Cosmology

Age of the Universe
- Future?
- The cosmic calendar
- Age of the Earth
- Red shift

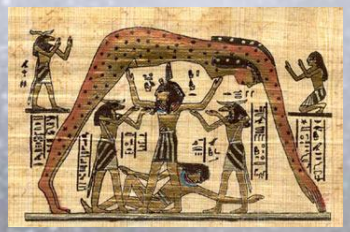
Structure and evolution of stars

Relativity
- Special Relativity
- Gravitational lensing
- Ideas of General Relativity
- Precession of Mercury

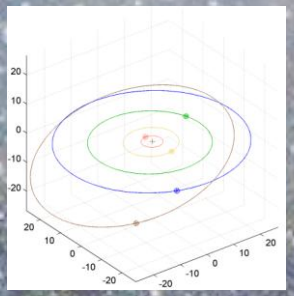
Size of the Universe
- Parallax
- Luminosity
- Measurement
- Earth
- Solar System
- Galaxy ...

Exotic case studies
- Neutron stars
- Black holes, quasars

A human history of cosmology



Gravity
- Newton/Kepler
- Einstein
- Computer Simulation

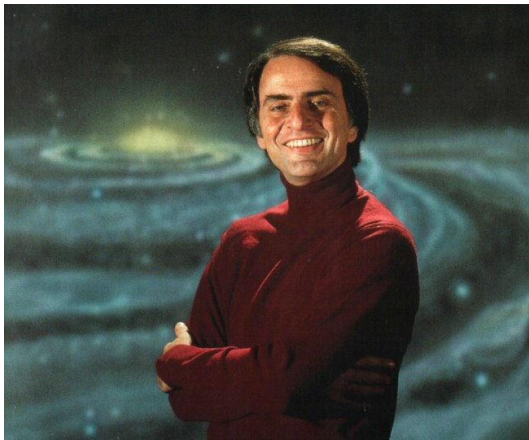


Planets & moons
- Detecting planets orbiting other stars
- The Solar System
- The Earth

The Cosmos is all that is or ever was or ever will be.

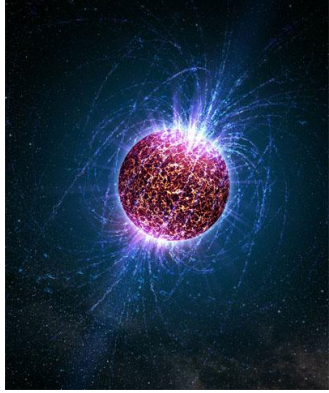
In the last few millennia we have made the most astonishing and unexpected discoveries about the Cosmos and our place within it, explorations that are exhilarating to consider. They remind us that humans have evolved to wonder, that understanding is a joy, that knowledge is prerequisite to survival.

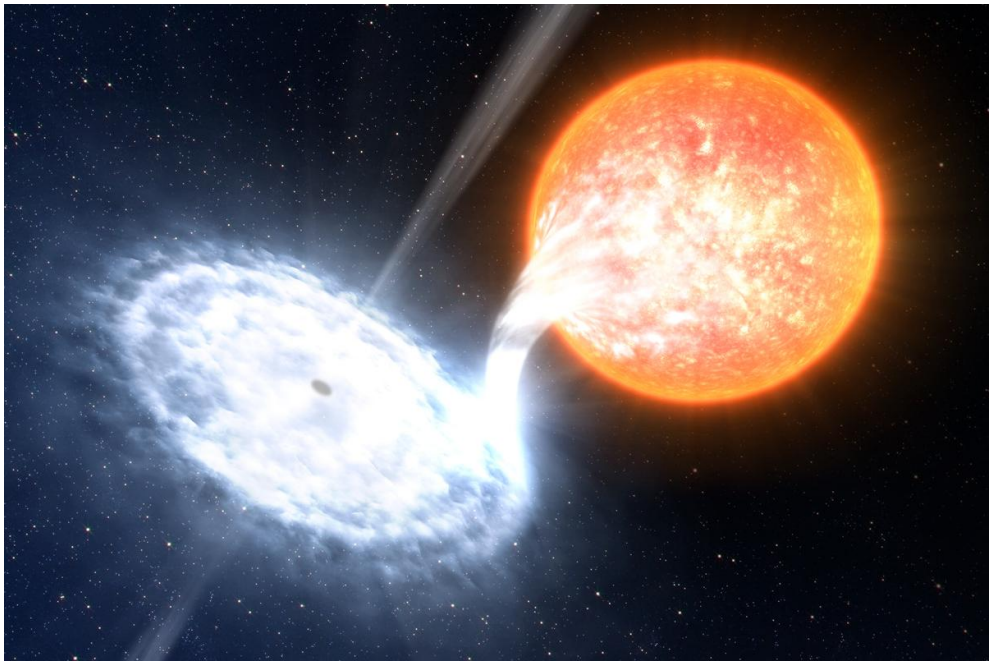
I believe our future depends on how well we know this Cosmos in which we float like a mote of dust in the morning sky.



