

Boscovich's theory: strict Newtonian physics, by Roger J. Anderton

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I will now look at Boscovich's theory according to Bertrand Russell. Bertrand Russell was one of the pro-Einstein supporters in the early days of Einstein becoming a celebrity, so this article highlights the relationship of the pro-relativity camp with respect to Boscovich in the early 20th Century.

According to Bertrand Russell- the physics of Newton can be considered as a deductive system. [1]

A deductive system is where one starts with a few assumptions and deduces the consequences of those assumptions; in the case of Newtonian physics those assumptions are called 'Laws of Nature' (such as Newton's first, second and third laws). Based upon those laws of Newton, one can work out the consequences of Newtonian physics.

Bertrand says:

"It is necessary to say something about the Newtonian system, since everything subsequent has arisen as an amendment to it, not as a fresh start. Most of the fundamental concepts of this system are due to Galileo, but the complete structure appears first in Newton's Principia." [1]

i.e. Newtonian physics that appears in Newton's book Principia is based in large part on the work of Galileo.

Bertrand continues:

“The [Newtonian] theory is simple and mathematical; indeed one of its main differences from modern theories is its belief (perhaps traceable to Greek geometry) that Nature is convenient for the mathematician, and requires little manipulation before his concepts become applicable.” [1]

i.e. Newtonian physics is based upon the ancient Greek philosophers’ idea that the universe/Nature is mathematical. I still hold that view and endorse a theory based upon that approach; namely Boscovich’s theory. In the next sentence Bertrand mentions Boscovich:

“The Newtonian system, stated with schematic simplicity, as e.g. by Boscovich, is as follows. There is an absolute space, composed of points, and an absolute time, composed of instants; there are particles of matter, each of which persists through all time and occupies a point at each instant. Each particle exerts forces on other particles, the effect of which is to produce accelerations. Each particle associated with a certain quantity, its “mass”, which is inversely proportional to the acceleration produced in the particle by a given force, the laws of physics are conceived, on the analogy of the law of gravitation, as formulae giving the force exerted by one particle on another in a given relative situation. This system is logically faultless. It was criticized on the grounds that absolute space and time were meaningless, and on the ground that action at a distance was inconceivable. The latter objection was sanctioned by Newton, who was not a strict Newtonian. But in fact neither objection had any force from a logical point of view. Kant’s antinomies, and the supposed difficulties of infinity and continuity, were finally disposed of by Georg Cantor. There was no valid a priori reason for supposing that Nature was not such as the Newtonians averred, and their scientific successes afforded empirical, or at least pragmatic, arguments in their favour. It is no wonder, therefore, that, throughout the eighteenth century, the system of ideas which had led to the law of gravitation dominated all scientific thought.” [2]

The things I wish to note from this; i.e. bring your attention to are- Boscovich’s theory is part of the Newtonian scheme, so Boscovich’s theory is in a sense Newtonian physics. However, as Bertrand points out – Newton was not a strict Newtonian; which means although Newton introduced Newtonian physics in his book Principia, he (Newton) did not rigidly stick to the Newtonian approach to physics that he started; i.e. Newton was not a strict Newtonian. If we stick rigidly to Newtonian

approach (which Newton could not do) then we get Boscovich's theory i.e. Boscovich's theory is strict Newtonian physics. The difference between the non-strict Newtonian physics and the strict Newtonian physics, being that strict Newtonian physics is about the relative nature of the universe.

As to the relative Nature of the universe, Bertrand says:

“The most formidable and persistent attack was upon absolute space and time. This attack was initiated by Leibniz in the lifetime of Newton, especially in his controversy with Clarke, who represented Newton.” [3]

i.e the relative Nature of the universe was championed by Leibniz against Newton.

Now Bertrand Russell also tells us:

“There are, speaking broadly, three great types of dynamical theory. There is the doctrine of hard extended atoms, for which the theory of impact is the appropriate weapon. There is the doctrine of the plenum, of an all-pervading fluid, for which the modern doctrine of the ether—the theory of Electricity, in fact— has at last partially forged the necessary weapons. And finally, there is the doctrine of unextended centres of force, with action at a distance, for which Newton supplied the required Mathematics. Leibniz failed to grasp these alternatives, and thus, from his love of a middle position, fell between, not two, but three stools. His view of impact as the fundamental phenomenon of Dynamics should have led him to the theory of extended atoms, supported by Gassendi, and, in his own day, by Huygens. His belief in the plenum and the fluid ether should have led him to the second theory, and to the investigation of fluid motion. His relational theory of space, and his whole doctrine of monads, should have led him, as it led Boscovich, Kant and Lotze, to the theory of unextended centres of force. The failure to choose between these alternatives made his Dynamics a mass of confusions. The true Leibnizian Dynamics is not his own, but that of Boscovich. This theory is a simple development of the Newtonian Dynamics, in which all matter consists of material points, and all action is action at a distance. These material points are unextended like the monads, to which Boscovich appeals as analogous.” [4]

i.e. the completed version of Leibniz's theory (Leibniz was unable to complete his own theory) was Boscovich's theory.

