

Fundamental Revelation

In order to address the question posed by FQXi we need first to consider popular definitions (i.e. meanings) of the concept “Fundamental”. The Concise Oxford Dictionary offers the synonyms “foundation”, “essential” and “primary”; Webster’s New Universal Unabridged Dictionary cites “a leading or primary principle, rule, law or article, which serves as the groundwork or basis; essential part...”, while the Thesaurus of English Words and Phrases by Peter Roget proffers “base”, “substructure” and “root” along with other substantives.

The above definitions prompt us to ask further questions: What are the forms of such definitions? Do they refer to time, space, energy or matter? If not, to what? What we are seeking is a conclusion with regard to what constitutes the single most elementary, minimalist and universally applicable component of all so-called fundamental states.

While time and space are inescapable contexts bearing upon everything else, neither environmental realm is specific enough to qualify as *the* fundamental element of all possible forms or thoughts.

Time

Human consciousness embraces an awareness of time, time consciousness, whereby events appear to take place in a sequential state of flow, either as time flows past the observer or as the observer moves through time, the difference being indistinguishable. Time appears to envelop all other experiences in such a way that it takes on the character of space to the degree that it extends its influence infinitely in all directions.

Heraclitus of Ephesus (c.500 BC) held time to be of the essence of reality, from which one can infer that time preceded all other actualities that necessarily rely upon duration.

From this point of view one draws the tentative conclusion that while time is absolutely indefinite, to be meaningful, of necessity, it must be absolutely defined. We subdivide time into increments for convenience notwithstanding a lack of understanding of the form of the entity that we are so dividing. It has been suggested that there is a minimal quantum of time that implies a unitary scheme whereby all time spans comprise multiple units of the smallest building block of time, so-called chronons; however this minimalist concept when earlier applied to matter did not hold, the atom having been divided, subdivided and subsequently sub-subdivided.

Space

Pythagoras, the Greek philosopher of the sixth century B.C., perceived the point as the smallest unit of volume, much as the numeral 1 was the smallest unit of number, lending support to the idea that matter comprised aggregations of points.

Aristotle, in the fourth century B.C., asked his peers to accept that the extremities of the end points defined the extremities of the straight line.

Of scientific and mathematical significance, Plato (c.428-348 B.C.), widely considered the most influential figure in the development of philosophy, constructed his world, not with matter but with *chora*, or space, expressed in his dialogue *Timaeus*.

In about 300 B.C. Euclid, a young Greek mathematician teaching in Alexandria, was to successfully challenge the laissez-faire beliefs of the pre-scientists and to lay the foundations to spatial understanding for the next two thousand years. In the *Elements*, Euclid introduces fundamental geometric concepts: the point, line, plane and angle, sometimes without definition, and further introduces propositions regarding these concepts, the triangle, the right-angle and the hypotenuse which he asks the reader to accept as being ‘axiomatically’ correct based upon the relation of such concepts to our experience of the physical world.

Thus it became apparent that mathematics, and specifically geometry, became the standard means by which to describe space in terms of one-dimensional distance, two-dimensional

areas and three-dimensional volumes, whether or not such spaces are void or occupied by matter.

While the units of measurement differed according to geography, a decimalized system was inferred and later clearly defined by the French clergyman Gabriel Mouton in the seventeenth century.

It can be seen however that the forcefulness of geometry as the bulwark of realism was beginning to falter as physical and mental constructs appeared interdependent. This fusion was conclusive with the publication in 1899 of *Grundlagen der Geometrie* by David Hilbert, with the opening words ‘*Wir denken uns ...*’ (‘We imagine three kinds of things...’). He is, of course, referring to points, lines and planes and we have returned to the open question as to what is ‘real’ and what is ‘imagined’.

Hilbert had broken the sensible space barrier. No longer was geometry to be relegated to merely the parochial role of designator of spatial experience. A fuller understanding of geometry now required extrasensory perception. Notwithstanding geometry’s deductive passage to reason, distinctions between the ‘real’ and the ‘imagined’ continue to be blurred, difficult to draw, or undifferentiable.

