Opinion

On Empty Space

Miroslaw Kozlowski*

Warsaw University, Warsaw, Poland

Abstract

In this essay, we present fact well known to scientists that matter is empty with very small percentage of elementary particles and nuclei. We argue that one cannot develop special relativity, the notion of the spacetime and localization of consciousness in empty space.

Keywords: Void, spacetime, atom, elementary particle, consciousness.

> *In some sense man is a microcosmos of the Universe therefore what man is, is a clue to the Universe. We are enfolded in the Universe.* David Bohm

Electrical phenomena have been known for thousands of years, but the mysteries of the magnetic compass needle, the sparks of lightning, and the nature of electricity remained well into the nineteenth century. The situation towards the end of that century was summarized in a book that I bought as a child in a jumble sale for one penny. Entitled Questions and Answers in Science it had been published in 1898 and in answer to the question 'What is electricity?' it opined with Victorian melodrama that 'Electricity is an imponderable fluid whose like is a mystery to man.' What a difference a hundred years makes. Modern electronic Communications and whole industries are the result of Thomson's discovery of the electron in 1897, answering the above question a full year before that book was published; news travels faster these days.

Electrons flow through wires as current and power industrial society; they travel through the labyrinths of our central nervous system and maintain our consciousness; they are fundamental constituents of the atoms of matter and their motions from one atom to another underpin chemistry, biology, and life.

The electron is a basic particle of all matter. It is the lightest particle with electric charge, stable and ubiquitous. The shapes of all solid structures are dictated by the electrons gyrating at the periphery of atoms. Electrons are in everything, so it is ironic that the discovery of this basic constituent of matter was a result of the ability developed in the nineteenth century to get rid of matter, to make a void.

* Correspondence: Miroslaw Kozlowski, Prof. Emeritus, Warsaw University, Poland. Email: m.kozlowski934@upcpoczta.pl

For a long time, there had been a growing awareness that matter has mysterious properties, although initially it did not directly touch on the question of the void. The ancient Greeks had already been aware of some of these, such as the unusual ability of amber (electron is the Greek for amber) to attract and pick up pieces of paper when rubbed with fur. In more modern imagery, brush your hair rapidly with a comb and on a dry day you might even cause sparks to fly. Glass and gems also have this magical ability to cling to things after rubbing. By the Middle Ages the courts of Europe knew that this weird attraction is shared by many substances but only after rubbing. This led William Gilbert, court physician to Elizabeth I, to propose that matter contained an 'electric virtue' and that electricity is some 'imponderable fluid' (as in my 1898 book) that can be transferred from one substance to another by rubbing. Gaining or losing this electric virtue was akin to the body being positively or negatively 'charged'.

Benjamin Franklin in America, taking time off from flaming the constitution of what would become the USA, was fascinated by electrical phenomena, notably lightning. A thunder cloud is a natural electrostatic generator, capable of creating millions of volts and sparks that can kill. Franklin's insight was that bodies contain latent electrical power, which can be transferred from one body to another. But what this imponderable fluid was, no one knew.

Today, we know that it is due to electrons, which contribute less than 1 part in 2,000 of the mass of a typical atom, and as only a small percentage of them are involved in electric current anyway, the change in mass of a body when electrically charged is so trifling as to be undetectable. How then was this imponderable fluid to be isolated, catalogued, and studied?

Electricity normally flows through things, such as wires, and as it was impossible to look inside wires, the idea developed of getting rid of the wires and looking at the sparks. Lightning showed that electric current can pass through the air and from this grew the idea that the flow of electric current might be revealed 'out away from the metal wires that more usually conduct it and hide it.

So scientists set about making sparks in gases contained in glass tubes. Air at atmospheric pressure transmitted current but obscured the flow of electrons. By gradually removing more and more of the gas, it was hoped that eventually only the electric current would remain. It was following the industrial revolution and the development of better vacuum pumps that bizarre apparitions appeared as scientists electrified the thin gas in vacuum tubes. As a result of this, electricity gradually revealed its secrets. At one fiftieth of atmospheric pressure, the current produced luminous clouds floating in the air, which convinced the English physicist William Crookes that he was producing ectoplasm, much beloved of Victorian seances, and he turned to spiritualism.

