CHAPTER 2

THE HARMONIC UNIVERSE

Harmonic motion

The contraction

Gravitation

Energy and Time

The motion of the Universe

> My God is a Goddess. She is the ruler of creation and evolution and Her laws are divine manifestations that cannot be broken by man. She does not care about our convictions or what we here on Earth believe is right or wrong or what we do or not do. After all we are not alone, there are more heavenly bodies in the Universe than sand pebbles on all our beaches and our presence here on Earth is less than one tick on the cosmological clock and our time might already be running out. My Goddess often seems cruel and hard but Her realm and Her creations are most beautiful and aesthetic. I have spent a lifetime studying Her laws and have learned how to live with them in harmony. She has taught me the art of living to be honest and fair and I am thankful for having been a small part of Her world. My Goddess is Mother Nature.

2.1 Harmonic motion

A periodic motion such as the swing of a pendulum or the circular movement of a planet in its orbit must obey the laws of harmonic motion. The name "harmonic" refers to mathematical functions that involve sines and cosines and periodic motions can be accurately described by such functions. A "simple" harmonic motion is usually associated with a to-and-fro movement of a mass about a central point. A typical example of such a motion is the piston in an engine or a weight at the end of a spring, see Fig. 3. A simple harmonic motion is characterized by the fact that the acceleration of the mass is zero as it passes through the central point, $x=0$, of the oscillation and increases on either side of $x=0$ with distance. The velocity of the mass on the other hand, is highest at the center and zero at the maximum amplitude or turn around point where $x=A$. A typical example of a simple harmonic motion involving gravity would be to imagine a hole drilled through the Earth from pole to pole. If we drop a stone through the hole it would accelerate and increase its velocity of fall until the acceleration reaches zero as it passes through the Earth's center. The velocity on the other hand, starts at zero and reaches a maximum as it goes through the Earth's center after which deceleration sets in bringing the stone to a stop as it reaches the other pole.

In a uniform circular motion, such as a planet orbiting the Sun, both acceleration and velocity remain constant. Here, the inward gravitational attraction is equal to the outward centrifugal force created by the rotation.

The frequency of oscillation is the number of turns or cycles per second completed by the oscillator and is usually expressed as Hertz (Hz). Instead of using turns per second (each turn equals 360° of rotation) we can also use angles per second based on the radian system where one radian$=360^o/2\pi=57.3^o$ standard degrees. Radians per second (57.3^o/s) is generally denoted by the symbol ω and is referred to as angular frequency or angular velocity. The name "radian" stems from the fact that the circumference of a circle equals $2\pi r=6.28$ radii and the distance of one radius along the circumference equals 57.3^o.

The relationship between a simple harmonic motion and a uniform circular motion can be demonstrated by connecting a piston to a flywheel as shown in Fig. 3b, where the handle on the flywheel, follows a perfect circular motion in unison with the to-and-fro motion of the piston. A circular motion can also appear as simple harmonic motion, as demonstrated in Fig. 3c, where the flywheel handle appears to move up and down in a to-and-fro motion when viewed sideways.

