Session 10: Black Holes
The Main Concepts…

1. Black holes are the end points of stellar evolution for the very massive stars
2. The idea of escape velocity
3. Black holes are objects where the escape velocity exceeds the speed of light
Escape Velocity

On the surface of the Earth, the faster you throw something upwards, the higher it goes before coming down.

If you throw something up at 25,000mph (7 miles per second) or more, it can leave the Earth's gravitational pull entirely and travel freely into space.

This speed is called the escape velocity; objects with a stronger gravitational pull than the Earth have a larger escape velocity.
Black Holes

• A black hole is an object with such strong gravity that the escape velocity is the speed of light.

• Since light cannot escape, black holes appear black!

• Also, since nothing can travel faster than light, nothing can escape from a black hole.
Life Cycle of a Star

Stellar Nebula

Average Star

Massive Star

Red Supergiant

Red Giant

Planetary Nebula

Supernova

Neutron Star

White Dwarf

Black Hole

© Sea & Sky

Afterschool Universe
Two Types of Black Holes

“Supermassive black holes”
Found at centers of galaxies, but origin is a mystery… have radii 1 million - 1 billion km.

“Stellar-mass black holes”
From the collapsed core of a dead massive star… can have radii in range 3-60 km.
Structure of a Black Hole

Objects outside of event horizon can avoid falling in.

Event horizon

Once inside all objects fall to the center.

“Spacetime singularity”
Black holes are very hard to see directly...

But we can often see the gases that swirl around them. Gas gets very hot and produces X-ray emission. We need special telescopes, X-ray telescopes, to see these emissions.