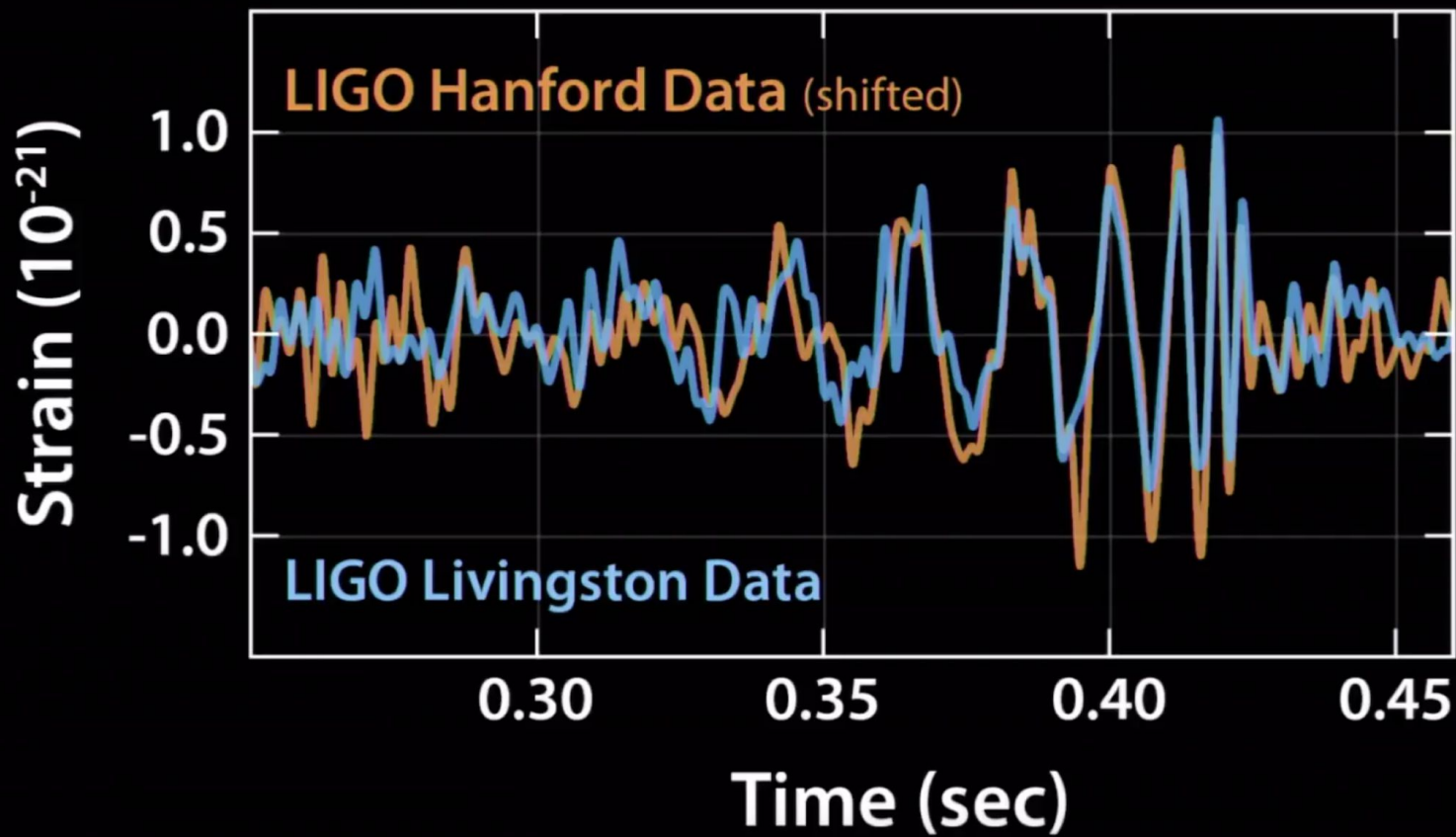
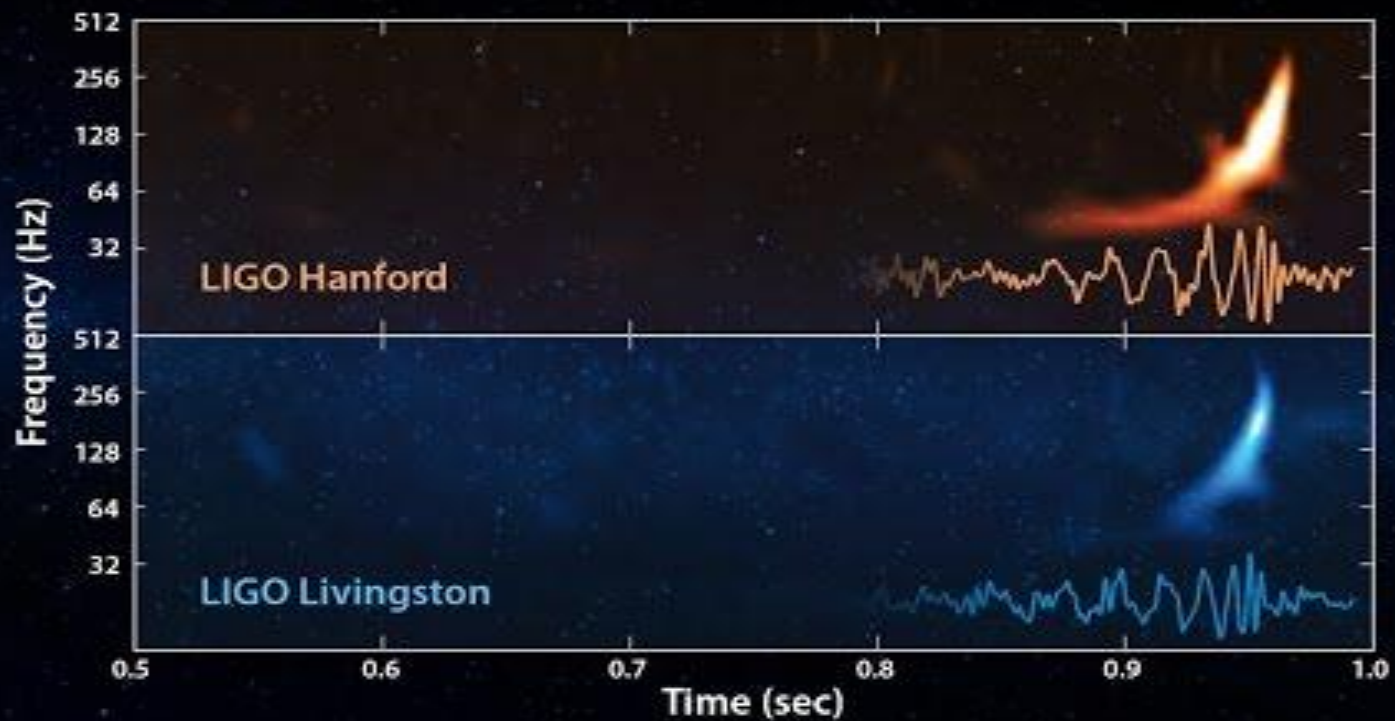
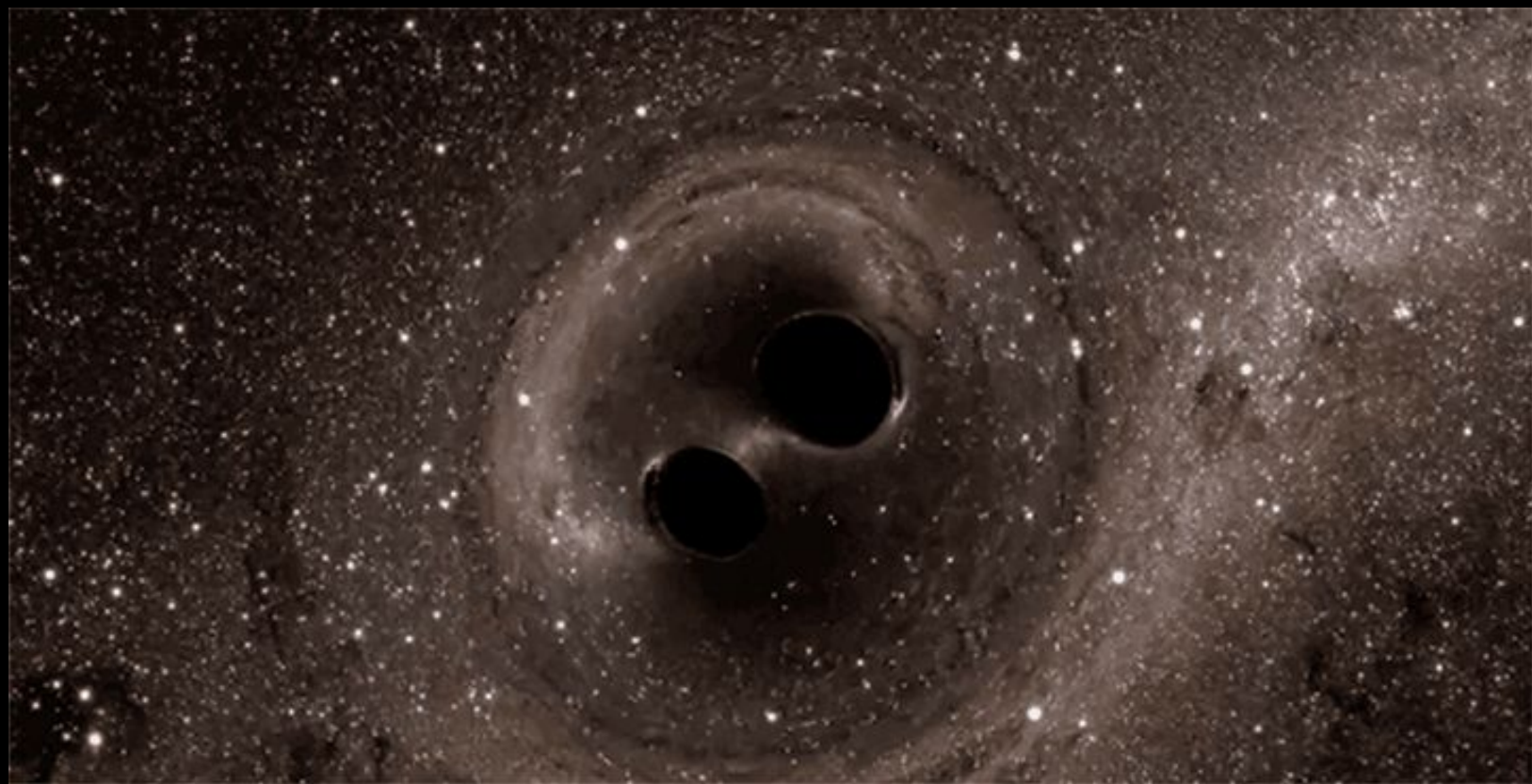


black holes!

splash 2019







what is a black hole??