So, here we have it: the strict Newtonian physics is Boscovich's theory. Newton was unable to rigidly stick with the approach he started, Leibniz argued against Newton; Leibniz was unable to complete his counter- theory, but Boscovich did complete it. Boscovich's theory is thus the unified Newtonian theory of physics.

Thus Bertrand Russell believed that Boscovich's theory was the completed version of Newtonian physics. Now Bertrand might have believed (or not that) Einstein's theory of relativity replaces Boscovich's theory – it does not matter, because as I have shown both Galilean relativity (i.e the relativity consistent with Newtonian physics) and special relativity work as mathematical descriptions of physical reality. [5]

There are confusions with understanding the relativity point-of-view that I have identified such as the subtle difference between the two uses of the word 'absolute.' A person might write an article on science using the word 'absolute' and slip carelessly between two different meanings (or uses) of the word in that same article.

In the conflict between those pro-absolute (supporting the absolute point-of-view) against those pro-relative (supporting the relative point-of-view) there has been a misuse of the term 'absolute' which I shall now try to explain.

The conflict of course was about space and time. Those pro-absolute were claiming absolute space and absolute time while those pro-relative were claiming it was 'relative.'

The issue is what does 'absolute space' and 'absolute time' mean; and they can mean different things; the term 'absolute space' has two meanings and the term 'absolute time' has two meanings. That fact has completely confused things when the argument starts, it immediately starts on badly defined words.

One sense of the term 'absolute' is in the sense of 'absolute rest'. That is the old idea pre-Copernicus that the earth was at 'absolute rest; and the heavens moved around the earth. With the

Copernican revolution it was realised that the earth could be modelled as moving around the sun. Motion was then relative between objects. The earth was then not at 'absolute rest' and it was better to talk of the motion of the earth relative to the sun. Those supporting the idea that there was 'absolute rest' usually abandoned their belief that the earth was at 'absolute rest' and looked for some other object they could say was at 'absolute rest.' Those supporting the relative nature of the universe abandoned the idea of 'absolute rest' and deemed motion only relative between objects.

The connection of this idea of 'absolute rest' was then tied into the idea of 'absolute space' and 'absolute time'; based upon this idea there was a frame of reference to measure this 'absolute space' and 'absolute time' from.

That was the first use of the term 'absolute' in relation to the words 'space' and 'time', the second use was as follows:

Given two or more observers, we need to compare their distance and time measuring. So, if person A measures a distance say 1 metre in time interval 1 second, we ask - is this the same intervals of distance and time that other observers make; i.e does what A measures as 1 metre equal 1 metre as what everyone else measures and does what A record as 1 second agree with what everyone else records as 1 second.

Einstein's approach was to assume that they don't, that gave him his special relativity. While Galileo was to assume that they did, that gave him Galilean relativity.

So, the theories are thus four types:

1. Absolute rest, an absolute frame of reference where time and space intervals are measured as being the same for everyone.
2. Absolute rest, but the frame of reference for this absolute rest does not have space and time intervals the same for all observers.
3. No absolute rest, frames of reference are relative, but everyone measures same space and time intervals
4. No absolute rest, frames of reference are relative, but everyone measures different space and time intervals.

Theory (4) is Einstein's special relativity.

Theory (3) is Galileo's relativity.

Theory (1) is what those who believe in the 'absolute' have generally believed.

It is of course theory (1) that is wrong; and all motion is relative as per theory (3) and (4). (Note - it is easier to deal with relativity when the motion is inertial.) And of course as I have stated both relativity theories work.

Recognising this misuse of the word 'absolute', let us now clarify some additional points.