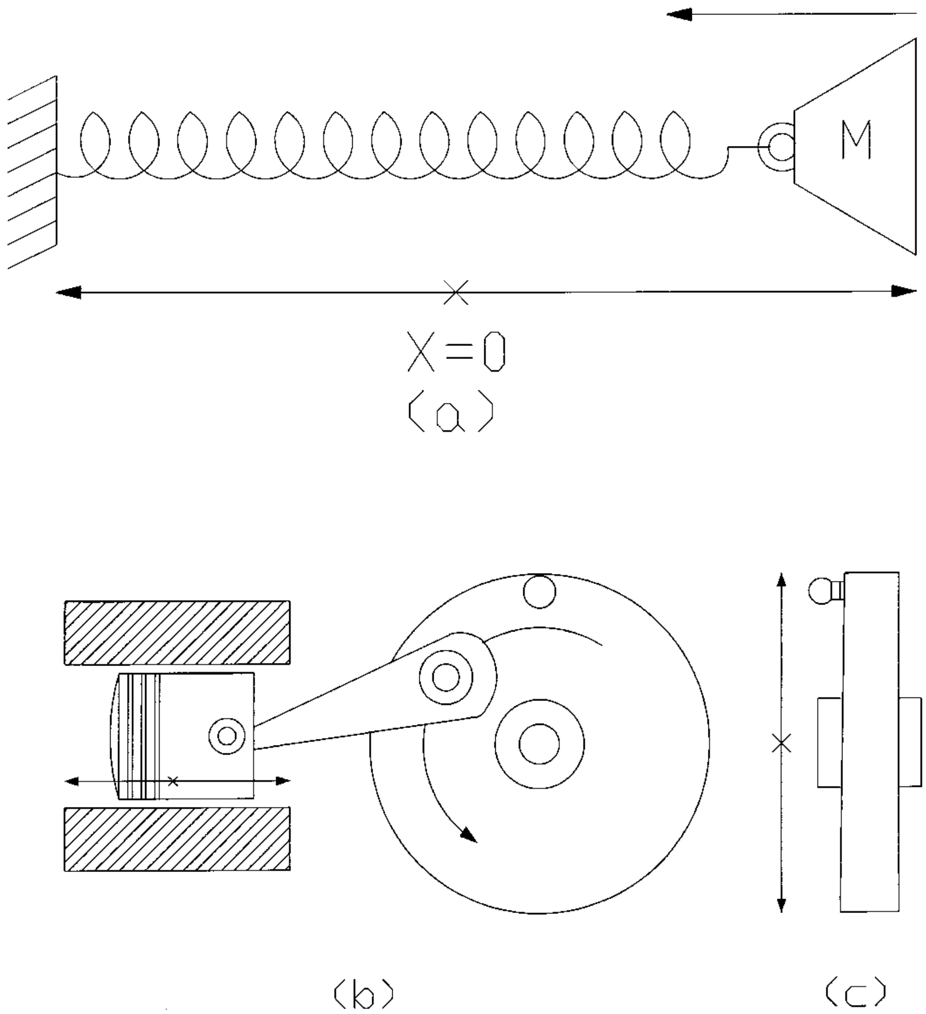

Fig. 3a. The to-and-fro motion of a weight at the end of a spring performing simple harmonic motions. b) A flywheel and a piston demonstrating the relationship between a circular harmonic motion and a simple harmonic motion. c) The apparent simple harmonic motion of a flywheel handle viewed edge on.

A harmonic motion could theoretically go on for ever without energy being added, assuming that there is no friction slowing it down. When friction sets in, the stored energy of the harmonic motion will dissipate into heat or radiation, which eventually brings the harmonic motion to a standstill. Friction, or loss of energy, has a damping effect on oscillations so that the flywheel in Fig. 3b and 3c will gradually slow down and change frequency to a value that approaches zero. In the case of the spring and weight oscillator shown in Fig. 3a, the frequency remains nearly the same, but the amplitude of the oscillations will diminish to zero as friction sets in. If the energy loss is so large that the oscillation dies out in less than one cycle, the harmonic motion is said to be critically damped. A golf ball dropped from a given height might bounce up and down several times before the damping action, or friction brings it to rest whereas a sandbag, on the other hand, would perform a "deadbeat" since it is critically damped.

Harmonic oscillators, such as electrons in atomic orbits or galaxies and planets in motion around gravitational centers of mass, behave in a rather peculiar way when exposed to damping and subsequent loss of stored (potential) energy. Should we be able to slow down a planet in its circular motion around the Sun it would fall into a closer orbit and its orbital velocity and frequency would increase. Alternatively, adding energy to the planet by increasing its orbital velocity would sling it out to a larger orbit, but slower orbital velocity. This seemingly paradoxical behavior, where added energy results in a decrease of velocity and where loss of energy produces an increase in velocity, is not what we usually experience during our daily routine on Earth, where additional energy seems to make everything go faster. However, we now know from experience that the velocity of a manmade satellite increases due to loss of energy by friction as it encounters the Earth's upper atmosphere and spirals closer to Earth. This **inverse energy-velocity relationship** is not only a characteristic of orbiting planets and manmade satellites, but it also applies to orbital electrons, galaxies and the Universe as a whole.

An expanding-contracting Universe can be classified as a simple harmonic oscillator in which the oscillations could go on forever, unless damped by loss of potential energy. A deadbeat, or critically damped Universe, would perform only one cycle of oscillation and all matter contained therein would lose energy and inertial mass to radiation within one cycle while accelerating toward the center, the center of mass of the Universe. We know from practice that matter radiates when subject to acceleration and the evidence so far is that the

Universe is losing potential energy, or mass, in the form of heat and light emitted by stars and galaxies. The observed loss of potential energy and mass and subsequent release of radiation, hints to a deadbeat Universe in a phase of collapse.