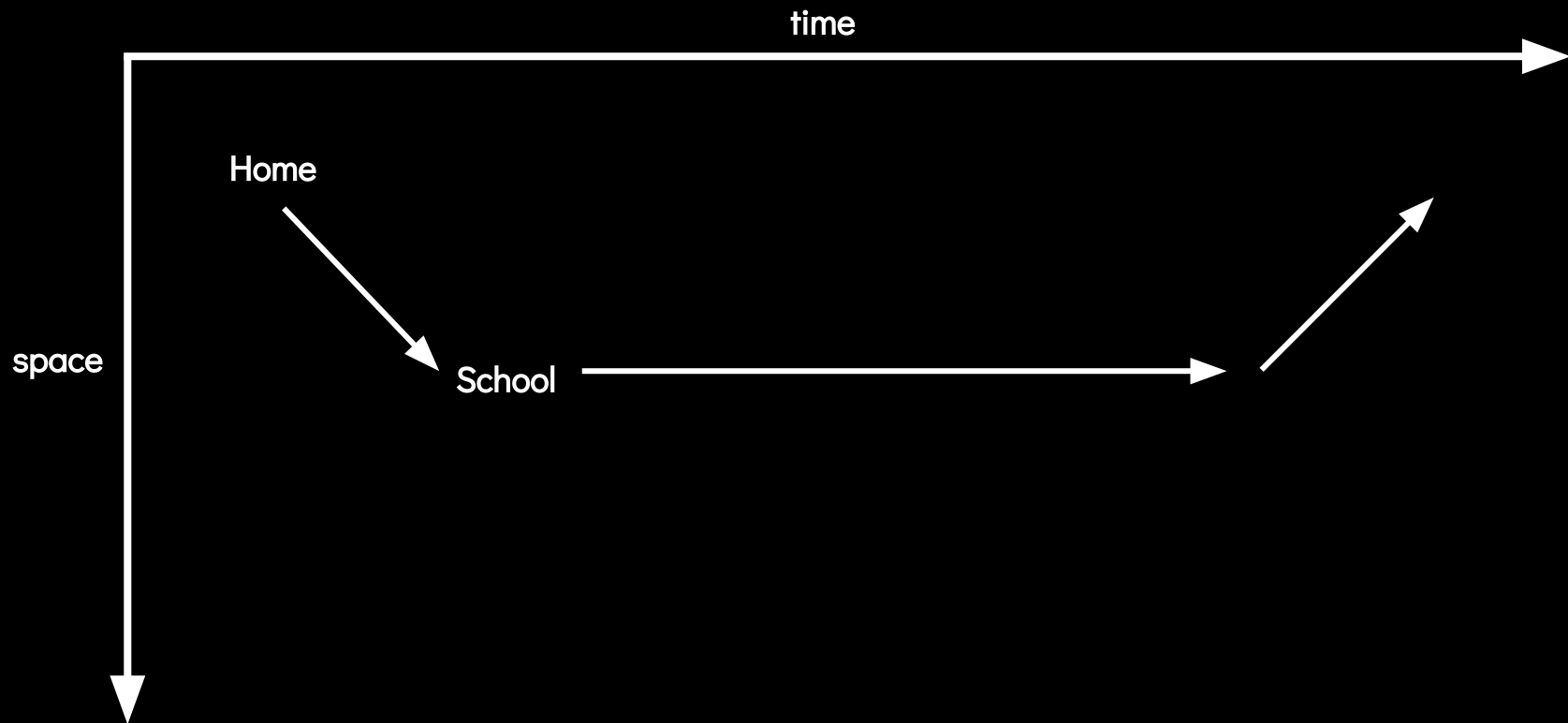
a **black hole** is a region of spacetime where the force of gravity is so strong that nothing, not even light, can escape.

let's talk about relativity!

299 792 458 m/s

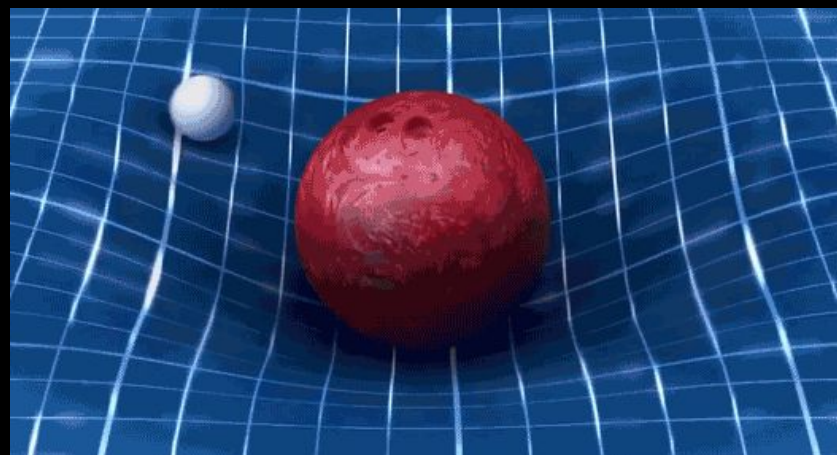
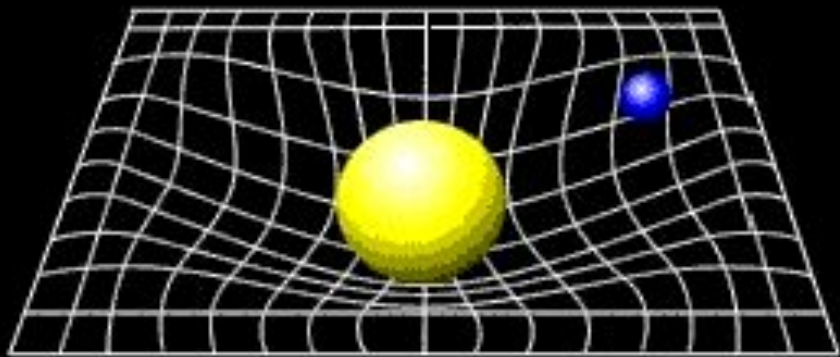
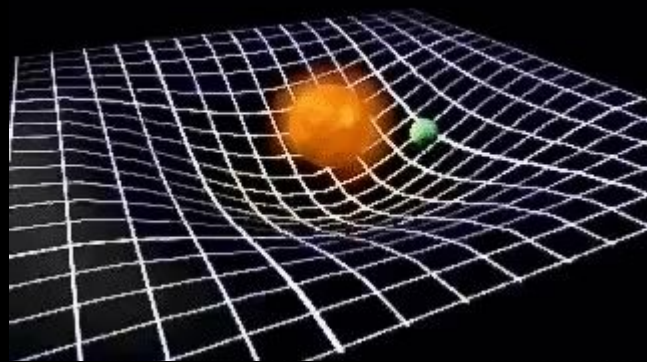
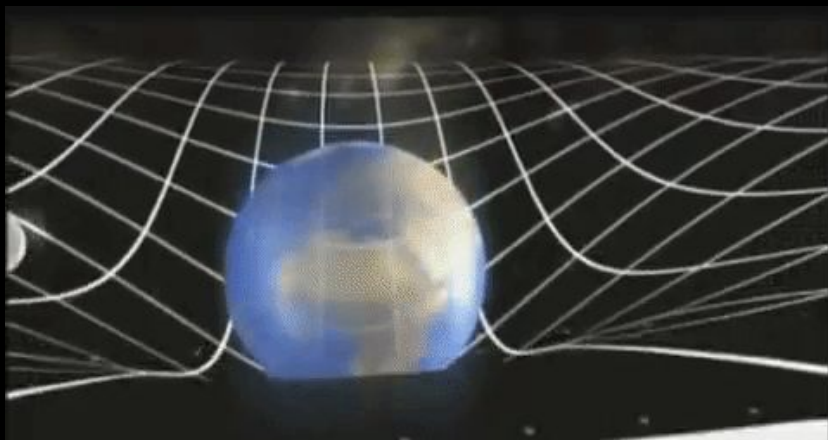
consider a train.

