can be no need, before this audience, to plead the higher rank of the intellectual, aesthetic, and moral life above the material, or to argue that the pabulum of the mind is worth as much as food for the body. Now, it is unquestionable, that, in the investigation and discovery of the secrets and mysteries of the heavens, the human intellect finds most invigorating exercise, and most nourishing and growth-making aliment. What other scientific facts and conceptions are more effective in producing a modest, sober, truthful, and ennobling estimate of man's just place in nature, both of his puny insignificance, regarded as a physical object, and his towering spirit, in some sense comprehending the universe itself, and so akin to the divine?

A nation oppressed by poverty, and near to starving, needs first, most certainly, the trades and occupations that will feed and clothe it. When bodily comfort has been achieved, then higher needs and wants appear; and then science, for truth's own sake, comes to be loved and honored along with poetry and art, leading men into a larger, higher, and nobler life.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SOME DISTINCTIVE FEATURES OF THE BRITISH ASSOCIATION.

THE general plan of organization of the British and American associations for the advancement of science is the same. The English body has a 'council' corresponding closely to our standing committee, and a 'general committee' corresponding to our body of fellows. There are, however, many points of difference which it is well worth while to study with a view of seeing what suggestions of value we may derive for our own guidance. The first of these is, that the British association has long since given up the practice of meeting and transacting business as an organized body. The general meetings are held only to hear such papers as the president's annual address, and not to transact business of any kind. The transaction of all business by the several committees saves much time which the American association spends in the work of organizing the meeting, and electing new members; and we may expect, that, as our numbers increase, this work will become so cumbrous that we shall finally adopt some plan of putting it entirely into the hands of committees.

The organization and conduct of the scientific proceedings are so like those adopted by ourselves as to call for little remark. The division into sections is substantially the same as with us; and the main difference between the sectional programmes is that no estimated length of a paper is given by our neighbors, thus avoiding one source of deception which frequently annoys intended listeners. Perhaps it was owing to the peculiar circumstances of the meeting, that the papers and discussions were of a quality superior to what we are wont to expect in a semi-popular assemblage. Only men who had some serious object could undertake so long a journey; and the result has been, that what such men have had to say was heard without any admixture of the crude and ignorant speculations so often interjected into the discussions, and even forming the subject of the papers. The one subject in which English thought has always been pre-eminent is the theories of physics, and the discussion on the seat of electromotive forces was all the more creditable from the barrenness of the subject. This discussion well illustrated the comparative state of science in the two countries; which may be expressed by saying, that, while a few men of the highest genius stand on the same level, foreign countries are greatly superior to us in the number of trained men, thoroughly grounded in first principles, which they are able to bring forward. The lucid statement by Professor Willard Gibbs of New Haven, of the principles involved, was the feature of the discussion; yet it would have been hard for the speaker to collect in his own country so appreciative an audience as that which greeted him from beyond the ocean.

The most valuable work of the British association has been the reports and investigations undertaken by committees of its appointment. Occasionally these reports have comprised synopses of the progress of science in special branches made by individual members, and presented to the society. The greater number have, however, been accounts of special researches, the funds for prosecuting which have been supplied by the association. A splendid example of such work, which must ever redound to the credit of the body which undertook it, is the system of electrical units now universally adopted, the basis for which was furnished by a committee of the British association. It can hardly be too much to say, that no one work of recent times has done more for the progress and diffusion of electrical

science than this. The committees are generally continued from year to year, and thus form permanent working bodies, each pursuing a definite object. Naturally, nearly all the work will be done by one or a small number of members; but the latter have the advantage and stimulus of the co-operation and advice of their fellow members, who again are in a position to provide for the continuance of the work in case the person in charge gives it up. An idea of the present importance of this feature of the organization may be gained from the fact, that there are more than forty such committees at work, reporting annually. Some examples may be cited to show the character of the work undertaken: A committee on underground temperature collects determinations of the rate of increase of temperature in mines, and other places where it is possible to determine it; another is collecting and investigating meteoric dust; another investigates the lunar disturbance of gravity; Mr. Francis Galton is at the head of a committee devising a system of statistical measurements of human beings; the economists have a committee investigating the rate of wages, and its relation to economic progress. In a word, a range of subjects from tables of binary quantics to patent legislation, and the migration of birds, are being regularly investigated. We wish there could be a body of men in this country pursuing similar objects.

