A BRIEF INTRODUCTION TO PHYSICS

As humans, we are a curious lot. Is this too wide an assumption? Specifically, there are days that come around when this writer wonders about how there is anything at all – days through which being content with observing events as detached and incomprehensible prove difficult. Consequently, I am left alone to stare at a playful desire for understanding the unseen order in the world. This craving has been with a good number of human beings since antiquity, now that it remains an unhindered enterprise: The search continues for a complete unified theory of laws that govern our universe. If one will ever be found, the writer cannot say. However, what is remarkable is that with each newer and more-complete understanding of physical reality the human's interaction with its surroundings is redefined. Consider the Industrial Revolution. Computers, the specks of light in the night sky, sky-scrapers, and the recent advances in invisibility cloaks (http://news.bbc.co.uk/2/hi/sci/tech/8025886.stm) – If you have ever had the urge to invent, to conceptually understand the inner workings of phenomena you observe daily, or to comprehend the meaning of your place within this world, then you have contemplated on things that many respected physicists have and still do!

Then, what is this *physics* exactly? Physics is originally a Greek word that roughly translates into "the science of change". Broadly speaking, a physicist seeks to analyze (and through such analysis, understand) the natural world and the relationships that therein occur. In a very important sense it creates a view of the world we inhabit by asking, and investigating through, basic questions: The fundamental science of physics involves the study of matter and energy, and the various interactions between them. Simplistically speaking, everything around you and me is made up of matter; and contained in this matter is energy. This energy gives matter the capacity to do work: to be transformed from one state to another, to move from one point to the next, and so forth – essentially, matter and energy interact to manifest the natural world and the observable occurrences therein. So it follows, for instance, that a physicist will tell you that in burning firewood to prepare a meal, chemical energy (contained in the bonds that give wood its identifiable structure) is converted into the thermal energy that cooks the food and makes the cook feel heat. Wood is transformed into charcoal and gas, a different and irreversible state of wood. The water is absorbed by the food and also transformed into vapor (a different but reversible state of water). As can be seen from this example, the scope of physics covers a very broad region; from the smallest subatomic particles through clusters of galaxies to the origin of existence. Most professional physicists have to limit their attention to one or two fields of the discipline: A physicist's work typically involves experimental investigations and theoretical analysis, though some choose to specialize in only one of these.

The history and development of physics is an engaging one. It is also long and dynamic, such that this essay will not even attempt to cover it. Perhaps some other time – Nonetheless, the works of the people from antiquity[1] through the Islamic scholars[2] to the Renaissance[3] and of the past two centuries[4], which live with us today, will always be regarded by the writer with the appropriate level of respect.

Let us now look into three ideas central to Physics.

One of the central ideas in physics is that behind the seemingly complex interactions that constitute our physical reality, there are hidden, simple, and approachable truths. By a process of observation that involves separating the properties of an object or a phenomenon from the actual object or phenomenon itself, physicists are able to uncover fundamental (and usually approximated) properties, rules, or relationships. For instance, it is true that the Earth is round (more-so a geoid) and not flat. There is confident evidence from two of Aristotle's arguments. His first argument is based on the shape of the shadow of the Earth during the eclipses of the moon, which is always round and never flat or elliptical. His second argument is based on the gradual manner in which a ship shows itself as it comes over the

[1] The early Mesoamericans, Babylonians, Egyptians, and so on.
[2] Abu Rayhan Ibn Ahmad Biruni, al-Hassan Ibn al-Haytham, Abu Bakr Ibn Zakariya Razi, and many others.
[3] Nicolaus Copernicus, Isaac Newton, Galileo Galilei, and many others.
[4] Albert Einstein, Paul Dirac, James Maxwell, and many others.

horizon. Both arguments are simple and verifiable. Now, if you do not believe Aristotle the Google image search engine might prove more convincing.

A second central idea in physics is that these hidden truths can be represented through the language of mathematics. Mathematics, as a language of nature, provides a reflector for the physical world. Of course, there is the ongoing debate about whether mathematical objects are naturally occurring, or simply human constructions. Even so, why is mathematics deemed important by physicists?