2.2 The contraction

The view taken by the author is of a critically damped contracting Universe, in which the laws of harmonic motion must be obeyed. The diagram in Fig. 4 shows the Universe as a simple harmonic oscillator in a phase of contraction (a). A comparison of the Universe to the harmonic motion of a weight at the end of a spring is shown in (b) and to a uniform circular motion in (c). Included in the diagram of Fig. 4 (see also page 146) is a list of several basic equations related to the behavior of harmonic motion and which are described in chapters that follow.

In a contracting Universe matter must be subject to an attractive force directed toward a central point, $x = 0$, the center of mass of the Universe. The inward attraction, which is created by the mutual gravitational field of all matter in the Universe, determines the rate of the cosmic acceleration a_0. In contrast to the theories of relativity, which allow us to consider ourselves at the center of the Universe and at rest, our present position must fall within a distance between $x = 0$ and the maximum amplitude $x = A$. Also, our velocity relative to the center of mass of the Universe must have a value which complies with the mathematical relation $v_0 = A\omega_0 \sin 45°$ where ω_0 is the frequency of the Universe in angular units.

If any two parameters could be found which relate to the harmonic motion of the Universe, such as the velocity v_0 and acceleration a_0, for example, it would be possible to excerpt many other features using the equations shown in Fig. 4 and on page 146. These features could then be used in a realistic comparison with scientific facts already known to us.

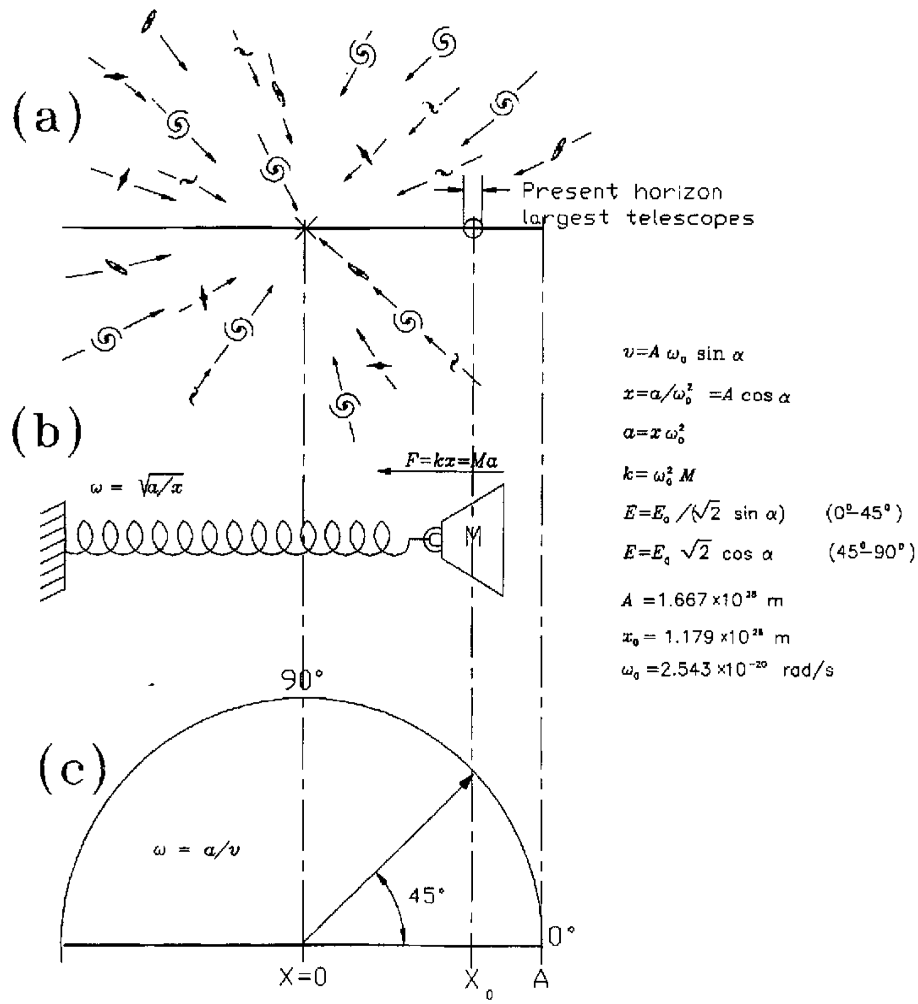

Fig.4a. The simple harmonic motion of the Universe in a phase of contraction. (b) The Universe compared to a simple harmonic motion of a weight at the end of a spring. (c) The simple harmonic motion of the Universe as related to a uniform circular motion.

