Henri Poincaré

The New Mechanics

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Introduction

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THE general principles of Dynamics, which have, since Newton, served as foundation for physical science, and which appeared immovable, are they on the point of being abandoned or at least profoundly modified? This is what many people have been asking themselves for some years. According to them, the discovery of radium has overturned the scientific dogmas we believed the most solid: on the one hand, the impossibility of the transmutation of metals; on the other hand, the fundamental postulates of mechanics.

Perhaps one is too hasty in considering these novelties as finally established, and breaking our idols of yesterday; perhaps it would be proper, before taking sides, to await experiments more numerous and more convincing. None the less is it necessary, from to-day, to know the new doctrines and the arguments, already very weighty, upon which they rest.

In few words let us first recall in what those principles consist:

A. The motion of a material point isolated and apart from all exterior force is straight and uniform; this is the principle of inertia: without force no acceleration;

B. The acceleration of a moving point has the same direction as the resultant of all the forces to which it is subjected; it is equal to the quotient of this resultant by a coefficient called *mass* of the moving point.

The mass of a moving point, so defined, is a constant; it does not depend upon the velocity acquired by this point; it is the same whether the force, being parallel to this velocity, tends only to accelerate or to retard the motion of the point, or whether, on the contrary, being perpendicular to this velocity, it tends to make this motion deviate toward the right, or the left, that is to say to *curve* the trajectory;

C. All the forces affecting a material point come from the action of other material points; they depend only upon the *relative* positions and velocities of these different material points.

Combining the two principles *B* and *C*, we reach the *principle of relative motion*, in virtue of which the laws of the motion of a system are the same whether we refer this system to fixed axes, or to moving axes animated by a straight and uniform motion of translation, so that it is impossible to distinguish absolute motion from a relative motion with reference to such moving axes;

D. If a material point *A* acts upon another material point *B*, the body *B* reacts upon *A*, and these two actions are two equal and directly opposite forces. This is *the principle of the equality of action and reaction*, or, more briefly, the *principle of reaction*.

Astronomic observations and the most ordinary physical phenomena seem to have given of these principles a confirmation complete, constant and very precise. This is