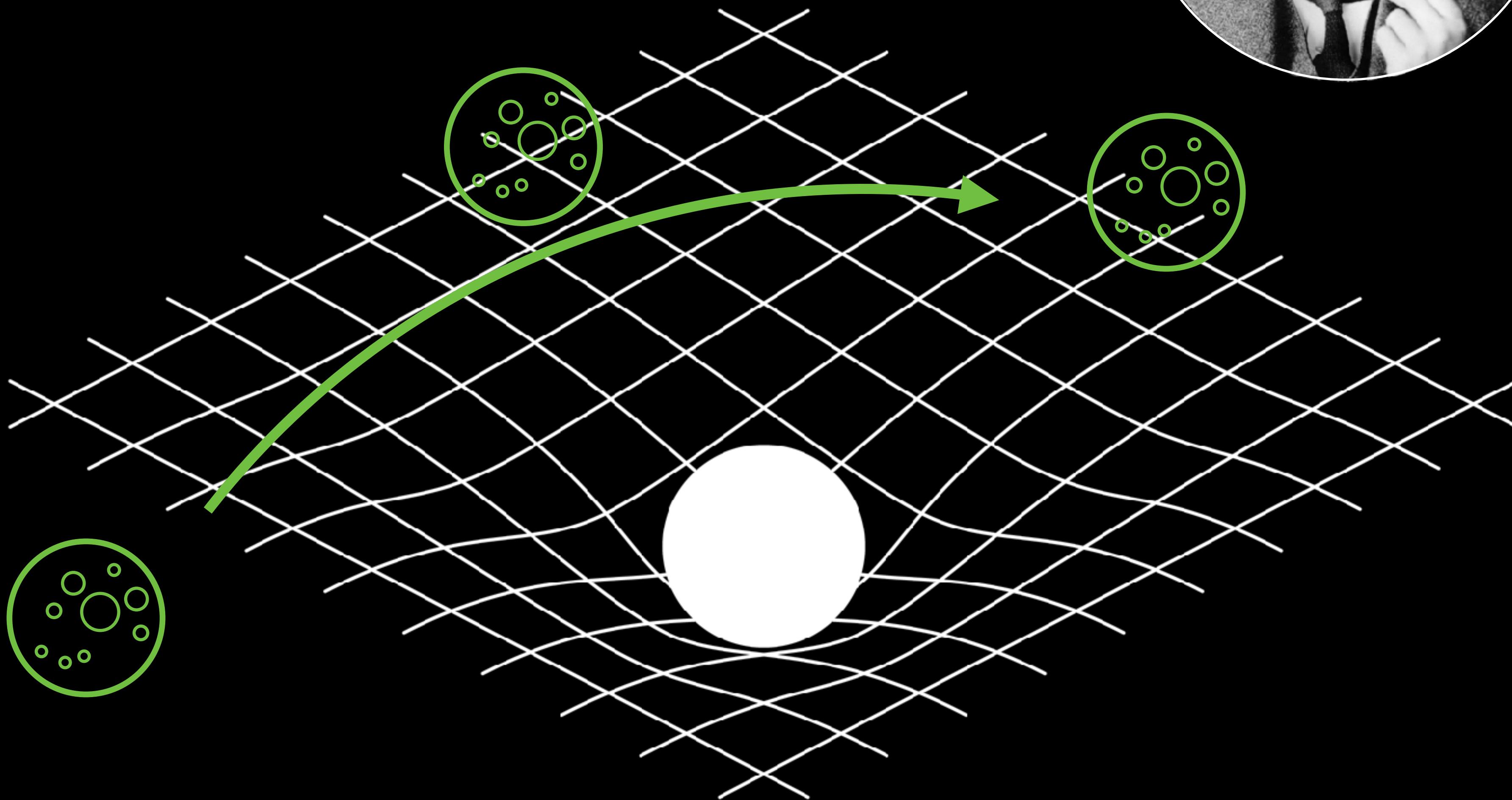
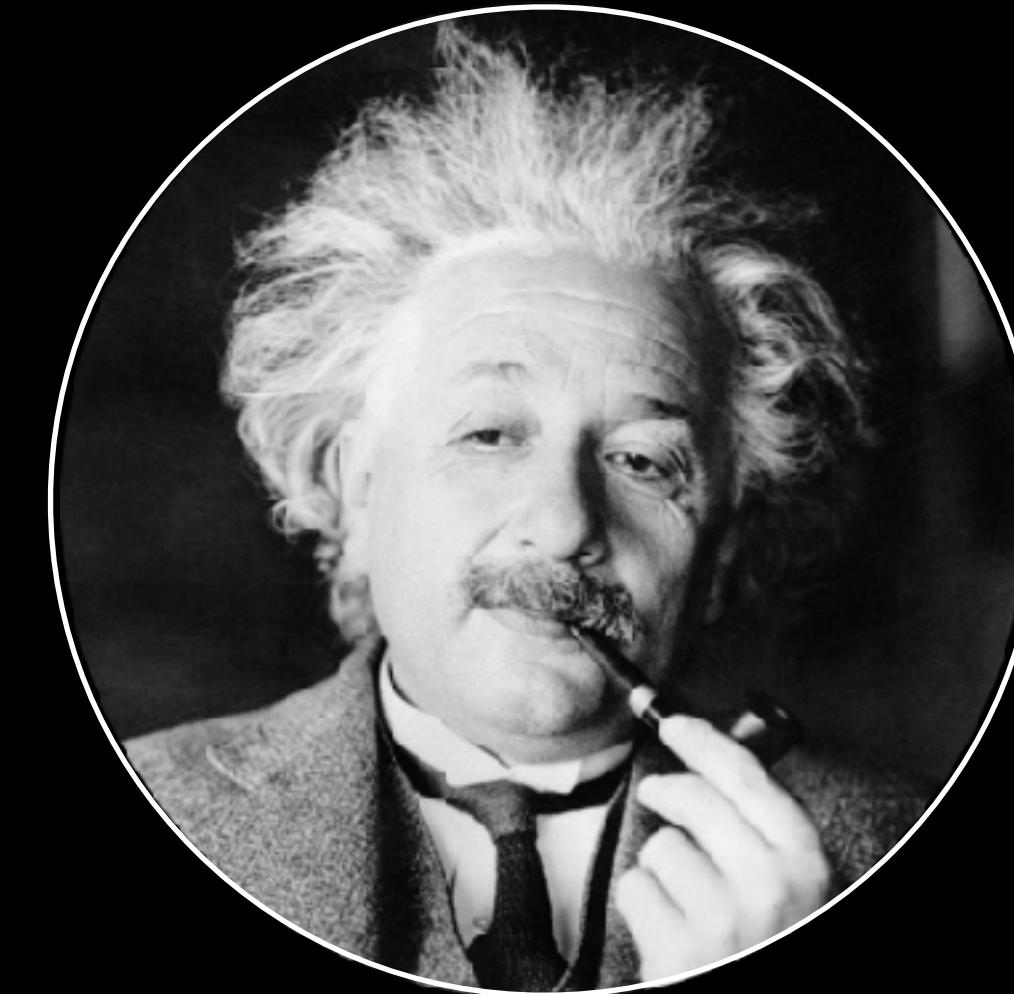


