

*Cours de Physique Mathématique de la Faculté des Sciences.* Compléments au Tome III. *Conciliation du Véritable Déterminisme Mécanique avec l'Existence de la Vie et de la Liberté Morale.* Par J. Boussinesq. Paris, Gauthier-Villars, 1922. xlviii + 217 pp.

Strange title for the third volume of a book on Mathematical Physics! Strange assertion in a strange title! Yet appearing in all simplicity in the closing volume of the new edition of an older publication, now the mature judgment of a distinguished scientist over eighty years of age, the affirmation in fact of a first statement made forty-five years ago! Happy the person who can more confidently state at eighty years of age what he thought was true when he was thirty-five! Member of the Institut, author of many treatises, many memoirs, and minor papers, professor of mathematical physics and of the theory of probabilities—who has a better right to state what he finds, with confidence and serenity?

What is the startling assertion? It is very simple and yet it makes much of scientific philosophy rock preparatory to its fall in ruins. This assertion is that mechanics declares the necessity of a directive principle which is outside mechanics in order to account for the phenomena of the universe. What! Can it be that the most definite of all the branches of physics, itself the most definite and well-understood of the sciences, the branch which even gives its name to that mode of thinking which passes among some scientists as the only straight and narrow path to truth—the mechanistic philosophy—can it be that this discipline itself has turned traitor to the cause, and gone over to the camp of the enemy where freedom smiles, where there are directive principles, entelechies, even perhaps real mind? Is this the outcome of a lifetime study of the laws of mechanics and probabilities? Yet so it is. And indeed he is not without very respectable company in these opening years of a new century, now almost a quarter gone.

The investigation of M. Boussinesq has all the clarity of French mathematics, is easy to read, is not—as he says distinctly—a metaphysical argument, but is the unescapable conclusion of a mathematical consideration of the laws of motion. It is simply this in brief: the laws of motion are stated always in the form of differential equations. These have in many cases, when we come to integrate them, ambiguities in the integrals, due to the fact that the characteristic curves of integration are bifurcated at certain points and also to the fact that these curves often have envelop curves that represent the singular solutions. A particle traveling on a characteristic curve—to take the simplest case—may follow the envelop, for each characteristic curve somewhere is tangent to the enveloping curve. What determines then the path chosen in these cases, since the laws of motion show that the paths are indeterminate, and yet the particles do follow unique paths? The only answer is that at the singular points where a choice of path is possible there must be a directive principle which selects the path. This does not affect the accelerations, therefore does not consist of a force, and hence is not to be accounted for in the energy equations. This becomes the true distinctive character of phenomena due to life, conformably to the extreme physico-chemical instability of living beings,