Chapter 1: Physical Foundation

We will first introduce related fundamental physical knowledge.

1.1. Physical World

As we all know, everything in the world is made of atoms. There are about more than one hundred kinds of atoms including artificial atoms. Atom is constructed by nucleus and electrons; Nucleus is constructed by protons and neutrons. These are all matters, and photon is matter as well.

Briefly, matter is proton, neutron, electron and photon, and all the things formed and derived from them. Its basic character is that it can be measured.

All newly discovered matters, including new galaxy, new comet, new species, new element, new particle, have undergone the process of first discovery and later validation by others. If a thing was only first discovered, but cannot be tested by others, then it is not matter and this discovery cannot be accepted.

Deity, spirit, immortal and Buddha are not matter. Their characteristic is that if you believe, they exist; if your do not believe, they do not exist.

Are unidentified flying objects (UFO) matters? Are they in reality? For UFO, we should investigate study, analyze and judge concretely for each event individually.

One UFO observed by many persons should be considered as real, because their results can validate each other. In fact, after follow-up investigations and serious researches, many UFO were identified as meteorological balloons, military stealth aircrafts etc. These things were not identified immediately because people were not familiar with them or the climate was special at that time.

Experience of one person with UFO is not considered as real, because it lacks of validation.

To know more about UFO, please see the book of C. Sagan (*The Demon-Haunted World, Random House* 1996)

All matters have two basic properties, one is inertia, and another is attraction to each other.

Basketball and shot will still move forward after toss; after you turn off the gas of planes and cars, they will still going forward; chairs cannot move by themselves. Without force, all matter maintains their original motion state of rest or uniform rectilinear. This is inertia. To quantitatively describe the inertia of matter, we definite a physical quantity--mass. When apply a force on an object, it will be accelerated, Newton second law told us the acceleration is in proportion to the force. This ratio constant is defined as the mass of the matter.

An egg will fall from the table when it is rolling to the edge; in autumn, leaves will drop from the trees; an object thrown to the air will fall down; satellite and moon revolve around the earth; the earth revolves around the sun. These things happen because matters attract each other. Gravitational force between two objects is proportional to the mass of these objects, and inverse proportional to squared distance between these objects. And the proportional constant is called as gravitational constant, normally presented as *G*, it is equal to $G = 6.67259 \times 10^{13}\ \mathrm{Ncm^2 \cdot g^{-2}}$. We can weight matters because there is gravitation between matters and the earth.

1.2. Mass

Since the masses defined by these two basic properties are equal to each other, mass is defined as the quantity of matter. In International System of Unit (SI), unit of mass is the quantity of a standard body of alloy of platinum and iridium, preserved in Paris. The method of quantitatively measurement of mass needs to use both of the two basic properties stated above.

As we know, matters normally appear in three states: solid state, liquid state and gas state. Solid matters are in a state with fixed size and shape. Normally they are called as solid matter, such as stones, metal and wood etc. Liquid matters do not have fixed shapes, they are mobile and their density is similar to solid matters. They are not easy to be compressed. The most abundant liquid matter is water, oil and mercury. Gas matters do not have fixed shape, they are very easy to move and their density is far less than solid and liquid. They are also easy to be compressed. The most abundant gas matter is air, and there are water vapor, coal gas, natural gas and all kinds of vapor.

Under certain conditions, all states of matter can transform to each other. In spring, ice will turn to water. Water will evaporate to vapor. Coal will turn to carbon dioxide and ashes after burn and emit light and heat.

During all reactions, quantity of matter does not change. This is the law of conservation mass: for any isolated system, the system mass will not change. A system is a quantified mass; an isolated system is a system which does not have any mass, energy change with other matters, and there is no related system. One kilogram of ice will thaw to one kilogram of water; and it will evaporate to one kilogram of vapor.

Principle of mass conservation is a universal law.

1.3. Energy

Horses are running, rams are jumping, clouds are flowing, and winds are blowing. All matters are in motion. Motion is absolute, static is relative. A man sitting in a running train is static relative to the carriage. However, he is in motion relative to the ground. A man sleeping on bed is static relative to the ground, but he moves around the sun along with the earth. This is macro motion. From the micro perspective, a man's heart is beating, blood is flowing, cells are metabolizing all the time. In the morning, there are always hairs left on the pillow. This is the result of skin and hair motion for a whole night. Living things have metabolic motion; non-living things have micro motion too. Rocks seem unchanged. However, they will expand with heat and contract with cold as the temperature change between day and night. Rocks will weather gradually.

To quantitatively describe motion, energy is defined. Energy is the quantity of motion.

Energy can be divided into two categories, kinetic energy and potential energy.

Kinetic energy is the ability of matter moving to do work. For example, air moving (wind) can move sailing boat and windmill to do work; water flowing can move waterwheel and ship to do work. Therefore, wind energy, water energy are all kinetic energy.

Potential energy is the ability of matter when it is in a state. Besides, this ability can transform to kinetic energy under certain condition. For example, when the striker of a wall clock gradually falling down it will move the pendulum to do work; when it is not falling down to the bottom, it has potential energy. Potential energy is a kind of stored energy.

From the motion formation of matters, kinetic energy can be divided into mechanical kinetic energy, molecular (particle) random kinetic energy (also called inner energy), sound energy, light energy etc; potential energy can be divided into gravitational potential energy, elastic potential energy, electromagnetic potential energy etc. All forms of energy can transform between each other. The potential energy of water in a dam will transform to kinetic energy when it flows down, and after it go into turbo generator the energy will transform to electric energy. In all the process of energy transformation, energy cannot increase or decrease. This is the law of energy conservation: energy of an isolated system maintain constant. It is a universal law.

1.4. Space and Time

As we know, matters have sizes. A table normal has a height about 80 centimeters. The diameter of a football is about 20 centimeter. The radius of the earth is about 6400 kilometer. All the examples indicate that matter has extensive property.

When matters move, their position will change. Take swimming for an example. The length of a swimming pool is about 50 meter.

Space is defined as extensive property of matter and its motion.

Space can be measured.

All people who have been to a theater know this fact. In order to identify a seat, we need to know the number, row and layer. A table has length, width and height. All the examples indicate that space has three dimensions. One dimension is a line, two dimensions is a plane. Space in reality is three dimensional. One dimension and two dimensions are got by ignoring other dimensions. For example, a piece of paper can be treated as a two dimensional space. However, it must be very thin. If it is thick so long as its thickness must be considered, it is three dimensional.