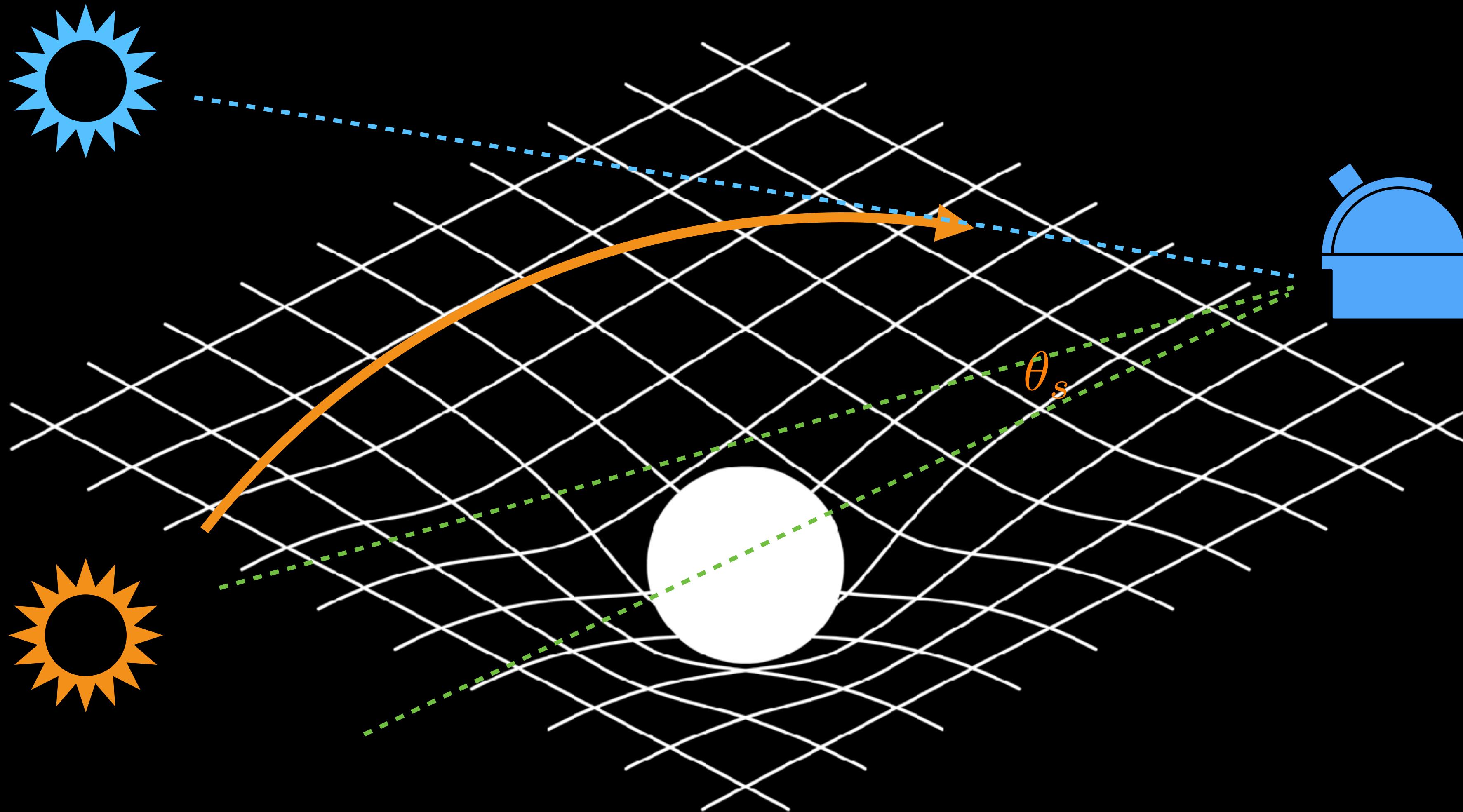
Black holes as magnifying glasses

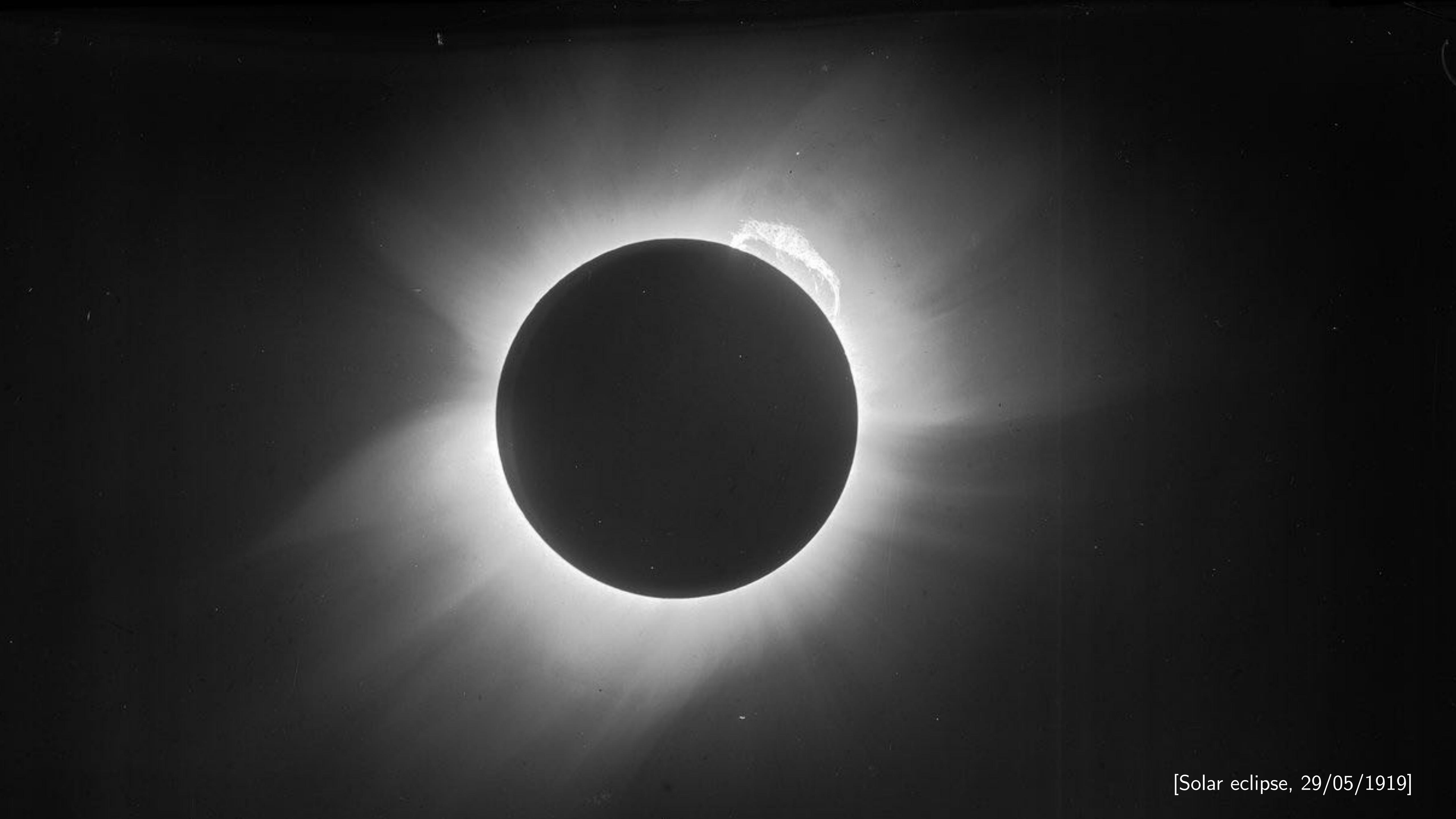
Jose María Ezquiaga
Niels Bohr Institute
ezquiaga.github.io

