Gravity

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1 Introduction to Classical Mechanics

In Classical Mechanis (CM) time and space are treated as two distinct concepts. Events are identified by their position in some frame of reference, represented by a vector $\boldsymbol{r}$, and the time at which they occur, represented by a scalar t.
The simplest formulation of CM can be summarised in three laws and is based on the concept of **force**. A force $\boldsymbol{F}$ is a vector quantity representing an interaction between two bodies. This formulation is (unduly) credited to Newton because it was first published as a unified theory in the *Principia*.

- **N0 Principle of Superposition:** the net force on a body is the vector sum of the individual forces acting on it.
- **N1 Law of Inertia:** an inertial frame of reference is one where, in the absence of external interactions, bodies are in uniform linear motion.
- **N2 Law of Acceleration:** in an inertial frame of reference the acceleration of a body is directly proportional to the net force acting on it.
- **N3 Law of Reaction:** when a body exerts a force on another it is subject to a force equal in magnitude and opposite in direction produced by the second body.

Law **N2** can be used to introduce the concept of **inertial mass** m, which is taken as the proportionality constant between force and acceleration. The law can then be stated with the following equation.

$$\boldsymbol{F} = m\ddot{\boldsymbol{r}} \tag{N2}$$

2 Galilean gravity

The simplest theory of gravity in our possession is due to Galileo and simply states that acceleration due to gravity is constant, regardless of the size, velocity or position of a body.

In hindsight, Galilean gravity can be thought of as gravity in the limit where Earth is and indefinitely extended plane with a uniform mass distribution.

$$\ddot{\boldsymbol{r}} = \boldsymbol{g}$$

This theory, although excessively simple, lays the foundation of the **Equivalence Principle**. One of many possible statements of this principle is that the trajectory of a body subject to gravity is only dependent upon its initial position and velocity. This principle is backed up by all experimental evidence to date.

3 Hookean gravity