

Science and Craftsmanship

General Science

SIR WILLIAM BRAGG, K. B. E., F. R. S., in his presidential address before the Glasgow meeting of the British Association for the Advancement of Science:

There are even some who think that science is inhuman. They speak or write as if students of modern science would destroy reverence and faith. I do not know how that can be said of the student who stands daily in the presence of what seems to him to be infinite. Let us look at this point a little more closely.

The growth of knowledge never makes an old craft seem poor and negligible. On the contrary, it often happens that under new light it grows in our interest and respect. Science lives on experiment; and if a tool or a process has gradually taken shape from the experience of centuries, science seizes on the results as those of an experiment of special value. She is not so foolish as to throw away that in which the slowly gathered wisdom of ages is stored. In this she is a conservative of conservatives.

What is true of a tool or process is true also of those formulas in which growing science has tried to describe her discoveries. A new discovery seems at first sight to make an old hypothesis or definition become obsolete. The words cannot be stretched to cover a wider meaning. By no means, however, is that which is old to be thrown away; it has been the best possible attempt to express what was understood at the time when it was formed. The new is to be preferred for its better ability to contain the results of a wider experience. But in its time it will also be put aside. It is by a series of successive steps that we approach the truth; each step reached with the help of that which preceded it.

Nothing in the progress of science, and more particularly of modern science, is so impressive as the growing appreciation of the immensity of what awaits discovery, and the contrasted feebleness of our ability to put into words even so much as we already dimly apprehend. Let me take an example from the world of the physical sciences. There is a problem of which the minds of physicists have been full in recent years. The nineteenth century theory of radiation asks us to look on light as a series of waves in an all-pervading ether. The theory has been marvelously successful, and

the great advances of nineteenth-century physics were largely based upon it. It can satisfy the fundamental test of all theories, for it can predict the occurrence of effects which can be tested by experiment and found to be correct. There is no question of its truth in the ordinary sense.

In the last twenty or thirty years a vast new field of optical research has been opened up, and among the curious things we have found is the fact that light has the properties of a stream of very minute particles. Only on that hypothesis can many experimental facts be explained. A wave theory is of no use in the newer field. How are the two views to be reconciled? How can anything be at once a wave and a particle? I do not believe that I am unjust to any existing thinker if I say that no one yet has bridged the gap. Some of you who were present at the Liverpool meeting may remember that Bohr—one of the leading physicists of the world—doubted if the human mind was yet sufficiently developed to the stage in which it would be able to grasp the whole explanation. It may be a step forward to say, as we have been saying vaguely for some years, that both theories are true that there are corpuscles and there are waves and that the former are actually responsible for the transference of energy in light and heat, and for making us see; while the latter guide the former on their way. This is going back to Newton, who expressed ideas of this kind in his "Opticks," though he was careful to add that they were no more than a suggestion.

We are here face to face with a strange problem. We know that there must be a reconciliation of our contradictory experiments; it is surely our conceptions of the truth which are at fault, though each conception seems valid and proved. There must be a truth which is greater than any of our descriptions of it. Here is an actual case where the human mind is brought face to face with its own defects. What can we do? What do we do? As physicists we use either hypothesis according to the range of experiences that we wish to consider. To repeat a phrase which I employed a few years ago in addressing a university audience familiar with lecture time-tables, on Mondays, Wednesdays and Fridays we adopt the one hypothesis, on Tuesdays, Thursdays and

Saturdays the other. We know that we cannot be seeing clearly and fully in either case, but are perfectly content to work and wait for the complete understanding.

And when we look back over the two centuries or so during which scientific men have tried systematically to solve the riddle of light, or even go farther back to the surmises of philosophers of still older time, we see that every conscientious attempt has made some approach to the goal. The theories of one time are supplanted by those of a succeeding time, and those again yield to something more like the first. But it is no idle series of changes, no vagaries of whimsical fashion; it is growth. The older never becomes invalid, and the new respects the old because that is the case.

Surely, it is the same in regard to less material affairs. The scientific worker is the last man in the world to throw away hastily an old faith or convention or to think that discovery must bring contempt on tradition.

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Aristocratic Utopias

Philosophy

Sir PHILIP GIBBS, in *The Day After Tomorrow* (Doubleday, Doran):

Mr. H. G. Wells, the only prophet of modern times who has actually seen some of his prophecies fulfilled—generally of a most unpleasant kind, like tanks and bombing aeroplanes—seems to have lost his faith in the advance of democracy to a flower-strewn Utopia with Men like Gods, and in his recent work suggests that human progress can only be attained by an intellectual aristocracy of very rich men, remarkably like Sir Alfred Mond, who will create enormous trusts, discipline the lower classes, and create a new heaven on earth by scientific organization and divinely inspired committee meetings.

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