The number of Americans present at the meeting was even greater than could have been expected; and the high character of the American representation is sufficiently shown by the fact that six ex-presidents of the American association were in attendance.

STEPS TOWARDS A KINETIC THEORY OF MATTER.[1]

THE now well-known kinetic theory of gases is a step so important, in the way of explaining seemingly static properties of matter by motion, that it is scarcely possible to help anticipating, in idea, the arrival at a complete theory of matter, in which all its properties will be seen to be merely attributes of motion.

Rich as it is in practical results, the kinetic theory of gases, as hitherto developed, stops absolutely short at the atom or molecule, and gives not even a suggestion towards explaining the properties in virtue of which the atoms or molecules mutually influence one another.

[1] Address to the mathematical and physical section of the British association at Montreal, Aug. 28, 1884, by Professor Sir WILLIAM THOMSON, M.A., LL.D., D.C.L., F.R.S., L. & E., F.R.A.S., president of the section.

Every one who has hitherto written or done any thing very explicit in the kinetic theory of gases has taken the mutual action of molecules in collision as repulsive. May it not, after all, be attractive? Imagine a great multitude of particles enclosed by a boundary which may be pushed inwards in any part, all round, at pleasure. Now station an engineer corps of Maxwell's army of sorting demons all round the enclosure, with orders to push in the boundary diligently everywhere when none of the besieged troops are near, and to do nothing when any of them are seen approaching, and until after they have turned again inwards. The result will be, that, with exactly the same sum of kinetic and potential energies of the same enclosed multitude of particles, the throng has been caused to be denser. Now, Joule's and Thomson's old experiments on the efflux of air prove, that if the crowd be common air, or oxygen, or nitrogen, or carbonic acid, the temperature is a little higher in the denser than in the rarer condition when the energies are the same. By the hypothesis, equality of temperature between two different gases, or two portions of the same gas at different densities, means equality of kinetic energies in the same number of molecules of the two. From the observations proving the temperature to be higher, it therefore follows that the potential energy is smaller in the condensed crowd. This (always, however, under protest as to the temperature hypothesis) proves some degree of attraction among the molecules, but it does not prove ultimate attraction between two molecules in collision, or at distances much less than the average mutual distance of nearest neighbors in the multitude.

We must look distinctly on each molecule as being either a little elastic solid, or a configuration of motion in a continuous, all-pervading liquid. How we can ever permanently rest anywhere short of this last view is not evident; but it would be a very pleasant temporary resting-place on the way to it, if we could, as it were, make a mechanical model of a gas out of little pieces of round, perfectly elastic, solid matter, flying about through the space occupied by the gas, and colliding with one another, and against the sides of the containing vessel. But alas for a mechanical model consisting of the cloud of little elastic solids flying about amongst one another! Though each particle have absolutely perfect elasticity, the end must be pretty much the same as if it were but imperfectly elastic. The average effect of repeated and repeated mutual collisions must be to gradually convert all the translational energy into energy of shriller and shriller vibrations of the molecule. Even if this fatal fault in the theory did not exist, and if we could be perfectly satisfied with the kinetic theory of gases founded on the collisions of elastic solid molecules, there would still be beyond it a grander theory, which need not be considered a chimerical object of scientific ambition, — to explain the elasticity of solids.

If we could make out of matter devoid of elasticity a combined system of relatively moving parts, which, in virtue of motion, has the essential characteristics