TESTING GENERAL RELATIVITY WITH BLACK HOLE-PULSAR BINARIES

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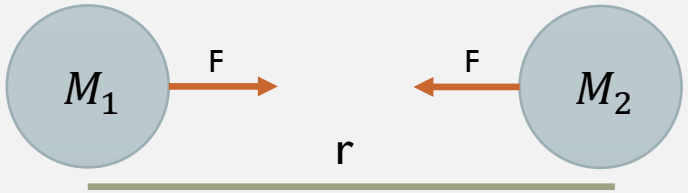
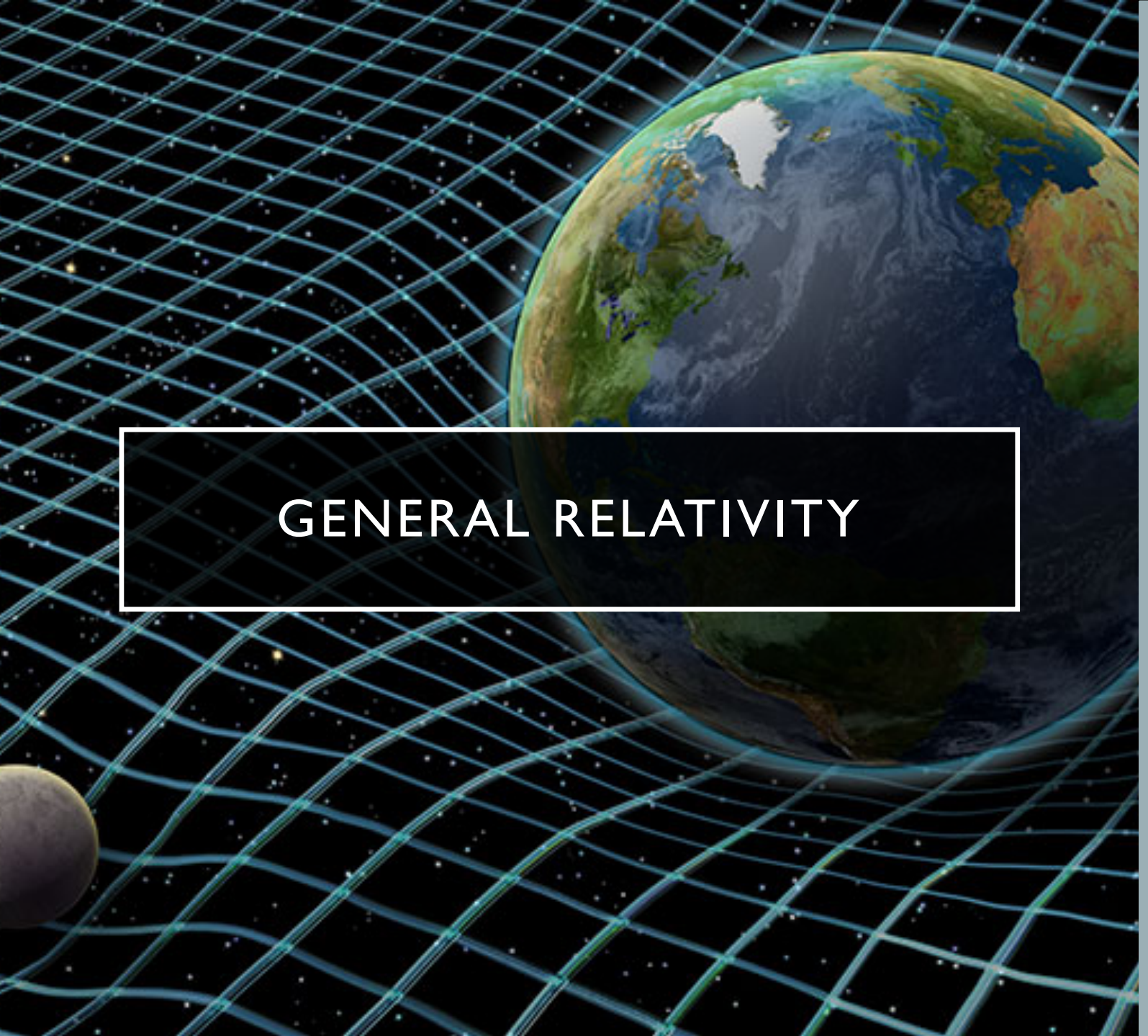
NEWTONIAN GRAVITY

