

which popular judgment will not destroy will have to be *profitable*.

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A PLEA FOR TERRESTRIAL AND  
COSMICAL PHYSICS<sup>1</sup>

ONCE upon a time, at a certain small dinner-party, the Duke of Wellington, on being urged to express his opinion frankly of the French marshals he had so successfully worsted in battle, pointed out their good qualities in a most free and magnanimous manner, showing wherein each particularly excelled. Whereupon one of the party said: "Well, sir, how was it that with such various great qualifications you licked them all, one after another?" The duke, taken back, paused, then said: "Well, I don't know exactly how it was, but I think if any unexpected circumstance occurred in the midst of a battle which deranged its whole plan, I could perhaps organize another plan more quickly than most of them."

This power of being able to instantly change an established train of thought, or to be receptive to a new set of circumstances and facts, and thus to be capable of immediately setting up a fresh plan of action, was tersely and most suggestively expressed by Maxwell. When writing Herbert Spencer about a subject of controversy in the latter's "First Principles," he said:

It is seldom that any man who tries to form a system can prevent the system from forming around him, and closing him in before he is forty. Hence the wisdom of putting in some ingredient to prevent crystallization and keep the system in a colloidal condition.

At the Ithaca meeting of the association, two years ago last summer, I prefaced a paper on the San Francisco earthquake by

<sup>1</sup>Presented at the Baltimore meeting of the American Association for the Advancement of Science, at the general interest meeting of the Section on Physics, December 30, 1908.

a few remarks calling attention to the disparity of papers pertaining to the physics of the earth and of the universe presented to-day before sections A and B. I stated it was my impression that this had not always been the case. Attend any similar meeting abroad, be it in England, Germany or France, and you are apt to find the names of foremost physicists down for papers on results of research in terrestrial or cosmical physics. These eminent investigators evidently find food for exhilarating thought and stimulating work in the unraveling of the phenomena of seismology, meteorology, geodesy, hydrology, atmospheric electricity, solar physics, terrestrial magnetism, etc. They appear to regard knowledge gained in the laboratory and in the university merely as a means to an end, not an end in themselves.

The chairman of the Section of Mathematics and Physics at the recent meeting of the British Association was the well-known physicist-meteorologist, Dr. W. N. Shaw, director of the London Meteorological Office. Besides making a most suggestive presidential address, he led an interesting discussion on "The Isothermal Layer of the Atmosphere"—a live topic in meteorology to-day. Those taking part in the discussion were: Shaw, Rotch, Dines, Cave, Turner, J. J. Thomson, Walker and others. Several times has it occurred within recent years at that association, that, owing to the number of titles presented, it was necessary to have a subsection on "Cosmical Physics" which I am very glad to note did not apparently meet with the favor of the physicists themselves. Our British colleagues want the cosmical physicists to stay with them and not flock off by themselves, and the present tendency seems, accordingly, to be at the British Association, not to form such a subsection. Indeed, Dr. Shaw, in the address referred to, said:

For the advancement of science in this sense we require all three—the professor with academic freedom, to illuminate with his genius any phenomenon which he may be pleased to investigate, the administrator, face to face with the practical problems in which science can help, and the living voice which can tune itself in harmony with the advances of science and in sympathy with the needs of the people whom it serves.

You will find among the past contributors to papers and discussions on the subjects mentioned, such names as, Kelvin, Rücker, Schuster, Lockyer, Eliot, Cortie, Teisserenc de Bort, Glazebrook, Chree, Gill, Thomson, etc.

I can not better illustrate the mutual help that may spring from friendly conference between the pure physicist and the world-inoculated one than to quote you a paragraph or two from a most admirable presidential address delivered by Dr. S. Weir Mitchell, at the second meeting of the Congress of American Physicians and Surgeons, held at Washington in 1891, entitled, "The Early History of Instrumental Precision in Medicine." Referring to this congress of the eminent of the land in medicine and surgery, Dr. Mitchell says:

It is here, therefore, that the open-minded man may feel the broadening influence of intellectual contact with those who have other limitations than his own; for, indeed, in our divergent attention to special studies we run some risk that, contrary to St. Paul, the eye may say to the hand, "I have no need of thee," or the head to the body, "I have no need of thee," for as to us also, there should be no schism in the body. . . .

What the specialist learns, until it is commonplace, is not easily enough assimilated by the mass of practitioners. At last, however, comes a time when it is, and then that whole body of medicine feels the gain in nutrition and repays the debt. The masters of our still most perfect art, medical optics, may wisely remember that it was physicians who most distinctively recognized and diffused the knowledge that headaches and some other brain disorders are due to eye strain, and thus, while lessening our own futile labors, crowded the waiting room of the ophthalmologist. . . .