Space-time curves



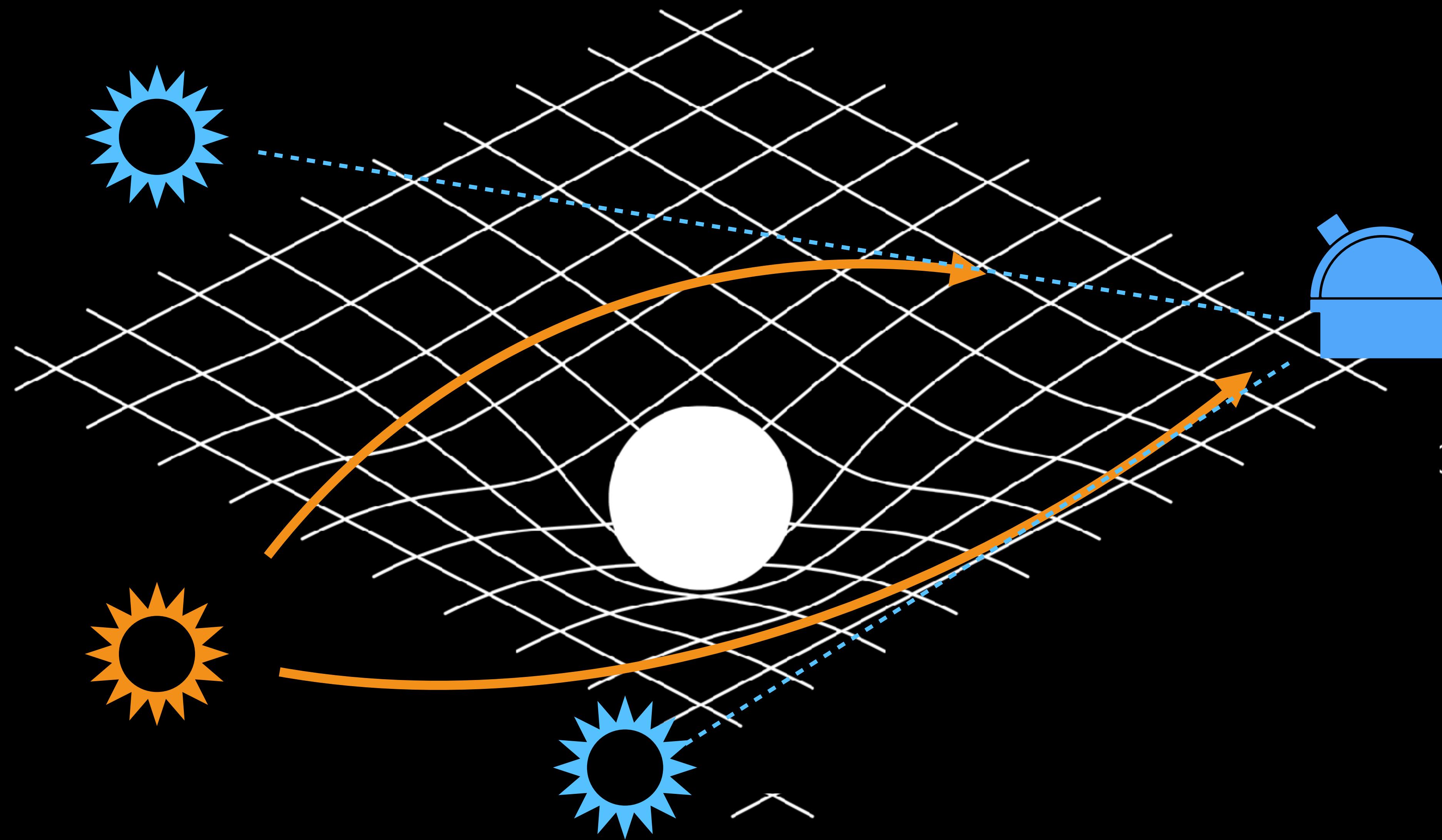
Gravitational lensing

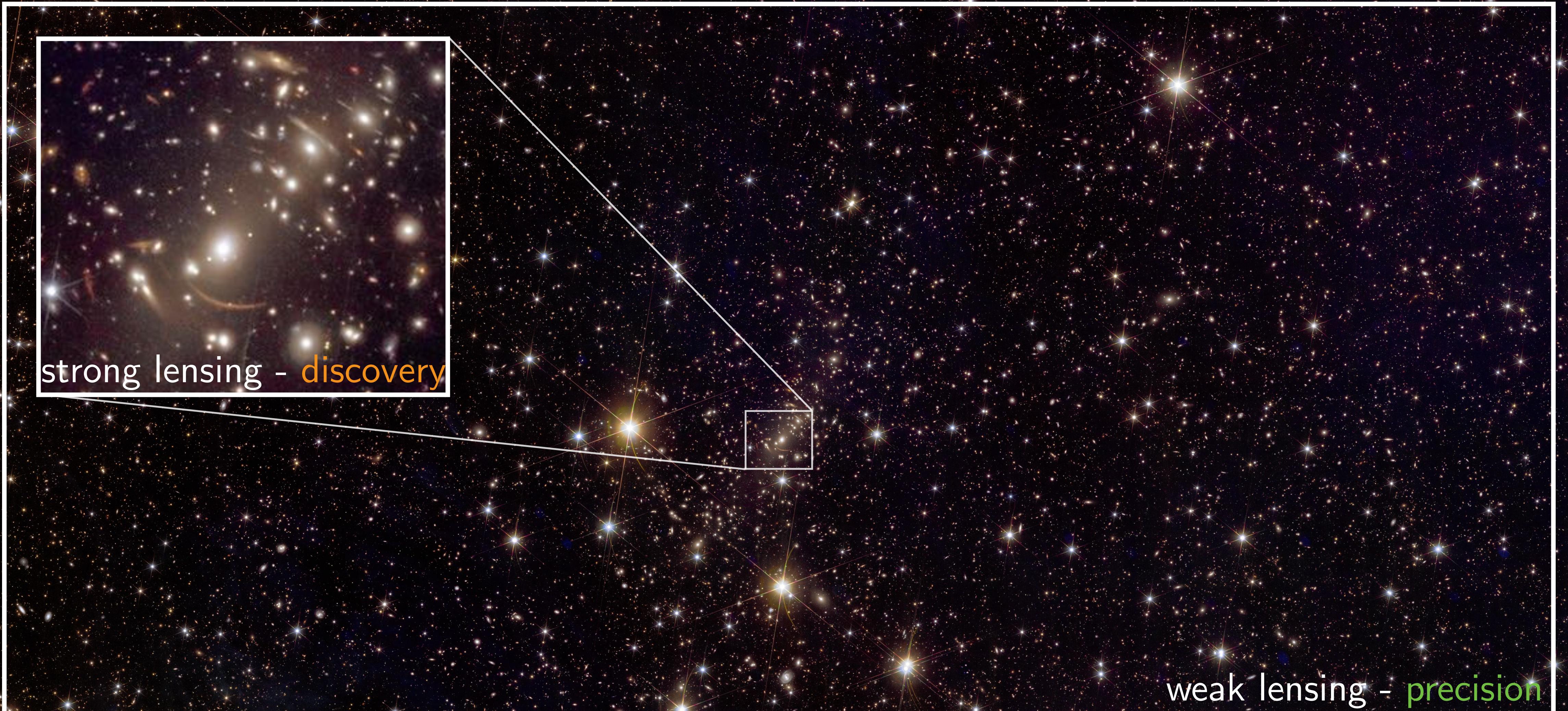




[Solar eclipse, 29/05/1919]

Multiple images







[multiple images]



[arcs and rings]

