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Our senses tell us that a table is a solid object, yet modern science tells us that the table is mostly empty space. How can this be? Is our reality merely a personal interpretation of something else, of another world existent far outside of our familiar experience? How then does this work, this reality of our synaptic self-creation, a human projection filtered through sight and sound, smell and touch into what we then sense the world to be. If the fundamental physics of this physical world acts on a scale far below our immediate senses, as scientists now say it does, then how do we reconcile that world of subatomic particles, quantum uncertainties and mostly empty space with the experiential realities of our worldly substance, force and form?

The answer is that we rely upon our immediate senses to inform our minds, but that also we use the accumulated knowledge of our greater experience to shape how we interpret and exercise that information. Science is not only a method of inquiry and way of knowing the physical world, but also a lens that brings focus and understanding to our interactions with the macroscopic world at the intersection of human sense and material substance. For example, I have never seen an oxygen atom, yet I firmly believe that it is oxygen that I need to breathe to live. Similarly I have never seen an electron, yet I believe that electrons exist, and collected into currents, can surge through power lines and lamps to bring light into darkness, to power the many machineries of the modern world, and even to modulate across the digital world of computers to facilitate the transformation of these considerations into written words and thoughts. Furthermore, I do not believe that my lack of direct personal experiential evidence detracts from the reasonableness of the scientific theories upon which these beliefs are constructed. For the structures of our modern scientific perspective are constructed upon the foundations of accumulated human experience and critical analysis.

Philosophically, it is important to recognize that scientific interpretation of reality is by its nature quite different from other ways of knowing. Science is empirical, rigorous and reproducible. Valid scientific theories, as defined by the philosopher Karl Popper, must be falsifiable. That is, they must be subject to vigorous and determinate examination. In this condition, science stands quite apart and in contrast to our humanistic sense of self, as defined more by the subtle contexts of our feelings and emotions. While our human world is enriched by its diversities and ambiguities, progress in our scientific world is measured by its simplifying reductionist order and underlying mathematical elegance. As American philosopher George Santayana describes, "Science is nothing but developed perception, interpreted intent, common sense rounded out and minutely articulated" (*The Life of Reason*, G. Santayana, 1905). It is therefore upon the empirically well-tested and quantifiably well-defined foundation of atomic physics that we can comfortably accept that a physical table of such sensory firmness is in greater reality mostly not there at all.

This atomic theory is in fact an extension of our experiential interaction with the physical world, not a contradiction to it. In 1910, Ernest Rutherford was pursuing the alchemists' ultimate goal, the transmutation of one element into another. He injected a beam of high energy alpha particles onto a thin gold foil target, and was surprised to discover that with only the smallest of exceptions, the alpha particles passed through the

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foil unimpeded. The molecular structure of the gold foil was proven incontestably to be mostly unoccupied space. Interestingly, as is often the case in science, it also was that slightest of exceptions he observed that proved to be the faint trace of an even deeper truth. The radically small fraction of the incident beam reflected back from the foil gave evidence leading to the discovery of the atomic nucleus, for which Rutherford was awarded the Nobel Prize in Physics (*The Electrical Structure of Matter*, E. Rutherford, 1926).

Today I understand that when my hand touches a table, it is not an interaction in the sense of molecules in collision, of molecules of my hand bouncing like microscopic billiard balls off of molecules of wood or steel. Instead, nature works in a far more elegant and ingenious way. Electrical forces between electrons orbiting the nuclei of my hand and of the table top, brought into near proximity, rise up in forceful mutual repulsion, increasing by square of the distance of their separation. Long before electrons and nuclei would find themselves in any threat of physical collision, the forces pushing against my hand from the table, and of my hand against the table, are of such magnitude that the masses of both are easily displaced. It is these same forces, aligned constructively in an attracting structure of molecular chains and bonds, that holds the table and my hand together at all. Furthermore, the resistance and displacement I have now encountered compresses the soft tissues and nerves within my finger tips, sending an electrical messenger racing off to alert my brain of the concurrent electrophysical effect. The interpretive synapses of my brain make note of the ongoing dynamic resistance, and give this unique signature of electrical impulses a name. I call it "touch."

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In a world of substance, there is no contradiction except in the mind of the scientifically uninformed. The firmness of the table is the consequence of interacting atomic fields of force. That this interaction can happen in the absence of matter, in the vacuum of subatomic space, is no more mysterious than recognizing that light can fill a room with its electromagnetic fields of force, irrespective of atmospheric clutter. The proof is ample, to the knowing eye, in the light of stars that grace the clear night sky, sending fields of force to our observation across the vast emptiness of space.

Still, there are some who would disagree. Buddhism offers an alternative that does not so much dispute the answer, but rather disputes the question. Enlightenment is a celebration of nature without explanation, experiencing wonder and mystery in every single act of life (from *The Tao of Physics,* Fritjof Capra, 1975). Perhaps my feelings here are the product of a distinctly Western upbringing, but I have always nourished a curiosity to understand how the world works. I prefer to explain mysteries rather than simply to celebrate them.

Others would argue that the scientific basis for the scientific method is logically flawed. After all, experiential science is necessarily influenced by the limits and fallibilities of our human perception, our senses serving as the final arbiters of reality. What assurance do we have, as postmodernists assert, that science is an accurate or superior method for interpreting this experience. Paul Feyerabend notes that the proof that science works is *a priori* a scientific proof, a circular consistency that offers no better assurance than any other self-consistent system of belief (*Against Method: Outline of an Anarchistic Theory of Knowledge*, P. Feyerabend, 1975). Personally I reject this argument, notwithstanding its sound philosophical basis. Again I rely on the

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accumulative record of our technological advancement exploiting the scientific world view. We went to the moon using rocket fuel and celestial mechanics, not superstitions or Ptolemaic canon. Even if this represents an article of faith in science, rather than proof, it is faith based upon the evidentiary weight of our entire human history.

Another criticism of this reconciled scientific world view is that its effectiveness is not in itself a proof. Quantum mechanics today is the source of much of this discomfort, as it represents a statistical probabilistic approach to explaining actions at the subatomic scale. Nature behaves in nonintuitive ways, with its very behavior influenced by quantum uncertainty and dependent upon whether particles and events are observed or not. The influence of the human observer is a concern for the very foundations of a mechanistic scientific world view, asserting that nature obeys fixed laws that operate outside of human experience or divine capriciousness. This question deeply bothered Einstein, who objected, "God does not play dice with the universe." Nevertheless, repeatedly and accurately, the quantum mechanical model has been verified by many tests, and withstood all materialist alternatives and deconstructionist critiques for nearly a century.

My personal need to reconcile the problem of the table, of its material substance in the macroscopic world we experience directly with our senses, and the near absence of physical substance in the atomic world, influences my approach to other problems in life. Atomic structure is not governed by artistic aesthetic, nor particle interactions influenced by irrational instincts and subjective judgments. Where scientific, mathematical and empirical approaches to natural challenges have currency, I believe they offer a superior means of reaching deeper truths. However, I do recognize the limitations of reductionist thought. In terms of the human dimension to our world, there is no atomic composite of nature that can compare to the complexity of a single human being, no swirl of galactic cosmology that compares to the dynamics of a global society. Science itself is the product of civilization, developed not out of innate curiosity for the mysteries of nature, but out of evolutionary need driven by our competitions, our conquests, and our commerce. Even so, to seek knowledge is an inherent human goal, to seek understanding of nature both a purpose and a practice. The question which drives my curiosity today is not why is there so little substance to the table, but rather why must there be any substance to it at all.