Carl Sagan (1934-1996)
Cosmos pp20

Exotic objects: Strange planets, Neutron Stars, Quasars, Supernovae, Black Holes

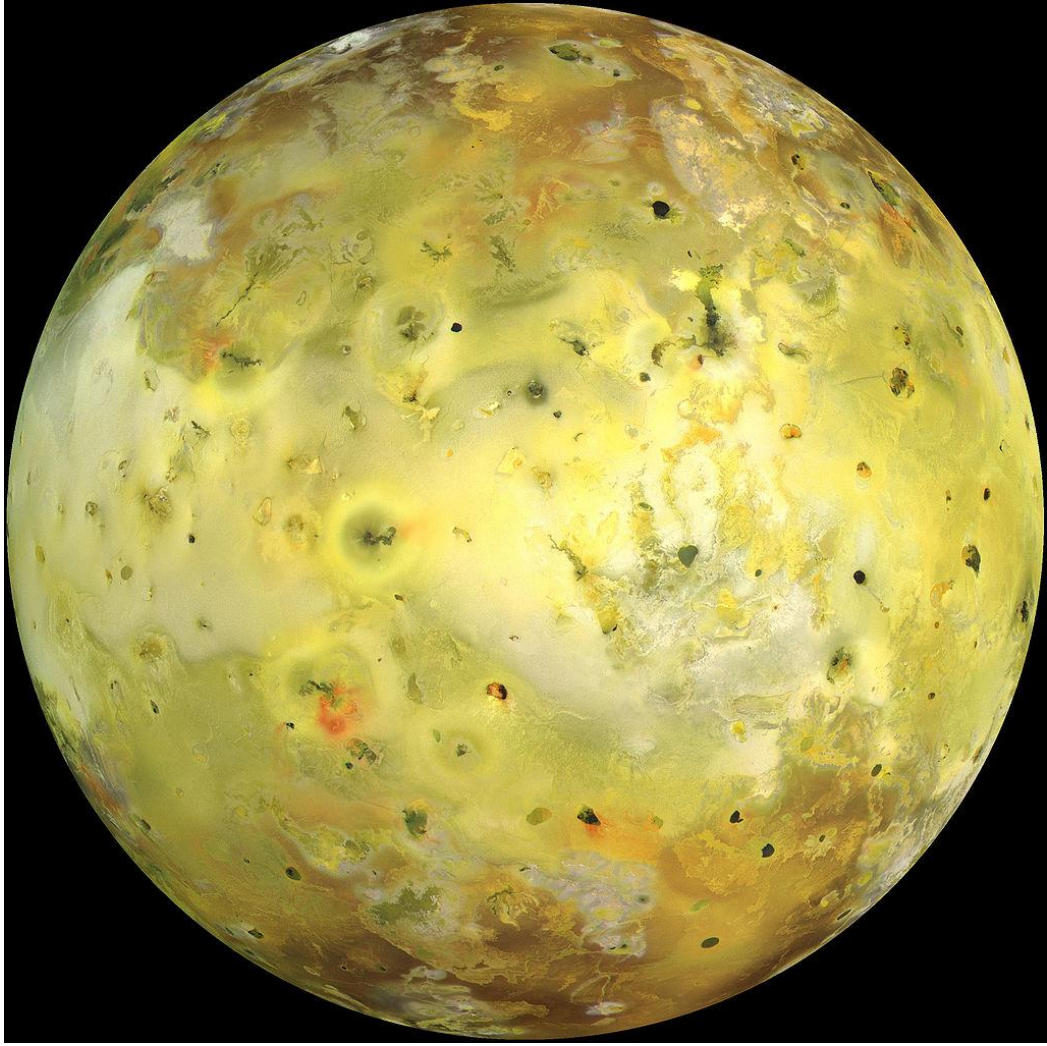


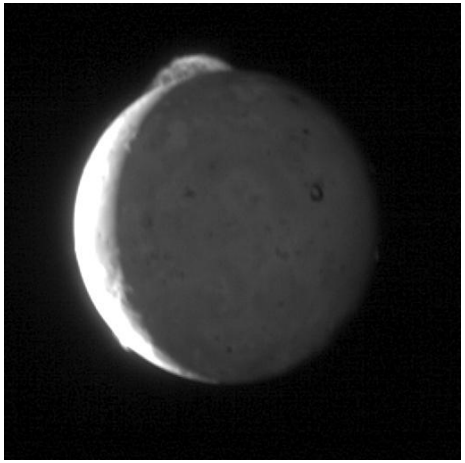


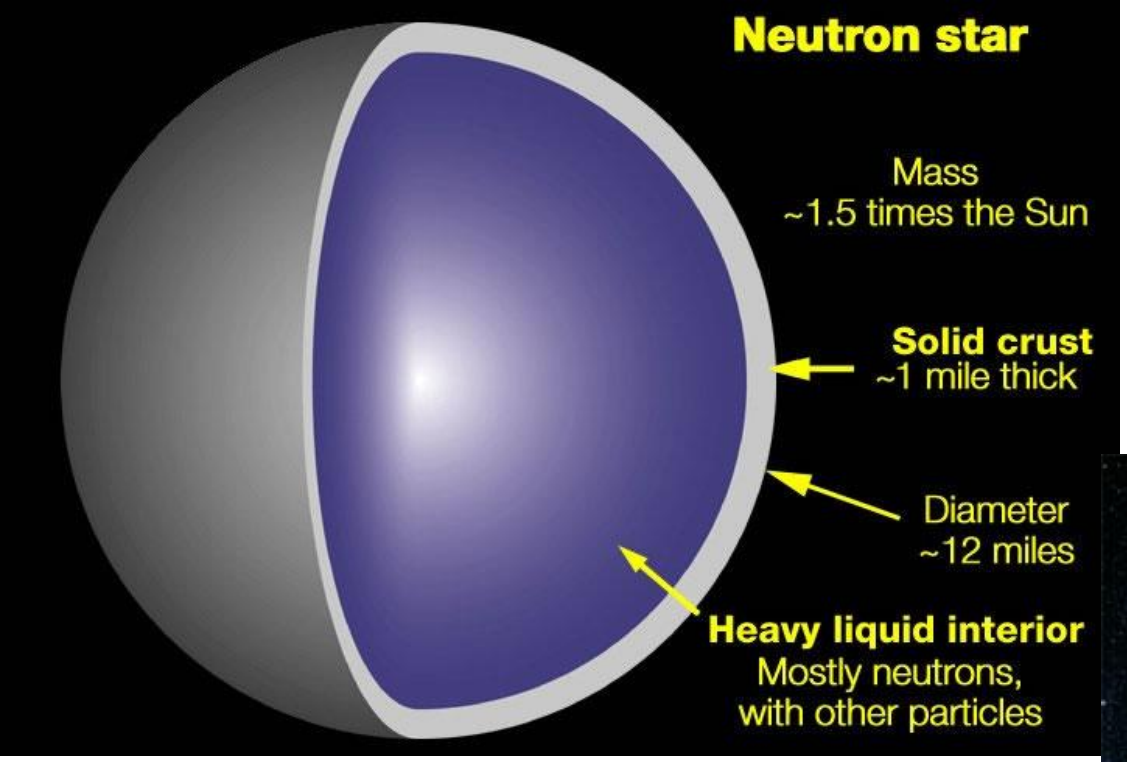
Io – a moon of Jupiter

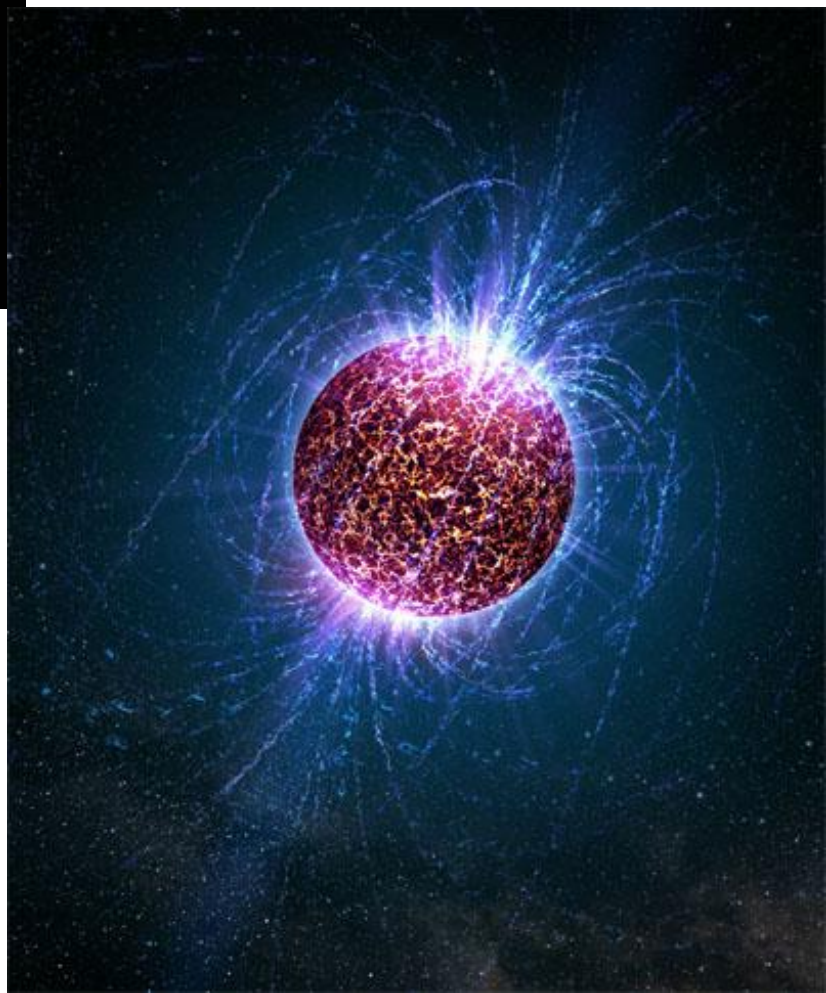
With over 400 active volcanoes, Io is the most geologically active object in the Solar System. This extreme geologic activity is the result of tidal heating from friction generated within Io's interior as it is pulled between Jupiter and the other Galilean satellites—Europa, Ganymede and Callisto.

Several volcanoes produce plumes of sulfur and sulfur dioxide that climb as high as 500 km above the surface.