By good fortune, exact values of velocity and acceleration are accessible from both astronomical red-shift measurements and from certain actions postulated by quantum mechanics. Red-shifts of distant galaxies show that we are moving with a velocity equal to or very near *c*, the speed of light, with respect to distant matter. Heisenberg's "Uncertainty Principle", a product of quantum mechanics, proves that matter is subject to a cosmic acceleration (Wåhlin (1981)), because it predicts an ever present change in both momentum and position of matter, which can only be explained by a change in velocity. Change in velocity is the manifestation of acceleration.

Once our velocity of fall and rate of acceleration towards the center of mass of the Universe have been established, numerous other parameters can be found, such as frequency of oscillation, distance to the center, total mass, mass density and temperature, see Table 1. In the chapters that follow it will be explained in more detail how the velocity and acceleration are established and how many other properties of the Universe, including those listed in Table 1, can be unveiled.

TABLE 1

1. Velocity: $c = 2.997924 \times 10^{8}\,\mathrm{m\ s^{-1}}$.

2. Inward acceleration: $a_0 = \frac{1}{2}\hbar\omega_1^2 / m_e c = 7.62247 \times 10^{-12}\,\mathrm{m\ s^{-2}}$.

3. Our position relative to the center: $x_0 = c^2 / a_0 = 1.17908 \times 10^{28}\,\mathrm{m}$.

4. Angular frequency: $\omega_0 = a_0 / c = 2.54258 \times 10^{-20}\,\mathrm{rad\ s^{-1}}$.

5. Period (Hubble's time): $t_0 = 2\pi / \omega_0 = 2.47118 \times 10^{20}\,\mathrm{s}$.

6. Total mass of Universe within x_0: $M_u = x_0^2 a_0 / G = 1.59486 \times 10^{55}\,\mathrm{kg}$.

7. Mass density: $\rho = a_0 / (\frac{4}{3}\pi G x_0) = 2.32273 \times 10^{-30}\,\mathrm{kg\ m^{-3}}$.

8. Potential energy of the Universe within x_0: $E = M_u c^2$.

9. Radiation: $L_u = M_u c^2 / t_0 = M_u a_0 c / 2\pi = \frac{1}{2}\ddot{h} M_u / m_e = 5.80044 \times 10^{51}\,\mathrm{w}$.

10. Temperature: $T = \left[M_u c^2 / (t_0 4\pi x_0^2 \sigma\right]^{1/4} = \left[a_0 c^2 / G t_0 4\pi\sigma\right]^{1/4} = 2.766\,^\circ\mathrm{K}$.

11. Red-shifts: $z \approx (2a_0 \Delta x)^{\frac{1}{2}} / c$. (non-relativistic).

12. Energy density of radiation: $U_r = 6\pi T^4 \sigma / c = 2.08756 \times 10^{-13}$ J m^{-3}.

13. Energy density of matter: $U_m = \rho c^2 = 2.08756 \times 10^{-13}$ J m^{-3}.

14. Planck's constant: $\frac{1}{2} h / 2\pi = \frac{1}{2}\hbar = m_e a_0 c / \omega_1^2 = 5.2729 \times 10^{-35}$ J ω_1^{-1}.

15. Gravitational const.: $G = (q / m_e)^4 \ddot{h} \mu_0^2 / (16\pi c) = 6.6445 \times 10^{-11}$ Nm^{2}kg^{-2}.

$q / m_e =$ electron's charge to mass ratio, $\omega_1 = 2\pi \text{s}^{-1}$, $\ddot{h} = h \text{s}^{-2}$,

$\sigma =$ Stephan-Boltzmann's costant.

The picture that emerges from the above physical and mathematical expressions, is of a Universe that is about 100 times larger than current estimates, see (3) Table 1. This means that we can only observe a small fraction of the Universe from our vantage point in space at x_0. The small circle around x_0 in Fig. 4a, outlines the horizon of our most powerful telescopes of today.

A one cycle (critically damped) Universe dissipates all its potential energy to radiation (8) over one period of oscillation (5), which means that all matter will vanish before reaching the center. This would be analogous to an electron dissipating its potential energy to radiation while falling towards the atomic nucleus. The calculated rate of radiation (9) matches the amount of radiation observed in our Universe and the same equations allow us to determine the rate of radiation from individual material bodies in the Universe. For example, the radiant energy from our Sun equals the Sun's potential energy divided by the period of the Universe or $M_{\text{sun}} c^2 / t_0 = 7 \times 10^{26}$ watts. The total radiation from all stars and galaxies in the Universe contribute to a black-body temperature just like the heating elements in a heating oven produce a specific oven temperature. The temperature of the Universe (10) can therefore be calculated to equal 2.766 degrees Kelvin, using Stefan's law of radiation.