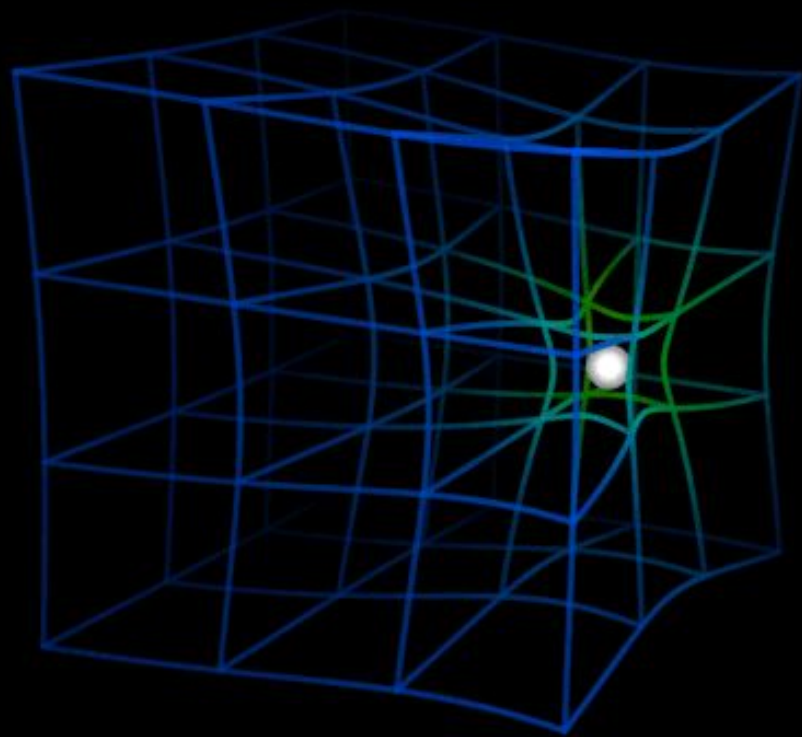
but it turns out that space and time
LINKED TOGETHER
still have meaning.



$$E = mc^2$$

$$E = \gamma mc^2$$





$$G_{\alpha\beta} = \frac{8\pi G}{c^4} T_{\alpha\beta}$$

$$G_{\alpha\beta} = \frac{8\pi G}{c^4} T_{\alpha\beta}$$

amount of curviness

$$G_{\alpha\beta} = \frac{8\pi G}{c^4} T_{\alpha\beta}$$

amount of curviness

amount of stuff
in space

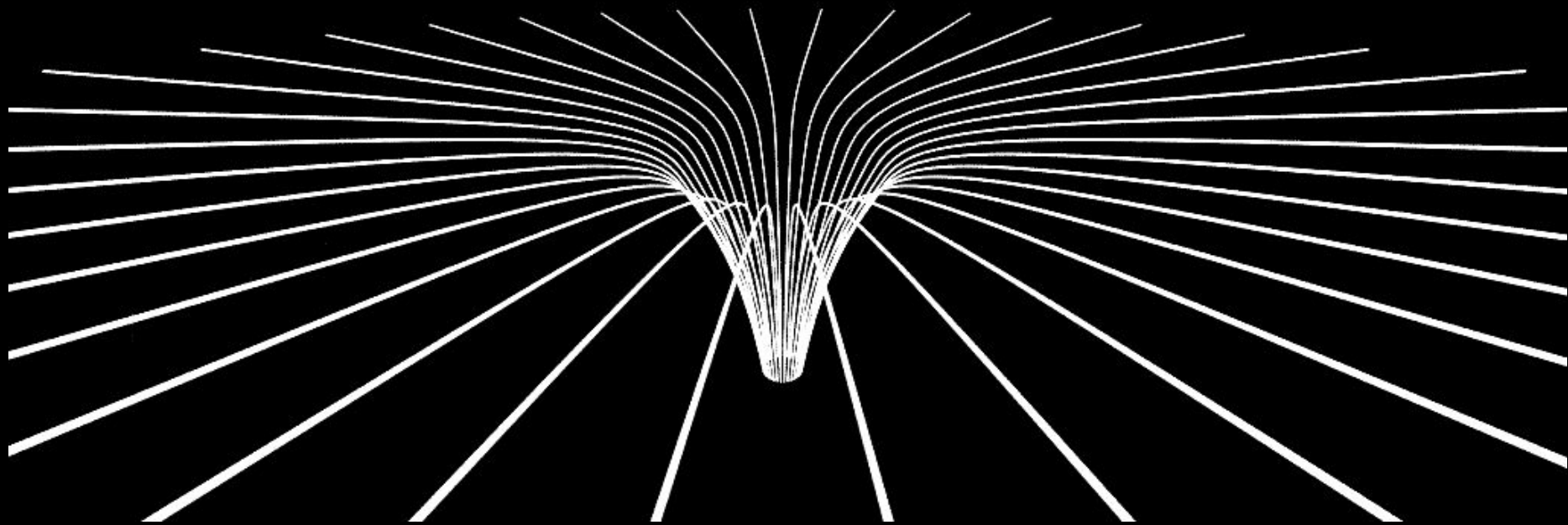
$$G_{\alpha\beta} = \frac{8\pi G}{c^4} T_{\alpha\beta}$$

not important for us!