- First, it is logical, quantitative, and uses a much briefer and convenient symbol system. Let us consider Hooke's law of elasticity. Using the English language, it states that "the extension of an elastic object is directly proportional to the load applied, so long as the load does not exceed the elastic limit of the object". Mathematically, however, Hooke's law can be written simply as

  $$F = -kx,$$

  where x represents the displacement of the object from its position of equilibrium,
  F represents the applied load, and
  k represents the force constant.

  Here we see mathematics conveniently express the logic and quantitative aspect of a phenomenon Robert Hooke observed.

- Second, it gives physicists a way of solving problems, a way to finding the value of one (or more) unknown(s) from other different and known values. In other words, by beginning with a mathematical statement that describes a particular phenomenon, one can use mathematical rules to proceed to make another (different) statement about nature: Physicists are able to proceed step by step from one result to the next. This was one reason behind why James Maxwell was able to synthesize the equations of magnetism and electricity into one consistent theory.

- Third, it allows physicists to generalize the results of particular experiments to be able to make predictions outside the experiment. For instance, from the experiments carried out by Ibn al-Haytham we are able to know about the propagation, the reflection, and the refraction of light.

Following this, we can thus predict that infra-red light from a remote control pointed at the image of a television in a mirror will reach the sensor of the actual television, and thereby execute the command.

Quantification in physics goes beyond depicting observable phenomena in mathematical form. It is about making elaborate and precise observations, and measurements.

It is not so obvious that taking measurements can help in making sense of the world around us. But when one thinks lightly on the concept, one begins to appreciate a certain kind of beauty. Here are everyday examples: A basketball player ready to take off for a dunk intuitively measures the amount of thrust s/he would need to apply to successfully complete the smash. A student on his way to class looks at his clock and realizes he is late to receive lectures. If you are going to cook rice for yourself, you may measure a cup or two to boil. Unless you have never cooked, measuring ten cups of rice does not necessarily add up (Sure – perhaps one has a refrigerator).

What then becomes fascinating about taking measurements is that there are only three fundamental dimensional quantities in nature! These are mass, length, and time. In viewing the world, physicists are able to use these fundamental dimensions to portray observations. Every physical quantity is simplistically related to every other physical quantity. Such permeability can be mind boggling.

A third central idea in physics is that of the scientific method. In acquiring new knowledge about a phenomenon, a physicist proposes an unknown hypothesis as an interpretation of the phenomenon. S/he then proceeds to test (or verify) the hypothesis against the real world through controlled testing or experimental studies. If the results from the experimental study contradict the prediction, then the hypothesis is reformulated or abandoned. If the results from the testing confirm the proposition made by the hypothesis, then the hypothesis is regarded as a theory. Theories so derived are, however, not the final say. In fact, this is what becomes interesting about scientific knowledge and the scientific theory: One can never be too sure of the validity of a theory regardless of how many experiments agree with it.

Furthermore, a theory can be disproved by a single observation that discords with the predictions made by the theory. Yet, it should be noted that each time a theory is proven to be correct through the performance of new experiments it becomes gradually and increasingly trustworthy.

In most physicists' world today, physical existence is described through the terms of two basic partial theories – Quantum Mechanics and the General Theory of Relativity. Simply stated, Quantum Mechanics deals with phenomena at the atomic and subatomic levels: "It is based on the premise that at small scales, and for small times, not all quantities associated with the interactions of matter can be simultaneously measured" (Krauss, 19). On the other hand, the General Theory of Relativity is a theory of gravitation that describes the force of gravity and the large scale structure of the universe: "It stipulates that measurements of position, velocity, time, and energy are fundamentally tied together by new relationships that become more evident as the speed of light is approached" (Krauss, 20). Presently, and generally speaking, the search continues for a unifying theory that will incorporate them both. The aforementioned theories are known to be inconsistent with each other.

It may be true that contemporary physics is in need of a new metaphysics. This is not the writer's concern, not at this moment.

At its core physics is one way of finding out about what lies behind rainbow's appearance and the feeling of time. Still as a human, the one thing I do know is that I do not really know much. At least, as of today the enigma that surrounds us is yet to be wholly solved. But if I can spend my time being amazed at what is, with considerable confidence, known and unknown; therein is a reason to get up in the morning.

Reference List

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