Picking up again from what Bertrand was earlier saying:

“The most formidable and persistent attack was upon absolute space and time. This attack was initiated by Leibniz in the lifetime of Newton, especially in his controversy with Clarke, who represented Newton.” [3]

Bertrand then goes on to say:

“In time, most physicists came to disbelieve in absolute space and time, while retaining the Newtonian technique, which assumed their existence.” [6]

Without my emphasis that there are two subtle meanings to 'absolute' this sort of statement by Bertrand seems nonsense- he is stating that in the reign of Newtonian physics -- physicists eventually rejected 'absolute' at the same time accepting it as part of the theory they are using. Now realising that there are two different 'absolute' what is really meant is that the physicists rejected 'absolute' in one sense of the word and accepted it in another sense of the word. i.e. they rejected space and time as 'absolute' in the sense of 'absolute rest' but accepted 'absolute' in the sense of observers measuring same space and time intervals -- i.e., as Galilean relativity.

That was then the situation of the physicists in the pre- Einstein revolution era, they were mostly supporters of the relative point-of-view in that they accepted Newtonian physics in the sense of Galilean relativity and that was Boscovichian. i.e. they were generally followers of theory (3). The opposition to them were the supporters of theory (1); supporters who were looking for a new frame of absolute rest (to replace the old frame of absolute rest of the earth). When the Einstein revolution happened then to be a relative supporter one was supposed to be supporting theory (4).

None of this was clearly highlighted at the time of the Einstein revolution; hence confusion over what was really the theory of relativity – theory (3) or (4) or other distortions.

The situation gets worse with this confusion, because according to Bertrand:

“In Clerk Maxwell’s ‘Matter and Motion’, absolute motion is asserted in one passage and denied in another, with hardly any attempt to reconcile these two opinions.” [7]

i.e. Maxwell was thus very confused.

Bertrand continues:

“But at the end of the nineteenth century the prevalent view was certainly that of Mach, who vigorously denied absolute space and time.” [7]

i.e. the prevalent view was I believe that of theory (3) at the end of the nineteenth century. Then Einstein came along in the 20th century to make things more ‘relative’ than theory (3) with his theory (4).

Bertrand continues:

“Although this denial has now proved to be right, I cannot think before Einstein and Minkowski it had any conclusive arguments in its favour.”

i.e. Bertrand is a relativity supporter, and has not fully realised the difference between the move from theory (3) to (4); or at least not explicitly stated it.

The arguments that Bertrand thought supported the relativity position must have been the experiments such as Michelson-Morley as explained from interpretation by special relativity.

Bertrand continues:

“The important reasons for rejecting absolute space and time were two. First, that everything we can observe has to do with the relative positions of bodies and events; secondly that points and instants are unnecessary hypothesis, and are therefore to be rejected in accordance with the principle of economy, which is the same thing as Occam’s razor.” [7]

It is interesting to note that in this paragraph what Bertrand is really doing is rejecting ‘absolute’ in the two senses of the word. First he rejects ‘absolute’ in the sense of ‘absolute rest’ and says it’s really about relative. And second he rejects ‘absolute’ in the sense of all observers measuring the same intervals of distance and time. The second rejection (of rejecting observers measuring same distance and time intervals) is not really clear, because he says it as rejecting points and instants; it becomes only slightly clearer with what he later says.

Bertrand’s position is theory (4), in that position the rejecting of observers having the same distance and time intervals is tied in with the idea of simultaneity; where observers cannot be sure if they are measuring the same space and time intervals.

Suppose person A measures distances x_A and time interval t_A . Another person B measures what he thinks is the same distance and time interval x_B and t_B . The problem then in special relativity is -- does x_A equal x_B and t_A equal t_B . Einstein answers this question by saying we cannot assume this, because we don’t know if these measurements were made at the same instant of time. i.e. it becomes his big issue of simultaneity. Bertrand interprets this by rejecting points of space and instants of time in what he says: “.....points and instants are unnecessary hypothesis.”--- He thinks this because in special relativity one cannot tell whether the same point in space is

measured by two or more observers, and one cannot tell if the same instant is measured by two or more observers. The position of a point becomes smeared out over a distance for different observers; similarly the instant of time becomes smeared out over a time interval for different observers. This has tie in with Heisenberg's uncertainty principle—where one cannot tell precisely the position and momentum of a quantum particle, and one cannot tell precisely the instant in time and energy of a quantum particle. No wonder Heisenberg was inspired by Einstein's relativity; his quantum mechanics was a development of this uncertainty inherent in special relativity.

References

[1] The Analysis of Matter, by Bertrand Russell. By Bertrand Russell, John G. Slater p 13

[2] ibid p13 -14

[3] ibid p 14

[4] A critical exposition of the philosophy of Leibniz, Bertrand Russell, George Allen and Unwin, London, original 1900, third impression (second edition) 1949, p 90- 92

[5] <http://www.wbabin.net/science/anderton9.pdf>

[6] The Analysis p 14 -15

[7] ibid p 15

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