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Boscovich's Theory and Newton's Third Law

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

The Acceptance of Newton's Third Law is interconnected with the Acceptance of Boscovich's theory; which gives a proper understanding of that Law namely in terms of Field interactions.

The article I am referring to below is by David Papineau, [1] and is dealing with Newton and Boscovich. Objective is to explain Boscovich's theory and why we have the Third Law of Newton in Physics:

1. Newton's third law of motion: to every force there is an equal and opposite reaction is symmetrical.
2. No one thought of motion in terms of Newton's third law until Boscovich revived it in 1745.
3. There was a pre- Newtonian (pre- 3rd law) way of thinking about things.
4. It was quite a mysterious process as to why Newton's 3rd law suddenly became accepted, replacing pre-Newtonian (pre- 3rd law) way of thinking.
5. No one had shown an interest in Newton's third law for sixty years until Boscovich showed interest in 1745.
6. Newton's third law seemed an unnatural way of thinking about things; counterintuitive.
7. Boscovich's theory is in part that an object changes it motion through interaction with a field..

Newton's Third Law comes from Definition IV of Newton's *Principia* that states "An impressed force is an action exerted upon a body, in order to change its state, either of rest, or of uniform motion in a right line" [2]

According to David Papineau Newton explains that "this force consists in the action only, and remains no longer in the body when the action is over. For a body maintains every new state it acquires by its inertia only. But impressed forces are from different origins, as from percussion, from pressure, from centripetal force." and "If a body impinge upon another, and by its force change the motion of the other, that body also (by the equality of the mutual pressure) will undergo an equal change, in its own motion, towards the contrary part. The changes made by these *actions* are equal, not in the velocities but in the motions of bodies."

In other words Newton thinks that impact of bodies involves two equal and oppositely directed forces, which arise in the impact, and act equally and oppositely to change the motions of the two bodies. (n.b. because force is equal and opposite to reaction, these forces are thus symmetrical; and we can think of Newton's Third Law as a symmetrical model.)

This Newtonian model of impact is what is taught today. However, it was not familiar to Newton's contemporaries and immediate successors. Between 1687 and 1745 all intellectuals (who were what we now think as scientists) did not think of impact in terms of Newton’s Third Law. Instead they thought in terms of the transfer of forces of motion.

As David Papineau explains it: “A body's 'force of motion' was a quantity attaching to the body itself. It didn't consist in the action only, but, on the contrary, remained in a body even in unimpeded uniform motion. In impact a body acted by transferring some of its force of motion to the other body, or, alternatively, by receiving some of the other's force of motion, in such a way that total force of motion was conserved in impact.”

David Papineau points out that in the period 1687-1745: “The only natural philosophers in the period who didn't analyse impact in terms of forces of motion were those who, like d'Alembert, adopted a strictly positivist attitude to forces of any kind, and argued that natural philosophy ought to restrict itself entirely to charting the effects observed in different situations, without worrying about the forces responsible for those effects. This kind of positivism became increasingly popular in the early 1740s.”

Different philosophic points-of-view have sought to impose themselves on Physics and has made it a mess. The Positivist philosophic interpretation has sought to delete certain ideas that are outside experiment and observation; this has often been a hindrance because for instance an idea such as atoms pre-20th Century were not observable of how Physics, and trying to not talk about atoms pre-20th Century stunted theoretical progress.

As David Papineau points out Newton’s Third Law was ignored for sixty years because it ran counter to intuition, then Boscovich in 1745 revived it. He thinks that it might have been the Positivistic philosophy (of such people as D’Alembert) of discarding ideas that did not have experimental confirmation that might have made room for Newton’s Third Law as a need for explanation.

David Papineau explains it:

“Newton represented any impact — even one, say, involving, a huge body with great speed bearing down on a tiny body at rest — as involving a symmetrical action, with the small body acting on the big one as much as vice versa. The adoption of this counterintuitive view, in place of the 'force of motion' concept which had been the basis of dynamic thinking ever since the medieval impetus theory, would have required a major conceptual shift. It would have been surprising if the mere publication of the new view, even in such an influential outlet as the *Principia,* had alone sufficed to bring about such a major conceptual revolution. Rather, in order for the new theory to be accepted, it was necessary that a positivist rejection of all dynamic concepts first clear the conceptual air. Once this positivist demolition had created a conceptual vacuum, so to speak, then, starting with Boscovich in 1745, it became possible for the Newtonian analysis of impact to move into the vacated conceptual space.”