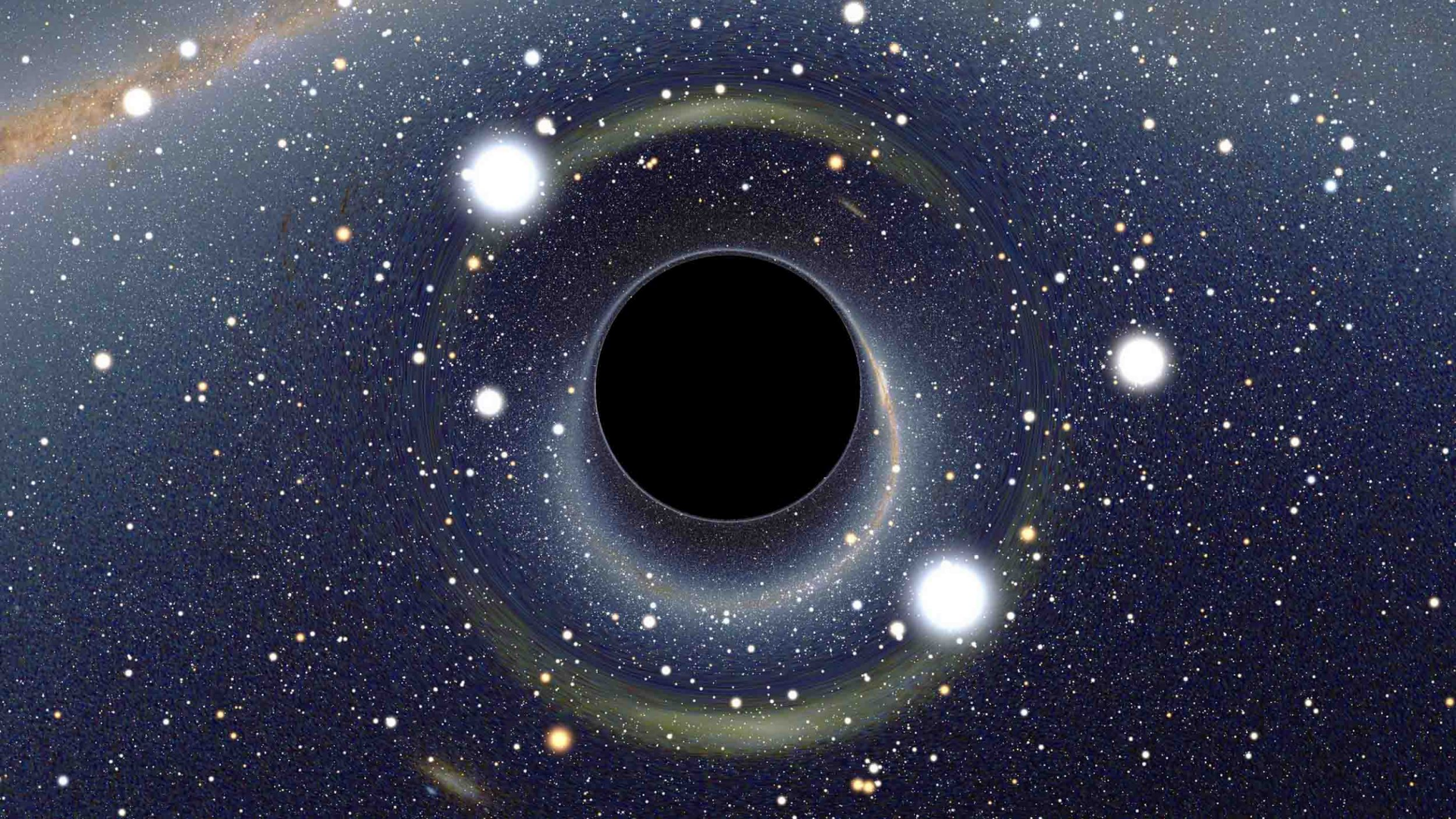
amount of curviness

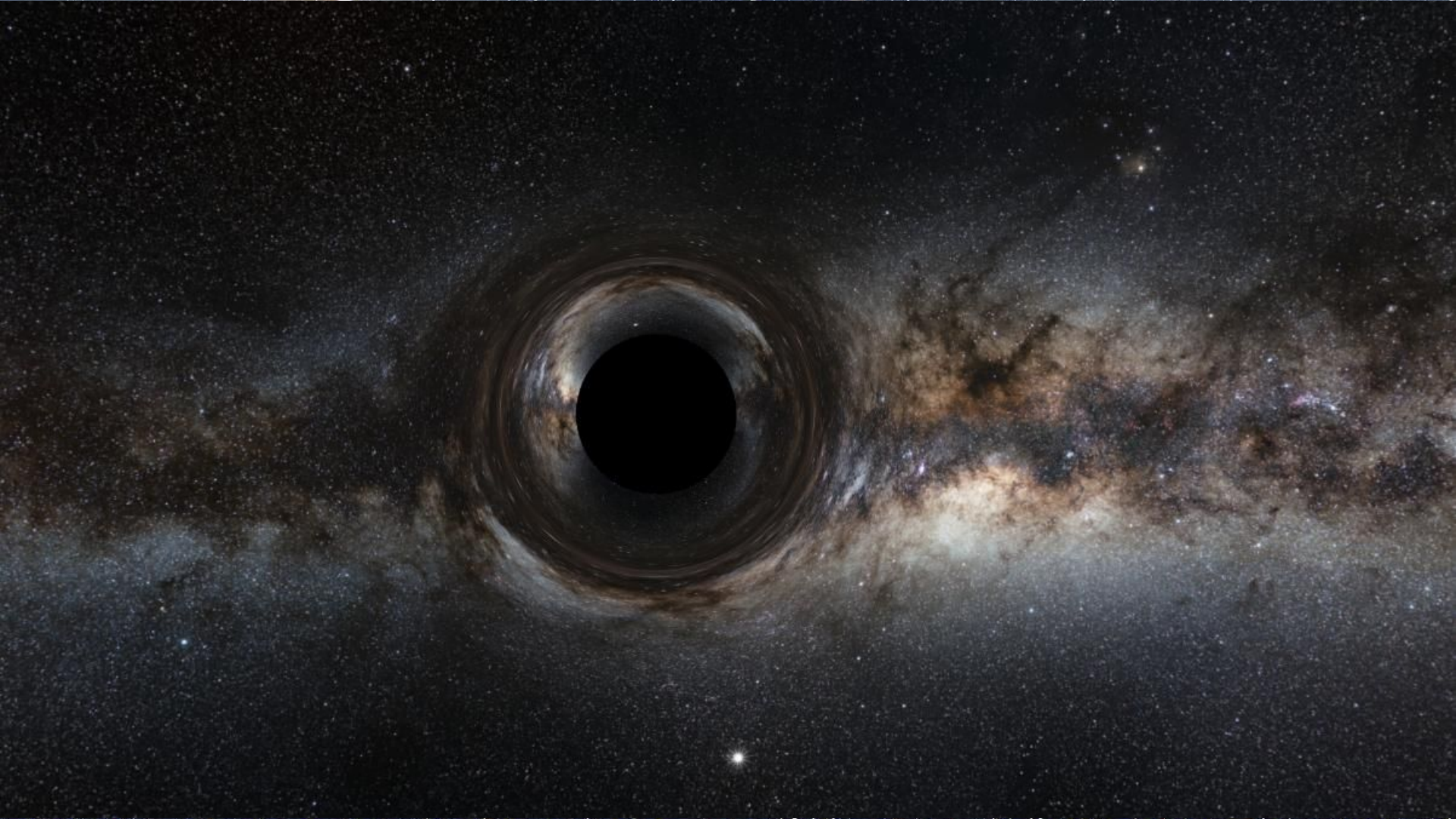
amount of stuff in space

The image shows the Einstein field equation $G_{\alpha\beta} = \frac{8\pi G}{c^4} T_{\alpha\beta}$ centered on a black background. Three white arrows point from text annotations to parts of the equation: one from 'amount of curviness' to $G_{\alpha\beta}$, one from 'amount of stuff in space' to $T_{\alpha\beta}$, and one from 'not important for us!' to the fraction $\frac{8\pi G}{c^4}$.

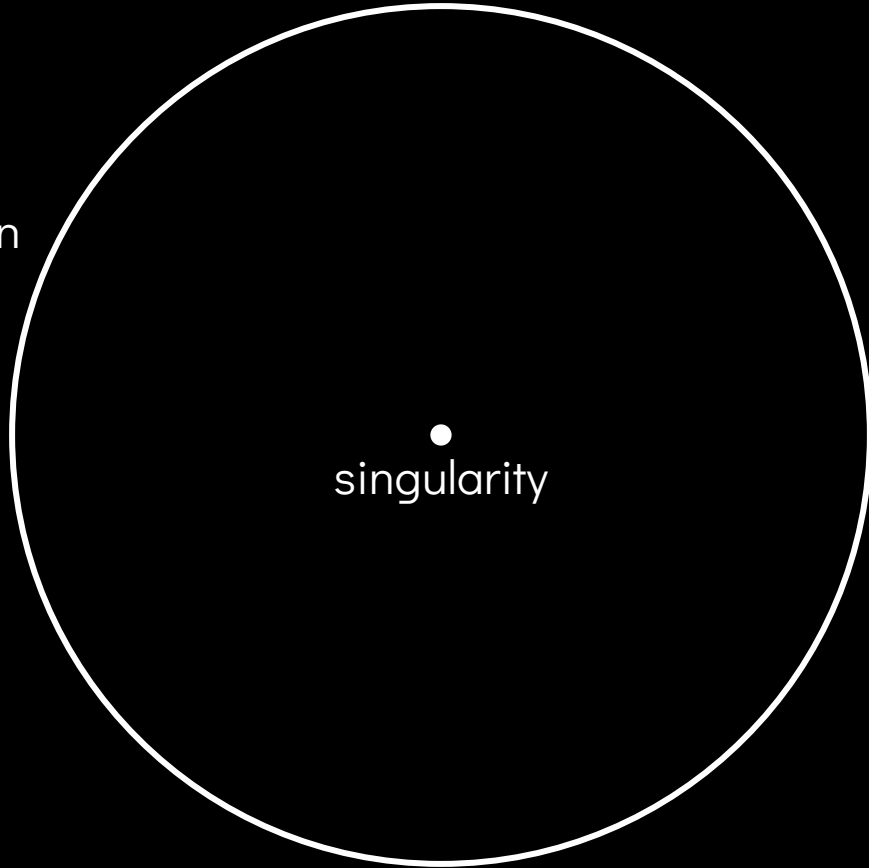


so what are black holes like?





event
horizon



singularity

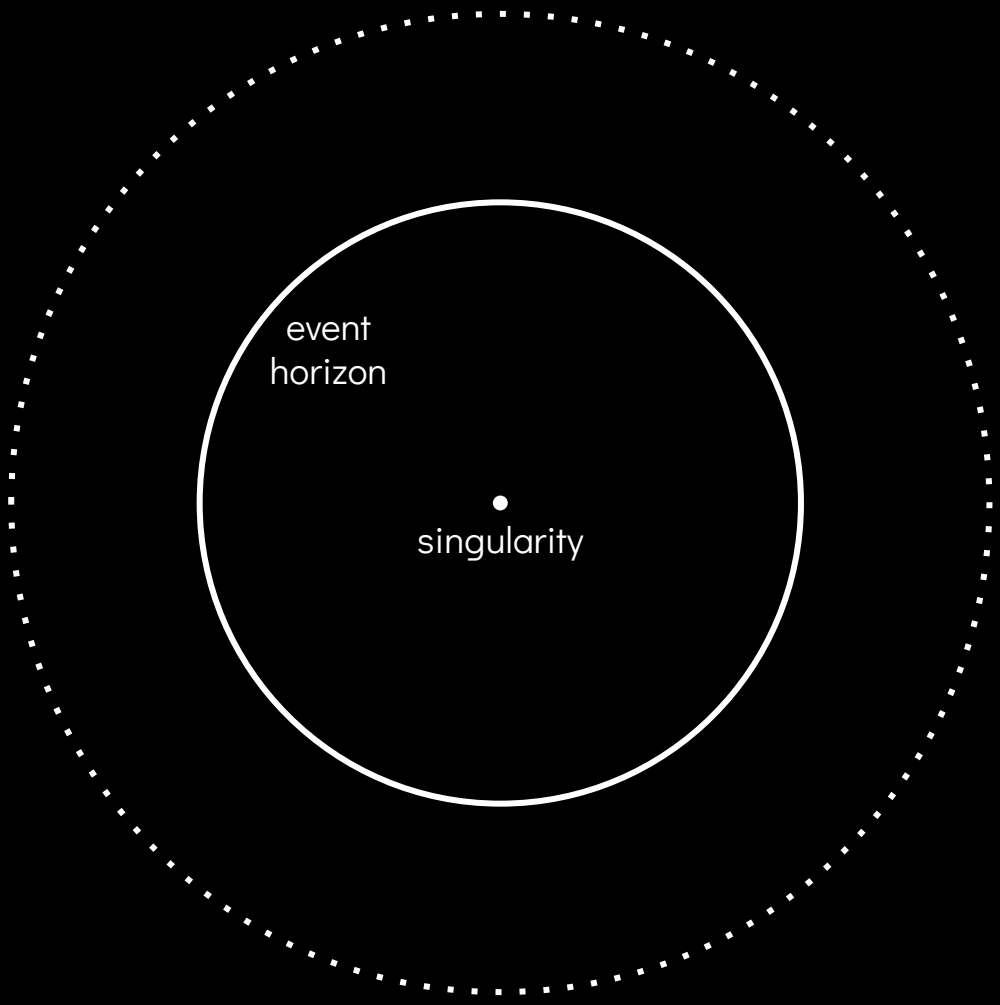
earth's event horizon is 9mm



stable orbits!

event
horizon

•
singularity





mass

mass
charge

mass
charge
spin

A woman wearing a voluminous white fur coat is leaning out of the driver's side window of a light blue classic car. Her head is tilted back, and her arms are extended outwards, resting on the car's roof. She is wearing multiple rings and bracelets. A long, dark fringe hangs from the top of her coat. The word "FORMATION" is overlaid in white, bold, sans-serif capital letters across the center of the image. The background shows a building with blue stairs and a fence under a clear sky.

