Simulating Black Hole-Neutron Star Mergers

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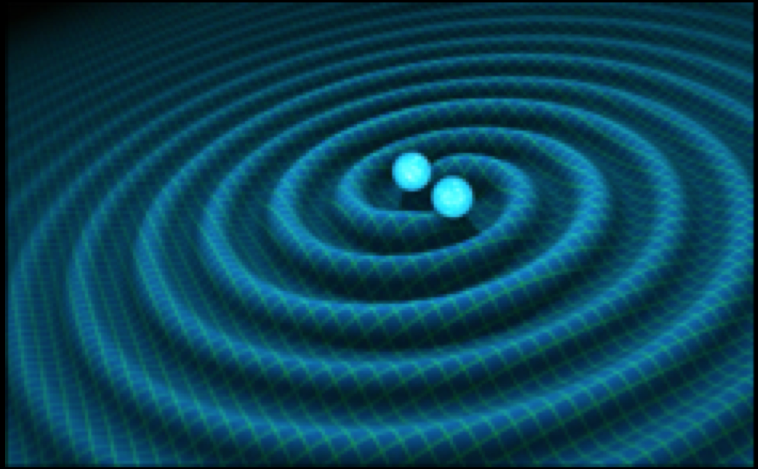
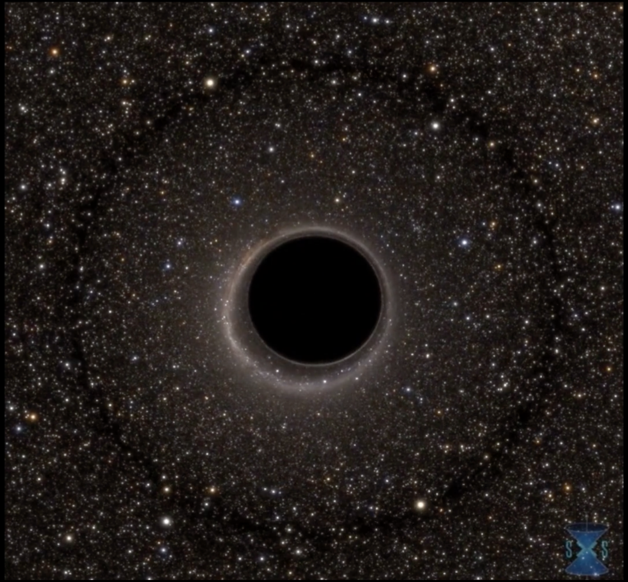
What are gravitational waves?

- 1915, Albert Einstein - theory of general relativity - gravity is actually the curvature of space and time
- Also predicted gravitational waves, ripples in space and time
- However in 2015, LIGO detected two black holes colliding



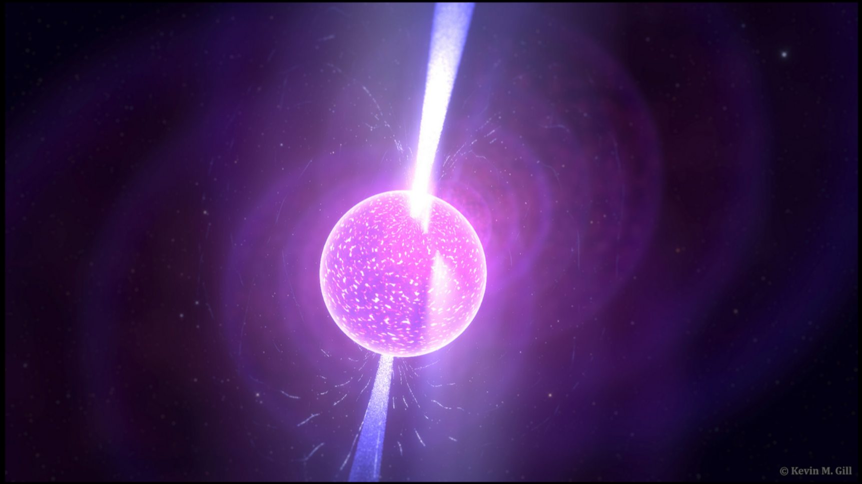
What are black holes?

- After a massive star collapses upon itself due to its immense gravity, the remains are what we call a black hole.
- The gravity of the black hole is so intense that not even light itself can escape.
- Black holes can spin, swirling objects around them into rotation, like a tornado swirls the air around it into rotation.



What are neutron stars?

