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From Atomic theory to String theory

Roger J Anderton
R.J.Anderton@btinternet.com

A brief outlook at the connection between point particle theory of Boscovich with string theory is presented.

1. Point-Particle is Foundation of Modern Physics

A great deal can be said about point-particles; it is glossed over when introduced to physics students.

A point-particle is roughly defined as: a particle with no spatial extent; specifically, one used as an idealized approximation of a real particle, with its entire mass treated as if it were located at its centre of gravity. [1] Usually considered as infinitesimal; vanishingly small, dimension vanishes to zero; dimensionless.

2. Einstein's Relativity built on the concept of 4D point

G C McVittie [2]: "In the language of relativity, an event is analogous to a point in space. As a point has no magnitude, so an event has neither magnitude in space nor duration in time."

Point in Newtonian physics context is 3D space, so event in Einstein' relativity context is point in 4D spacetime.

As G C McVittie [2] explains: "Each event is 'plotted', so to speak, as a 'point' having four, instead of three, co-ordinates; three of these fix the position in space of the event relative to some frame of reference, the fourth is a co-ordinate specifying the instant of occurrence of the event in the same frame of reference.

Thus, without 4D point (event) there would be no Special Relativity. I contend a mess has been made building on this concept.

When have a point can assign values to it of such things as mass, electric charge etc. Thus, the concept of point-particle gets built upon, e.g. point obeying Fermi-Dirac statistics is different to point obeying Bose-Einstein statistics; the first is called fermion and the latter is called boson. Fermions cannot occupy position in space with same quantum state, but bosons can.

3. The First reasoned description of Atomic theory

Michael Van Duisen tells us: "The first man to put forth a reasoned description of atomic theory, Croatian-born mathematician and physicist Roger Joseph Boscovich beat modern theories by over 100 years. Not only that, he was a leader in the field of geodesy, the scientific field concerned with the shape and size of the Earth. Boscovich is also credited with inventing or perfecting various scientific instruments. Among the first scientists to accept Isaac Newton's theory of gravity, he wrote a number of papers on the subject. Lastly, Boscovich was also a man tasked with fixing various structural problems, including reinforcing the dome of Saint Peter's Basilica and repairing fissures in the Milan Cathedral." [3]

4. Discovery of the maths for String theory

Discovery of string theory is explained [4] as-

BRIAN GREENE: From the start, many scientists thought string theory was simply too far out. And frankly, the strange way the theory evolved —in a series of twists, turns and accidents — only made it seem more unlikely. In the late 1960s a young Italian physicist, named Gabriele Veneziano, was searching for a set of equations that would explain the strong nuclear force, the extremely powerful glue that holds the nucleus of every atom together binding protons to neutrons. As the story goes, he happened on a dusty book on the history of mathematics, and in it he found a 200- year old equation, first written down by a Swiss mathematician, Leonhard Euler. Veneziano was amazed to discover that Euler's equations, long thought to be nothing more than a mathematical curiosity, seemed to describe the strong force. He quickly published a paper and was famous ever after for this "accidental" discovery.

GABRIELE VENEZIANO (CERN) : I see occasionally, written in books, that, uh, that this model was invented by chance or was, uh, found in the math book, and, uh, this makes me feel pretty bad. What is true is that the function was the outcome of a long year of work, and we accidentally discovered string theory

Euler and Boscovich were working on the same type of 18^{th} century physics. J. S. Rowlinson [5] notes: "He [Boscovich] was, for example a contempor[ar]y of Euler, and they were interested in many of the same problems." (J. S. Rowlinson also notes there wasn't much mention of Boscovich by Euler.) Precisely, how much interest in the same problems of course needs to be clarified.

Also, I noted that Boscovich deemed that his point-particles be considered in pairs i.e. forming what we now call strings. [6]

5. Typical treatment of point-particle as basis for modern physics in physics texts

Mainstream physics is built on the concept of point-particles; for example, Norman D. Cook in his book Models of the Atomic Nucleus [7] says:

"Mainstream nuclear theory is the shell model. Although the "compound nucleus" model advocated by Niels Bohr became dominant in the 1930s with several quantitative successes involving nuclear binding energies and fission, by the late 1940s, the discontinuities in binding energies and the changes in nuclear properties associated with certain numbers of protons and neutrons indicated nuclear substructure that was not explicable on the basis of the collective properties of nucleons. Data suggestive of shells of nucleons similar to the well-understood electron shells of atomic structure encouraged Mayer, Jensen and colleagues (Mayer and Jensen, 1955) to devise a model that emphasized the properties of the independent particles within the nuclear collective. While related ideas had been entertained in the 1930s (e.g., Wigner, 1937), a coherent description of the quantum mechanics of the nucleons was not devised until the late 1940s with the introduction of a spin-orbit coupling force. That "independent-particle" description of nucleon states also explained the nuclear shells and consequently became the dominant theoretical paradigm in nuclear structure physics. Conceptually, the independent-particle (or shell) model is built on the idea of a Fermi gas: nucleons are assumed to be point particles that are free to orbit within the nucleus due to the net attractive force of a potential-well."

The relevant bit: “nucleons are assumed to be point particles”. Unfortunately, after mentioning point-particles then does not say anything about the theory of point-particles or whose theory that is: Boscovich. It seems the typical tact of such literature to gloss over point-particle theory.

6. Brief history of Boscovich Atomism

Stanford Encyclopedia of Philosophy [8] tells us about atomism: “Atomism in the form in which it first emerged in Ancient Greece was a metaphysical thesis, purporting to establish claims about the ultimate nature of material reality by philosophical argument. Versions of atomism developed by mechanical philosophers in the seventeenth century shared that characteristic. By contrast, the knowledge of atoms that is now taken for granted in modern science is not established by a priori philosophical argument but by appeal to quite specific experimental results interpreted and guided by a quite specific theory, quantum mechanics. If metaphysics involves an attempt to give an account of the basic nature of material reality, then it is an issue about which science rather than philosophy has most to say. A study of the path from philosophical atomism to contemporary scientific atomism helps to shed light on the nature of philosophy and science and the relationship between the two.”

Then jumping to Newtonian atomism says: “The key sources of Newton's stance on atomism in his published work are Querie 31 of his Opticks, and a short piece on acids (Cohen, 1958, 257–8). Atomistic views also make their appearance in the Principia, where Newton claimed, “the least parts of bodies to be—all extended, and hard and impenetrable, and moveable, and endowed with their proper inertia” (Cajori, 1962, 399). If we temporarily set aside Newton's introduction of his concept of force, then Newton's basic matter theory can be seen as a version of mechanical atomism improved by drawing on the mechanics of the Principia. Whereas mechanical atomists prior to Newton had been unclear about the nature and status of the laws governing atoms, Newton was able to presume that his precisely formulated three laws of motion, shown to apply in a wide variety of astronomical and terrestrial settings, applied to atoms also. Those laws provided the law of inertia governing motion of atoms in between collisions and laws of impact governing collisions.”

Newtonian atomism had a few problems. Jumping to Boscovich: “Acceptance of force as an ontological primitive is evident in an extreme form in the 1763 reformulation of Newtonian atomism by R. Boscovich (1966). In his philosophy of matter atoms became mere points (albeit possessing mass) acting as centres of force, the forces varying with the distance from the centre and oscillating between repulsive and attractive several times before becoming the inverse square law of gravitation at sensible distances. The various short-range attractive and repulsive forces were appealed to as explanations of the cohesion of atoms in bulk materials, chemical combination and also elasticity. Short-range repulsive forces varying with distance enabled Boscovich to remove the instantaneous rebounds of atoms that had been identified as an incoherency in Newton's own atomism stemming from their absolute hardness and inelasticity.”

Then deals with Daltonian atomism etc.

But basic idea of Boscovich atomism of point-particles stays as part of Modern Physics!

And as pointed out by Dragoslav Stoilkjovich [9] the atomism of Boscovich led to modern quantum physics, i.e. it was what quantum mechanics was built upon!

The conclusion of Stanford Encyclopedia [8] is: “Atomism, which began its life as speculative metaphysics, has become a securely established part of experimental science.”

And that atomism although not explicitly stated comes from Newton via Boscovich to modern quantum physics. Also, not explicitly stated in Stanford Encyclopedia, the Atomism of Boscovich being that of a theory of point-particles is now omitted from the education given to physics students.

I checked this education issue. Up to beginning of 20th century at least: Boscovich part of most education to physics students when Europe dominated science. Then came revolutions of Einstein, Bohr et al. Then came WWII and then came America as Superpower. America takes control of science/physics looks at new things from Einstein, Bohr et al that must now be included in modern physics and decides that needs to trim the Physics education to accommodate these new things. What it decides to cut out is Boscovich.

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