1.1 THE WORLD OF PHYSICS

Welcome to physics - the most fundamental science.

Physics is devoted to the understanding of all natural phenomena. In physics we try to understand physical phenomena at all scales, from the world of subatomic particles to the entire universe. Despite the breadth of the subject, various subfields of physics share a common core. The same basic training in physics will prepare you to work in any area of physics and related areas of science and engineering.

Introductory courses in physics follow the historical development of the subject with the **classical physics** or the pre-1900 physics, followed by the modern physics or the post-1900 physics. Newtonian mechanics is the foundation of classical physics and we will begin with a thorough treatment of the subject. You will learn to examine the world from the mechanical viewpoint of Sir Isaac Newton (1642-1727), the great architect of mechanics and Calculus, among other things. After you have mastered the basics of Newtonian mechanics, you will learn how to apply Newton's laws of motion to such diverse areas as gravitation, fluids, waves and sound.

Part 1 of this textbook is devoted entirely to these topics. Often heat is also included in a course on the classical physics. Part 2 gives an introductory treatment of the laws of thermodynamics. Part 3 covers the subject of electricity and magnetism. Finally, in part 4 of this textbook you will study the fundamentals of optics. A course on Modern physics usually covers special relativity and introductory quantum mechanics and you will be taught these topics in a future course.

A physicist's understanding of the nature is usually expressed in **conjectures, theories, and laws**, which are usually expressed mathematically. Expressing the laws of physics mathematically allows one to investigate and deduce their implications more fully. Therefore, a solid training in mathematics is essential for a student to appreciate and understand the laws of physics. Classical physics uses calculus extensively. This book will use calculus to express the ideas of physics more precisely.

Nature is quite complicated. Over the past several centuries physicists have discovered a number of laws that have universal applicability but they are not necessarily infallible. The laws of physics summarize the current understanding of the nature. A particular theory's merits are decided on how well its predictions hold up against

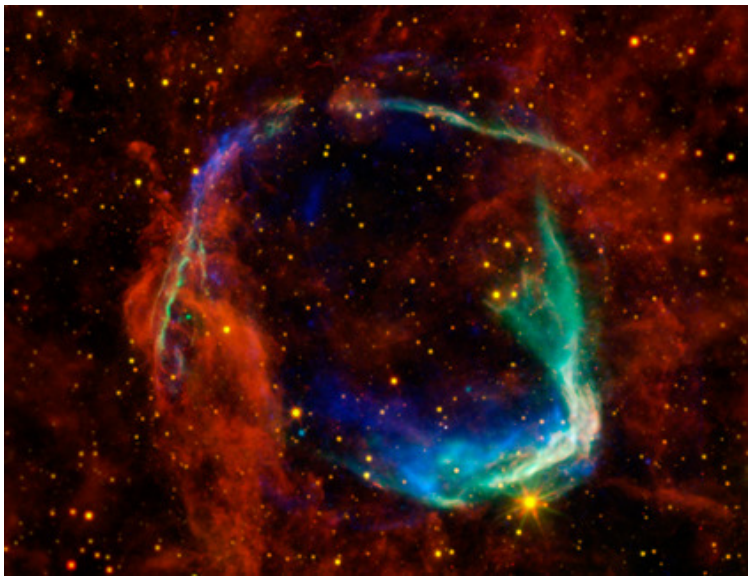

Figure 1.1: The image of the oldest recorded supernova RW86 observed by Chinese in 185 A.D. The bluish color are in the X-ray from NASA's Chandra X-ray Observatory and the European Space Agency's XMM-Newton Observatory and the yellow and red are infrared data from NASA's Spitzer Space Telescope, as well as NASA's Wide-Field Infrared Survey Explorer (WISE). The Chinese had recorded that the guest star remained in the sky for eight months.Credits: X-ray: NASA/CXC/SAO & ESA; Infared: NASA/JPL-Caltech/B. Williams (NCSU).

reproducible experiments or observations. This makes physics an **empirical science**, although physicists do spend much time developing models and theories. In physics, experiments and theory complement one another, and together, they provide the most powerful tools at our disposal for unlocking the mysteries of nature.

The **theories** in physics range from the empirical to the abstract. Often a theory is simply a model or a mental image that helps grasp the experimental observations better. Theories may also suggest new experiments to render the physical situation clearer. Physicists also explore theories that seek to unearth the abstract principles that can explain a number of phenomena. Although the words - theory and model - are often used interchangeably, theories are usually understood to mean more general ideas while models usually refer to a particular phenomenon.

When many predictions of a general theory have been tested and found to be correct, the theory gains the status of a **law of physics**. The testing of the predictions of laws is usually limited by the development in technology, which itself is guided by a progress in physics, and/or the human ingenuity. With increased precision, or an access

to some previously inaccessible physical conditions, or some hitherto unimagined experiment, the old accepted laws are often tested in new ways.

Sometimes, new tests show flaws in the accepted laws. Since many such exciting discoveries have been made in the past, physicists keep an open mind about their subject and treat the presently accepted laws as tentative. If a law is inconsistent with reliable observations, then either the law is modified or a new theory is invented to replace the old one. In this sense, physics is quite dynamic, changing continuously as our understanding of the world improves. Whether this process of correcting and replacing the old laws with new ones will ever end up with the eventual discovery of "the final laws" is unclear at this time since we do not know if such immutable final laws even exist.