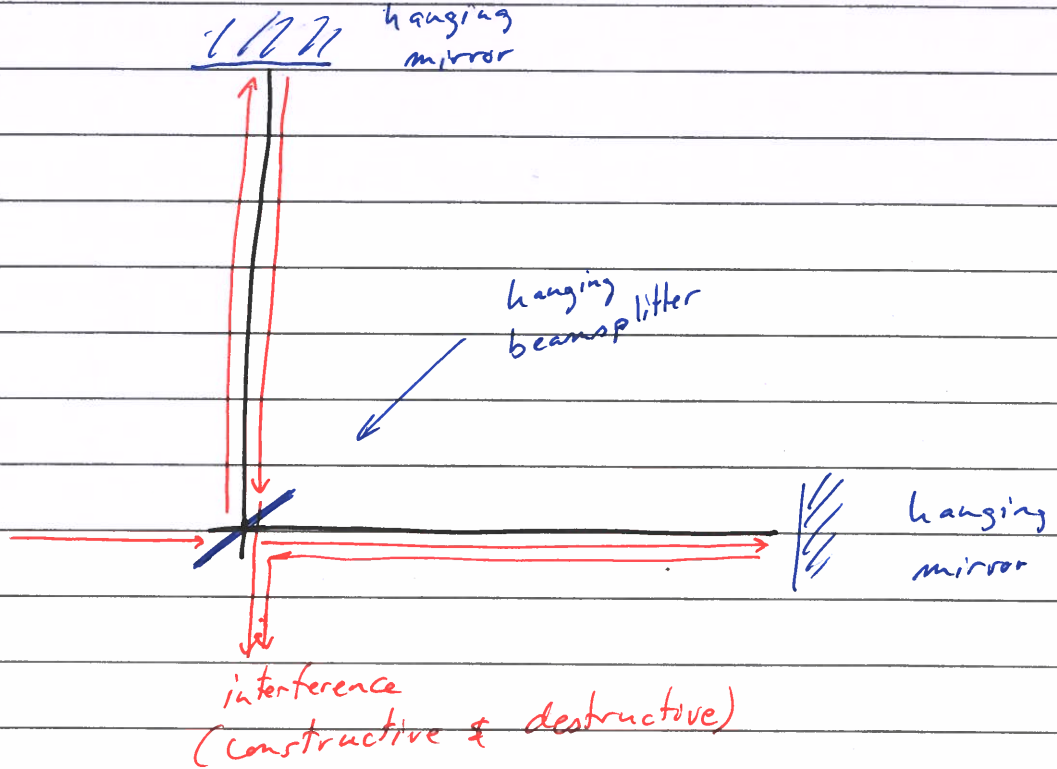


Wednesday, April 1, 2026

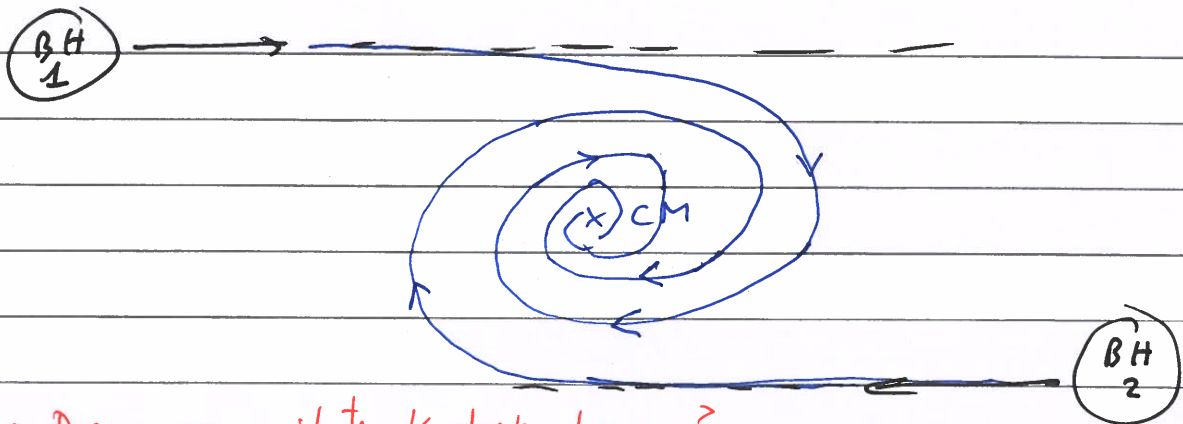
Gravitational Wave Detection



Rubber Ruler Paradox

Black hole merger

CM = center of mass



Q: Does merger violate Kepler's laws?

↳ No Gravitational waves provide a 3rd, 4th, 5th ... body!

Example: How big is the blackhole at the center of the Milky Way galaxy?

$$\begin{aligned} \text{Mass of the blackhole} &\approx 4 \times 10^6 M_{\text{sun}} \\ &= 7.96 \times 10^{36} \text{ kg} \end{aligned}$$

$1.99 \times 10^{30} \text{ kg}$

Newton's Constant
"big G"

Event horizon radius = $R_s = \frac{2GM}{c^2}$
(Schwarzschild radius)

$$\begin{aligned} &= \frac{2(6.6743 \times 10^{-11}) (7.96 \times 10^{36})}{(3 \times 10^8)^2} \\ &= 11.8 \times 10^9 \text{ m} \\ &\approx 12 \times 10^6 \text{ km} \\ &\approx 17 R_{\text{sun}} \end{aligned}$$

$\frac{12 \times 10^6 \text{ km}}{6.96 \times 10^5 \text{ km}} = R_{\text{sun}}$

$$\Rightarrow \boxed{R_s = 17 R_{\text{sun}}} \approx 0.08 \text{ AU}$$

Note: M87 central blackhole has $R_s \approx 128 \text{ AU}$

↓
Mass = $6.5 \times 10^9 M_{\text{sun}}$

somewhat larger
than solar system