Experimental philosophy reappraised

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Abstract.

It seems that the genuine foundations of experimental philosophy, as Isaac Newton called his science, lie still hidden in his widely unread "Principia". An attempt to raise that treasure independently of the paradigms of analytical mechanics is made. This brings to light some hitherto unrecognized potentialities of the ideas of Galileo and Newton.

Introduction.

Newton's "Principia" was published about 300 years ago in 1687[1]. Meanwhile its fame has been reduced by Albert Einstein[2], and modern scientists in a sense even see the whole theory defeated[3]. But everybody is not enthusiastic about that. Remember what Alexandre Koyré added to Alexander Pope's epigram on the godsend Newton, who had shed light upon the laws of nature hid in night: " 'T was not for long, for Devil, howling: 'Ho, let Einstein be!' restored the status quo"[4]. Einstein in his time had to revise insufficient theories, but in spite of his important contributions he did not succeed in conceiving a homogeneous theory[5].

Criticism of the concept of force.

To make a new attempt in that direction, I shall criticise the basic concept of force which is used in 'classical' mechanics, and which was Einstein's unquestioned point of departure. Above all, let me say that

$$F = \Delta(mv)/\Delta t \tag{1}$$

is not equivalent to Newton's second law of motion. There has already been some criticism of this general belief, but only with respect to whether the effect of the force F should be expressed by $\Delta(mv)$ or by $\Delta(mv)/\Delta t$ [6]. For my part, I prefer $\Delta(mv)$, since, like B. D. Ellis, I think that we have to respect Newton's clear words[7]. But I mainly want to focus attention on the fact that the force F, according to Newton, is *not equal, but proportional* to its effect $\Delta(mv)$. Having studied the development of science in the seventeenth century for the past two years, I can assert that one cannot by any means impute to Newton the idea that force (which in his philosophy means 'cause') and change of motion (which means the 'effect' of the cause) are *equivalent*. On the contrary, this is an original and genuinely "metaphysical principle" of G.

W. Leibniz, who, against all the philosophical convictions of his time, and against the explicit opposition of his contemporary Ch. Huygens[8], created and propagated it as a basic concept of his philosophy [9], which was totally rejected by Newton[10].

Proportionality of cause and effect.

Now, from the *proportionality* of cause, or force F, and effect $\Delta(mv)$, both being not equal, but different physical entities, as Huygens emphasized, or incommensurables, following John Wallis's words[11], there results a constant:

$$F \text{ [dimension A]} \;:\; \Delta(mv) \text{ [dimension B]} = c \text{ [dimension A/B]} \qquad (2)$$

and this constant, as it bears a dimension, cannot be swept aside by putting it equal to "one", as, for instance, Steven Weinberg has suggested[12]. So the correct Newtonian law of force, according to the words of Newton's second law of motion, includes a constant, which has to be a basic natural constant, because the second law in Newton's own view is a natural law. The question now is, what this Newtonian constant might be, or, more physically expressed, what its dimension is.

As a result of my successful attempts to solve various proportions which Newton introduces in the "Principia" in using the equation (2) as concept of force[13], the dimension of the constant appears to be "space over time" [L/T]. The same constant can be found in the writings of Galileo[14].

Loss and return of a constant of proportionality.

There is, of course, no difference between this constant and the "c" [L/T] which dominates Einstein's theory. c turns out to be an essential of the correct concept of Newton's motive force, which had been lost in L. Euler's and J.L. Lagrange's analytical mechanics as a consequence of the Leibnizian idea of the equality of cause and effect. But this idea proved to be wrong when, arising from experimental physics, the constant c recovered its place in physical theory, although Einstein, firmly rooted in analytic conceptions, did not succeed in showing the right place for it.

Let me now demonstrate the close relationship of 'my' Newtonian concept of force (equation (2)) to Einstein's fundamentals. First, I generalize the formula:

$$F = mvc \qquad (3)$$

(vector notations are ignored throughout this paper). Next I replace *v* by *nc*, with *n* being a number. Requiring *F* to be zero if velocity $v = 0$, and to have a maximum mc^2 if $v = c$, *n* becomes

$$n = 1 - 1/(1 - v^2/c^2)^{1/2} \qquad (4)$$

requiring *F* to be $= mc^2$ in the state of rest ($v = 0$), and to converge to infinity if *v* converges to *c* , then we have

$$n = 1/(1 - v^2/c^2)^{1/2} , \qquad (5)$$

the Lorentz factor.