As I have mentioned the need for continuous

individual cultivation of our multifarious science on a broad scale, and for personal consultation, I like to enlarge the plea and call a meeting like ours a general consultation. And this, in fact, it is; a focal point for condensed opinion, for authoritative statements, for criticism from varied standpoints and for significant indications as to those accepted gains which ought to become, from time to time, a part of the mental equipment of all other special, and indeed of all general practitioners.

Change the words physician, surgeon, medicine, to corresponding ones applicable to this gathering, and what apter or truer characterization of what our own aims and purposes should be could be given than is embodied in these words! One is tempted to wish that we might also, like the "Deutscher Naturforscher und Ärzte Versammlung" of Germany, gather with us in annual conclave the physicians and surgeons as well. Picture to yourselves the opportunities this would afford for enlivening and quickening discussions in several of our sections, and you will appreciate what I am seeking to emphasize, especially here, with regard to open, general meetings between the generalist and the "broadened" specialist. I say "broadened specialist" advisedly, for I believe upon critical examination it will frequently appear that the very pursuit of a speciality has a widening influence not adequately appreciated by one whose sphere of activity is restricted solely within the bounds of his own general science. For there is no more patent and suggestive fact of present-day research than that the most notable and the most rapid achievements are not in the older, well-recognized sciences, but in their borderlands or "twilight zones." Thus the true research worker soon finds it necessary to make excursions into regions beyond what he had been regarding as his own particular zone. He makes new acquaintances, learns new customs and laws and gradually begins to

perceive that there really is no well-defined line of demarcation—like the famous Great Wall of China—between one science or another!

One of the recent fundamental researches on the “Motions of the Moon” has been made by a college professor who, though an American resident, got his chief training and inspiration at Cambridge, England. This same investigator has contributed articles on meteorological mechanics. Columbia University, in its admirable endeavor to present a popular course of lectures on subjects of applied physical science, must draw for its lecture on “Atmospheric Phenomena and Physical Theory” upon another foreign-born, Cambridge-inspired, now American resident mathematical physicist. There are several of you here whose work lends additional eloquent testimony to the broadening and cosmical influence of that eminent school of physics. However, there are other European departments of physics of which much, along similar lines could be stated and exemplified. Is it not possible to have more home-inspired university product of our own to draw upon in these fields? Shouldn't we strive that our country be adequately represented on international committees formed to consider and to investigate some of the great world-wide questions? I believe we do not lack the talent. If there is less incentive among us, why is it?

The fact I wish to emphasize is strikingly shown by glancing for a moment at the general character of the programs presented in the first two decades of the association's history before the section on general physical science. The papers classified under physics of the globe, meteorology, geodesy and navigation, frequently exceeded those in physics, chemistry, mathematics and astronomy, whereas now, as you all know, they are in a minor-

ity. Among the authors of the first-named papers we find names which as soon as heard you will identify as among the most distinguished of the college professors of the middle of the last century: Redfield, Bache, Olmsted, Coffin, Alexander, Henry, Silliman, Peirce, Loomis, Espy, Horsford, Guyot, Lovering, Dana, Trowbridge, Mitchell, etc. Among the more eminent of those occupying government positions we find again Henry and Bache, and such men as Maury, Davis, Hunt, Hilgard, Schott, etc. The mental grasp of many of these geo- and cosmical physicists was considered sufficiently broad to make them desirable timber for the highest positions of honor in the association.

In those “good old days” some of the best contributions in meteorology and terrestrial magnetism were made by the college professor. Bache made a magnetic survey of Pennsylvania early in the forties while still a professor at Girard College, where he also established the first magnetic observatory in this country. John Locke, the inventor of the electro-chronograph (which, by the way, is unique in the history of science in this country as being the only scientific invention, I believe, receiving an award from our Congress, viz., \$10,000), in the thirties and forties undertook a magnetic survey of North America with Cincinnati as a base station. He even extended his investigations into Canadian territory and made many of the early observations of the three magnetic elements in the eastern states. Locke was a contemporary of the astronomer Mitchel, holding the chair of professor of chemistry and pharmacy at the Ohio Medical College. He lived at the time when the college professor frequently had to acquire his instruments of research and pay the expenses of his experiments out of his own meager salary. Yet he found ways of doing it and, moreover, had the necessary time to

go beyond his class-room and extend his good work in the territory round about and far away.

Loomis's work on the aurora borealis is still quoted. The contributions to meteorology by Espy, Redfield, Coffin, Maury and Loomis are even known to those of us who do not profess to be meteorologists. These few illustrations must suffice for our present purpose.

If the college professor now lacks the necessary time and incentive during the scholastic year, let him follow the example of Locke, Bache or Nipher who spent their vacations in the open in order to learn something of the physical laws governing natural phenomena. Let him behold his colleagues abroad like Rücker and Thorpe—one a physicist, the other a chemist—who jointly made a magnetic survey of the British Isles during their vacations with the aid of grants which probably just covered expenses and with doubtless no remuneration. The eminent Japanese physicist, Tanakadate, is another instance in point.

