Gravitational Wave Detection by LIGO from Former Leader of LIGO, Prof. Barry Barish of Cal Tech

Short Introduction to Black Holes by Dennis Silverman

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Lecture to OLLI at UC Irvine

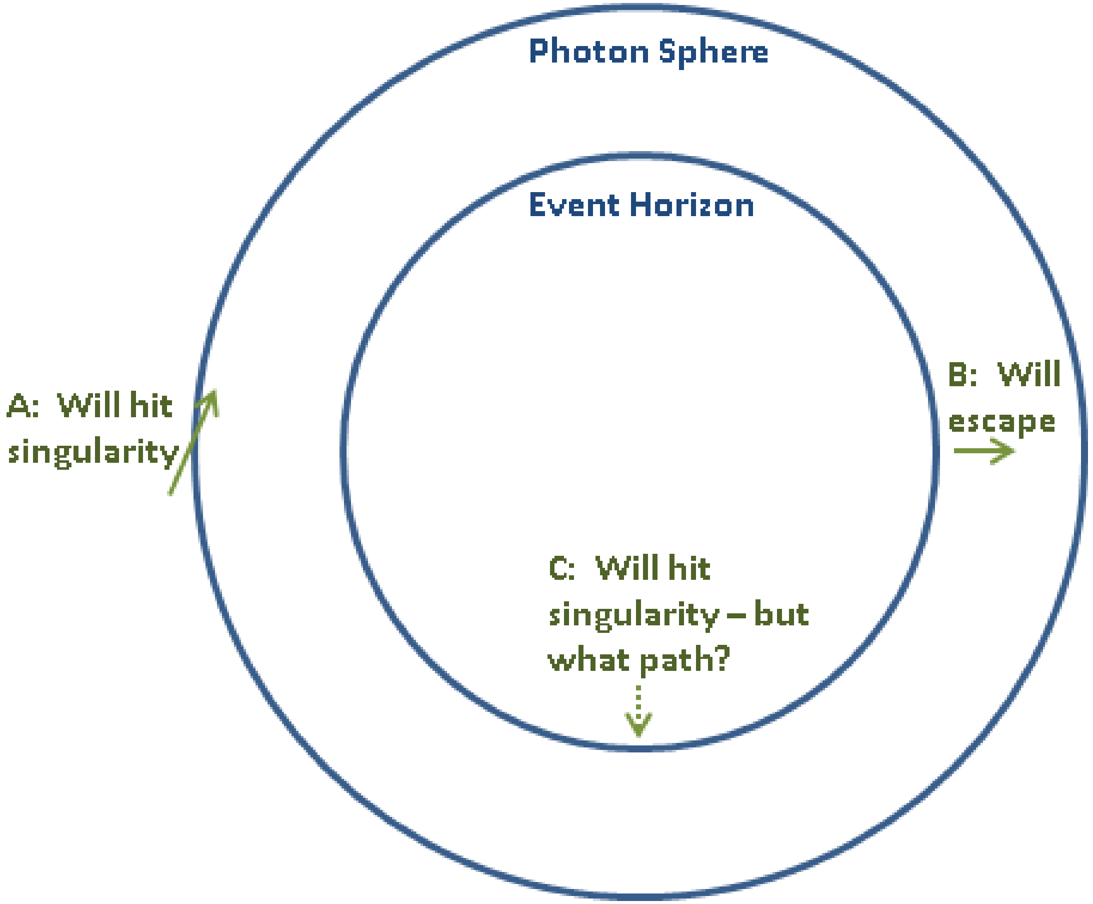
What is a Black Hole?

- Imagine walking a short distance down hill. Then recall that you had to expend energy to get back up. If you call your potential energy zero at the starting level, your potential energy goes more negative as you descend, and then you add the opposite amount of positive energy to get back.
- If an object is falling into a gravitational source, its negative potential energy is:
- $-GMm/r$. If falling from rest, far away, the object's starting energy is its rest energy $E = m\,c^2$.
- As it descends, its total energy is $E = -GMm/r + m\,c^2$.
- If it gets to small enough r, its energy total energy E becomes zero.
- It can no longer climb back out. That distance is called the Event Horizon, and with a relativistic correction is at $R = 2\,GM/c^2$, also called the Schwarzschild Radius after its discoverer in 1916.
- The event horizon and its inside is called the Black Hole.

Capture Orbits and the Photon Sphere around a Black Hole

- 50% further than the black hole radius R is the photon sphere, at
- $R_\gamma = 3\ GM/c^2$
- Outside the photon sphere, objects or planets can orbit as around a star, without being “sucked in”, contrary to many Hollywood depictions.
- Exactly at the photon sphere, tangential photons can orbit around the black hole indefinitely.
- Inside the photon sphere, objects without extra energy will spiral into the black hole.

Illustration of Spheres of Fate for a Photon around a Black Hole



Detection of Gravitational Waves by LIGO
[YouTube Talk given by Barry Barish at Fermilab].

- The link to his YouTube talk is at:
- https://youtu.be/BNlK_nSJDyc?list=PLBD9gufKJAfeZc77AVoE_B7roXW6vnfqF