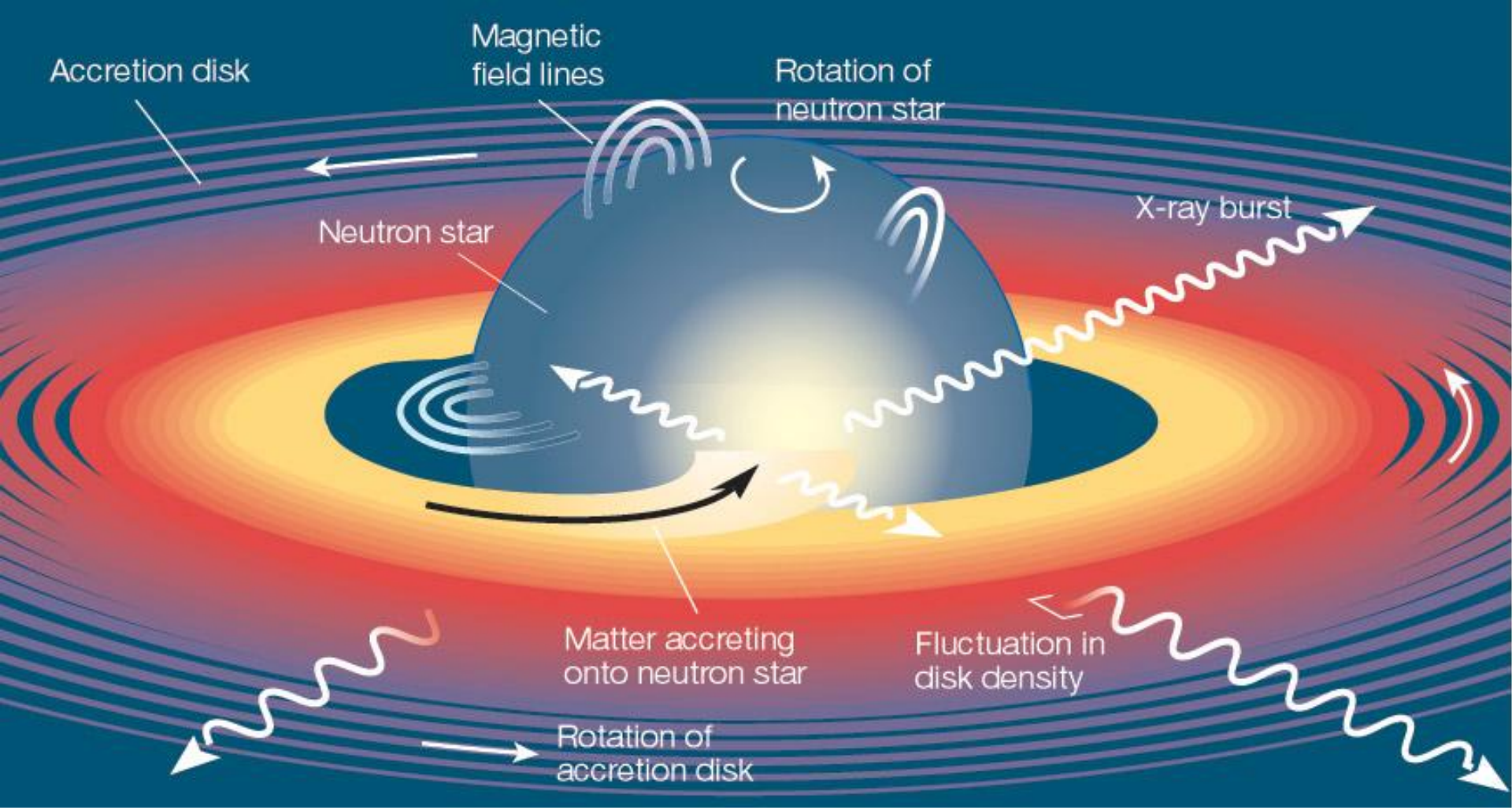


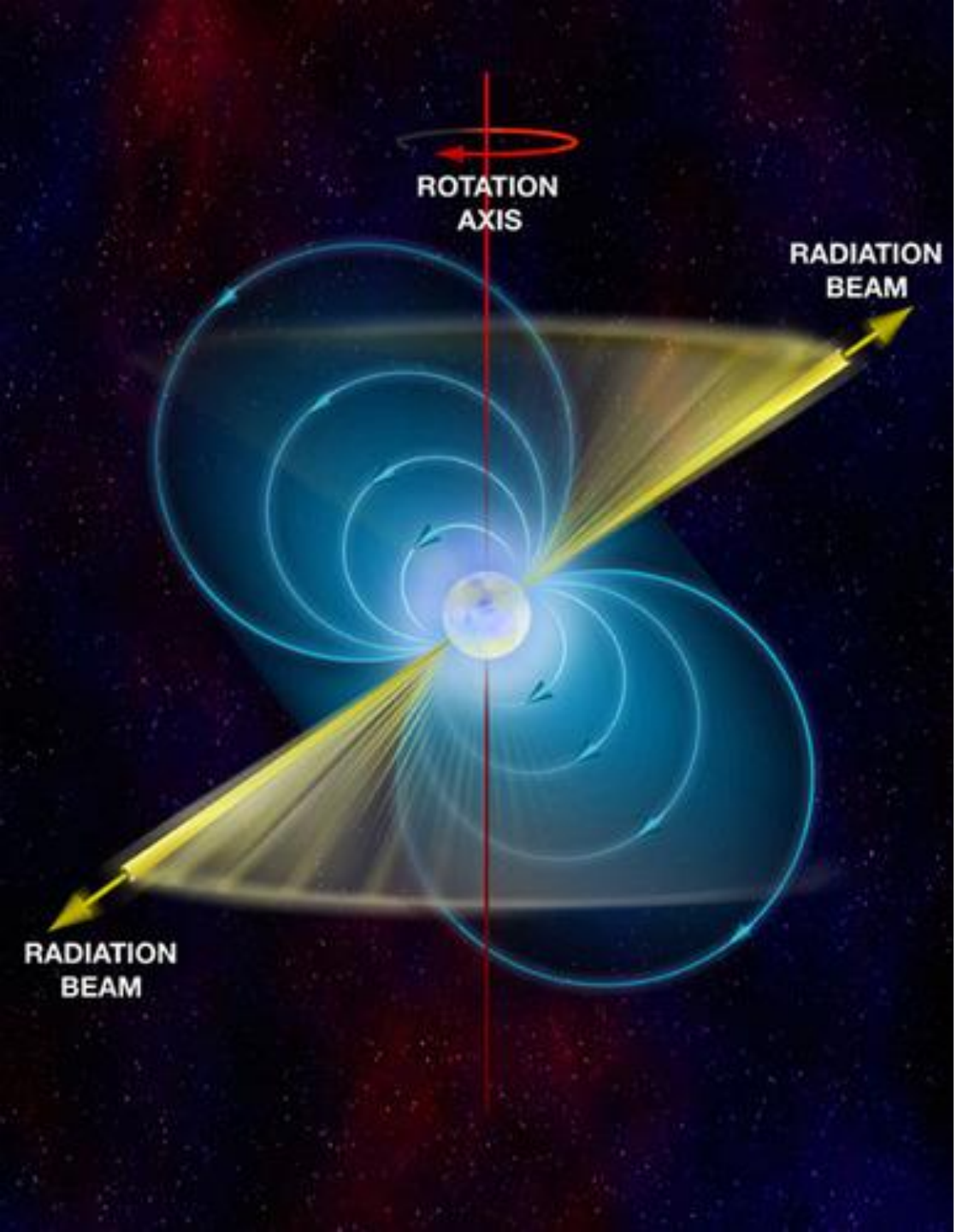



Neutron star
Mass
~1.5 times the Sun
Solid crust
~1 mile thick
Diameter
~12 miles
Heavy liquid interior
Mostly neutrons,
with other particles

