

From the PHILOSOPHICAL MAGAZINE for October 1898.

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*On the Question of Absolute Velocity  
and on the Mechanical Function of  
an Æther, with some Remarks on  
the Pressure of Radiation.*

BY

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UNDER the belief that fundamental doctrines of science can be and should be treated in an exceedingly simple manner as well as by abstruse processes, the following short paper was mostly written a few years ago as a continuation of an elementary treatment of dynamical foundations, and as a prelude to a similar treatment of some more difficult problems concerning which I thought at that time that I had some trustworthy facts. It may be some time now before it is completed, so I publish it as it stands at present.

In the *Phil. Mag.* for February 1889, vol. xxvii. p. 115, Professor Newcomb calls attention to a fact that must often have struck people as a difficulty (Mr. Heaviside mentioned it twenty-five years ago in 'The English Mechanic'), viz. that

the kinetic energy of a definite mass moving with given speed varies according to the standard of rest arbitrarily chosen ; in other words that energy is as arbitrary and relative as velocity ; and the amount of work needed to confer a given velocity on a body depends on how fast that body was already moving [because  $(u+v)^2 - u^2 = v^2 +$  a term proportional to  $u$ ], a datum either meaningless or impossible to know.

But further, even though *work* might be rigidly defined, with reference to two bodies and their velocities relative to their centre of mass, by a suitable statement of the third law of motion, yet the same would not be true of *energy*, for it is not expressible in terms of their relative motion, and is therefore essentially arbitrary. Professor Newcomb takes this as limiting the generality of the law of the Conservation of Energy ; and says that it would promote sound philosophy if the limitation were made clear.

But I submit that it is more consonant with physical habit to assume the law of conservation and to deduce its consequences. Nothing that we know about energy points to its being a relative thing ; it has all the marks of objectivity. No one can really suppose that energy is destroyed or created wholesale by a mere change in the origin or point of reckoning for velocity. It is kinematically convenient to confer an arbitrary velocity on an extensive system so as to bring some body in it to rest, but it is not physically possible without performance of work ; hence it would appear that there is a real meaning in absolute velocity after all. Newton perceived this, and his great *scholium* preceding the *axiomata*, though it has been often criticised and misunderstood, is one of the most interesting details of his philosophy.

It was indeed the instinctive feeling of the race that absolute motion had somehow a real meaning which caused the excitement concerning Copernican views of astronomical movements, as taught by Galileo and others.

To show that conservation of energy, as accepted, demands attention to absolute velocity, and that it is only the customary neighbourhood of a practically infinite mass which has masked the ambiguity, it suffices to take the simplest possible case ; say the earth and a stone initially moving together with absolute velocity  $u$ . Their absolute energy is  $E_0 = \frac{1}{2}(M+m)u^2$ , their relative energy is nothing.

Fire the stone in the same direction, with extra velocity  $v$ , and let the earth recoil with velocity  $w$  ; the absolute energy is now  $E_1$ , such that  $E_1 - E_0 = \frac{1}{2}mv^2 + \frac{1}{2}Mw^2 + (mv - Mw)u$  ; and, since the last term is zero, the gain of absolute energy is equal to the gain of relative energy *provided the imparted velocity be reckoned from the centre of mass the only point whose velocity*