- Gravitational constant is fundamental part of Newton's formulation of gravity.
- G is the constant in time and equal to $6.674 \times 10^{-11} \frac{m^3}{kg^1\, s^2}$

$$F_{gravity} = G \frac{M_1\, M_2}{r^2}$$



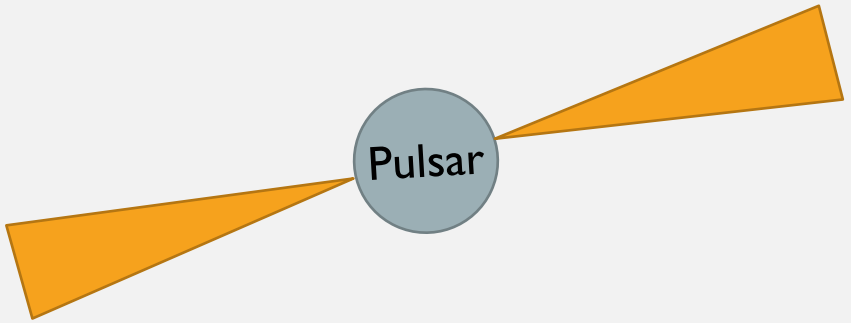


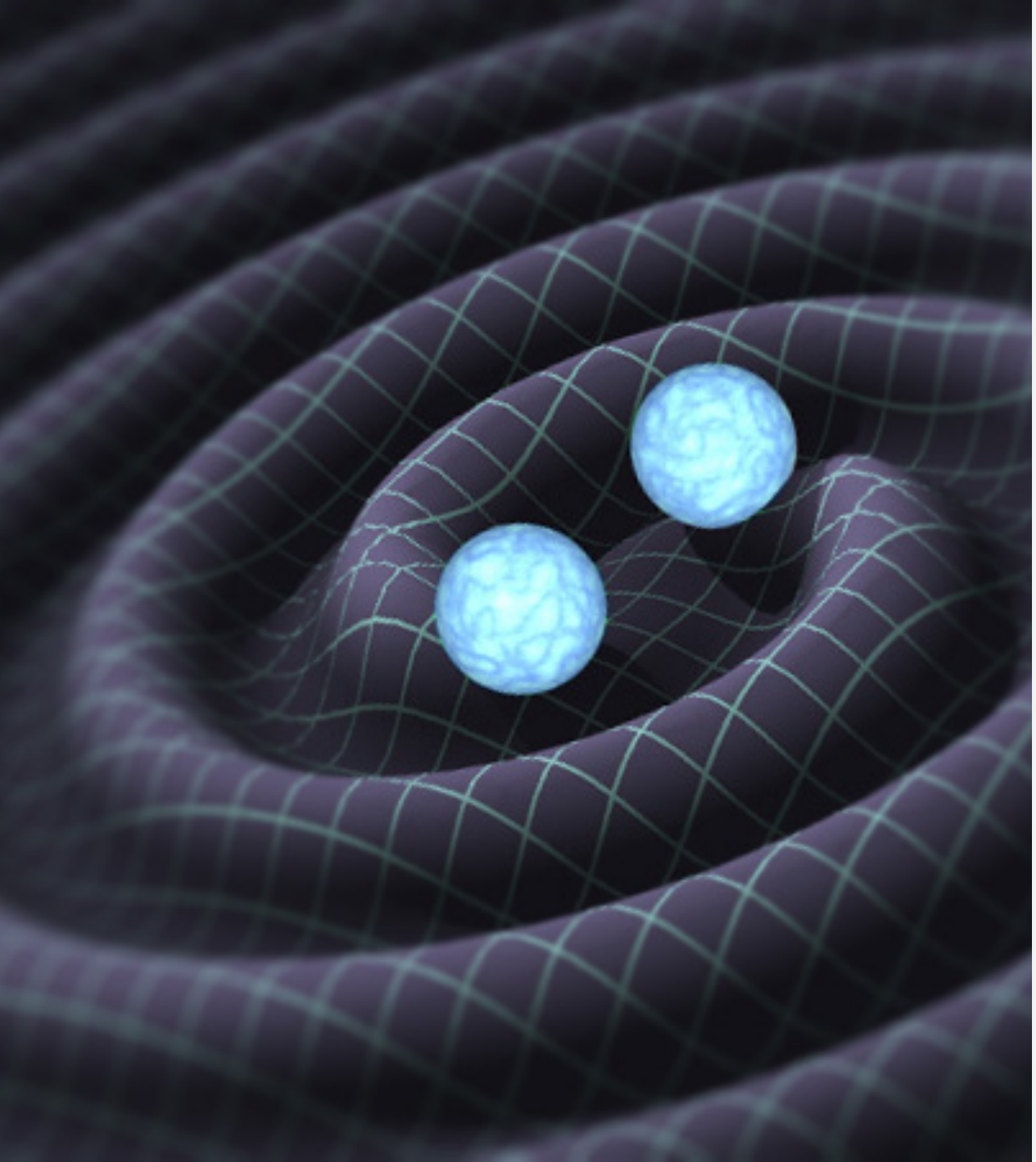
GENERAL RELATIVITY

- Einstein's general relativity improved Newtonian gravity to deal with relatively strong-field experiments.
- Gravitational force is caused by curvature of spacetime.
  - Mass distorts spacetime
  - Spacetime distortion moves matter

NEW STARS IN GENERAL RELATIVITY

- New types of special compact stars emerge such as black holes and pulsars.
- A black hole bends space so much that nothing, including light, can escape it.
- A pulsar is as heavy as the sun but around the same width as Washington DC.