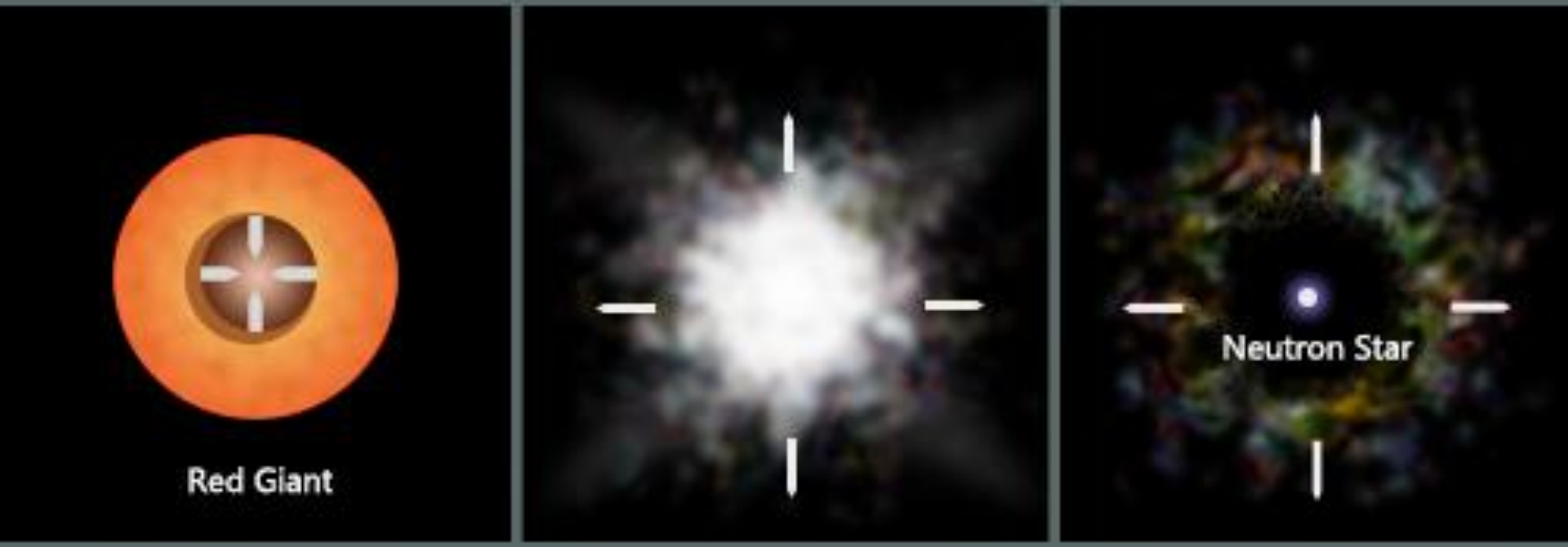



Neutron Star
Vancouver
www.kindaroomy.com

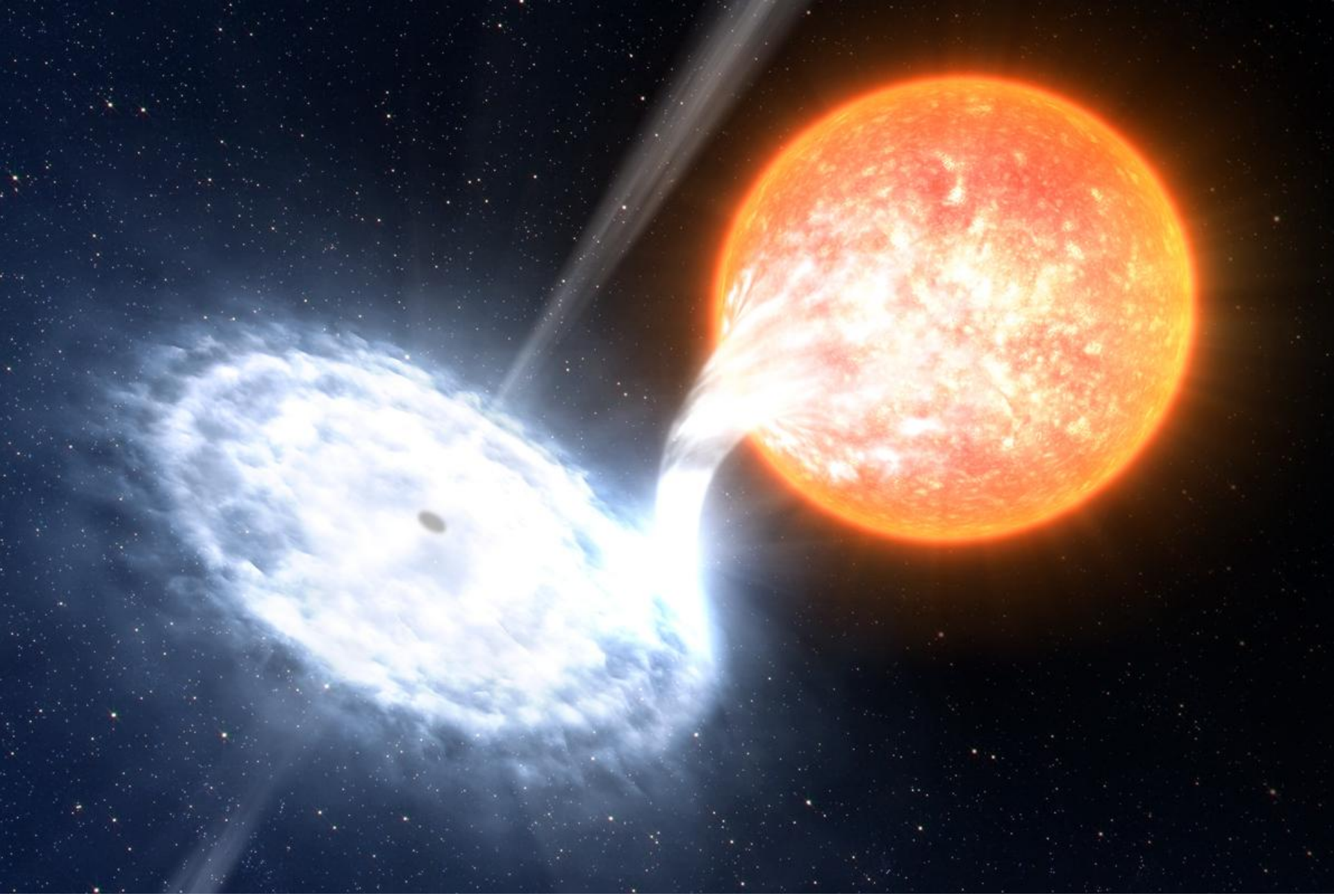

Accretion disk
Magnetic field lines
Rotation of neutron star
Neutron star
X-ray burst
Matter accreting onto neutron star
Fluctuation in disk density
Rotation of accretion disk