FORMATION



formation

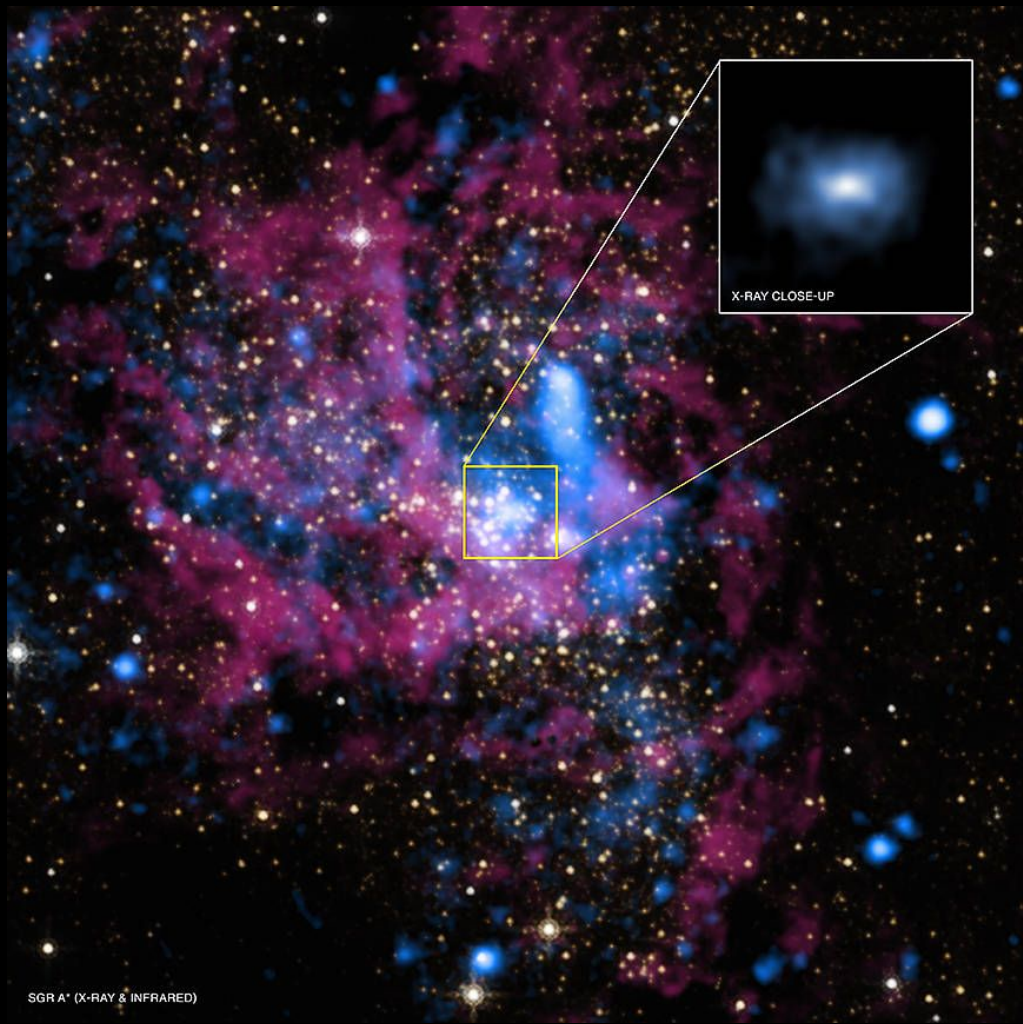


**supernovae can
make black holes!**



* as long as the
star is big enough

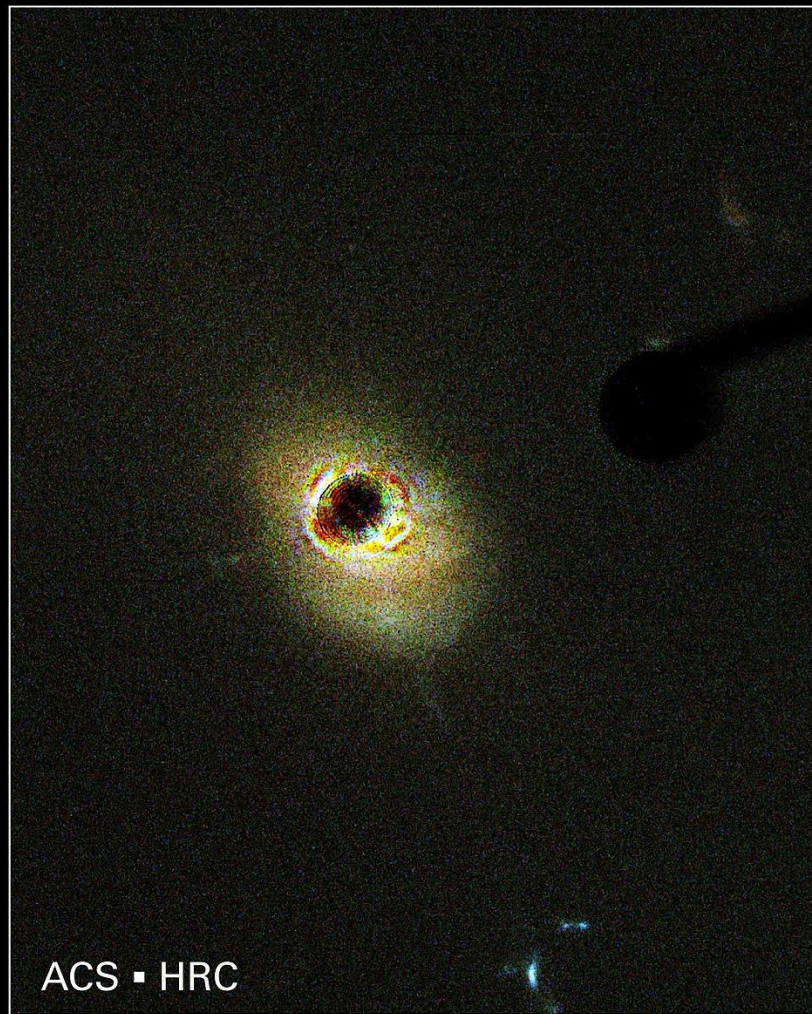
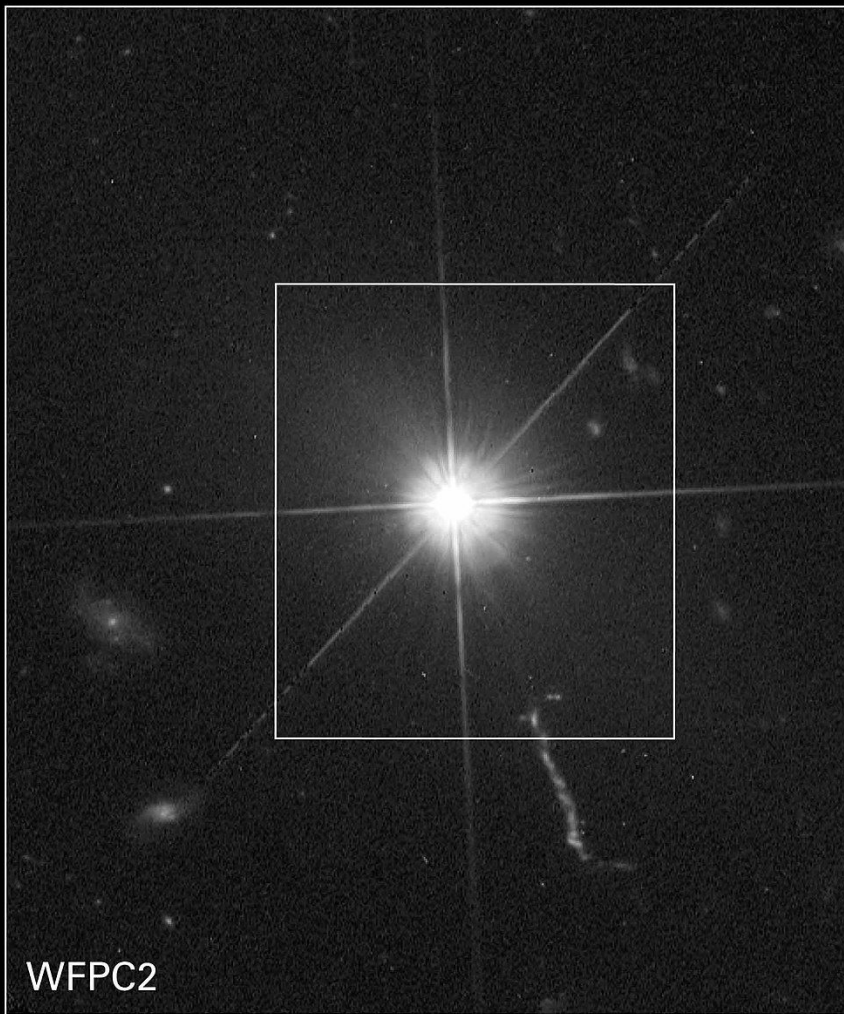




SGR A* (X-RAY & INFRARED)