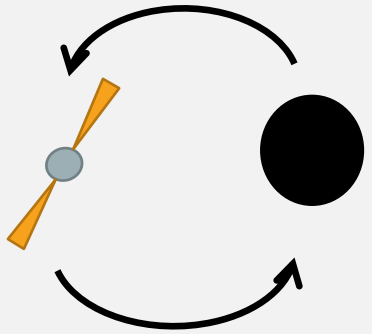
GRAVITATIONAL WAVES IN ASTROPHYSICAL BINARIES

- General relativity also predicted that orbiting heavy objects emit gravitational waves (ripples of spacetime).
- Gravitational waves emit energy, so stars spiral together.
  - This decreases the orbital period.
- 2017 Nobel Prize awarded to LIGO for first direct gravitational wave detection!

EXPERIMENTAL SETUP

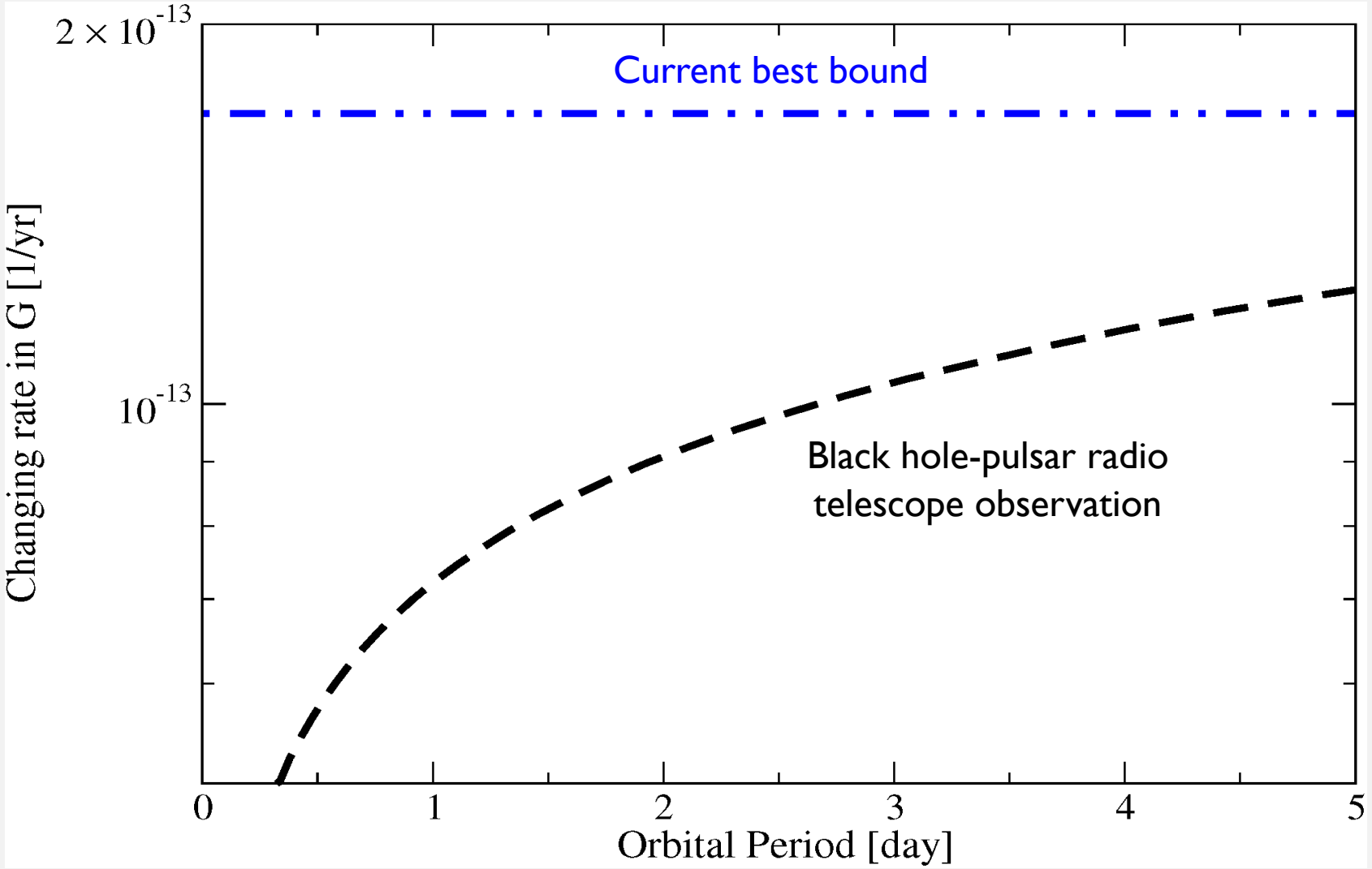
- Radio telescopes and gravitational wave observatories have found double black hole and double pulsar binaries and are actively searching for a black hole – pulsar binary.
- When one is found, observations of orbital period change will be powerful for testing general relativity.
- We can test if the gravitational constant is truly constant by observing the binary.

Radio Telescope



Black Hole-Pulsar Binary

BOUNDS ON A CHANGING GRAVITATIONAL CONSTANT



CONCLUSION AND FUTURE WORK

- General relativity is the best current theory of gravity.
- Gravitational waves have a promising powerful future for understanding our universe.
- A black hole – pulsar binary will present new ways to test general relativity.