The colours of the light in these wispy apparitions depended on the gas, such as the yellow light of sodium and green of mercury familiar in modern illuminations. They are caused by the current of electrons bumping into the atoms of the gas and liberating energy from them as light. As the gas pressure dropped further the lights eventually disappeared but a subtle shimmering green colour developed on the glass surface near to the source of the current. In 1869, came the critical discovery that objects inside the tube cast shadows in the green glow, proving that there were rays in motion coming from the source of electric current and hitting the glass except when things were in the way.

Crookes discovered that magnets would deflect the rays, showing that they were electrically charged, and in 1897 J. J. Thomson using both magnets and electric forces (by connecting the terminals of a battery to two metal plates inside the tube) was able to move the beam around (in effect a prototype of a television set). By adjusting the magnetic and electric forces he was able to work out the properties of the constituents of the electric current. Thus did he discover the electron, whose mass is trifling even compared to that of an atom of the lightest element, hydrogen. From ’the generality of his results, which cared naught for the nature of any gas left in the tube or the metal wires that brought the electric current into the vacuum tube, he inferred that electrons are electrically charged constituents of all atoms.

Once it was realized that electrons are at least 2,000 times lighter than the smallest atom, scientists understood the enigma of how electricity would flow so easily through copper wires. The existence of the electron overthrew forever the age-old picture of atoms as the ultimate particles and revealed that atoms have a complex inner structure, electrons encircling a compact central nucleus.

Phillipe Lenard bombarded atoms with beams of electrons and found that the electrons passed through as if nothing was in their way. This almost paradoxical situation—matter that feels solid is nonetheless transparent on the atomic scale—was encapsulated by Lenard with the remark, ‘the space occupied by a cubic meter of solid platinum is as empty as the space of stars beyond the Earth’.

Look at the dot at the end of this sentence. Its ink contains some 100 billion atoms of carbon. To see one of these with the naked eye, you would need to magnify the dot to be 100 metres across. While huge, this is still imaginable. But to see the atomic nucleus you would need that dot to be enlarged to 10,000 kilometres: as big as the earth from pole to pole.

The simplest atom of hydrogen can give an idea of the scales and emptiness involved. The central nucleus is a single positively charged particle known as a proton. It is the path of the electron, remote from the central proton, that defines the outer limit of the atom. Journeying out from the centre of the atom, by the time we reach the edge of the proton we have only completed

one ten thousandth of the journey. Eventually we reach the remote electron, whose size also is trifling, being less than one thousandth the size of the proton, or a ten millionth that of the atom. So having made a near perfect vacuum, which led to the discovery that atomic matter contains electrons, we appear to have come full circle in finding that an atom is apparently a perfect void: 99.9999999999999 per cent empty space. Lenard's comparison hardly does the atoms emptiness justice: the density of hydrogen atoms in outer space is huge compared to the density of particulate matter within each of those atoms!

The atomic nucleus also is an ephemeral, wispy thing. Magnify a neutron or proton a thousand times and you would find that they too have a rich internal structure. Like a swarm of bees, which seen from afar appears as a dark spot whereas a close up view shows the cloud buzzing with energy, so it is with the neutron or proton. To a low-powered image they appear like simple spots, but when viewed at high resolution they are found to be clusters of smaller particles called quarks. To reveal the quarks we would need to expand the dot out to the Moon, and then keep on going another twenty times more distance.

A quark is as small compared to a proton or neutron as either of those is relative to an atom. Between the compact central nucleus and the remote whirling electrons, atoms in practice terms are mostly empty space, and the same can be said of the innards of the atomic nucleus. In summary, the fundamental structure of the atom is beyond real imagination, and its emptiness is profound.

Now, let us formulate the SR postulates: 1. There exists inertial reference frames; and 2. In each inertial reference frames the Law of Nature are the same. Now how the inertial reference frame are defined, for example, in 3D?

The axes of inertial reference frames are defined by the motion of solid body with constant velocity. But in void there are no solid body, so inertial reference frame does not exist. So one cannot develop special relativity, the notion of the spacetime and localization of consciousness in empty space.

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