Gravitational Radiation

- Newtonian gravity propagates instantly.
 - This is in conflict with relativity: nothing can travel faster than light.
- Distortion in spacetime propagates at the speed of light, just like waves in ocean!
 - Distortion propagates as waves (or ripples), just like waves of light
 - Particle-wave duality: There are gravitons, which propagate through spacetime at the speed of light, exchanging gravitational force.

Example: Neutron Star Binary





- As neutron stars orbit each other, spacetime is distorted periodically.
- Angular momentum is lost as gravitational radiation is emitted.
- This effect *has been* observed!

Toward direct detection



LIGO (in operation)



LISA (to be launched)

- As gravitational radiation passes through an object, the shape of the object is distorted.
- "Interferometers" are used to detect such distortion; however, distortion is tiny.
- *h*=fractional distortion
- $h \sim 10^{-20}$ is typically expected
 - Distortion of Earth is only 1/1000 of the size of hydrogen atom!
 - Distance between Earth and Moon changes by 1/30 of the size of hydrogen atom.
 - Scientists are trying to detect such a tiny distortion.