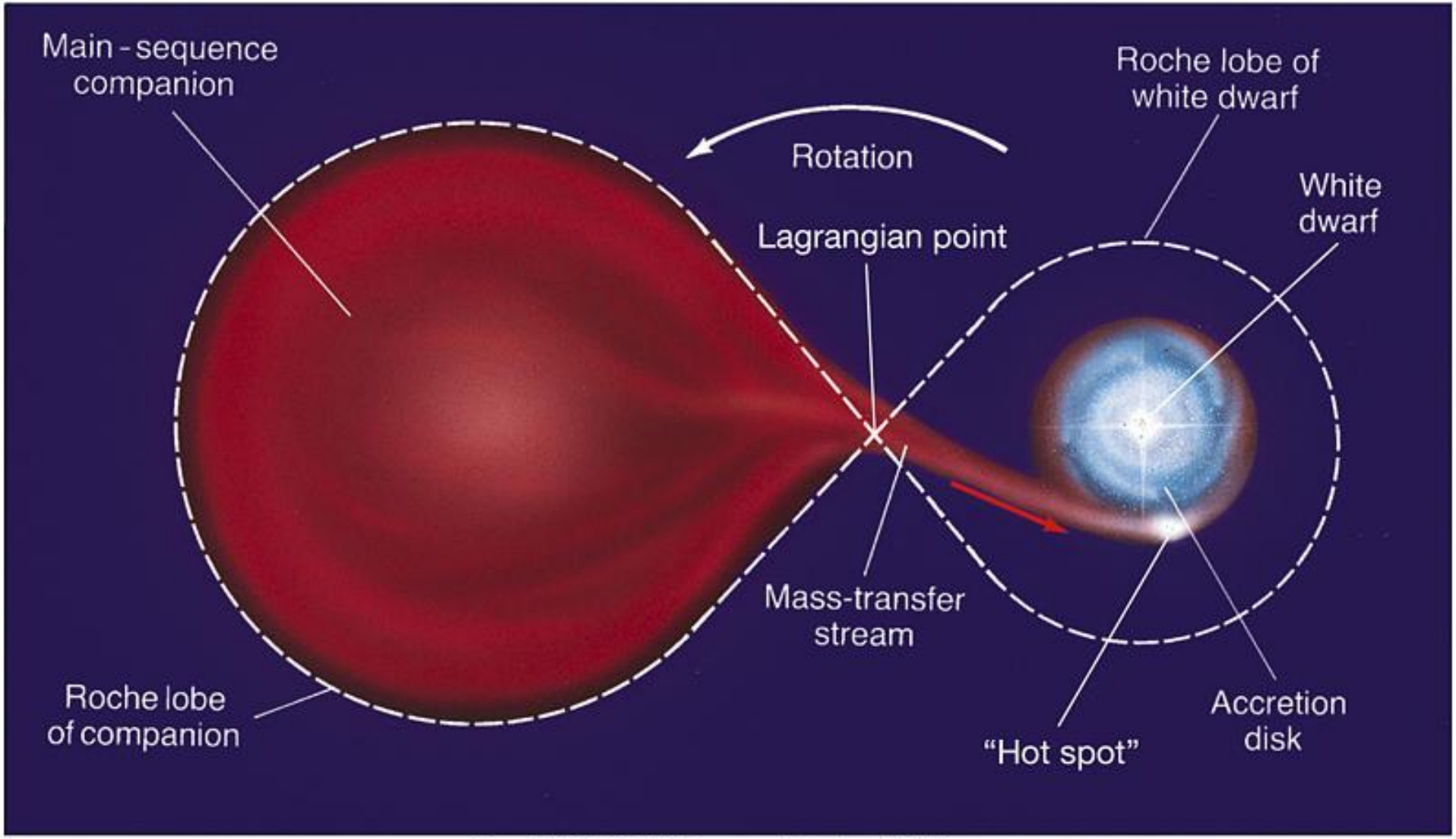

ROTATION
AXIS
RADIATION
BEAM
RADIATION
BEAM

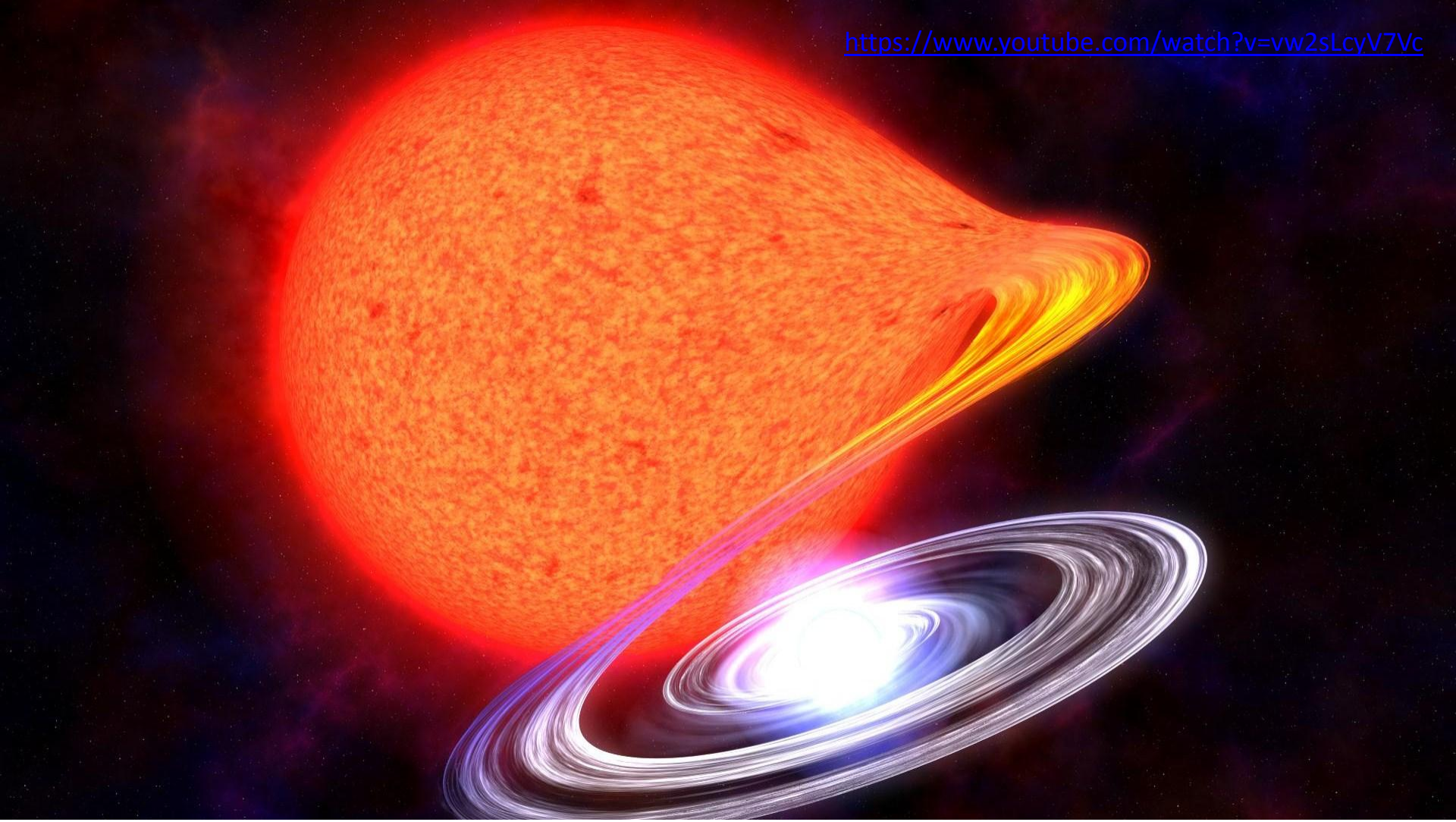
Birth of a Neutron Star



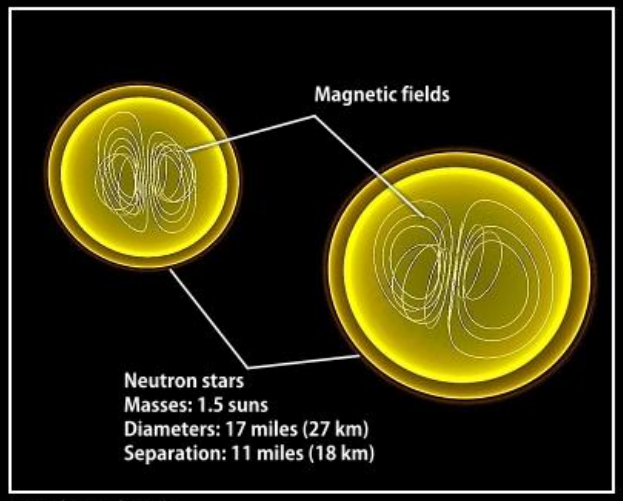
Core Implosion → Supernova Explosion → Supernova Remnant



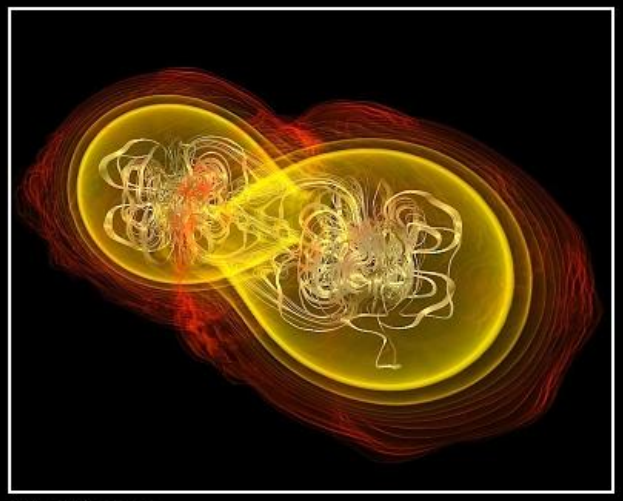



https://www.youtube.com/watch?v=vw2sLcyV7Vc

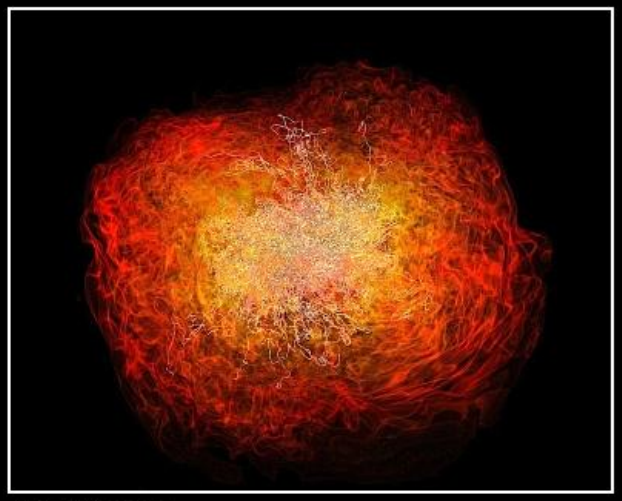
Crashing neutron stars can make gamma-ray burst jets