No one so eloquently disclosed the importance of this turn of events as Albert Einstein in a 1921 lecture *Geometrie und Erfahrung*: ‘As far as the mathematical theorems refer to reality, they are not sure, and as far as they are sure, they do not refer to reality.’

Scientists disagree upon the extent of space, some holding to the belief that space extends its influence infinitely in all directions, while others elect to confine it within the bounds of the so-called universe.

It would appear that any definition of space is acceptable if, when applied to an intended end, it is found to be useful. In other words, we have defined space per se as having no intrinsic qualities at all, save dimensionality. What do these revelations tell us about the states of science and mathematics, our most disciplined search-engines of truth? We suffer from an obdurate confusion between space as volume, dimensions that are means of describing it, and what space contains, which are merely contents.

We conclude that space lends itself to being applied metaphorically to elucidate mathematical, linguistic and visual relationships, as stepping stones on a path through perception to cognition. As such, space can hardly qualify as being the single most elementary, minimalist and universally applicable component of all fundamental states.

Energy

Regarding the nature or form of energy; energy is the ability to exert force, do work or produce change by virtue of potential in reserve or the fact of motion. Energy has the property of transforming itself from one state (or form) to another when released, assuming the qualities of force, heat, sound, light, electricity or chemical energy. This capacity, of itself, suggests that energy per se is not as elementary or fundamental as that which we are seeking. We need to consider theoretically the reduction of all energy to a single form.

Theoria, the contemplation of unassailable and unchanging truth from which the modern word ‘theory’ is derived, originated in Plato’s logical method of classification from the large to the small. The . theory of division became a useful way of correlating dependencies.

Aristotle regarded *theoria* as the highest calling, since it aspired to simulate in man’s humble will and actions, those presumed of God.

Early rational man looked for ‘fits’. He wanted his ideas to ‘fit’ his experience. Such a way of looking became the subject of yet another theory, the ‘theory of unity’, whereby the integrity and performance of things small was found to be critical to the integrity and performance of things relatively larger. Hence FQXi’s big question!

In the Lilliputian world of minutiae Democritus had constructed his ‘theoretical’ model of the indivisible atom. His ‘proof’ rested upon pure reason. He imagined the smallest thing possible and called it the smallest thing possible. Robert Boyle had speculated, a ‘theory’, that the smallest indivisible part of anything was elementary. John Dalton ‘proved’ the correctness of Boyle’s supposition with respect to elements, confirming the existence of specific atoms. Earnest Rutherford was to reveal that the atom was not quite as elementary as supposed but comprised a package encompassing even smaller ‘things’. Otto Hahn split the atom in 1939 but did not know what he had done, and atomic hackers have been subdividing the subdivisions of atoms ever since. Academia had been absorbed in splitting hairs for so long that it had lost sight of the nature of the bodies of which the hairs were working parts. Having disassociated the objects of investigation at the macro and micro ends of the scale long ago, it was about time to put the theories rather than the particles together to see what we had as a whole.

We may assume that theory stands somewhere between imagination and the truth, but how near to each remains an open question until a particular theory is confirmed or debunked for all time – and that is a long, long time. Theories are stepping-stones to truth that get displaced by new, more plausible ones over time. Thus we should expect the most currently held ideas about the way the universe operates to be retired when they get tired, and replaced by more rationally defensible ones.

What we have been alluding to is the process by which the utility value of knowledge is found to be time-sensitive. Faith-based beliefs give way to knowledge-based beliefs. Here we are finding that knowledge has potential for enhancing its credibility and utility value through a process of ‘theory’ that injects speculation into the current state of knowledge for the purpose of searching for the next logical step forward. Indicative of the values that we place upon such searching are the extraordinary resources that we expend on what we properly call re-search, that is, searching over and over again to improve upon past performance; and on the practical testing of our theses through conducting development programmes. Notwithstanding, we remain open to the probability that our current ‘proof’ may not be synonymous with absolute ‘truth’. What we can construe from these successive theories is that they are evolutionary. Each has a useful life that contributes to a more comprehensive approximation of truth.