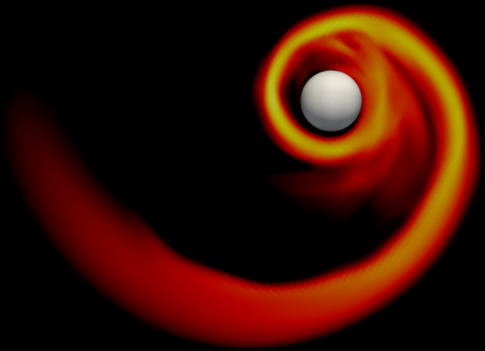
- Neutron stars are the smallest and most dense stars known to exist.
- Once a massive star dies (runs out of nuclear fuel), it collapses under its gravity. As the matter collapses into mostly neutrons, eventually a quantum effect called neutron degeneracy provides an outward pressure strong enough to balance the inward balance of gravity.



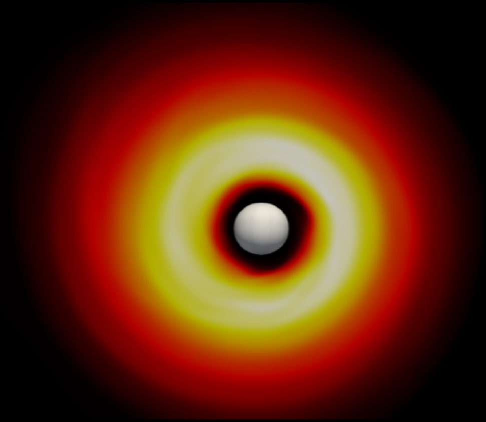
LIGO

- The Laser Interferometer Gravitational-Wave Observatory (LIGO) is about to conclude its second observation run. Other detectors around the world will join it in the coming years forming a network of detectors.
- Accurate gravitational-wave predictions help LIGO detect as many waves as possible while learning as much as possible of their sources

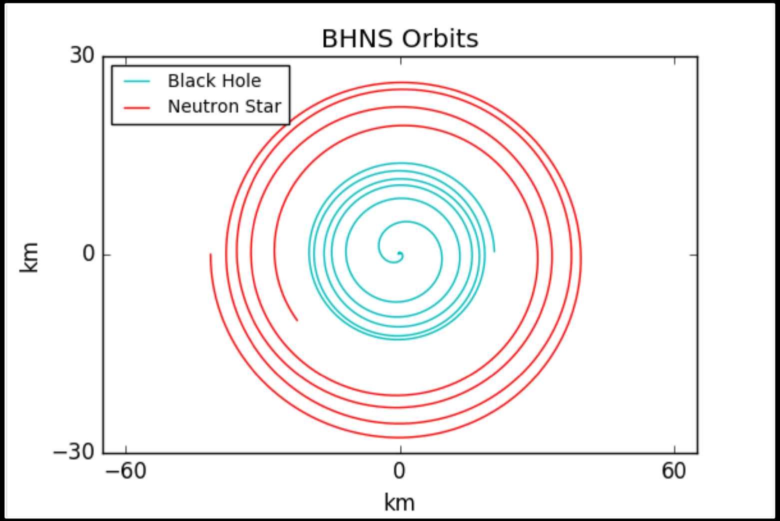
- 1.4-solar-mass neutron stars (with a simple Gamma=2 polytrope) equation of state, which determines how the size of a neutron star depends on its mass. One simulation had a black hole twice as massive as the neutron star, while the other had a black-hole three times as massive

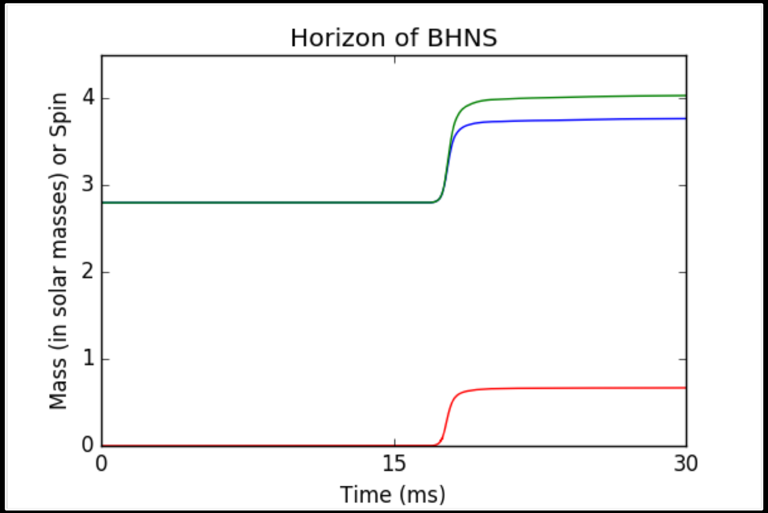


Mass ratio: 3.0
Spin: 0.5
Initial separation: 13.29 km
t = 14 ms



Mass ratio: 2.0
Spin: 0.0
Initial separation: 22.16 km
t = 63 ms





The black hole absorbs mass and spin angular momentum as matter from the star falls in.