

### What is Theoretical Physics?

The aim of physics is to understand the phenomena around us: we are trying to discover and understand the laws of causes and effects. For example, when you lift a ball and let it go, it falls. Physics is here to find out the law of the way it falls -- its trajectory -- and on the time it takes to fall down.

Generally, physicists use theories to make predictions and carry out experiments to test the predictions. In the case of the falling ball, there are two main theories of gravitation: Newtonian gravitation and General Relativity. Both describe the way bodies act on one another but they describe this in different ways. Theoretical physicists invent and study theories. These theories are written in a mathematical language and use mathematical tools. The discipline of mathematical physics focuses on the more formal aspects of physics.

### How can we know when a theory is valid?

Why are there different theories to describe the same phenomenon -- in this case, gravitation? Before answering this question, we are delighted when there is at least one theory! Some phenomena haven't yet found a satisfying theory. Competing theories need experiments to decide among them.

Coming back to gravitation, the Newtonian theory was invented in the 17th century and it enabled us to understand the planets' motions around the sun. Nevertheless, this theory couldn't explain some phenomena in a satisfying way, particularly subtle motions of the orbit of the planet Mercury. A new theory had to be found, and General Relativity was born, Einstein's greatest invention. It explained Mercury's peculiar motions perfectly. And, it predicted that starlight passing close to a massive body such as the sun would bend (slightly)! This prediction was triumphantly confirmed during a solar eclipse in 1919! Here, then, is a fundamental premise of physics: experiment is the only way to decide which theory provides the best description of a body of phenomena.

### What about LAPTh?

Scientific activities of the LAPTh group can be divided in three main themes:

- Mathematical physics
- Phenomenology
- Astrophysics of particles