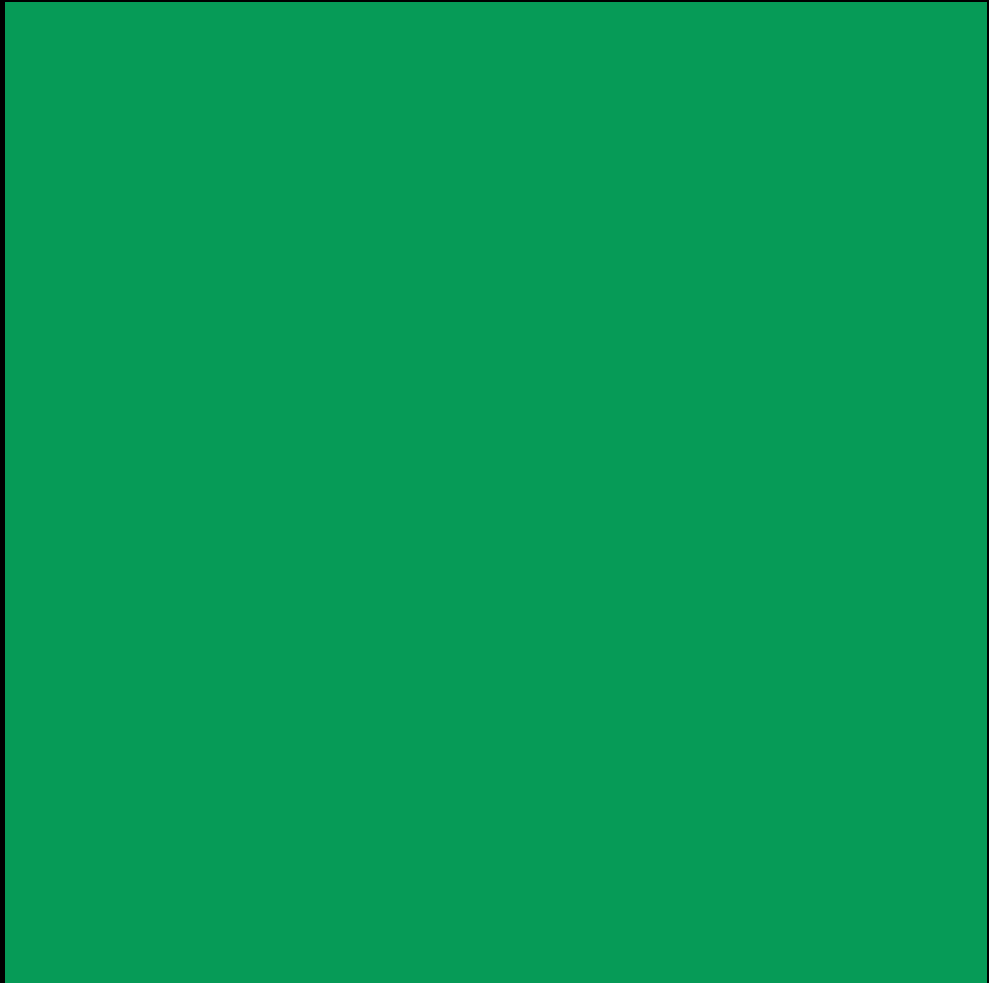


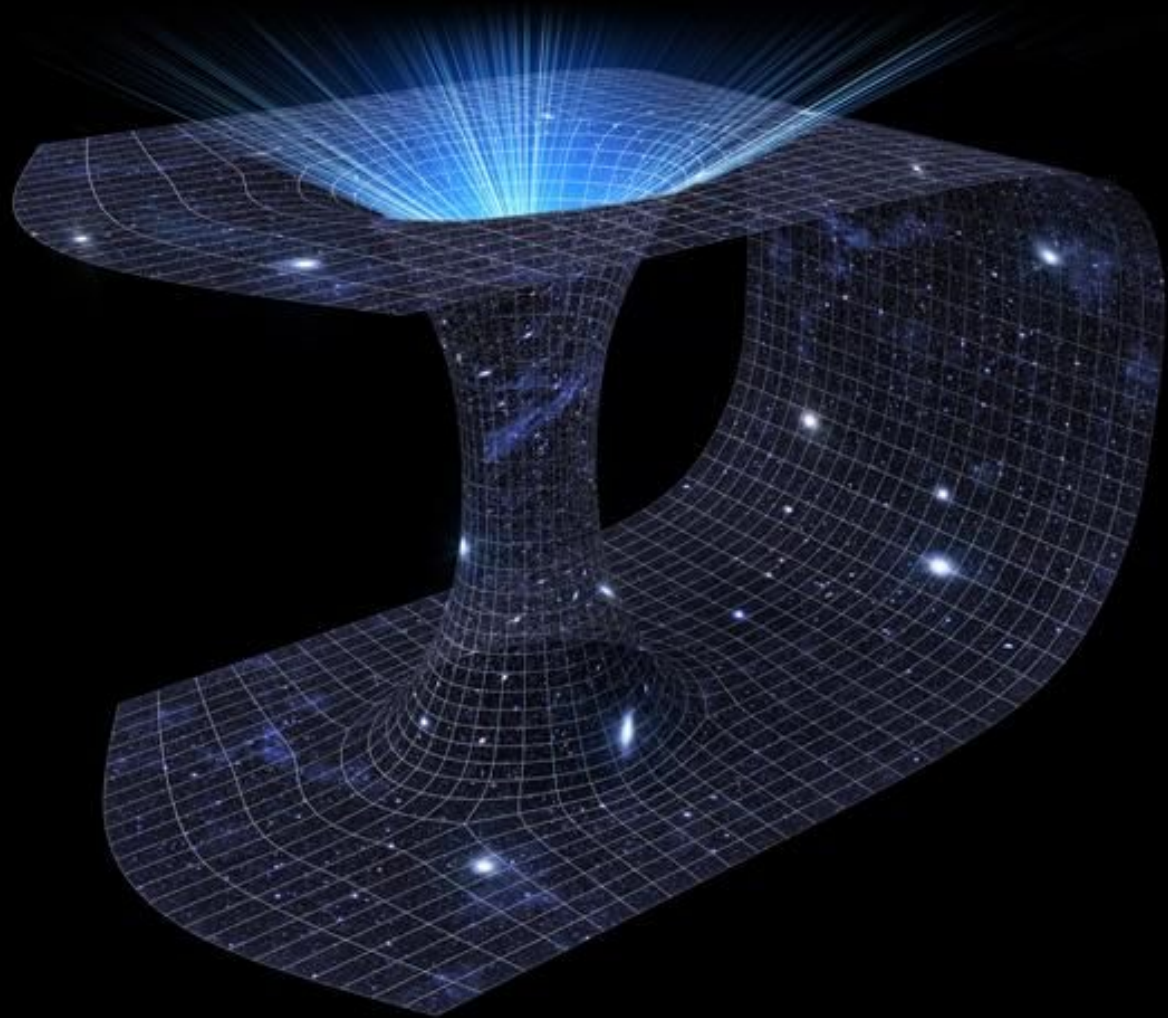






black holes are ~weird~







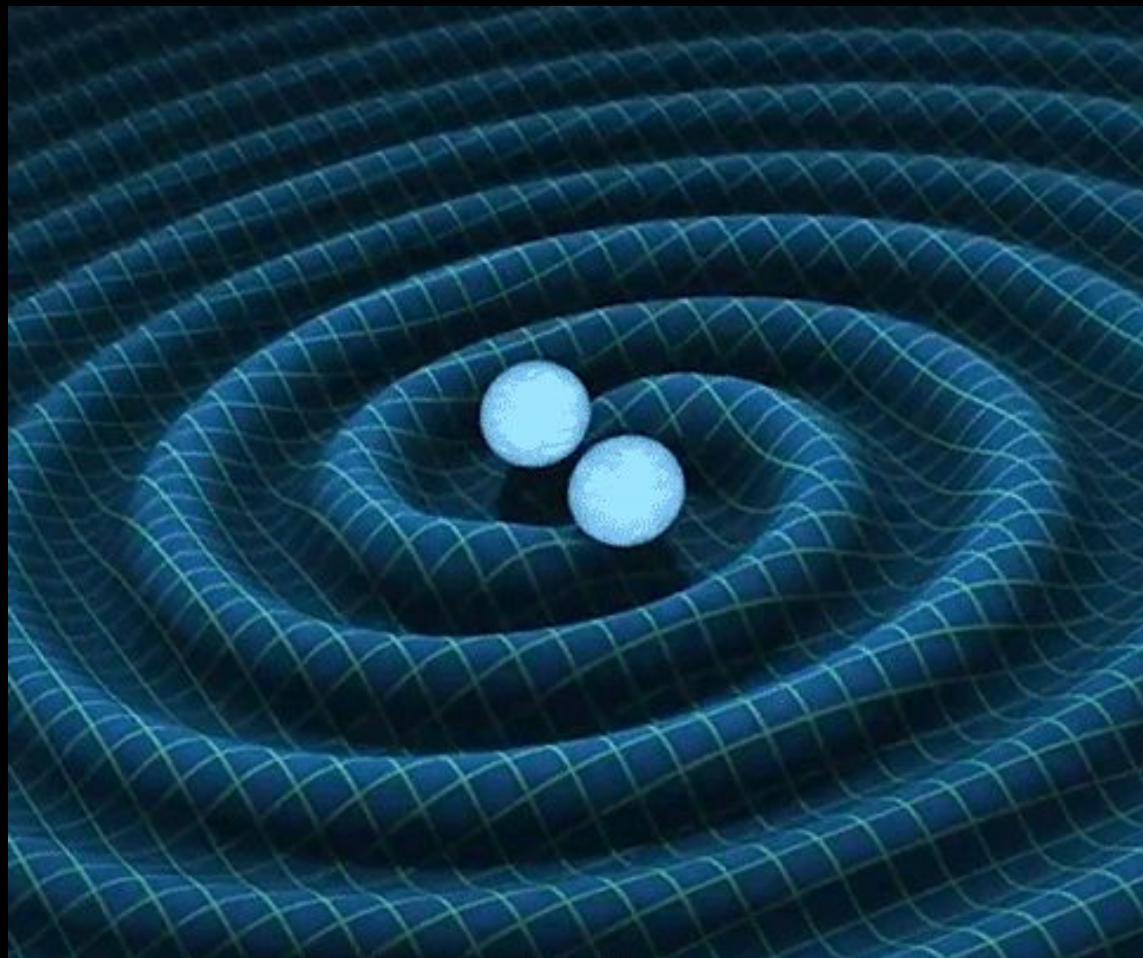
