

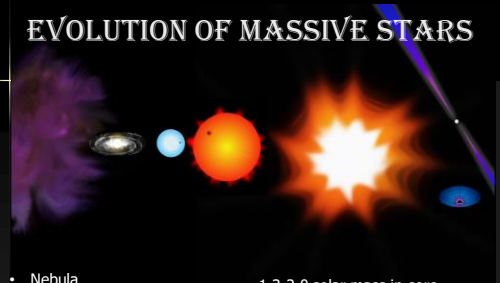
TMARTSCIENCE YOUTUBE

ASTRONOMY

SUPERNOVAE LEFTOVERS
NEUTRON STARS AND BLACK HOLES

www.adventureearthscience.org

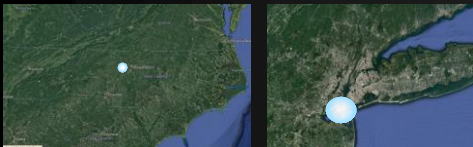
EVOLUTION OF MASSIVE STARS



- Nebula
- Protostar
- Blue Giant
- Red Super Giant
- Supernova
- 1.3-2.0 solar mass in core
Neutron Star
- >2.0 solar mass in core
Black Hole

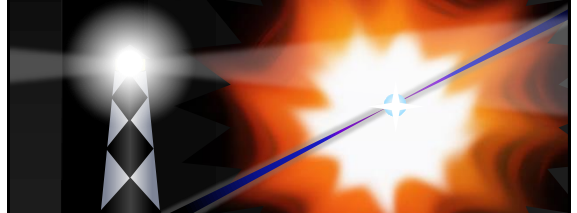
STARS 1.3-2.0 SOLAR MASS IN CORE

- When core collapses electrons smashed into protons forming neutrons
- Star core becomes as dense as the nucleus of atoms
 - Density 100 million tons / cc
 - Diameter of 30-40 km



NEUTRON STAR / PULSAR

- Strong Magnetic fields
- Often have jets or bright spots
- Rotating rapidly



NEUTRON STAR / PULSAR
M-1 CRAB NEBULA

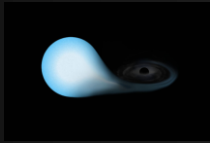
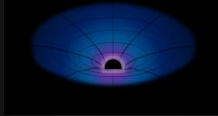


STARS >2.0 SOLAR MASS IN CORE

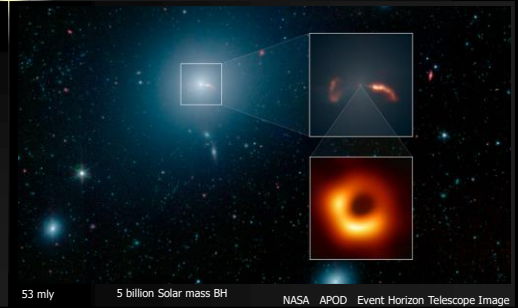
- Violent supernova - Hypernova
- Core collapse actually shoves matter into the same place.
- Volume becomes a point
- Density...
 - approaches ∞
- Gravity becomes so great even light can't escape

BLACK HOLE

- Gravitational warping of space
- Cygnus X-1
 - 6.8 Solar Mass
 - 0.2 AU from star
 - Dist 6000 ly



M-87 BLACK HOLE



53 mly 5 billion Solar mass BH NASA APOD Event Horizon Telescope Image

BLACK HOLES ARE:

- Object with escape velocity greater than c
- Object with a radius \leq to the Schwarzschild radius
- Volume = 0
- Density ∞ (sort-of)

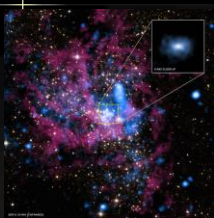


BLACK HOLES ARE NOT

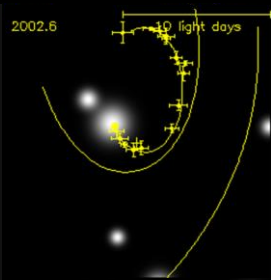
- A place to do time travel
- Giant vacuums that suck up everything around



SGR A* MILKY WAY BLACK HOLE



NASA Chandra X-Ray Image



4 msm 25 klv

European Southern Observatory image

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