Observed star position

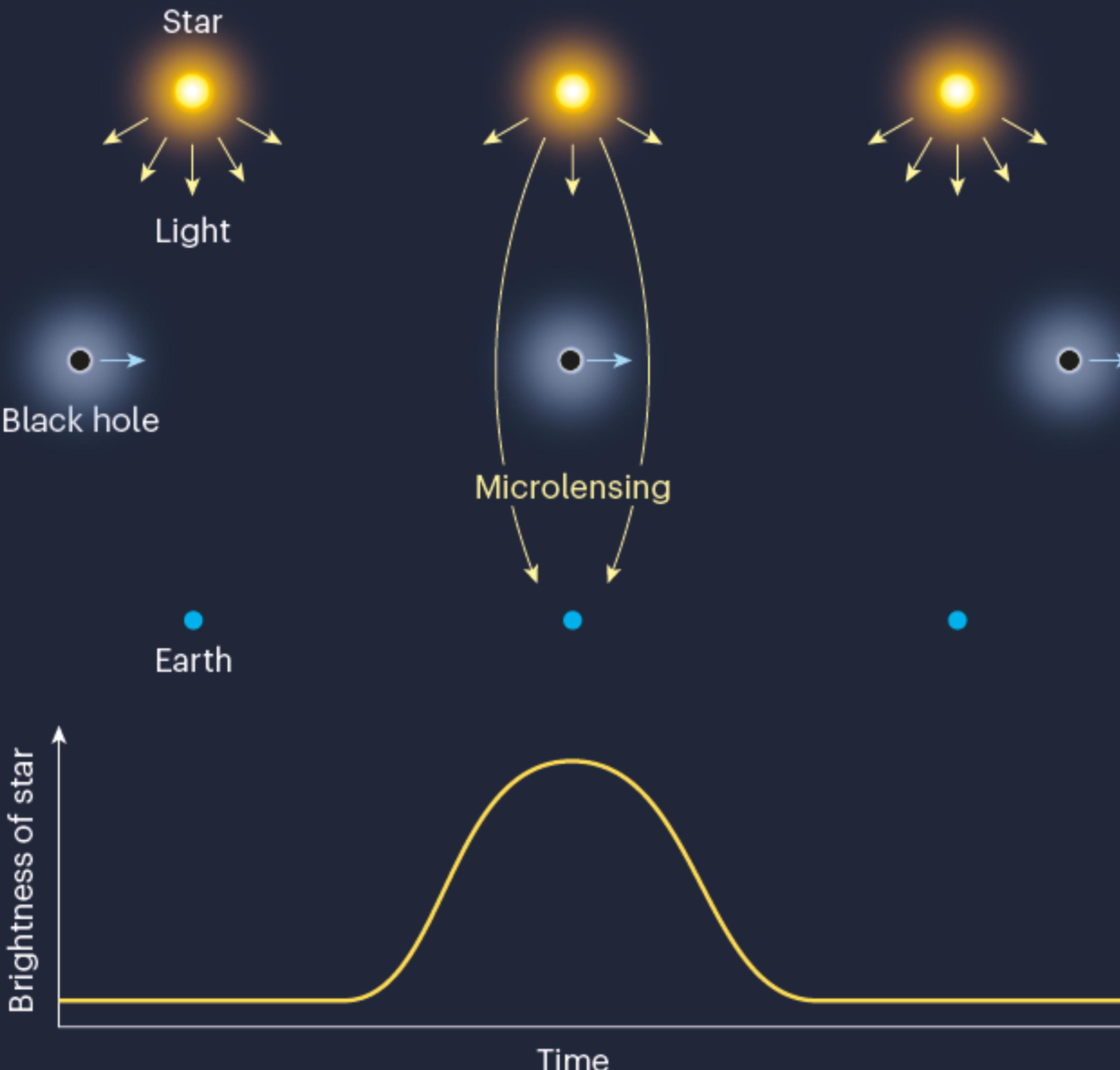
Real star position

Black Hole

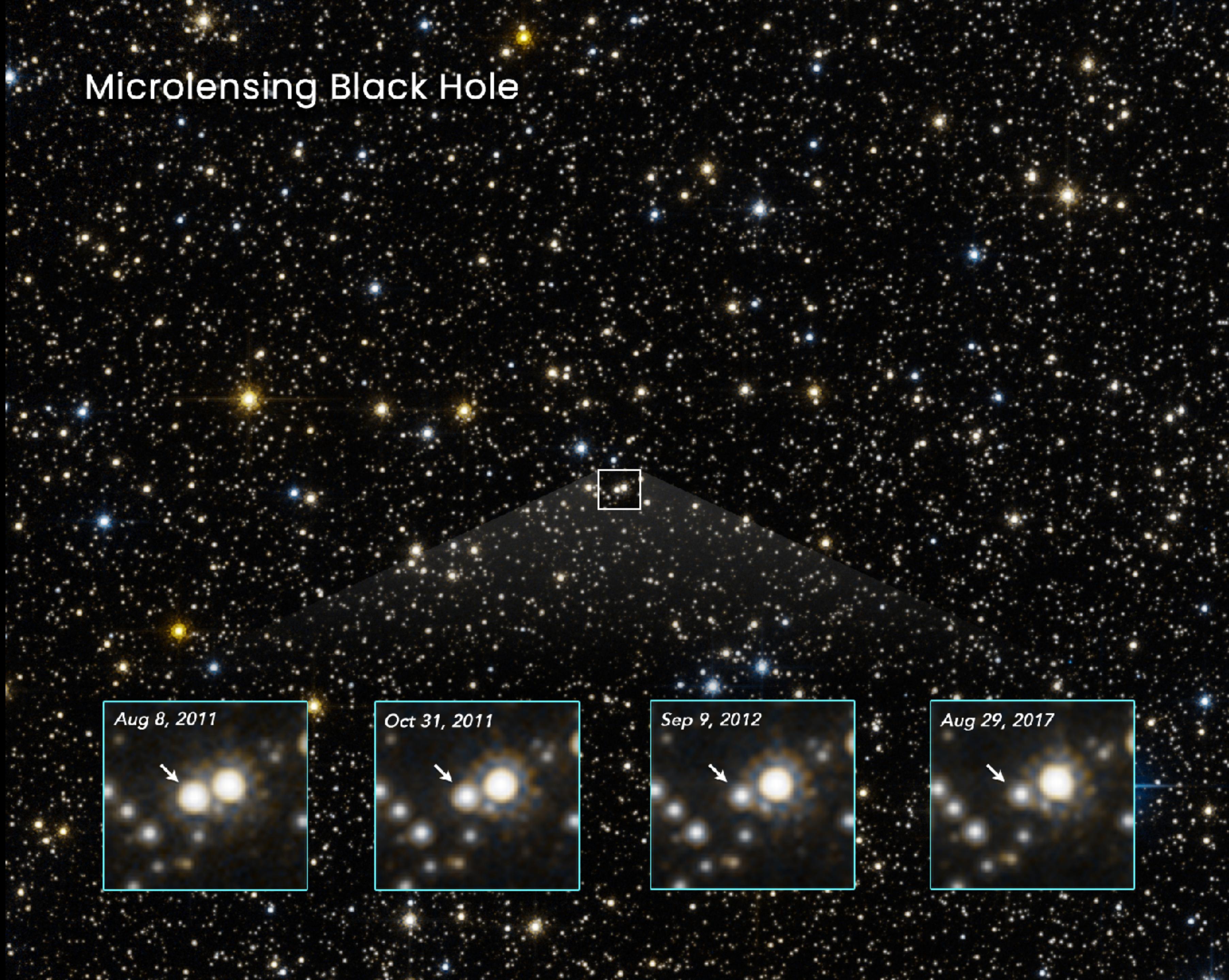
[credit: NASA Hubble]

COSMIC LENSES

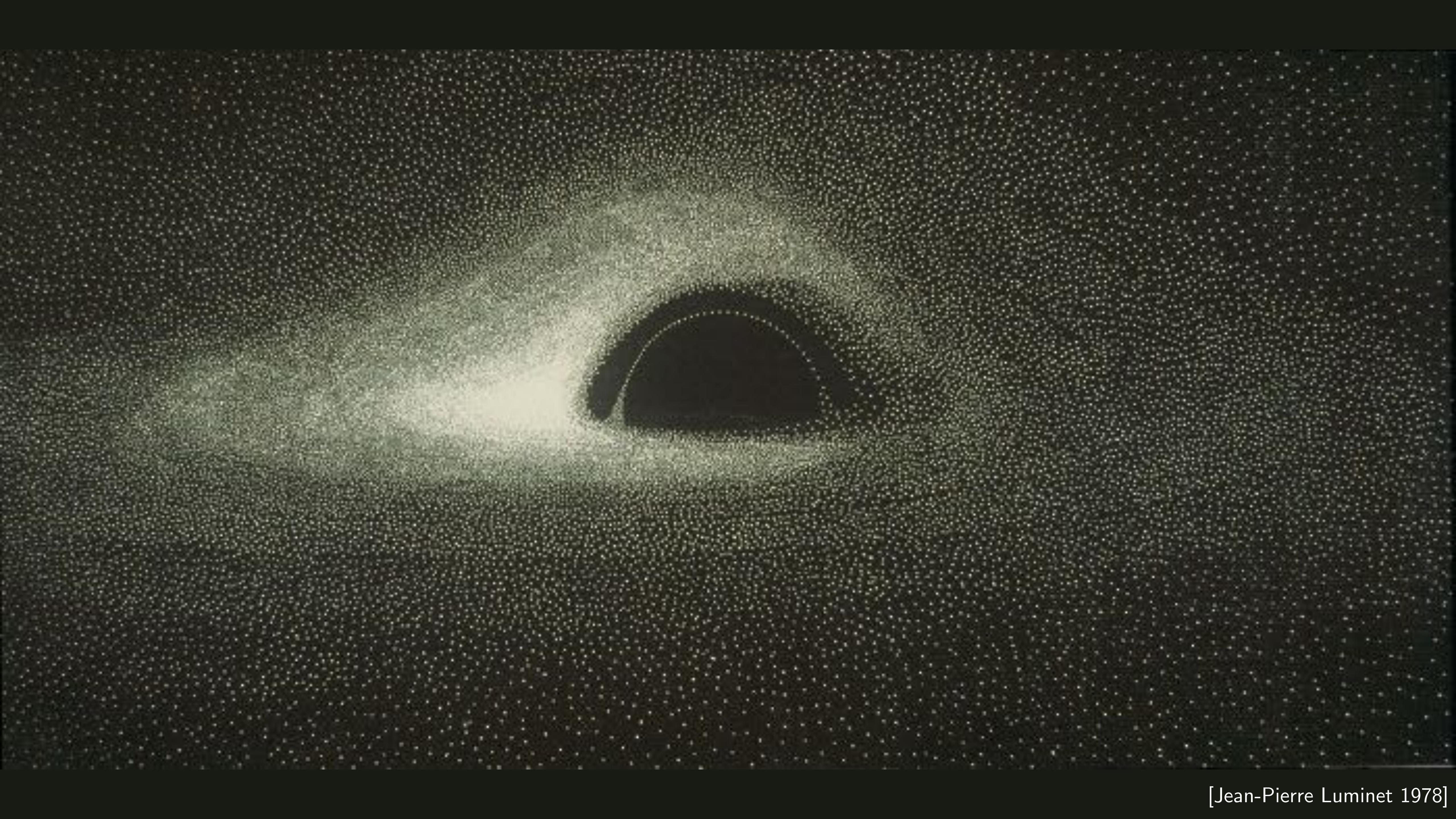
A black hole can be detected using a technique called microlensing. When a black hole passes between a star and Earth, its gravitational pull bends and focuses light from the star, temporarily amplifying the star's observed brightness.



