Gravitational Waves

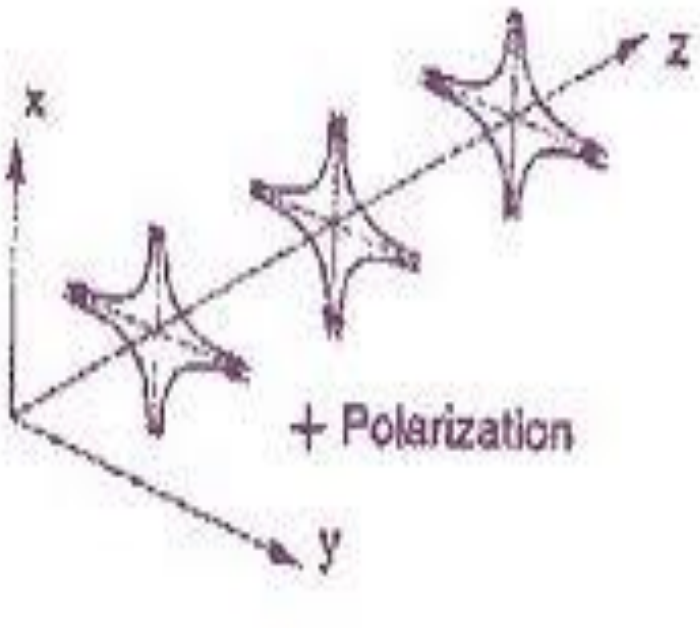
EM vs Gravity

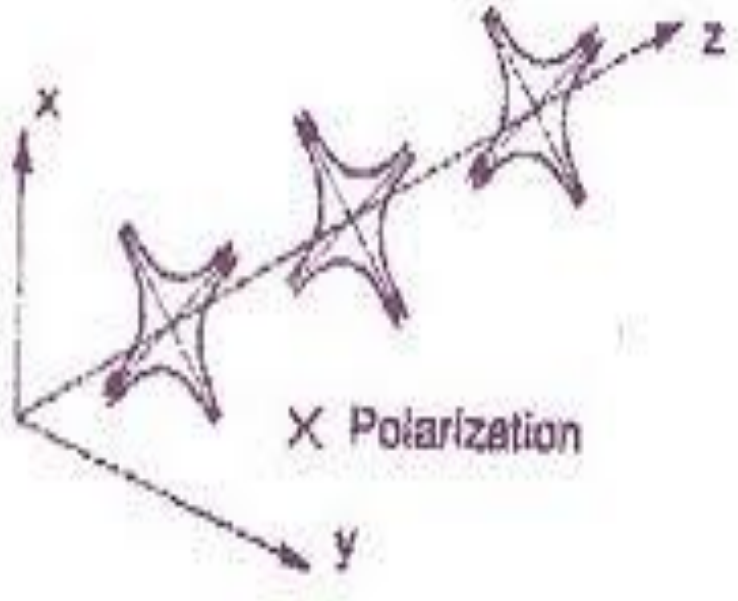
- EM- fields
- Charge
- Maxwells eqs

- Gravitational fields
- Energy and momentum
- Einstein's eqs

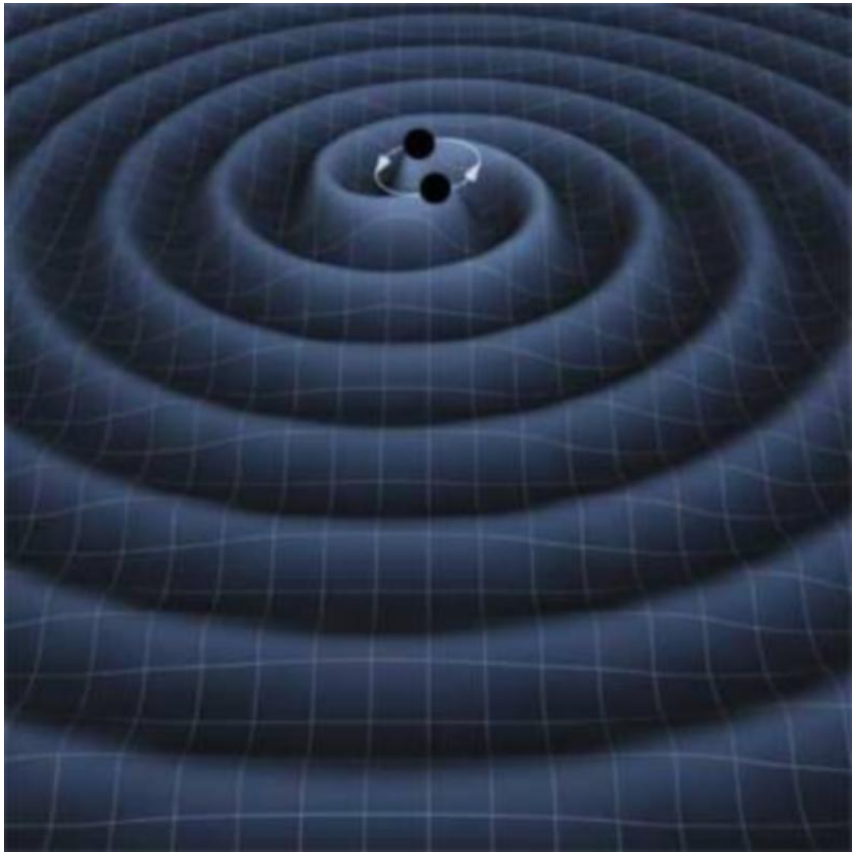
$G_{\mu\nu}=-8\pi G T_{\mu\nu}$

Gravitational waves





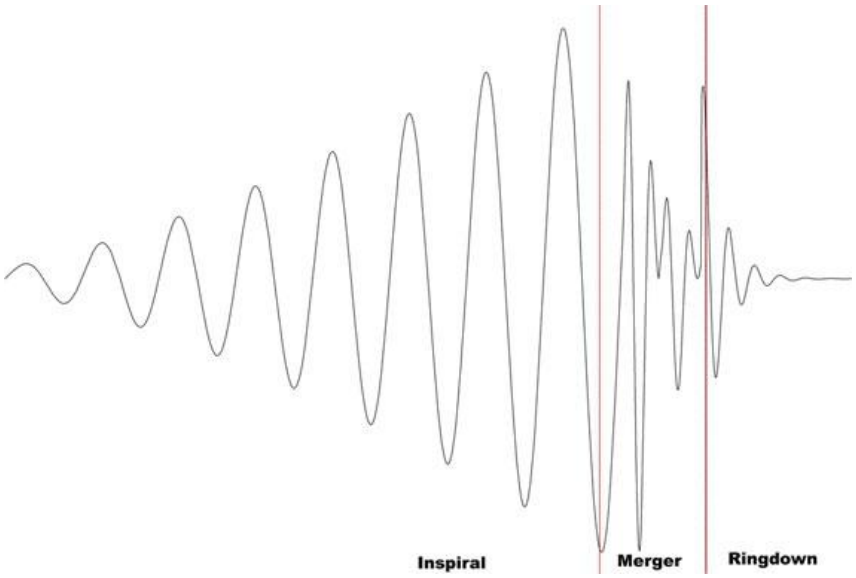
Black-hole binary



- Black holes
- Virial theorem

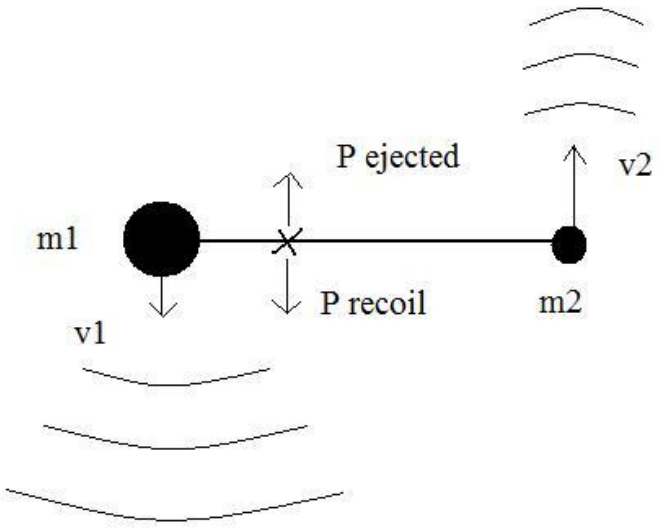
  $GM/r \sim \sigma^2$

Three stages



- Inspiral
- Merger
- Ringdown
- $f_{GW} \sim 2f_{orb} \sim (M/R^3)^{1/2}$

Unequal mass and spin?



- Unequal mass =>

  GW emission is non spherical => recoil
- Spin => spin-orbit interaction

Why are GWs a hot topic?

- Weak interaction with matter
- Only 20% of matter emitts EM radiation.

Detection

- 1960:First antenna was built
- 1975: First observable evidence
- LIGO

  f_{GW} ~10-10^4 Hz
- LISA

  f_{GW} ~10^-5-1 Hz
- Binary Pulsars

  f_{GW} ~10^-9-10^-7 Hz