An interesting observation is that the cosmic energy density of radiation (12) and the energy density of matter (13) are equal. This suggests that there is an equilibrium between matter and radiation, which favors the idea of continuous creation proposed by Hoyle (1948), and Bondi and Gold (1948), see Chapter 7, sec. 7.4. For example, it is a known fact that matter can be created by radiation which is proven by the process of pair production where photons convert into one electron and one positron. Hoyle, Bondi and Gold championed a steady state Universe in which everything would remain the same, such as mass density, radiation and temperature. The Big Bang theory however, predicts that the Universe expands and therefore gets thinner and cooler with time. The above authors suggested that spontaneous or continuous creation of matter, would remedy these changes, by filling the void left behind by the expansion with new matter, thus keeping the matter density of the Universe constant. Unfortunately, the steady state theory and continuous creation did not get much support.

2.3 Gravitation

Another remarkable feature of a collapsing Universe is that the universal gravitational constant G can be determined from Planck's constant h, because Planck's constant relates to the value of the inward cosmic acceleration a_0 (2). This relationship, shown by (15) in Table 1, is of great importance because it establishes a connection between gravitation and quantum theory. The theoretical value of G (15) is about 0.004 times less than the measured value at the Earth's surface. A possible explanation of this discrepancy is that the theoretical number represents the astronomical free-space value of G and that measurements near the Earth's surface might deviate slightly in accordance with experimental claims which show an increase in G at short range near massive bodies.

2.4 Energy and Time

The main substance in the Universe is Energy, which appears in the form of inertial mass (potential energy) and electromagnetic radiation (loss of inertial mass). That mass and energy are related was proposed by Hasenöhrl 1905 and Albert Einstein (1906) who concluded that inertial mass m of a body contains an energy of mc^2. Inertial mass and gravitational mass are commonly believed to be equivalent which might be debatable. The term inertia refers to the fact that mass can be measured by its resistance (inertia) to acceleration. A body which accelerates to where its velocity increases by 1 m/s every second, when subject to a force of one newton, has an inertial mass of one kilogram.

As previously mentioned, mass and weight are not quite the same thing, although the measured quantity is the same. Weight is really a measure of the Earth's gravitational force, $g \times m$, on a mass placed on a weighing scale, where g is the Earth's gravitational acceleration. Mass on the other hand, is a measure of resistance to acceleration. For example, if we try to push a 500 kg miners cart on a frictionless rail, it would take quite some time and effort to get it moving because of its large mass, or inertia. However, it takes the same effort to get the cart moving on the Moon as on Earth, even though its weight on the Moon is about 100 kg or five times less, because the inertial mass of the cart is the same on the Moon as on Earth and inertia has nothing to do with weight.

Also, a body that has been accelerated from relative rest to a given velocity will experience an increase in inertial mass which is proportional to the amount of energy spent in the accelerating process. Relative rest refers to a mass at rest relative to a stationary point, such as a laboratory on Earth from which the measurements are taken. Adding energy to matter by acceleration not only increases its inertial mass but it also causes time and physical processes to slow down in its immediate environment. This time effect which is called “time dilation” is hardly detectable under normal circumstances, but studies of high energy or rapidly moving atoms show that atomic clocks slow down proportionally to their increase in energy and consequential increase in inertial mass. One example is the increase in lifetime of high velocity high energy cosmic pions.

The structure of time is not yet fully understood. There are no physical laws that define time or the difference between past and future. Isaac Newton believed that "absolute mathematical time flows equably without relation to anything external". However, the fact that time slows down proportionally to increase in energy or inertial mass proves that time and inertia are related. Inertia of mass equals resistance to acceleration, and should inertia become infinite, all masses in the Universe would offer infinite resistance to acceleration, which means that nothing could be moved and all physical processes including time keeping clocks, would stall and time would come to a standstill. On the other hand, if there was no inertia or resistance to acceleration at all, physical processes would occur instantaneously and time would pass infinitely fast. It is obvious that we are somewhere between these limiting cases where time flows at a rate determined by the present inertia of mass.