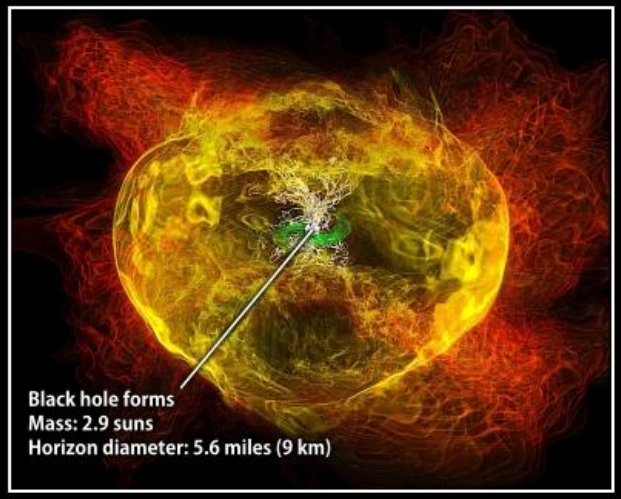
Simulation begins



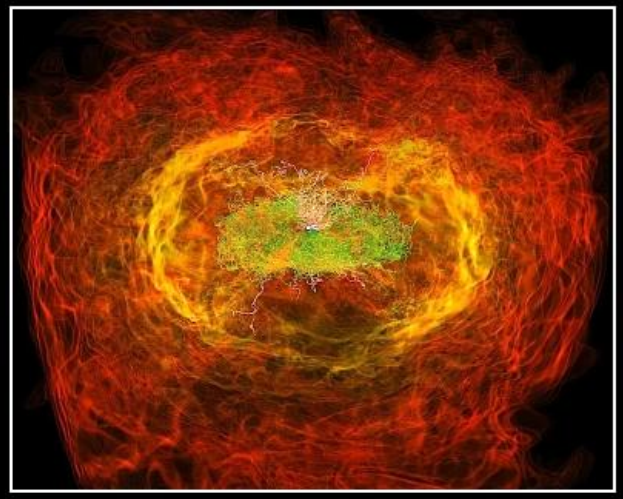
7.4 milliseconds



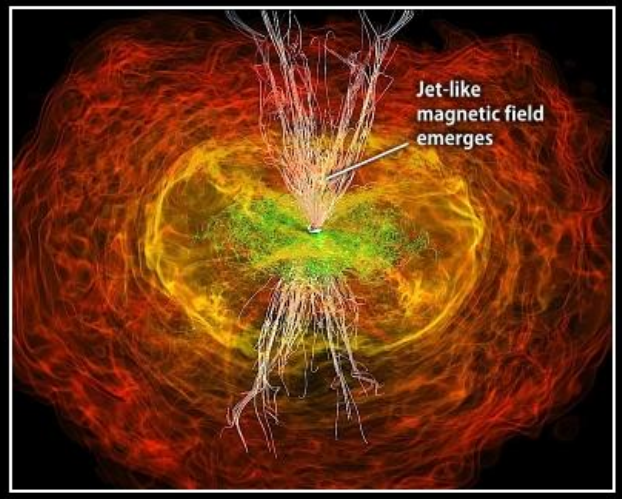
13.8 milliseconds



15.3 milliseconds



21.2 milliseconds



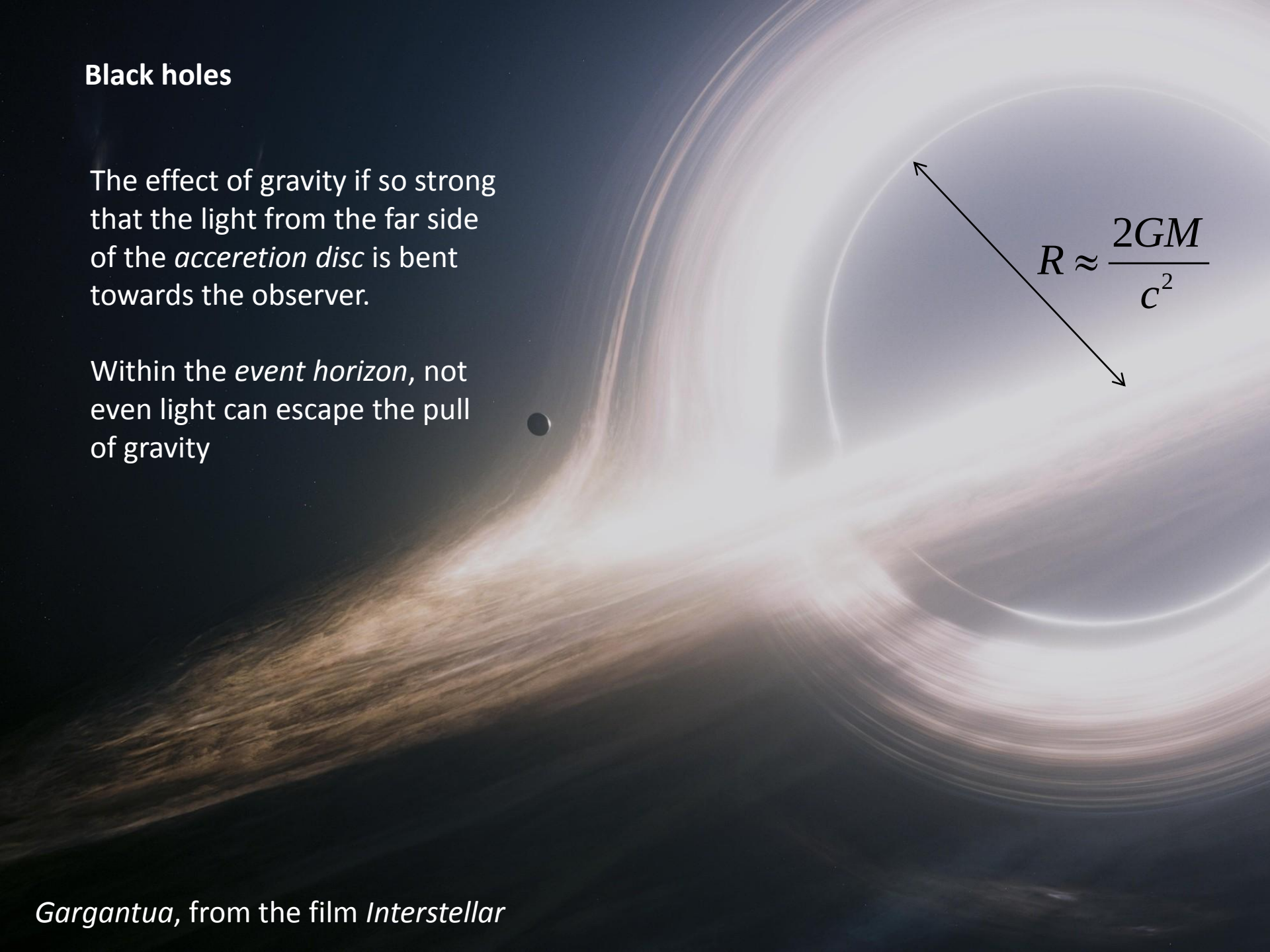
26.5 milliseconds

Credit: NASA/AEI/ZIB/M. Koppitz and L. Rezzolla

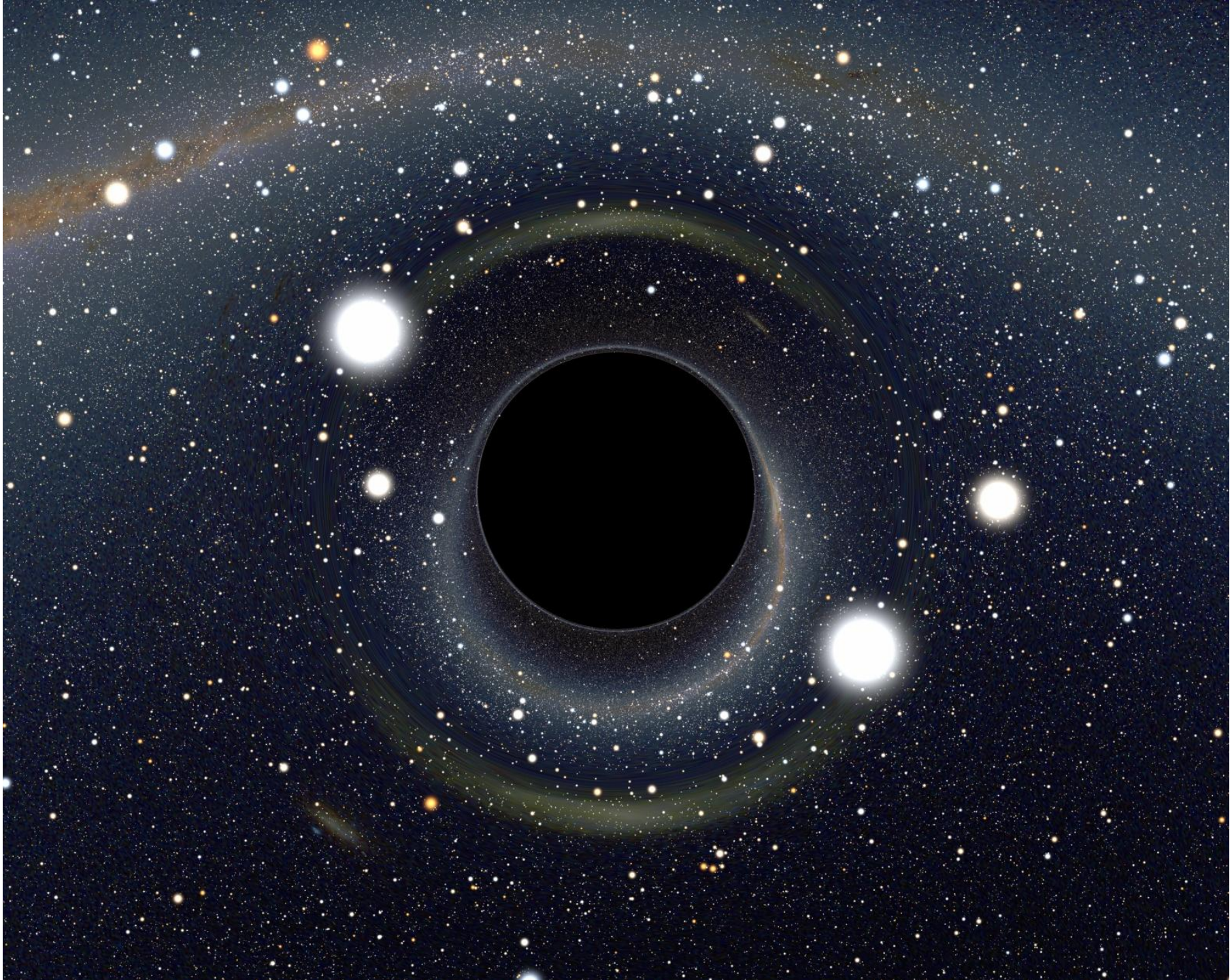
Black holes

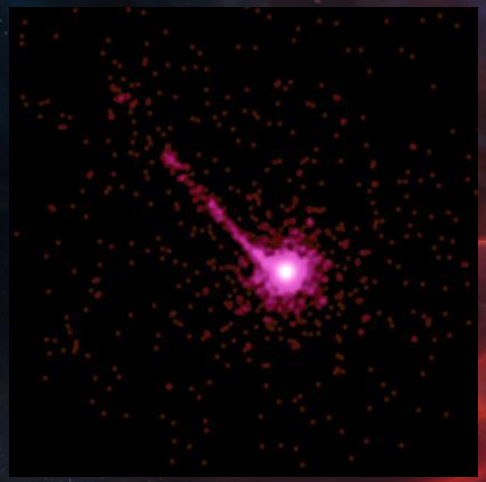
The effect of gravity if so strong that the light from the far side of the *acceretion disc* is bent towards the observer.

Within the *event horizon*, not even light can escape the pull of gravity



Gargantua, from the film *Interstellar*





The Chandra X-ray image is of the quasar PKS 1127-145, a highly luminous source of X-rays and visible light about 10 billion light years from Earth. An enormous X-ray jet extends at least a million light years from the quasar. Image is 60 arcsec on a side.