Microlensing Black Hole



[credit: NASA Hubble]

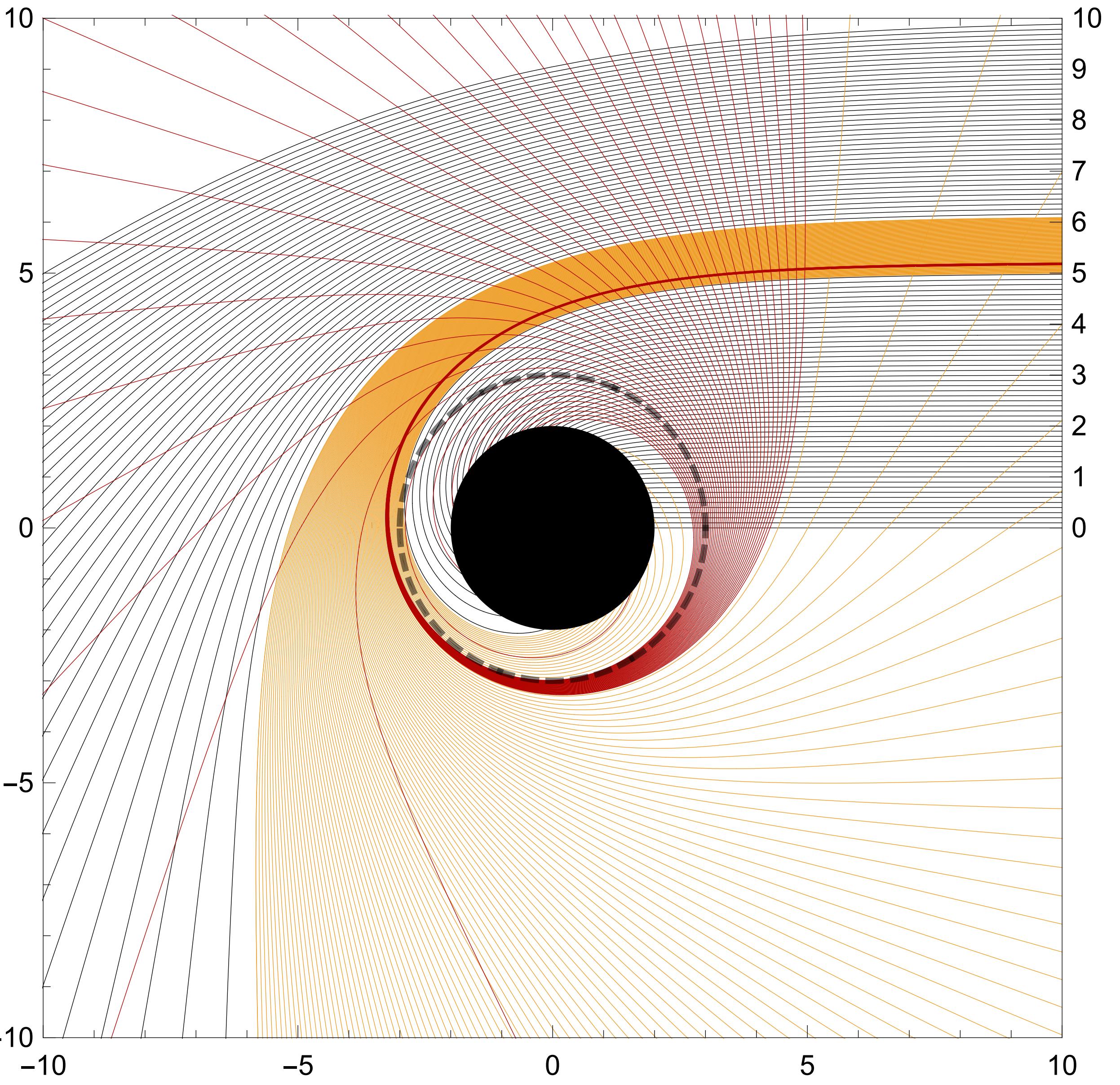
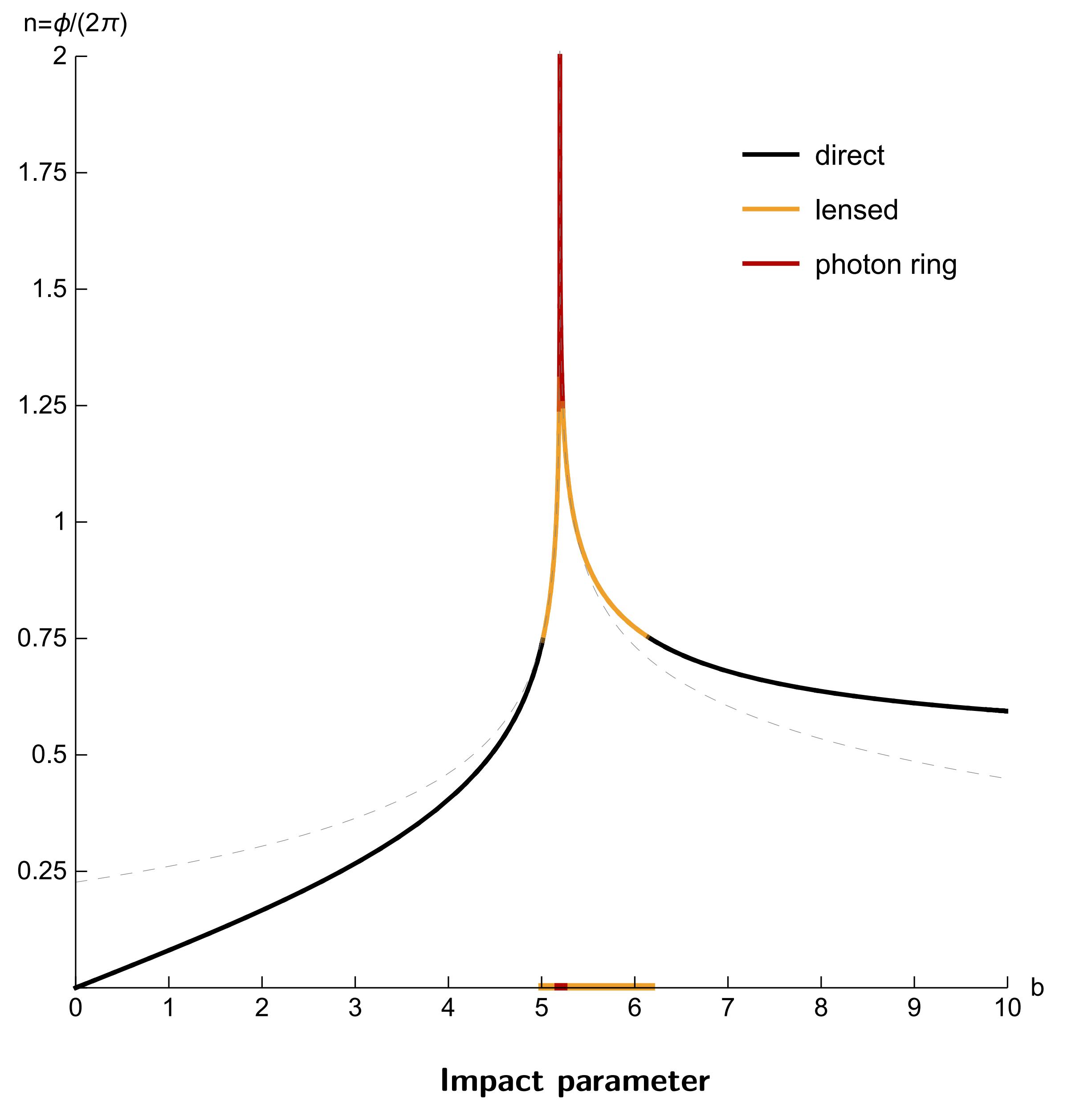