What determines inertia of mass or time in the Universe? It is the cosmic gravitational tension $\phi_{Univ} = GM_{Univ} / R_{Univ} = c^2$ (energy per mass or *E/m*) in the Universe that sets the parameters of inertia and time. *E/m* can also be derived from Einstein's formula $E = mc^2$ by writing $\phi_{univ} = E / m = c^2$. Time, like distance, is measured in length. For example, the length of one meter is the scientific unit for distance and the length of one second is the scientific unit for time. Unlike the unit of distance, the unit of time can change from place to place in the Universe as the gravitational tension changes. One **standard second** is therefore referred to as a second measured at our frame of reference at rest here on Earth. The energy per mass (tension) can also change in a frame of reference that is moving relative to us. In general terms the length of time is directly proportional to tension or the energy per mass

($\phi = E / M$) whether the energy is gravitational or kinetic (increase in inertial mass due to velocity) or a combination of both.

One possible way to describe time in scientific terms, as seen from our reference in space, is to write the equation

$$s\phi_{univ} = s\frac{GM_{univ}}{R_{univ}} = t_1, \quad \text{(one standard second)} \qquad (t) \qquad (1)$$

where $s = 1.11265 \times 10^{-17}$ second^3/meter^2 is a constant or $s = t_1 / c^2$ (one standard second divided by c^2) and G is the universal gravitational constant. For example, if the mass and radius of the Universe had been equal to that of the Sun then the length of time would be much shorter or the rate of time would flow about 500,000 times faster to what we are used to *i.e.* one second at the Sun's surface would correspond to $sGM_{Sun} / R_{Sun} = 2.095 \times 10^{-6}$ standard seconds. In reality, the 2.095×10^{-6} seconds generated by the Sun's gravitational tension does in fact add to the standard second (sGM_{Univ} / R_{Univ}) produced by the entire Universe causing time to flow slower at the Sun's surface by a factor of 2.095×10^{-6}. The proportional slowing of time with kinetic energy or gravitational tension leads to perplexities such as the "Twin Paradox". A twin brother who traveled several years through space in a space ship at high speeds would on his return find his brother older than himself. Clocks and physical processes slow down on board, due to the increase in energy per mass of the space vehicle and everything within it, generated by its speed. During flight the traveling twin would not be aware of a slow-down in time since everything in his environment would change pace concurrently, including clocks. The slow-down of time due to gravity or speed (time dilation) was realized by Einstein already in the beginning of the 20th century and the twin paradox was one of the products of his great insights. Another noteworthy characteristic of the harmonic Universe presented here is that the rate of time must change with time just as inertial mass and energy changes with time. This means that one second gets shorter every second by the amount of $1\,\text{s}/t_0 = 4.0466 \times 10^{-21}$ seconds per second, where t_0 is the period of the harmonic motion of the Universe. It also means that we are running out of time, not in the sense that seconds are ticking away, but that seconds are getting shorter and shorter. For example, in a persons average life time of 70 years the total time lost is nearly 0.02 seconds. The constant loss of potential energy, inertial mass and time due to the harmonic motion of the Universe is the price we pay for the privilege of life because nothing would really happen if time stood still and if there was no exchange of energy. The rate of loss in time or inertial mass or energy is determined by the constant $\nu_0 = 4.0466 \times 10^{-21} \mathrm{s}^{-1}$ which is the frequency of the one cycle Universe or $\nu_0 = 1/t_0$.

2.5 The motion of the Universe

The simple harmonic motion of the Universe as depicted in Fig. 4 is possibly an oversimplified view and many other modes of harmonic motion can be considered, such as the spiral motion, for example, that is typical of many galaxies. It is also conceivable that the Universe is shaped like a disk having spiral arms like as our own galaxy. The Universe could perhaps be thought of as a hierarchy of oscillating systems starting from atoms, solar systems, galaxies, clusters and super clusters of galaxies and ultimately to a meta cluster of all galaxies contained within it. This idea was proposed by Charlier (1908) before galaxies were even discovered and later by Kiang and Saslaw (1969). The most striking feature of the contracting Universe is that absolute velocity is inversely proportional to absolute energy according to the diagram in Fig. 4, while we at our frame of reference here on Earth, as mentioned before, are used to relative velocity being directly proportional to the square root of relative energy. This inconsistency will be explained in Chapters 3 and 9.

The parameters and features presented in the following chapters are derived as we see them from our vantage point x_0 in space and for practical reasons the simple model in Fig. 4. will be used.