A **quasar** ('quasi-stellar radio source')is a compact region in the centre of a massive galaxy surrounding a central supermassive black hole. Its size is 10–10,000 times the Schwarzschild radius of the black hole. The energy emitted by a quasar derives from mass falling onto the accretion disc around the black hole.

Quasars are extremely luminous and were first identified as being high redshift sources of electromagnetic energy, including radio waves and visible light, that appeared to be similar to stars, rather than extended sources similar to galaxies. Their spectra contain very broad emission lines, unlike any known from stars, hence the name "quasi-stellar". Their luminosity can be 100 times greater than that of the Milky Way.

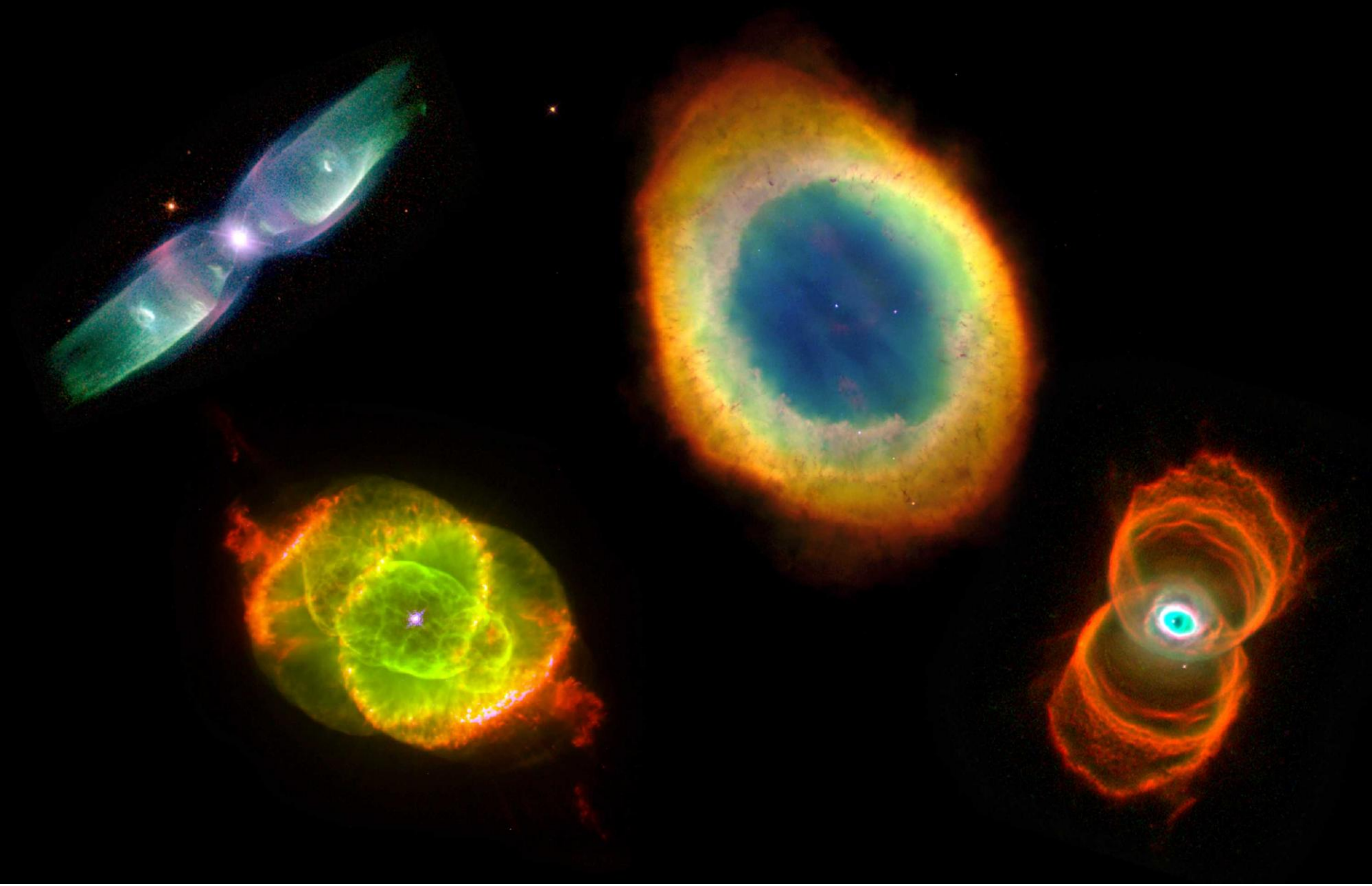
Nebulae

A nebula (Latin for "cloud") is an interstellar cloud of dust, hydrogen, helium and other ionized gases.

