On the Temperature-equilibrium of an Enclosure in which there is a Body in Visible Motion. *By* Prof. BALFOUR STEWART, *F.R.S.*

It is now several years since Professor Tait and the author of this paper came jointly to entertain the belief that there is some transmutation of energy, the exact nature of which is unknown, when large bodies approach or recede from one another. It is desirable to vindicate an idea of this nature, both from the theoretical and the practical point of view—that is to say, we ought, if possible, to exhibit it as a probable deduction from those laws of nature with which we are already acquainted; and, on the other hand, it ought to be supported by observations and experiments of a new kind. In our case the experiments and observations have been of a difficult nature, and are yet in progress; it is therefore premature to bring them before the notice of the Association. A theoretical vindication of the idea has been obtained by Professor Tait, and more recently one has occurred to the author of these remarks, which he now ventures to bring forward. Men of science are now sufficiently well acquainted with Prevost's theory of exchanges, and its recent extension. We know that in an enclosure, the walls of which are kept at a constant temperature, every substance will ultimately attain the very same temperature as these walls, and we know also that this temperature-equilibrium can only be brought about by the absorption of every particle being exactly equal to its radiation, an equality which must separately hold for every individual kind of heat which the enclosure radiates. This theoretical conclusion is supported by numerous experiments, and one of its most important applications has been the analysis of the heavenly bodies by means of the spectroscope. Let us now suppose that in such an enclosure we have a body in visible motion, its temperature, however, being precisely the same as that of the walls of the enclosure. Had the body been at rest, we know from the theory of exchanges that there would have been a perfect equilibrium of temperature between the enclosure and the body; but there is reason to believe that this state of temperature-equilibrium is broken by the motion of the body. For we know both from theory and experiment that if a body, such for instance as a star, be either rapidly approaching the eye of an observer or receding from it, the rays from the body which strike the eye will no longer be precisely the same as would have struck it had the body been at the same temperature and at rest—just as the whistle of a railway engine rapidly approaching an observer will have to him a different note from that which it would have had if the engine had been at rest. The body at motion in the enclosure is not therefore giving the enclosure those precise rays which it would have given it had it been at the same temperature and at rest; on the other hand, the rays which are leaving the enclosure are unaltered. The enclosure is therefore receiving one set of rays and giving out another, the consequence of which will be a want of temperature-equilibrium in the enclosure, in other words, all the various particles of the enclosure will not be of the same temperature. Now, what is the consequence of this? The consequence will be that we can use these particles of different temperature so as to transmute part of their heat into the energy of visible motion, just as we do in a steam-engine; and if it is allowable to suppose that during this process the moving body has retained all its energy of motion, the result will be an increase of the amount of visible energy within the enclosure, all the particles of which were originally of the same temperature. But Sir W. Thomson has shown us that this is impossible; in other words, we cannot imagine an increase of the visible energy of such an enclosure unless we acknowledge the possibility of a perpetual motion. It is not, therefore, allowable to suppose that in such an enclosure the moving body continues to retain all its energy of motion, and consequently such a body will have its energy of motion gradually stopped. Evidently in this argument the use of the enclosure has been to enable us to deduce our proof from the known laws of heat and energy, and we may alter the shape of the body without affecting the result; in other words, we should expect some loss of visible energy in the case of cosmical bodies approaching or receding from one another.

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