let's talk about ligo

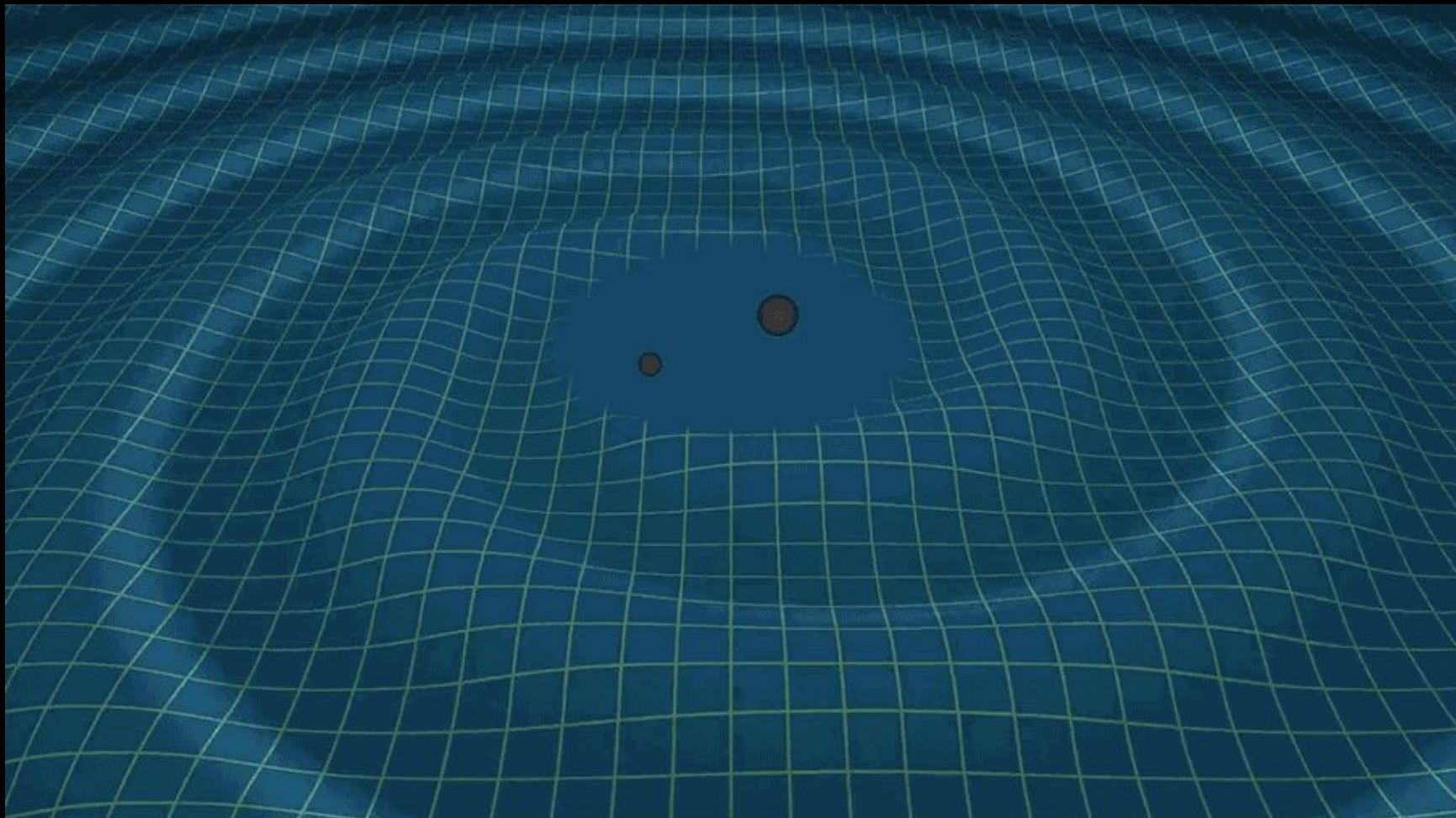
L laser

I interferometer

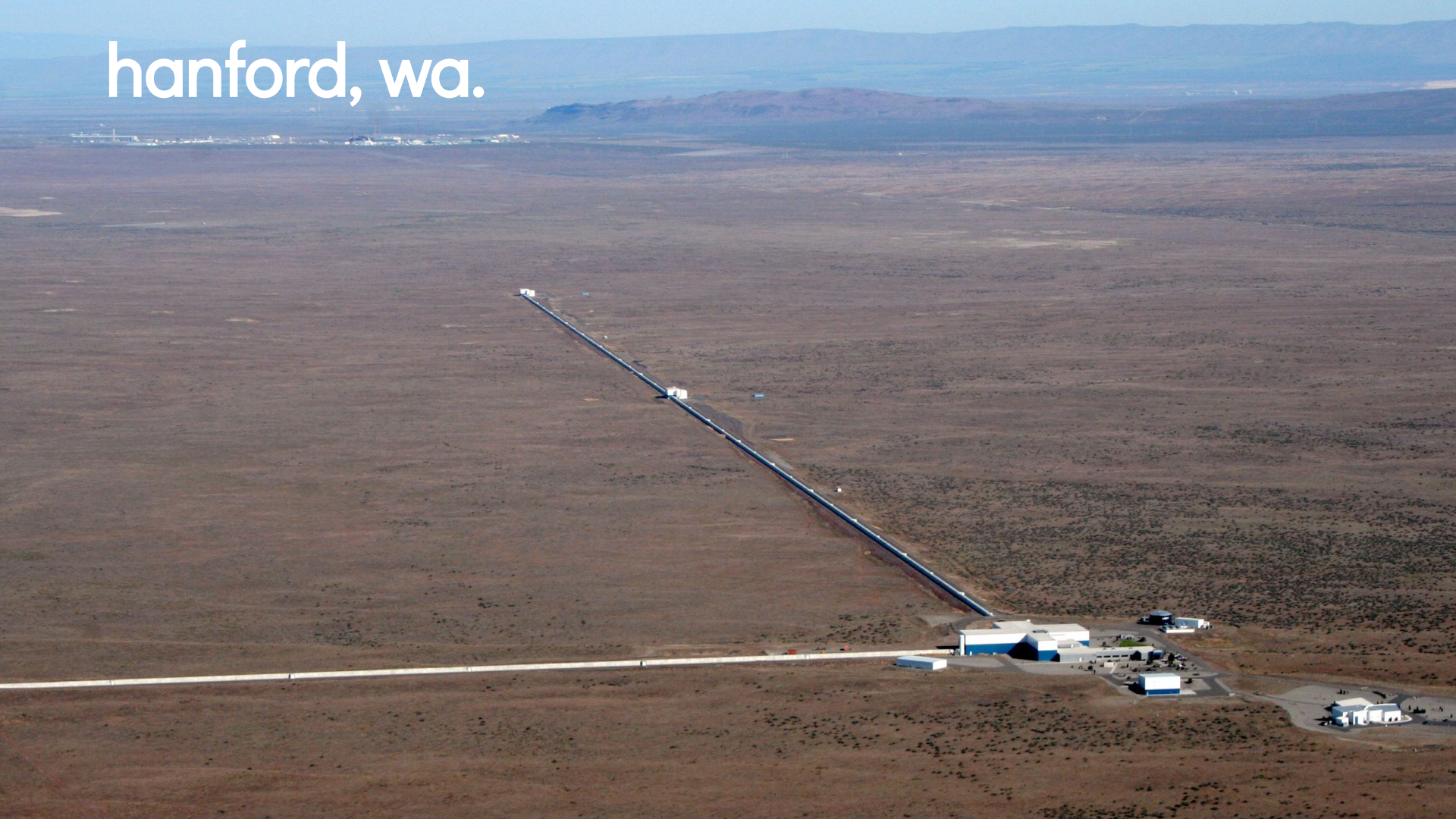
G gravitational-wave