Validity in energetics.

Einstein's concept, though, is one of energy, not of force. But is it the right one?

Together with Peter Guthrie Tait[15] I am sure that, against all common convictions, Newton had already an energetic conception. This result from his third law of motion and from a remark Newton makes at the end of the "scholium" that follows the laws of motion and their corollaries in the "Principia". After referring to ordinary machines, he defines the term "actio", which he already uses in the third law, by the product of force and velocity, and this product will, as Newton says, always be equal to the "reactio", which results as a product of velocity, friction, cohesion and so forth. Now if, according to my findings, the measure of force is *mvc*, then the measure of "action", *A*, force times velocity, is

$$A = mvc * v = mv^2c . \qquad (6)$$

And here we have mv^2, the measure of kinetic energy *E*. Equation (6) shows the proportionality of "actio" *A* and energy *E* :

$$A/E = c ; A = Ec . \qquad (7)$$

With a side-glance at thermodynamics, A might be replaced by the temperature T, and with $E = mv^2$ we find

$$A = T \times 1/c = mv^2 , \qquad (8)$$

which equation uncovers the meaning of the Boltzmann constant k, k obviously being equivalent to $1/c$.

Newton's "actio", as can be seen from his third law, is a conservation principle. Since "actio" mv^2c is conserved, T must be the equal "reactio", if a mechanical "actio" is totally converted into heat. And so we find the correct Newtonian geometric dimension of temperature to be $[L^3/T^3]$.

Thus with regard to 'energy in Newton's physics' I believe that the whole second book of the "Principia", which deals with motion under resistance, hydrodynamics and so forth, is dedicated to 'energetic' problems, although Newton does not use this term.

Conclusion.

Sir Isaac Newton, in a draft for the Leibniz-Clarke correspondence, opined that he, while Leibniz had spent his life in making disciples, had left "truth to shift for itself"[16]. Obviously truth did not do that and still does not; it has to be advanced by its servants.[17]

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References.

1) Newton, I., *Philosophiae naturalis principia mathematica*, London (1687).
2) Einstein, A., in Schilpp, P.A. (editor), *Philosopher Scientist*, p. 30 ff.., New York (1951).
3) Popper, K.R., *The Logic of Scientific Discovery*, 7th German ed., p. XXIV, Tübingen (1982).
4) Koyré, A. *Newtonian Studies*, p. 18; Chapman & Hall, London (1965).
5) Einstein, A. *Letters to Maurice Solovine*, p. 94, Paris (1956).
6) Jammer, M., *Concepts of Force*, pp. 130-1, Harvard University Press, Cambridge (1957).
7) Ellis, B. D., *Newton's concept of motive force*, J. Hist. Ideas 23 (1962).

8) Huygens, Ch., *Oeuvres Completes,* XIX, 162-165 (1967).

9) Leibniz, G.W., in Dosch, H.G., Most, G.W., and Rudolph, E. (editors), *Specimen Dynamicum* p. 122, Meiner, Hamburg (1982).

10) Alexander, H.G., *The Leibniz-Clarke Correspondence*, Manchester University Press (1956).

11) Wallis, J., *Mechanica Sive de Motu Tractatus Geometricus*, Prop. VII and "Scholium", London (1670).

12) Weinberg, S., *The Discovery of Subatomic Particles*, Scientific American Books Inc., New York (1983).

13) Newton, I., Book I Lemma X.

14) Galilei, G., *Discorsi,* Leyden (1638).

15) Tait, P.G., *On the Conservation of Energy*, Phil. Mag. 25, (4), 429-443 (1863).

16) Koyré, A., and Cohen, I.B., *Newton and the Leibniz-Clarke Correspondence*, Arch.Int. Hist.Sci. Nr. 15 , 111 (1962).

17) Dellian, E. *Die Newtonische Konstante*, Philosophia Naturalis Vol. 22 Nr. 3 (1985).