Matter

In 1687 Isaac Newton published his treatise *Philosophiae Natralis Principia Mathematica*. In *Principia* Newton advanced his universal theory of material relations in space and time, the gist of which was to contend that relationships between celestial bodies were governed by mutually attractive forces (i.e. energy) that increased in proportion to increased bodily mass and with decreased distance. Through this theory Newton was not only able to proffer his theory of gravity but to render a clear accounting for the apparent stability of the universe as a system of infinite parts positioned by the total effects of forces generated by each competitive mass with respect to its distance from all others. He described the architecture of the universe. Relations are formal sets of mutual impacts. In considering “Matter”, definitions like “foundation”, “base”, “substructure” and “root” can be interpreted to be material, but such definitions are only made possible through the liberal application of the English language that relies upon the reader to determine from the context which of several possible word-meanings is intended where a particular word is used. In terms of our current interest in defining the concept “fundamental”, it is clearly not reasonable that we should consider the form of all that is fundamental to be “material”.

Unification

Evolution is no longer a theory; it is the inescapable progression of changing time, space, energy and matter to which all things subscribe. The evolution of theory has been a process of moving from total ignorance towards total knowledge. Until we reach a point of absolute knowledge of all things, we have to accept that theories will continue to evolve as suppositions suspended in uncertainty.

Insofar as change is pervasive, we needed an invariable system of comprehending totalities irrespective of the dynamics of change; that is to say, a system that disregards unknown anomalies. Henri Poincaré's 'Principle of Relativity' and Hendrik Lorentz's 1904 'Theorem of Relativity' were soon to be modified by Albert Einstein in 1905 whose formulation came to be known as the 'Special Theory of Relativity'.

The assumption of the notion of relativity, i.e. dependence upon comparative relations, being fundamental to the pursuit of truth and knowledge appeared to have gained credibility.

Significantly, Poincaré published his findings regarding the dynamics of electrons in 1906 in which many of the conclusions engendered in 'Special Relativity' had been arrived at independent of Einstein. Poincaré had focused upon the whole electromagnetic spectrum, whereas Einstein's thesis had turned around the behaviour of visible light.

In 1916 Einstein amended his Special Theory of Relativity in the interest of drawing gravity into the scope of a more comprehensive or general theory. This more expansive approach came to be known as Einstein's General Theory of Relativity.

Relativity introduces the notion of relations between space, time, energy and matter, and, by implication, relations between relations. Compounding interrelationships has the effect of increasing complexity. Now we need to travel backwards in time to discover how theories, which are relational models, are related to each other as parts of wholes. We are looking for the whole truth and nothing but the truth. We believe in the integrity of unity because we observe that our environment works in its parts and works in its entirety.

Recalling that James Clerk Maxwell had 'unified' electricity and magnetism to create the greater theory of electromagnetism, we were left with the task of establishing the correct connections between the four fundamental forces: 'the strong nuclear force' (binding the parts of the atom's nucleus, known as quarks, to each other); 'electromagnetism' (the broad spectrum of magnetic conditions that result from currents of electricity interacting between electrically charged particles, as between positively charged protons and neutrons, and negatively charged electrons); 'the weak nuclear force' (binding atoms to atoms, atoms to molecules and therefore molecules to molecules), and 'gravity' (affecting all matter that possesses mass, from the particle to the star, such that each appears to attract all others in proportion to its mass).

The first of these three connections to emerge was reconciliation between electromagnetism and the weak nuclear force. What came to be known as the electro-weak theory was propounded by Sheldon Glashow, Steven Weinberg and Abdus Salam. The link was an overlapping connection to radioactivity whereby the distinctions between electromagnetic forces and the weak nuclear force disappear at energy levels above about 100 giga-electron-volts (GeV) (100,000 million electron volts). The stage was now set for a search for overlaps between the new electro-weak theory and the strong nuclear force. The mechanism of this relation came to be known as the Grand Unified Theory or GUT, a term that has fallen into disfavour for failing to achieve the full promise implicit in its name.

