The speeds of world, body and mind

How science helps us understand impermanence
Source: **Dhanu-g,gahā Sutta** (S 20.6), SD 52.7 (2.1+2.2).

Daily motion

We may be silently reading this or sitting still in meditation. The reality is that nothing within us and around us is still: everything is moving, especially in the physical universe. In simple terms, as we sit here reading this on planet **earth**, it turns on its axis once a day. Everything on and in the earth is moving with it. How fast are we turning?

The earth makes a full rotation in 24 hours. It moves at the greatest speed on a point on or near the earth's equator (say Singapore), where it moves at close to **1600 kilometres per hour** (1000 miles per hour). The speed decreases as we move north or south. We do not feel the earth's rotation because gravity holds us down on the earth's surface.

However, we can see evidence of the earth's rotation in the great cyclic streams of water in our oceans and of air in our atmosphere—this is known as the Coriolis effect. As the Earth turns, faster at the equator and the slower the nearer the poles, great cycles of water and air circulate in the northern and southern hemisphere.

For example, the Gulf Stream, which carries warm water from the Gulf of Mexico all the way to Great Britain, and makes England warmer and wetter than it otherwise would be, is part of the great wheel of water in the North Atlantic Ocean. The Gulf Stream is part of a cycle that holds more water than all the rivers of the world put together. It is circulated by the energy of our revolving planet.

Yearly motion

Besides spinning on its axis, the earth also revolves around the sun. We are about 150 million km (93 million miles) from the sun, and at that distance, it takes us one year (365 days) to go around the sun once. The earth's full orbit is close to 970 million km (600 million miles). To go around this immense circle in one year takes a speed of **107,000 kph** (66,000 mph)! At this speed, we could get from Singapore to South Korea or from San Francisco to Washington DC in less than 3 minutes.

The sun's motion

Our sun is just one star of several hundred billion others that together make up the Milky Way. This is our immense galaxy or "island of stars," within which each star is itself moving. Any planet orbiting a star will share its motion through the Galaxy with it. These stars move around in their own neigbourhood in a random manner.

The question now is: how do we describe the motion of a star like our sun, or measure the speed at which it is moving? Speed is relative motion: we need a "reference post" to which we can measure motion—which we define by comparing the moving object (earth) to some kind of fixed point (the galactic centre).

Scientists define a "local standard of rest" in our section of the Galaxy by the average motion of all the stars in our neighbourhood (to use an over-simplistic word for an immense quadrant of space). Even the nearest star is over 40,000 billion km (25,000 billion miles) away.

Relative to the local standard of rest, our sun and the earth—our solar system itself—are moving at about **70,000 kph** (43,000 mph), roughly in the direction of the bright star Vega in the constellation of Lyra. This speed is not unusual for the stars around us and is our "milling around" speed in our suburban neighbourhood of the Galaxy.

Circling the galaxy

Besides the individual motions of the stars within our Galaxy, it is itself spinning like an immense pinwheel. Now, the problem is that stars at different distances move at different speeds. However, we can focus on the sun's speed around the centre of the Milky Way. It takes our sun about **225 million years** to make a full trip around our Galaxy. This is sometimes called our "galactic year." Since the sun and the earth first arose, about 20 galactic years have passed: we have gone around the Galaxy 20 times. Yet, in terms of galactic time, in all of recorded human history, we have hardly moved in our long path around the Milky Way.

How fast do we have to move to circumambulate the huge circle of the Milky Way in one galactic year? The sun has to move at an astounding **792,000 kph** (483,000 mph)! The earth, caught in the sun's gravity, follows along at the same speed. Even then, this is still a long way from the speed limit of the universe itself—the speed of light. Light travels at an incredible **1.09 billion kph** (670 million mph).

Moving through the universe

When we speak of the different speeds of celestial bodies, we always need to compare them to some "local standard of rest". When we talk about our speed going around the Galaxy, we measure it relative to the center of the Milky Way. Let us finish up by looking at the motion of the entire Milky Way Galaxy through space.