Pillars of Creation
Eagle Nebula
(7000 light years away)

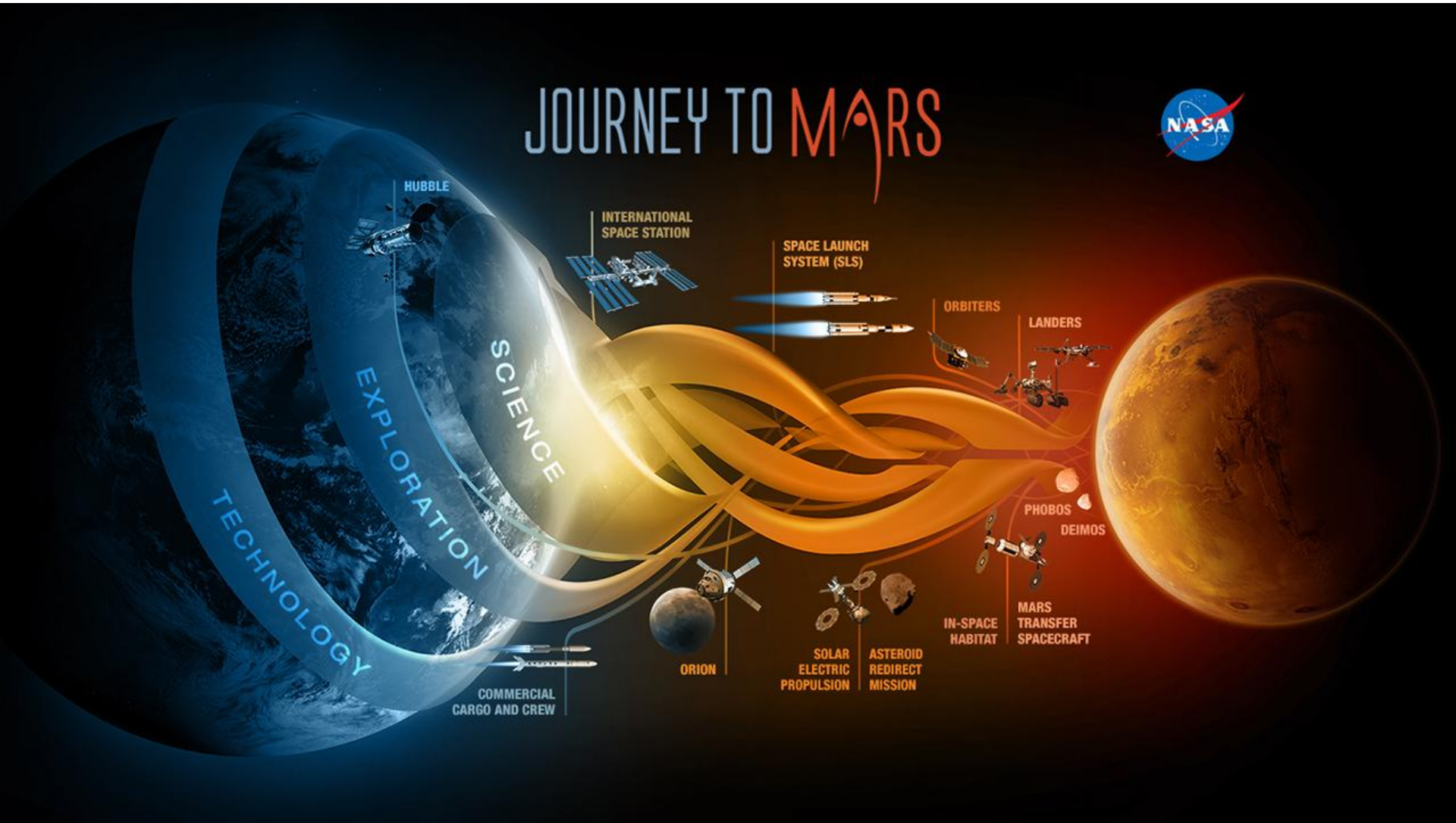
Hubble space telescope, 2014

Horsehead Nebula



Various nebulae, photographed by the Hubble space telescope

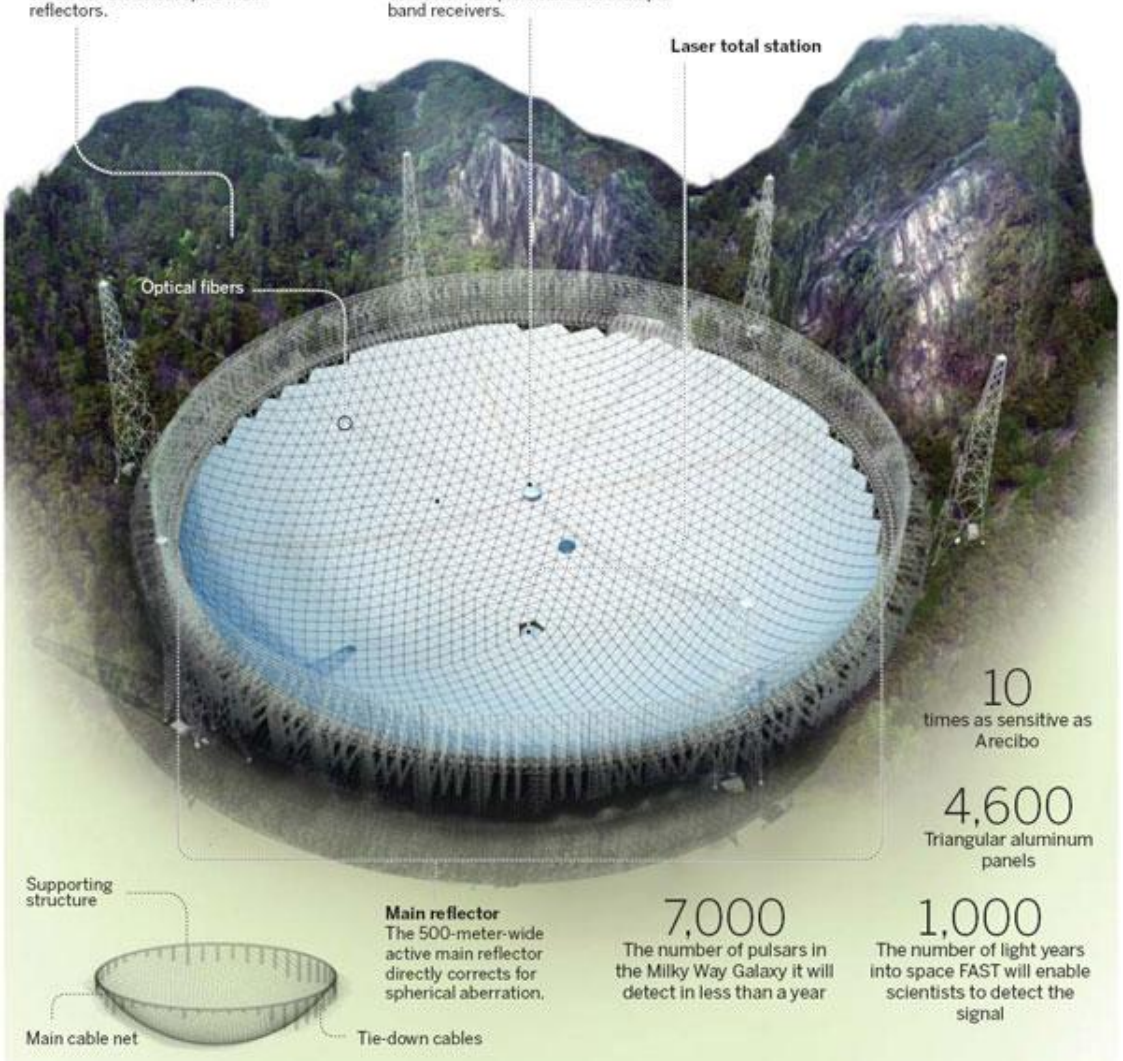
The future of cosmology astronomy & space exploration



A BIG EYE ON THE SKY

500-meter aperture spherical radio telescope (FAST)

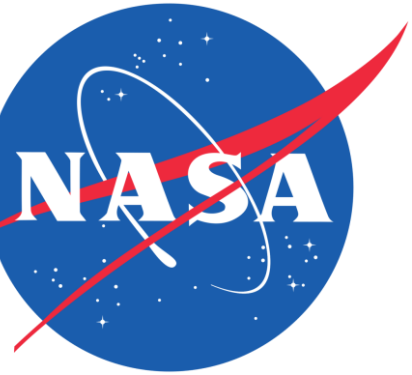
- Surveys neutral hydrogen in the Milky way and other galaxies
- Detects new galactic and extragalactic pulsars
- Finds and researches the first shining stars
- Finds out where extraterrestrial life might exist in space
- Detects dark energy and helps us understand the evolution of galaxies



Orion: Multi-Purpose Crew Vehicle
The Moon, Asteroids, Mars ….

http://www.nasa.gov/externalflash/orionfirstflight/

References



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University of Oregon