It is important to recognize that as energy levels increase, the strong nuclear force gets weaker while the electromagnetic and weak nuclear forces get stronger. Somewhere their graphs will cross, a point representing the idea of unification. Testing at such energy levels is economically and practically prohibitive. If this is the kind of problem that we are facing,

involving near-infinite amounts of energy, it may be a long, long time before the books are closed on this investigation.

At the microcosmic scale, present presumptions concerning the beginning of the universe suggest that temperatures were sufficiently high to fuse all forces into one. As the universe expanded and cooled, the only particles that existed, quarks, condensed and coalesced to form electrons and positrons (anti-electrons). Electrons, being inexorably attracted to their opposite numbers, the positrons, were mutually destroyed. A few quarks, in the guise of electrons, survived to form matter, including writers and readers. Thus, the ‘theory’ now known as the Standard Model still stands, in the absence of laboratory testing, as an explanation for our presence, and ‘we’ are the living ‘proof’. Were Ptolemy still alive he would be gratified to learn of our current stance: that common experience reinforced by common sense suffices as acceptable ‘proof’.

To tie the last force, gravity, into the other fundamental forces in order to unite all within a single theory, the *pièce de résistance* of physics, it would appear necessary to express the four forces in terms of a common denominator. The challenge is not to verify that relativity (the grand theory that endeavours to explain phenomena of cosmic proportions) is correct and that the quantum theory (that seeks to explain small things and their relations at the other end of the spectrum of scale) is incorrect, or vice versa, but to express one in terms of the other.

To that end we should remember that we live in a universe that is structured by opposing yet coexisting principles. It is probable that either relativity or quantum theory will have to relinquish precepts that have hitherto been held essential to their integrity in order to achieve a compatible ‘fit’ as parts of the same universal idea. What is needed is to test each in relation to the other by dropping out postulates to see if the theories could be brought into agreement, or to add new postulates.

In making the connections between the strong nuclear force, electromagnetism and the weak nuclear force, the common thread that had tied them together has been the presence of electrical charges. The obvious test was to seek to express gravity (or macro-dynamics) in terms of electromagnetism, since electromagnetism was already tied to the strong and weak nuclear forces above and below it in strength. What emerged in the wake of the GUT was the concept that sub-atomic particles were minute ‘strings’ of space, packed so tightly together that there was nowhere for their energy to dissipate. String Theory was born, and in its infancy ‘strings’ were found to be identical to gravitons. *Voilà!* The seeds or carriers of gravity appeared to be already integrated into the ultimate theory.

According to String Theory, all particles are made of hyperdimensional space inferring that there may exist an inescapable connection whereby time and space, linked as space-time, are themselves linked to particles represented as matter but made of energy. And so we are moved to conclude that matter does not exist except as an expression of packaged energy.

Electrical energy is all we have because it is all there is. We implicitly acknowledge this when we classify gamma radiation, X-rays, ultraviolet light, visible light, infrared light, microwaves, radar, FM, short wave and AM radio wave lengths as frequency ranges within the electromagnetic spectrum. Perhaps Poincaré got closer to identifying a more fundamental, universal theory of general relations than Einstein after all. We can call our ‘local’ force models ‘gravity’, the ‘weak force’, ‘electromagnetism’ or the ‘strong force’; the point is that whatever forms of force we like to describe separately because we experience distinctions in what they ‘do’, they are essentially the same at all scales of operation, are universal and electrical.

The nature of atoms is overwhelmingly void and devoid of anything that one can call something. Atoms are slightly infected bubbles of space.

The notion ‘hyperdimensional’ suggests that time, space, energy and matter are aspects of the same phenomenon viewed as different ‘dimensions’ along different axes, as limited visions of existence.