What can we compare its motion to—what is the right *frame of reference?* To understand this, we need to know a bit about the effect of the Big Bang on our universe. The Big Bang was the huge explosion that was the beginning of space, time and the whole universe. Right after the Big Bang, the universe was full of energy and extremely hot. In fact, for the first few minutes, the entire universe was hotter than the centre of our Sun.

Our universe was an unimaginable whirlpool of energy and subatomic particles, slowly cooling and sorting itself out into the universe we know today. The gamma rays (like the flash of a nuclear bomb) has stretched to become much longer, lower energy waves. These waves stretched the space they occupy, and so they filled the whole universe, just they did when the universe arose. Some 12 to 15 billion years after the Big Bang, the universe today—and space itself—is still expanding at a great rate.

Cosmic background radiation

All these stretched waves are collectively called the cosmic background radiation (CBR). Astronomers can now measure how fast the earth is moving compared to this radiation filling all of space. (Technically, our earth's motion causes one kind of Doppler Shift in the radiation we observe in the direction that we are moving and another in the opposite direction.)

Put another way, the CBR provides a "frame of reference" for the universe at large, relative to which we can measure our motion. From the motion we measure compared to the CBR, we need to minus the motion of the earth around the sun, and the sun around the centre of the Milky Way. The motion that's left must be the particular motion of our Galaxy through the universe.

No rest anywhere

From this, we know that the Milky Way Galaxy is moving at an astounding **2.1 million kph** (1.3 million mph)! We are moving roughly in the direction of the constellations of Leo and Virgo. This great attraction is probably caused by a huge concentration of matter—many groups of galaxies—from that direction. The short of this long story of our universe is that there is nothing that stands still for even a moment. Everything is in a constant state of flux, moving, changing, becoming other. This is the impermanence that is everywhere in the universe.

Ancient Indian world-view

This **scale of progressive speeds** of the various parts of our physical universe makes an interesting contrast to the scale of progressive speeds the Buddha mentions in the Dhanu-g,gahā Sutta, as represented in this table:

The Dhanu-g,gahā Sutta	**Motions in our physical universe**	
(1) The flying arrows	(1) The earth on its axis:	1600 kph
(2) The superman catches the flying arrows	(2) The earth around the sun:	107,000 kph
(3) The sun and the moon	(3) Solar system towards Vega:	70,000 kph
(4) The deities preceding sun and moon	(4) Solar system around galaxy:	792,000 kph
(5) The ceasing of the life-formations	(5) The Milky Way:	2.1 million kph

Both the scales of progressive speeds give us the same idea of increasing astronomical speeds of cyclic motions—except for "the motions in our physical universe" (3)—that of *the solar system speeding towards the bright star Vega in the constellation of Lyra*. This is a direct motion heading for its destination and not a cyclic motion like the rest. Even if we discount this motion, the general idea of *the scale of progressive speeds* is clear enough.

The Dhanu-g,gahā Sutta opens with the Buddha telling us to imagine how a man with super powers is able to catch the mid-air flying arrows shot by 4 archers [§3]. The monks, when asked by the Buddha, replied that even if that man were to catch just *one* flying arrow, he would be considered to be super-fast.

Having established an idea of relative **super-speeds**, the Buddha then tells us that the sun and the moon move even move swiftly in the heavens [§6.1], that is, faster than the speed of a flying arrow, or the speed at which the superman is able to catch them. This is **the parable of the celestial bodies**, which states that the sun and the moon move faster than such earthly speed—of the arrow or the superman who is able to catch them. Yet, even faster than that celestial bodies are the deities that race in their "mansions" ahead of these bodies.

The Buddha's description of the scale of progressive super speeds of celestial bodies builds up to climax in the Sutta's key teachings, of which there are two:

(1) "The life-formations pass away even faster than that!"; and
(2) The monks (including us) are to "dwell diligently," that is, work for awakening here and now.

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[an occasional re-look at the Buddha's Example and Teachings]