which have been deduced from their properties; and finally some three chapters to the well-known analogies between hydrodynamics and electromagnetism. One chapter is somewhat of a polemic on mechanical explanations of the phenomena of physics.

There are two fundamental difficulties which are always encountered in any attempt at mechanical or electrical explanations of gravitation. The first arises from the marvellous accuracy of the law: at the distance of the moon there can be no deviation from the well-known index 2 of the inverse square greater than one divided by a hundred million, and very probably the deviation is less than one tenth of this fraction. At one time Newcomb brought forward a larger deviation to explain the outstanding difference between theory and observation in the motion of the perihelion of Mercury, but abandoned it when the theory and observation of the moon showed that its adoption would require the explanation of a much larger error in the motion of the perigee of the moon. In fact, astronomers of the present day rarely invoke any such hypothesis to explain their difficulties.

The second difficulty arises from the apparently instantaneous propagation of gravitation. It has been computed that its velocity must be at least a million times that of light. In view of these facts one is tempted to wonder whether any of the ordinary mechanical explanations are possible, unless indeed it is a case where two effects counterbalance one another, as in the principle of relativity. It must be said in this connection that M. Combebiac emphasizes in his preface the fact that analogies and not explanations constitute the chief object he has in view. "Mais l'analogie," he says, "n'est-elle pas l'un des plus efficaces moyens utilisés par l'esprit humain dans son effort d'adaptation au déterminisme naturel?" For this reason, the volume will be acceptable to all those who have puzzled their minds over this fascinating problem.

E. W. Brown.


The plan adopted by Professor Abbe for forwarding the interests of meteorology by the republication of the more important memoirs has several advantages peculiar to this
subject. It is not one which is ordinarily taught in educa-
tional institutions except incidentally in connection with
physiography or geology, and naturally it is rare for a student
to go much further than to learn the principal phenomena
and their causes. If, later, he wishes to obtain a more extended
grasp of the subject by reading its literature, he is confronted
with a mass of discussions, opinions, guesses, and facts of
every variety of value from the worst to the best. The
treatises which are available are not extended enough for the
sifting of all this material. Hence when a worker with long
experience gathers together the papers and memoirs which
have real value, translates those in a foreign tongue and
arranges them in a manner sufficient to show their connection,
he performs a service which cannot fail to be highly appreci­
ciated by future if not by present generations of meteorologists.

The danger in this procedure—that of tending to make
future investigations follow the same grooves as those of the
past—is probably not very serious. The study of the motions
of our atmosphere is only beginning to emerge from the
condition of a pure theory to one which has some relation to the
phenomena, and it is probably better for the present to
follow lines of investigation already established than to start
many new methods, lest neither the old nor the new be
properly developed.

The theoretical difficulties arise mainly from the fact that,
in the language of the mathematician, there is apparently no
first approximation; at any rate, none generally applicable
has yet been found. Forces which ordinarily might or would
be neglected in a first approximation have a habit of causing
effects as great or greater than those which arise from the
forces which have been included. The motions of liquids
are troublesome enough, but they can usually be reduced to
symbols unless there is turbulence: the motions of the atmo-
sphere which we desire chiefly to know are nearly always
turbulent. There is much to be done too in reducing law and
order in the mass of observations which has been collected
during the last few decades. A thorough investigation into
the best methods of treating this material seems to be almost
as much needed as is theoretical research.

From the point of view of the mathematician a detailed
review of Professor Abbe's third collection is not necessary.
The great majority of these papers consist of applications of
theory to observation and they are therefore somewhat outside the province of a mathematical society. It is interesting to notice, however, that while most of the papers have been published since 1880, we have one by George Hadley dated 1735. Another by Poisson (1837) is on a subject which has received attention once again, namely, the motion of projectiles taking into account the rotation of the earth.

E. W. Brown.

NOTES.


At the meeting of the London mathematical society held