We are accustomed to viewing the four so-called fundamental forces of nature in distinctly different ways because we have defined them in different ways. But we observe that they all coexist together in the universe and in that sense they are unified. Are the four forces simply local expressions of a single force operating at different scales, the local forms serving as checks to prevent bodies of greatly differing sizes from transiting from one fundamental force zone to another, as would be the case if an unregulated atom ‘escaped’ into a gravity field?

Insofar as ‘gravity’ gets weaker with an increase in distance between bodies, and the ‘strong nuclear force’ gets stronger with added distance, this dilemma would be overcome if we were to recognize gravity for what it really is; an effect in precedence to a cause.

As a result of experiment and observation we are predisposed to thinking that nature abhors a vacuum; vacuum being unfilled void or space. By ‘nature’ we mean the totality of all phenomena that exhibit behaviour. Vacuum, which we consider to be devoid of behaviour, we conclude to be hostile and ‘unnatural’. We take this position because our immediate environment is almost totally natural. It teems with phenomena exhibiting behaviour. The God-like view of all there is would logically reverse polarities and hold that universal vacuum is ‘natural’, being the dominant medium of the cosmos, and what we call ‘nature’ to be a contamination of vacuum. The logic of the situation demands that, as in biology, one should establish the physiology of normality against which one can then compare departures from the norm.

In matter we find an exhibition of defiance against vacuum, the exception that proves the rule. What is the rule? The rule is that vacuum (unfilled void or space) abhors nature, and flows to fill its absence. That flow is Nirvana from the Sanskrit *nir* meaning ‘out’, and *vati* meaning ‘it blows’.

Conclusion

One cannot avoid questioning why the extension of the word fundamental to fundamental elicits the idea of mentality. Mentality may be essential to consideration of the fundamental constituents of all known things and ideas, but that does not serve to account for the fundamental underpinning of things and ideas not yet perceived or conceived.

The pursuit of the holistic view, while not literally an achievable end, is an eminently worthy and thoroughly absorbing undertaking; a claim that resonates well with Plato’s persuasion that philosophy is ‘the spectator of all time and all existence’.

Having, through String Theory, equated time, space, energy and matter with some form of energy; and having reduced the four fundamental forces to electrical energy, we have been drawn to entertain the idea that electrical energy is all there is.

We are mischievously tempted to entertain the idea that the answer to FQXi’s question is staring us in the face so to speak, and resides in, indeed is, the question (at least in speech): What is fundamental.

One is inevitably reminded of the title of a book by Richard Feynman, one of the world’s most highly regarded physicists: *Surely Your Joking, Mr Feynman!* But is this a joke or a poke in the wrong direction?

Neither What or Watt qualifies as meeting the prescription of being the ultimate fundamental, even though What is the fundamental question underlying the five cardinal questions: What, Where (meaning what place), Why (what reason), When (what time) and How (meaning by what means).

We have omitted consideration of the form or forms that ideas assume. Ideas don’t fit comfortably into the realms of Time, Space, Energy or Matter; nor do they belong in the range of forms that are reducible to electrical energy. While the direct cause of ideas can be

readily attributed to a highly sophisticated electrically driven organ, the brain, with its 100 billion Neurons (nerve cells) generating an almost infinite number of mutual relations; electricity cannot be confirmed to be the fundamental component of ideas.

We should remind ourselves that we are searching for that which is fundamental to all things, including ideas.

Imagine being posed perhaps the most outrageous of all questions concerning your own existence. Then imagine that there may be an answer to that question supported by a rationale that is so compelling that you are inexorably led to the conclusion that you do not exist. Such questions we might call fundamental. They are seldom asked and answers to them are therefore seldom forthcoming. The answers are believed to be self-evident, axiomatic and requiring no proof.

We must ask ourselves what qualifies as being the foundation of our thinking and all things, be they tangible or ephemeral, known or unknown, past, present or future - and the answer jumps out and hits you as, oh so obvious: Existence is “Fundamental”.

Existence qualifies as being fundamental to all subjects whether or not any subject in question is known to mankind, nature or is merely speculative by virtue of bearing the form of an idea. Everything is nothing in the absence of existence.

QED.

References

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