[Jean-Pierre Luminet 1978]

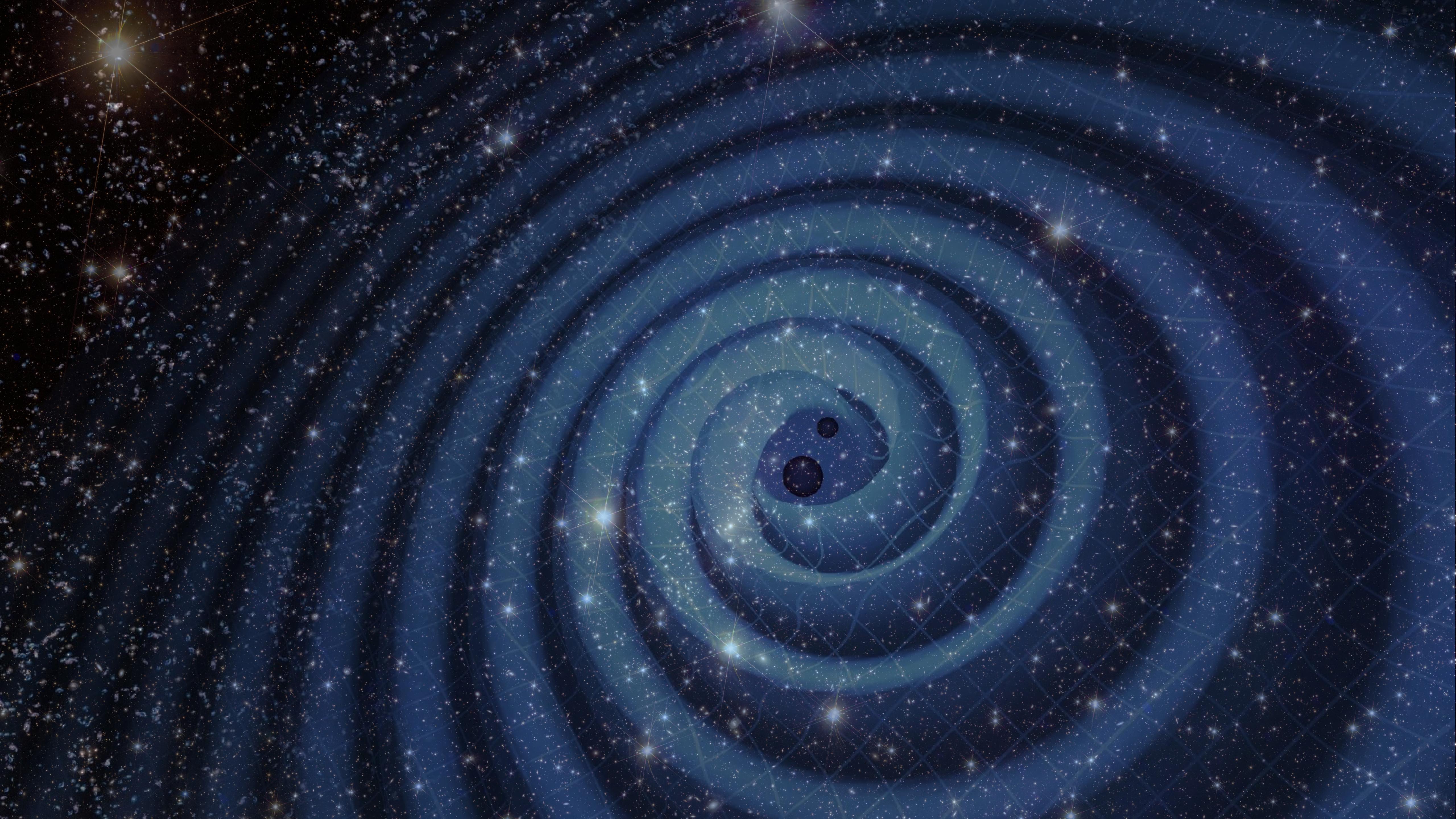


[Interstellar (2014)]

