electron orbits are largely symmetrical. In other words, if we retain the relativity explanation of the spectroscopic-doublet formula, we are obliged to suppose that two orbits which have the same shape but different orientations with respect to the nucleus may exhibit widely different screening constants—which is only another way of saying that these orbits may possess widely different energies.

To this extent, then, I am able to help out the chemist in his attack upon the electronic orbits of the physicists. I am able to enable him to say with a good deal of certainty that these orbits can not be of precisely the type which we physicists have been playing with so assiduously for the past five years. If we retain the explanation which has heretofore been given to the relativity doublet formula, an explanation which requires entirely different shapes for the two orbits corresponding to these doublets, then we must begin to work with an atom which is very much less symmetrical with respect to the differently oriented orbits than we have hitherto been imagining.

R. A. MILLIKAN
NORMAN BRIDGE LABORATORY OF PHYSICS

REMARKS ON THE SCIENTIFIC ATTITUDE[1]

IF all our farmers were acquainted with the discoveries made by agricultural experts and were willing to adopt methods recommended by these experts the agriculture of this country and of the world would be far in advance of what it is. If all people were acquainted with the laws of health and hygiene and with the knowledge of these subjects possessed by our best investigators in preventive medicine and were willing to follow expert advice the average life would be greatly prolonged. Social progress is made possible through the activities of the few who are far in advance of the masses. The masses, at least in the more civilized countries, accept the material benefits conferred through the activities of the few. There is little hesitancy in adopting the telephone, the radio and the automobile. But in the realm of spiritual things, society lags. There is mental inertia, just as there is physical inertia. How reluctant have been the masses to accept the theory of evolution! The reason for this difference between the masses and the advanced thinkers must be sought in the mental attitude. Let us, then, examine the mental qualities of the scientist, who is an advanced thinker in physical progress, with the assurance that much the same qualities must be possessed by leaders of thought in all branches of social progress.

The scientist searches for truth. He seeks to establish facts. He combines facts, works out their relation, modifies existing theories or systems to accord with increased knowledge. The ideal mental condition of the scientist is known as the scientific attitude. It is open-mindedness in the sense that new ideas are received on their merits and are not discounted in advance by prejudice and preconceived notions.

All here in my audience know what is meant by this term, the scientific attitude. Probably none of us possess this attitude in its ideal completeness. It is a state of perfection toward which we strive but probably never quite reach. The reasons for this imperfect attainment lie in our phylogenetic history.

Man as a social animal is controlled very profoundly by inherited tendencies—instinct it is called among the lower animals. Society also is controlled by inherited tendencies, that is, tradition and custom. In accord with these influences man has tended to be conservative and society has tended to be static. As a unit of society man is and always has been influenced by the mental attitude of the mass, which is that what is, is right. The constructive leader in progress is an individual who is mentally what the horticulturist would call a sport, he must diverge sharply from the average. In so far as he wishes to develop or modify social, political, economic or religious customs or beliefs he comes in contact with the static condition of the masses who think and act in accord with inherited tendencies.

Again, what is the usual ontogenetic history of the individual? From the moment that a child is born it is subjected to the will of others. With few exceptions it is taught to think as do its parents, to obey authority. In school the same kind of influence continues. A good boy is one who obeys his teacher, one who respects authority. In society the youth is taught to look up to his elders, to his superiors, to his boss. Parental discipline, school discipline, organization discipline, on the average and in the main tend to stifle independent thought. In this I am not intending to decry parental authority or school discipline, but to point out that the usual environment in which we grow up does not tend to develop the scientific attitude.

In attaining a condition of open-mindedness we are overcoming our inherited tendencies and the effects of our childhood and our present-day environment, and very few of us are able to do this completely.

There is conservatism in science as in other branches of human knowledge. An accepted theory in chemistry, geology or biology becomes in a sense a tradition, and facts tending to disprove such a theory are not infrequently viewed with a hostile eye by its supporters.

[1] From the address of the retiring president of the Biological Society of Washington. There were three parts: (a) Remarks on the scientific attitude; (b) botanizing in Ecuador; (c) how to help the Biological Society.