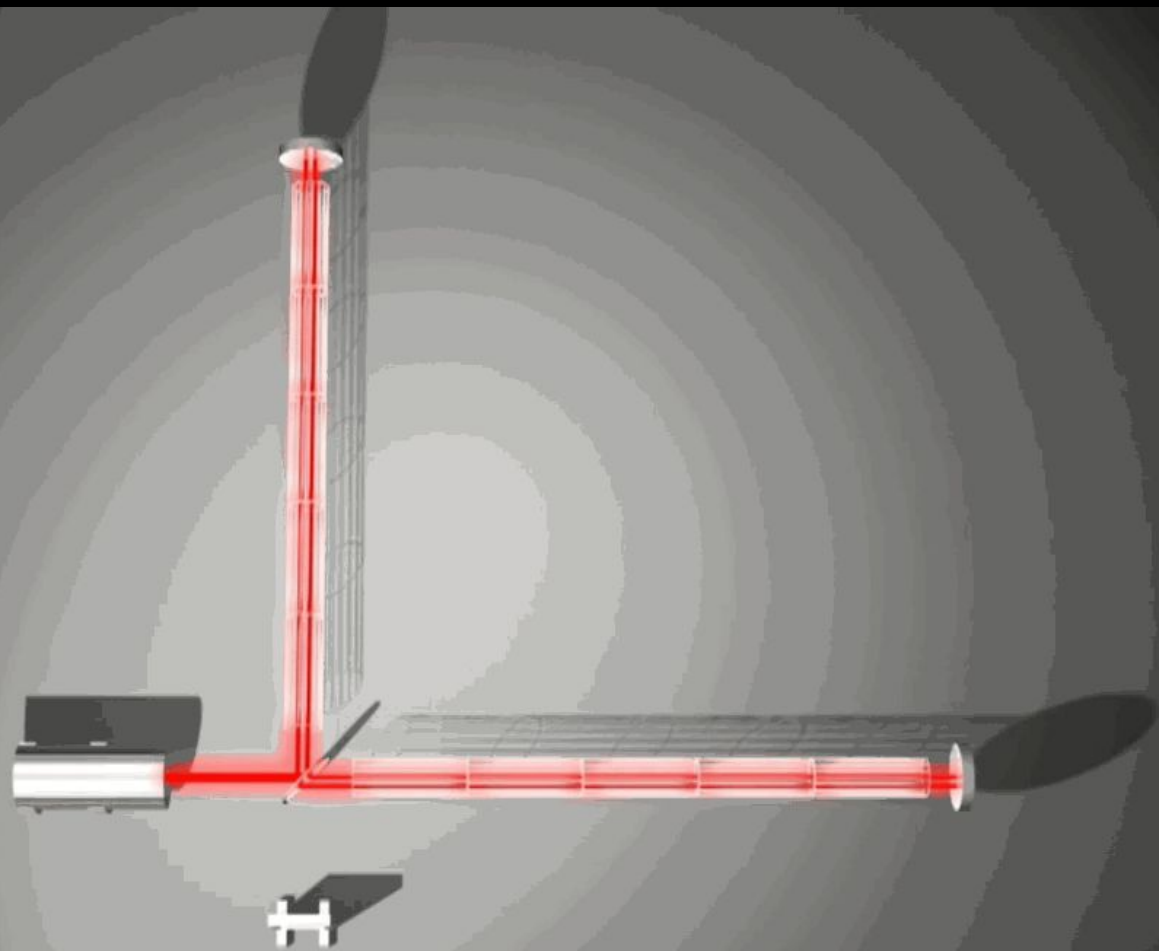
O observatory

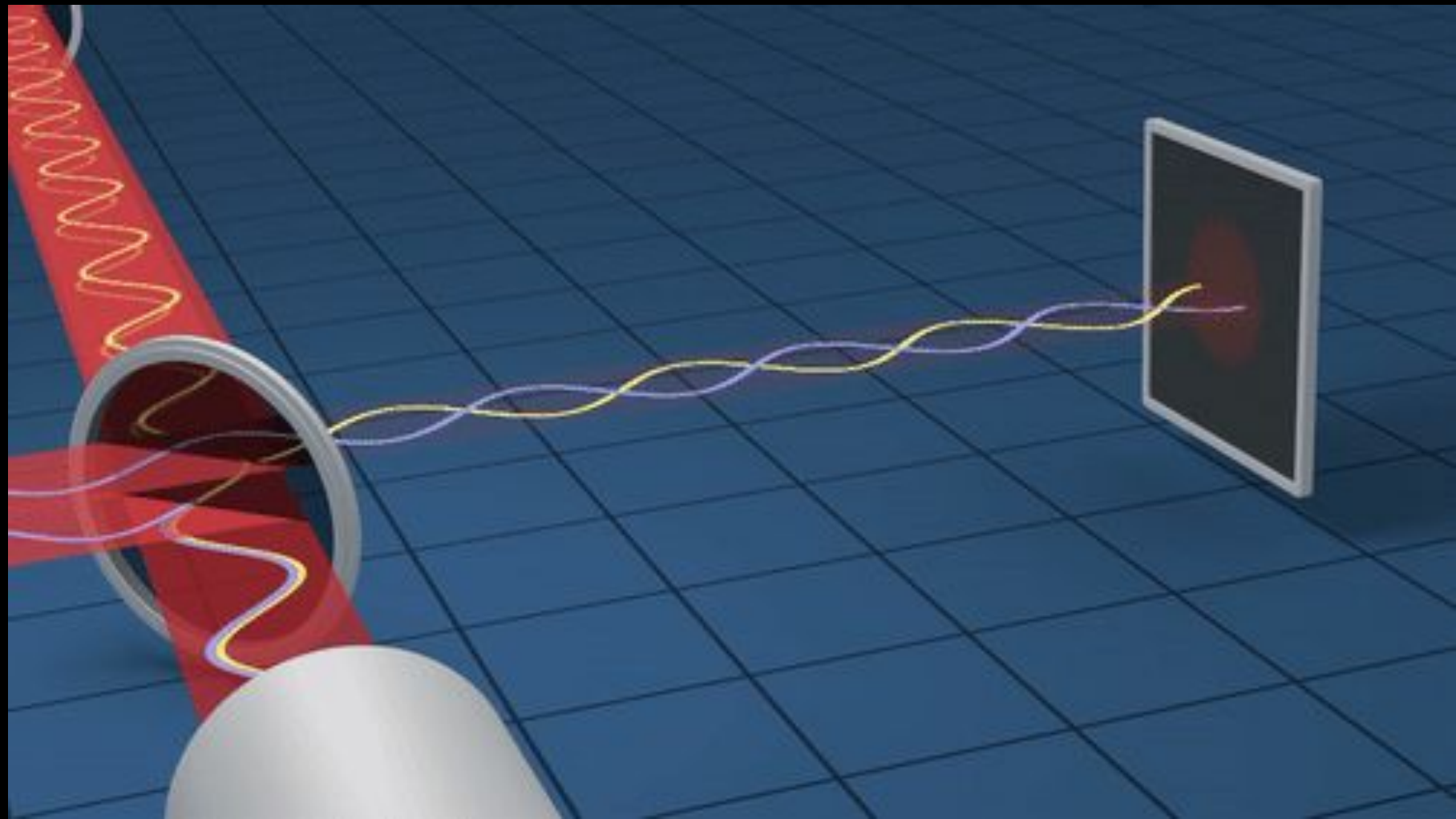


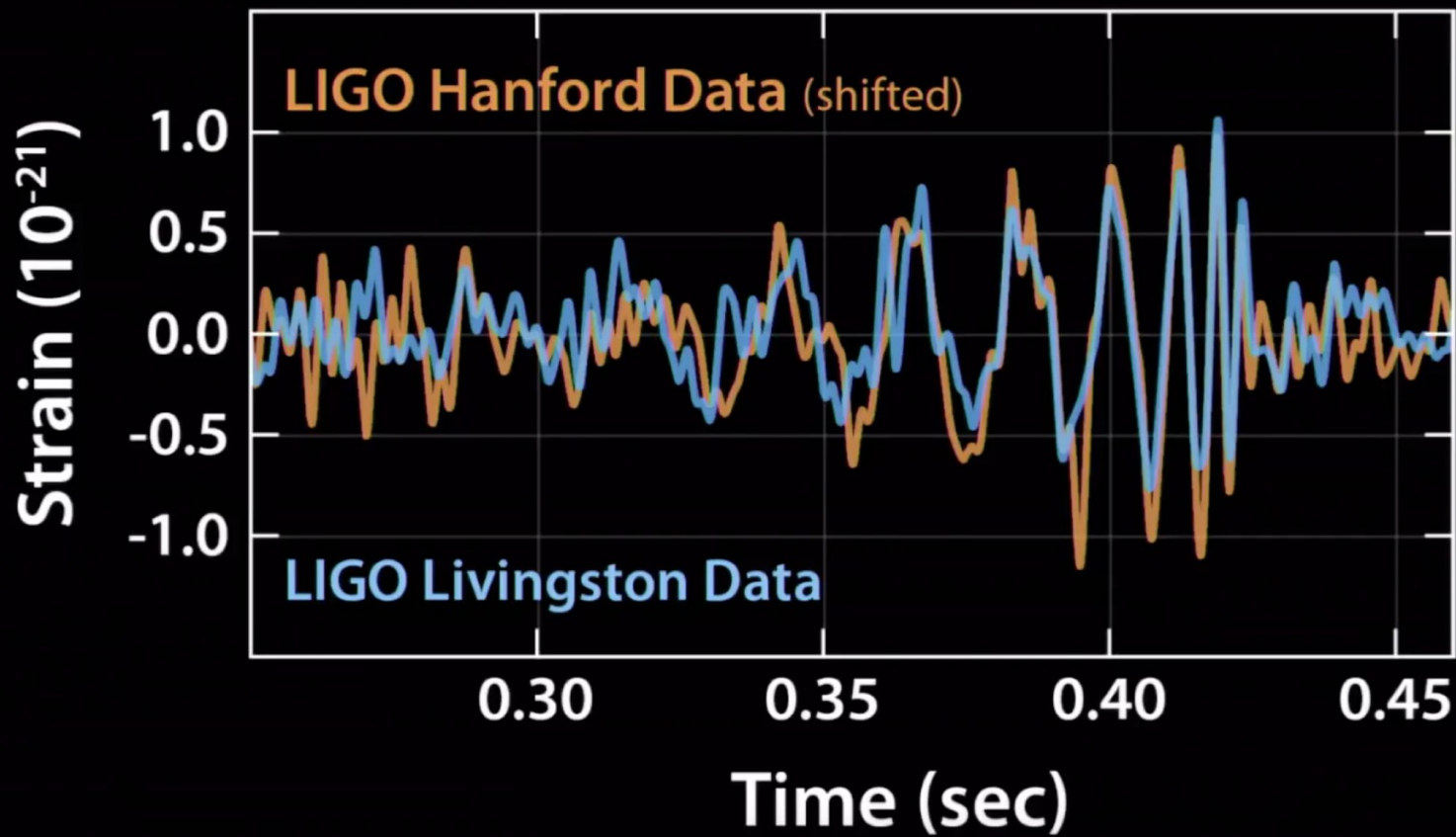


hanford, wa.











thank you! questions?