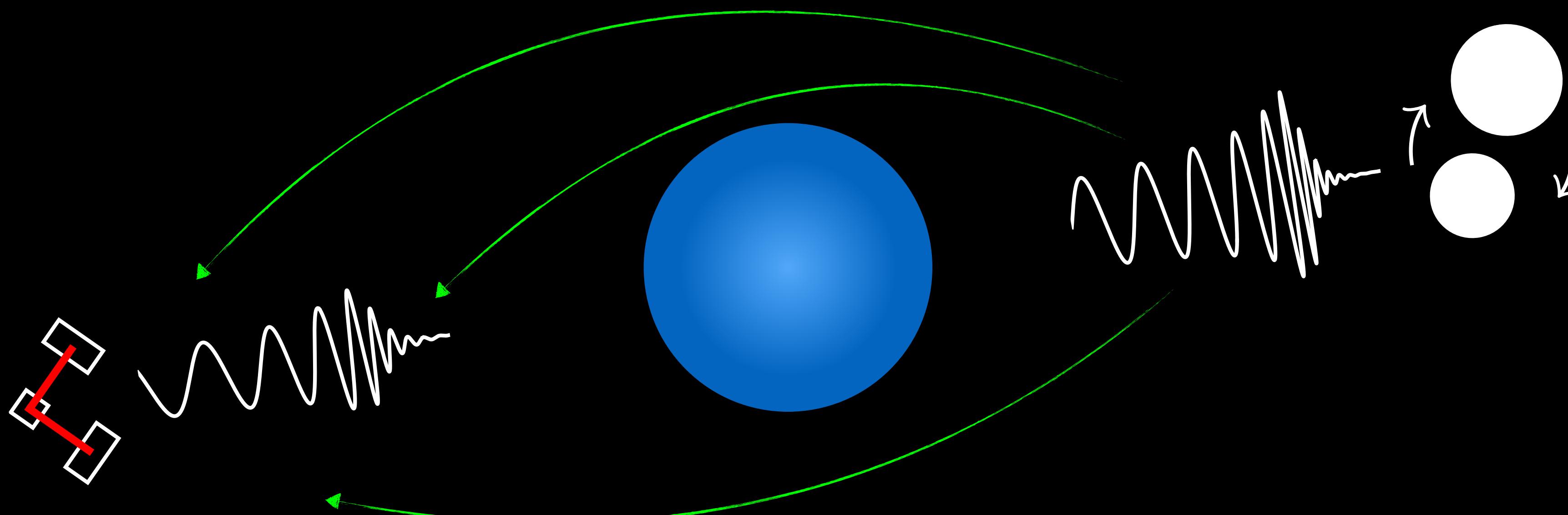
Number of loops around black hole



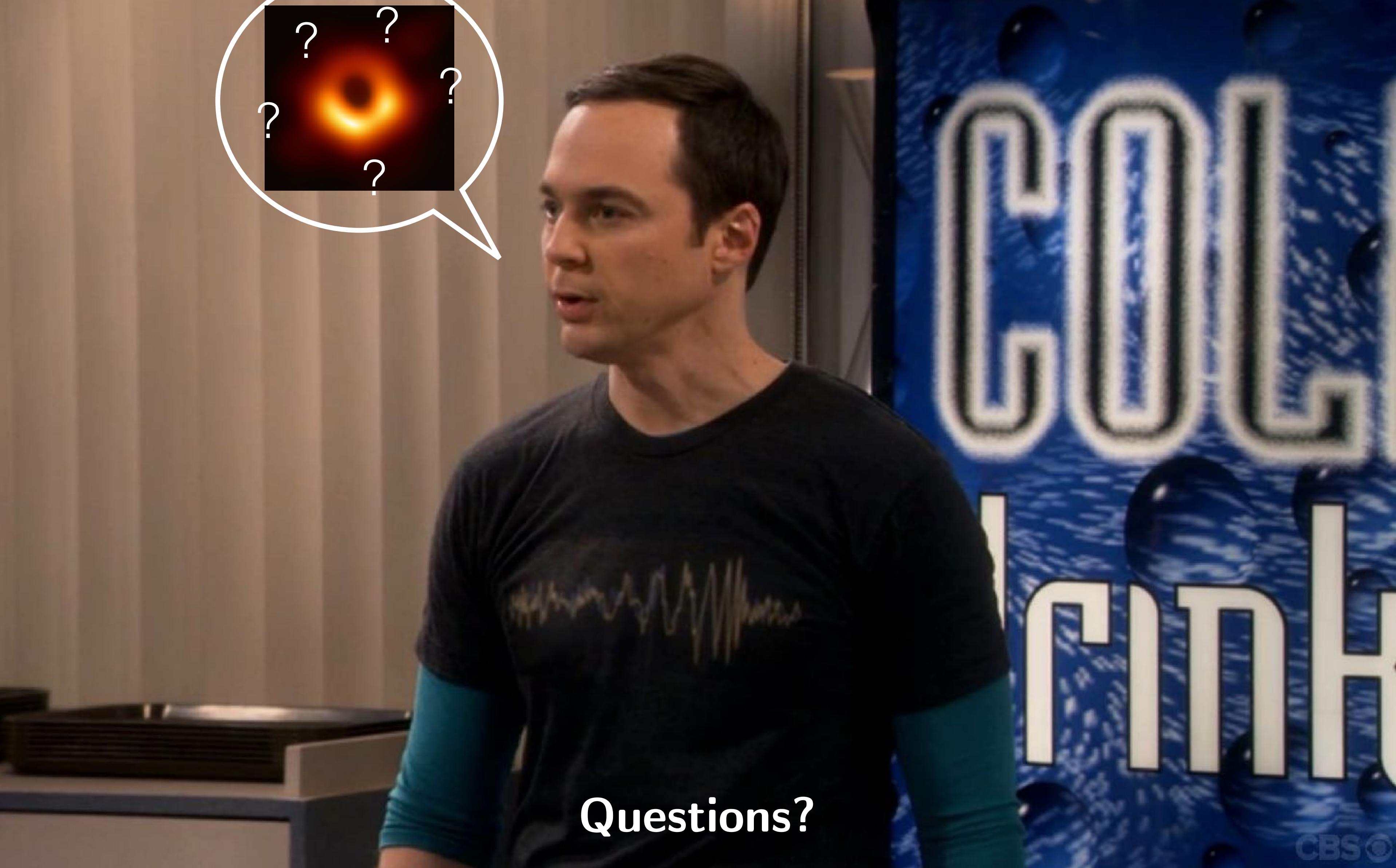
[Gralla, Holz, Wald; PRD'19]



Gravitational wave lensing: distorted waveforms







Questions?