Why is it that, in spite of the truly wonderful spirit of research that has literally *seized* us in this country, there are so few of us entitled to be enrolled among those who are making definite contributions to terrestrial and cosmical physics?

We note with pleasure that the American physicist is very prominently represented, indeed, in astronomy and astrophysics. May we not hope that he will soon realize that this planet on which we dwell, and which must form the basis of all our astronomical speculations, is also worthy of the highest and most unselfish devotion? That, indeed, to reap the full and most lasting benefit of our celestial researches we must keep equal pace with our terrestrial ones? Let him recall that nearly every one of the great physicists

has at one time or another extended his mental vision beyond the problems immediately before him and considered what the application of his laboratory discoveries might be towards solving some of the riddles of the universe, or how he might benefit mankind. Faraday, Maxwell, Kelvin, von Helmholtz, Hertz, Mascart, Langley and Rowland are but a few of the inspiring names.

Happily, there are already some indications of a reawakening, and we note with pleasure the example recently set by our retiring president, who turned his sabbatical year to fruitful use in the study of some perplexing atmospheric phenomena. We note movements at some of our large universities to expand their graduate courses in the direction of the applied science here had in mind. At the present meeting we find 12 papers before Sections A and B, which might properly be classified under terrestrial and cosmical physics.

Von Helmholtz, as many of you know from actual experience, was a notoriously poor lecturer. He seemed utterly incapable of imparting his vast knowledge in any systematic manner, and doubtless the chief value which his listeners got was the inspiration imparted by class-room association with this gifted man. Von Bezold, who delivered the Berlin memorial address on von Helmholtz, told me the latter gave as the reason of his inability to impart his acquired knowledge methodically, the fact that he himself had not gained it in that way. He would take up his mathematics, for example, only when he required it—not by going systematically and consistently through a volume of higher analysis without some impelling or suggesting motive. And so it was with the other sciences with which he had to familiarize himself to push to successful completion an intricate and complex piece of research. Yet how

truly marvelous was the grasp this man displayed in so many varied subjects!

Now who has ever attempted to apply his knowledge to fields outside his own immediate one that has not felt this same irresistible, impelling, burning desire to know all that has been done before him in the new country he is about to explore? Haven't we each one of us found that with such an all-conquering impetus back of us the most complex mathematics or the most abstruse subject teems with a new and living interest? What was irksome before has now become a pleasure! And if there is one of you who for lack of excursions into such green pastures has not had new and invigorating blood course through his veins and has not been given a glimpse of a higher, truer and more ennobling vision of life, he has missed the greatest pleasure and the highest compensation open to the research worker!

Do you know of a school of thought that has prevailed for any length of time without resistance to that most subtle and, therefore, most dangerous of all insidious modes of attack, viz., the one coming from within its own fold of devotees, due to the pernicious habit of in-breeding? Is there any greater danger than that which besets a university which fills its chairs repeatedly from among its own graduates? We all know of the fallacy of the brilliant professor who thinks his ideas can be made to continue longest by surrounding himself with assistants drawn, if not entirely, at least chiefly, from among his own disciples. Will he not surely find, as Maxwell put it, that his "system has closed him in before he is forty" because he has forgotten the essential element to prevent crystallization—the importation of fresh blood and the introduction of new ideas?

If you agree with the speaker thus far, may not similar occurrences be recorded of our societies, because of the suicidal policy

of a particular class of members who are apt to believe that the best result can be reached by increasing their representation, and thus by their majority vote be able to dictate and control the general policy of the society to which they belong? Is it wise organization for membership in any deliberative body to be so constituted as to make it possible for the act of the assembly to be unduly influenced by one set of investigators? Is there not here subject for careful thought—a source of degeneracy due to the in-breeding in societies to be equally guarded against? Joseph Henry truly said: "Votes in science should not be counted, but *weighed*!"

This then is my specific plea: a broader conception and a more scientific representation of the subjects of physical research. Could we not make the attempt certainly once a year to devote most of our time and attention to some of the greater aspects of our work and take stock, so to speak, of our achievements, and of their possible applications?

L. A. BAUER

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REPORT OF THE COMMITTEE OF THE AMERICAN CHEMICAL SOCIETY APPOINTED TO COOPERATE WITH THE NATIONAL CONSERVATION COMMISSION

In May, 1908, a meeting of the governors of the different states was held at the White House in Washington to consider the conservation of our rapidly wasting natural resources. Following this meeting, a commission was appointed by the president of the United States to investigate the subject, and the principal scientific societies of the United States were invited to cooperate with it. The committee of the American Chemical Society, appointed in response to this invitation, now has the honor to submit the following preliminary report.

On December 8, 9 and 10 the National Conservation Commission met in Washington in joint conference with the delegates of