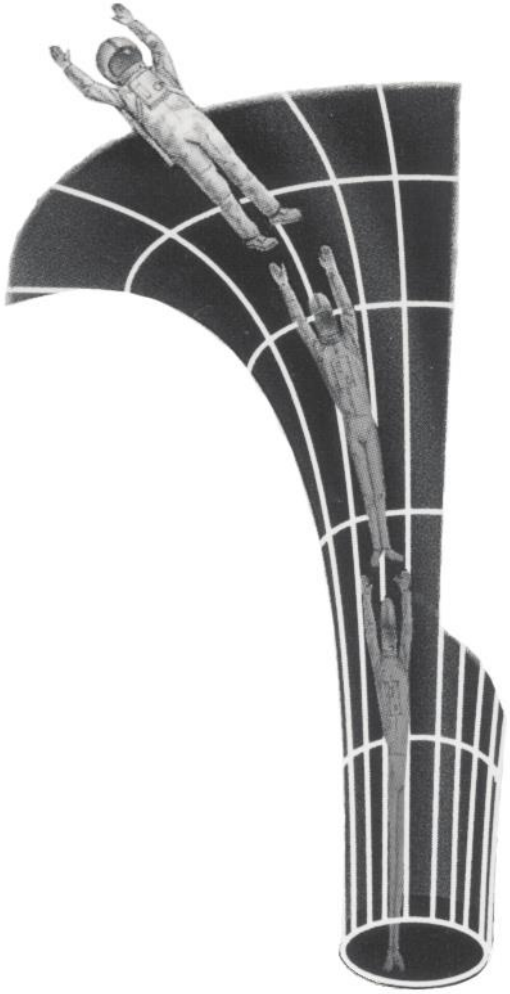
Spaghettification-

- the tidal effect (*tidal disruption*) caused by strong gravitational fields.



- When falling towards a black hole, an object is stretched in the direction of the black hole and simultaneously compressed perpendicular to it as it falls, which can result in it breaking out into a line of debris.

More Black Holes Facts



https://science.nasa.gov/universe/black-holes/