He thinks there is a general pattern in Science when there is a new idea (innovation) there needs to be positivism to discard the existing ideas so as to make general acceptance of the new idea.

His general idea is that existing concepts might be able to explain observed phenomena, then a new concept might be in conflict with these existing concepts, when this happens before the new concept can be accepted, there is a need to discard the existing concepts, by what the author calls a Positivistic approach of discarding the existing concepts which then creates the need for the new concept to explain what is happening in the phenomena.

There is a problem here of cause- and-effect; if there is a new concept that needs the existing concepts to be discarded before it can be accepted, what is the “cause”. I pass on this problem.

David Papineau mentions about the old idea of vis viva (living force, was mass times velocity squared), but in general that idea is no longer used by modern physics, instead is used kinetic energy (of half mass times velocity squared).

Those who followed Newtonian ideas often differed from Newton on certain issues, for instance the Newtonian MacLaurin thought of force as mass times velocity; whereas nowadays have force as mass times acceleration, this caused him to take the Newton’s laws differently..

Boscovich thought in terms of point-particles with a sphere of influence around them which we would now call field, this field prevented point-particles from actually coming into contact, this was a denial of contact of these point-particles. David Papineau says:

“Let me conclude with some remarks about the precise significance of Boscovich's denial of contact. I have claimed that it was this denial of contact that loosened the grip of the 'force of motion' concept and led Boscovich to his model of impact in terms of symmetrical applied forces. But how essential was this denial of contact? Couldn't a symmetrical model have been achieved without it?”

“Well, yes. After all, the Newton of the *Principia* thought of impact in terms of contact, indeed contact between hard bodies producing instantaneous finite changes of motion. Yet this didn't stop him thinking of the causes of those changes of motion as symmetrical and oppositely directed impulses.”

“But that was Newton. The fact remains that for more than half a century all natural philosophers, including Newton's own followers, were persuaded by their commitment to contact to continue thinking of impacts as transferring some force which added to or canceled out the force of the receiving body.”

So, what is being said is that the commitment to contact as being part of what happens in collisions meant that they did not want to think in terms of Newton’s third law, but with the idea that there was no contact, that interactions happened through a field, Newton’s third law was more acceptable as part of a descriptive.

David Papineau notes that Euler was the only person other than Newton who thought in terms of Newton’s third law and retaining contact; Papineau also thinks that this is the modern view. But I think the modern view should be that of field without contact; because field view is a large part of most modern science thinking.

The denial of contact comes from the body having a field around it; so two colliding bodies do not touch on the subatomic level, instead there is an interaction between the two fields of the objects. So, given an object moving in such-and-such a way, it might change its motion without an apparent other object hitting it, instead it can change its motion through the interaction it has with a field. For instance a thrown object can start falling to earth, this is a deviation from the direction it was thrown in, and hence a change in the motion from how it was thrown, no object(s) are observed hitting the thrown object, instead its change in motion is due to the gravitational field of the earth.--- That is a large component of Boscovich's theory.

A modern way of thinking is to have this field itself represented by a particle; so that a two particle collision with its interaction by the Boscovichian field has that field being an exchange of another particle between those two colliding particles.

References

[1] Boscovich and the Newtonian Analysis of Impact, by David Papineau, R J Boscovich: vita e attivita scientifica his life and scientific work, Atti del Convegno Roma, 23- 27 maggio 1988, A cura di Piers Bursill - Hall, Istituto della Enciclopedia Italiana, Fondata da Giovanni Treccani s.p.a Roma, published 1993, p183-194

[2] I. Newton, *Mathematical Principles of Natural Philosophy* [1687], trans. by A. Motte, 1729, ed. by F. Cajori, Berkeley, 1934.