

quantitative reasoning, mathematical modelling, prediction and verification or falsification of theories. Speculation and conjecture also have a place in science; but ultimately, a scientific theory, to be acceptable, must be verified by relevant observations or experiments. There is much philosophical debate about the nature and method of science that we need not discuss here.

The interplay of theory and observation (or experiment) is basic to the progress of science. Science is ever dynamic. There is no 'final' theory in science and no unquestioned authority among scientists. As observations improve in detail and precision or experiments yield new results, theories must account for them, if necessary, by introducing modifications. Sometimes the modifications may not be drastic and may lie within the framework of existing theory. For example, when Johannes Kepler (1571-1630) examined the extensive data on planetary motion collected by Tycho Brahe (1546-1601), the planetary circular orbits in heliocentric theory (sun at the centre of the solar system) imagined by Nicolas Copernicus (1473-1543) had to be replaced by elliptical orbits to fit the data better. Occasionally, however, the existing theory is simply unable to explain new observations. This causes a major upheaval in science. In the beginning of the twentieth century, it was realised that Newtonian mechanics, till then a very successful theory, could not explain some of the most basic features of atomic phenomena. Similarly, the then accepted wave picture of light failed to explain the photoelectric effect properly. This led to the development of a radically new theory (*Quantum Mechanics*) to deal with atomic and molecular phenomena.

Just as a new experiment may suggest an alternative theoretical model, a theoretical advance may suggest what to look for in some experiments. The result of experiment of scattering of alpha particles by gold foil, in 1911 by Ernest Rutherford (1871-1937) established the nuclear model of the atom, which then became the basis of the quantum theory of hydrogen atom given in 1913 by Niels Bohr (1885-1962). On the other hand, the concept of antiparticle was first introduced theoretically by Paul Dirac (1902-1984) in 1930 and confirmed two years later by the experimental discovery of positron (antielectron) by Carl Anderson.

Physics is a basic discipline in the category of **Natural Sciences**, which also includes other disciplines like Chemistry and Biology. The word **Physics** comes from a Greek word meaning nature. Its Sanskrit equivalent is *Bhautiki* that is used to refer to the study of the physical world. A precise definition of this discipline is neither possible nor necessary. We can broadly describe physics as a study of the basic laws of nature and their manifestation in different natural phenomena. The scope of physics is described briefly in the next section. Here we remark on two principal thrusts in physics : **unification and reduction**.

In Physics, we attempt to explain diverse physical phenomena **in terms of a few concepts and laws**. The effort is to see the physical world as manifestation of some universal laws in different domains and conditions. For example, the same law of gravitation (given by Newton) describes the fall of an apple to the ground, the motion of the moon around the earth and the motion of planets around the sun. Similarly, the basic laws of electromagnetism (Maxwell's equations) govern all electric and magnetic phenomena. The attempts to unify fundamental forces of nature (section 1.4) reflect this same quest for unification.

A related effort is to derive the properties of a bigger, more complex, system from the properties and interactions of its constituent simpler parts. This approach is called **reductionism** and is at the heart of physics. For example, the subject of thermodynamics, developed in the nineteenth century, deals with bulk systems in terms of macroscopic quantities such as temperature, internal energy, entropy, etc. Subsequently, the subjects of kinetic theory and statistical mechanics interpreted these quantities in terms of the properties of the molecular constituents of the bulk system. In particular, the temperature was seen to be related to the average kinetic energy of molecules of the system.

1.2 SCOPE AND EXCITEMENT OF PHYSICS

We can get some idea of the scope of physics by looking at its various sub-disciplines. Basically, there are two domains of interest : macroscopic and microscopic. The macroscopic domain includes phenomena at the laboratory, terrestrial and astronomical scales. The microscopic domain includes atomic, molecular and nuclear