

Ch1_Statement_of_GR

Questions of the chapter

1. Definition of mass in Newton's 2nd law. Definition of mass in Gravitational law
2. What is statement of geodesic hypothesis
3. Combined with geodesics, what phenomenon gives away the curvature of spacetime

Interpreting Newton's Gravitation law

- Mass of an object in Newton's Gravitational law and Newton's 2nd law are different entity
- m_g in gravitational law represent how strong would the object **couple to gravitational field**.

$$\frac{GM}{r^2} m_G = F_g$$

- m_I in 2nd law represent how strong the object **resist to accelerate** when acted upon by a force

$$F_g = m_I a$$

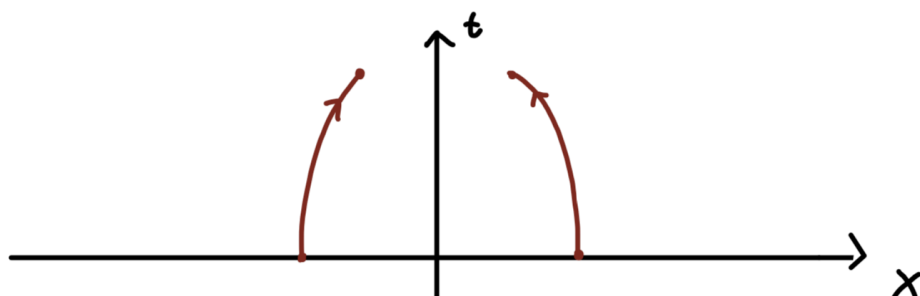
The Geodesic Hypothesis

The **geodesic hypothesis** states:

- A free particle follows a geodesics in spacetime
 - **Geodesic** is the path of shortest distance (minimal) between two points
 - A particle is **Free particle** if it is only under effect of gravitational effects

The implication of geodesic hypothesis:

1. On earth, a bullet and a ball moves from point A to B with different speed in two distinct parabola, two distinct path. If geodesic is unique between two point in *space*, shouldn't they follow the same path? No, because the endpoint might be same location, but is different in time, thus two distinct endpoints for bullet and ball in spacetime.
2. m_I and m_G would be essentially the same number
3. ? The weight actually measures our tendency to resist acceleration instead of our couple strength to gravitational field
4. Earth's surface frame is not inertial. Objects in this frame are not free particles
5. Two free falling objects separated horizontally by a distance would come closer as they fall. This has two implications:
 1. Variation in gravitational field is observable in an inertial frame.
 2. **Spacetime is curved**. Two object all followed their geodesic. Drawing them out on a spacetime diagram would trace out two geodesics that is curved.



The curved spacetime leads to the development of Einstein's Equation. Which states that the curvature of spacetime(as a tensor) is related to the density of matter and energy and their flow. Which leads to the main statement of general relativity:

-  Spacetime tells matter how to move. Matter tells spacetime how to curve