The individual may be open-minded to the work of others but be very conservative when considering facts which tend to upset his own published conclusions.

Of course open-mindedness can be carried to an extreme. To be open-minded does not mean to accept all statements with equal freedom. That would be credulity and not open-mindedness in the sense of the scientific attitude. The scientist does not receive the statement that the earth is flat by saying: "That may be so; some say it is round. I will look into the matter."

I now wish to speak of a not infrequent tendency among scientists against which we all need to struggle. We may retain the scientific attitude in our specialty or in science in general but lose this attitude when we approach such subjects as politics, religion or business. During the recent war there were people who under the influence of war hysteria hated everything German, even German music, and belittled the achievements of German science—an attitude scarcely to be called unprejudiced. Can we say that all scientists were free from this feeling? Since the war many people, good and true, fearful for the foundation of things as they are, have been stampeded into condemning others because they were said to hold radical views and, Heaven protect us! they even might be Bolshevists. This, though these good people might not know what a Bolshevist was—the word was enough, it sounded bad. Can we say that all scientists were entirely free from this feeling—this unreasoning mass action?

Clear thinkers are responsible for social progress. Scientists are well in the van among leaders of the world's thought. But we are of the people. We are not separated as a class phylogenetically. We are not moving in a definite direction by means of physical evolutionary processes, as is the Morgan horse or the collie dog. Our ranks are being ever added to from the mass of the species. The roots of our lives lie in the prejudices of the past. From this standpoint one may well express surprise that so many have disentangled themselves from the past and have progressed so far toward the ideal of absolute open-mindedness. These links with our common heritage have been largely severed by scientists so far as concerns their own special field. But in other fields the links may still hold us. We require verification concerning statements of scientific facts; but we may accept without hesitation the most unverified statements about the League of Nations or German reparations. Propaganda could make no headway were statements met with scientific inquiry.

Finally, I believe strongly that scientists as a class should carry their scientific attitude into the realms of affairs outside the world of science. The scientific method of thought has been applied chiefly in a material way and not sufficiently toward the solution of economic problems. It is absurd for a scientist to shiver with fear if he sees a black cat cross his path or if he walks under a ladder. It is equally absurd to believe that all Germans or all democrats, or all Roman Catholics or all I. W. W.'s, or all the members of any social, political or religious class are undesirables and a menace to society. Why should we hesitate to apply scientific methods of thought to the tariff, to ship subsidy, to birth-control, to the recognition of Russia, to the ancient custom of marriage, to the Centralia trials, to the Ku Klux Klan and to a thousand other subjects upon some of which we may have formed opinions based upon unverified statements, thus often being the victims of systematic propaganda? Until we can do this we have not attained freedom; until then our ancestors are reaching up from the oblivion of the past to direct our course.

A. S. HITCHCOCK

U. S. DEPARTMENT OF AGRICULTURE

UNIVERSITIES AND LEARNED SOCIETIES

IT is with gratitude that we of the universities return once a year to this ancient society, and we depart again with confidence renewed. Here, but seldom elsewhere in our country, we find an unchanging devotion to the truth for its own sake, and a simple conviction, such as a plain man may grasp, of the *value* of truth. This is a society which has and feels no need to advertise its wares, and thereby to cheapen them, which happily escapes the tendency that is turning our institutions into mechanisms, which still believes in the individual, and does *not* believe in committees and councils of the elect.

These rare and surpassing merits of the Philosophical Society perhaps are, and have been, more the result of good fortune than of deliberation. They are due to detachment, to a failure to cooperate in setting up visionary projects which are not adapted to the nature of man; in short, to a blessed inactivity on the part of the society and to a corresponding free activity on the part of the members.

How uncommon elsewhere are these old-fashioned virtues! The colleges and universities, their equilibrium disturbed by the addition of vast schools of journalism and of pedagogy, of summer schools, evening schools and correspondence schools, move on with the civilization which they serve into a future that we can not prophesy. This is as it should be. But the change is painful, it is often directed by ignorance, and it leads to the worship of many strange new gods.

[1] Speech at the annual dinner of the American Philosophical Society, Philadelphia, April 26.