

现代物理学的 概念和理论

**The Concepts and Theories of
Modern Physics**

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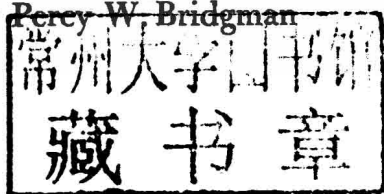
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CONCEPTS AND THEORIES
OF
MODERN PHYSICS

By

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INTRODUCTION

IN November 1881, D. A. Appleton and Company of New York City issued as Volume XXXVIII of their International Scientific Series a highly unusual sort of book, entirely without precedent in this country and with very few precedents in Europe. This was *The Concepts and Theories of Modern Physics* by Judge J. B. Stallo of Cincinnati. If the book were published today, it would unhesitatingly be classified as philosophy of science, but at that time the term was barely coming into use, and in fact the concepts back of the term had hardly emerged. As a consequence, its reviewers were at a loss how to take the volume, and there was much misunderstanding of its purpose and significance.

Reviews were about equally divided between the complimentary and the condemnatory. The editor of *Popular Science Monthly*, a widely read and ably conducted journal, thought the study of such importance he took the unusual course of calling attention to it in advance of publication, referring to the production as a "work of such exceptional importance to various classes of readers that we deem it proper to call special attention to it in this place."

The book was apparently well received by the public, for a second edition was issued early in 1884. In reviewing the second edition the editor of *Popular Science Monthly* stated that "the first edition, and a pretty large one, of this profound work was exhausted some time ago, which speaks well for the interest of American readers in the thorough discussion of the fundamental ideas which are at the basis of science and philosophy."

The second edition contained a new forty-page introduction by Stallo, in which he answered some of the criticisms of the first edition and amplified his position in some respects.

There was a third American issue in 1888, substantially like the second. It is this 1888 issue that is here reproduced. Simultaneously with the appearance of the first edition in America the book was published in England by Kegan Paul, as was the general practice with books in the International Scientific Series. There were second and third English editions, the third in 1890. Immediately after the first American edition a French translation was published by Félix Alcan in Paris under the title *La Matière et la Physique Moderne*, with an introduction by S. Friedel. There were subsequent reprintings of the French translation, improperly referred to as "editions," the fourth dated 1905. There are references by Stallo's biographer, H. A. Rattermann, to Italian, Spanish, and Russian translations, but these references seem to be of doubtful authenticity.

Without question the most important of the foreign editions was the German translation published by Barth in Leipzig in 1901. This translation was made at the instigation of Ernst Mach, who provided for it a thirteen-page introduction. The translation was followed almost immediately by a forty-page article in the *Vierteljahrsschrift für Wissenschaftliche Philosophie* by the translator, Hans Kleinpeter, giving a detailed analysis of the book and of Stallo's general philosophical outlook. There was a second German edition in 1911. It is to be remarked that neither the later English reissues nor the translations reproduced the new forty-page introduction to the second (and later) American editions. The reason for this does not appear.

That the public interest and attention bestowed on the book may not have been entirely due to docile acceptance of what Stallo had to say is suggested by the following quotation from Josiah Royce's introduction to Halsted's translation of Poincaré's *The Foundations of Science* in 1913.

Some of us well remember how, when Stallo's *Concepts and Theories of Modern Physics* first appeared, this sense of scientific orthodoxy was

shocked among many of our American readers and teachers of science. I myself can recall to mind some highly authoritative reviews of the work in which the author was more or less sharply taken to task for his ignorant presumption in speaking with the freedom there used regarding such sacred possessions of humanity as the fundamental concepts of physics.

In spite of the contemporary attention the book received and of some enthusiastic predictions that it would exert a permanent influence, it is today almost completely forgotten. Stallo is unknown even to some professional American historians and certainly to most American scientists. There are doubtless several reasons for this neglect. In the first place there was the intrinsic difficulty of the subject, coupled with a general lack of familiarity with the abstract ideas required of anyone entering this field. One reviewer speaks of the natural difficulty that would make Stallo's subject all but impossible, were it not for the crystal clarity of the exposition. Probably the principal reason for the desuetude into which the book has fallen is, however, its failure to make vital connection with the needs of the working physicist, who was always somewhat cool toward the volume, largely on intuitional grounds. Thus P. G. Tait in a review in *Nature* containing little legitimate criticism ends by saying: "But the reader cannot fail to doubt the validity of a method which upsets with equal ease the most irrefragable truth and the most arrant nonsense." Oliver Lodge in his review showed equal lack of comprehension of the significance of the volume and made equally shallow criticisms.

S. P. Langley grudgingly referred the book to Henry Adams in response to the latter's demand for some reference work that would show him what modern science was all about, but Langley added that he doubted whether Adams would get much out of it. Adams admits in fact that he did not understand it, but he puts the blame on his own inadequacy; and in his *The Education of Henry Adams* he says: ". . . for

twenty years past Stallo has been deliberately ignored under the usual conspiracy of silence inevitable to all thought that demands new thought machinery." It must be admitted, moreover, that Stallo lacked the instincts of the working experimental scientist. He put too much emphasis on what the scientist said as opposed to what he did or was trying to do. The importance of the book lies in other directions than that of a handbook for the experimentally creative physicist.

The treatise was to a large degree the product of Stallo's own reflective thought, based on his very extensive reading and with practically no benefit from give-and-take discussion with colleagues having similar interests. In fact he had no such colleagues; the community in which he lived did not breed them. For this reason it is particularly important to understand the author's personality and background.

Johann Bernhard Stallo was born in southern Oldenburg in Germany on March 16, 1823. (Stallo is not an Italian name but a genuine Frisian one meaning "forester.") His forebears on both his father's and his mother's sides, as far back as the line could be traced, had been country school teachers. With regard to his early education there are some discrepancies between the short account Stallo himself gave in a letter to Mach (which Mach quotes in his introduction to the German translation) and the account Rattermann in his biography says that Stallo gave to *him*. Since Rattermann is known to have been inaccurate in other particulars, greater weight is to be given to the Mach letter. Stallo's earliest education was apparently at home, perhaps because of the poverty of his father. Both his father and grandfather seem to have had a hand in this early education. German was of course his native tongue, but from them he learned English, French, and arithmetic. He was seemingly a boy of great precocity: he could read before his fourth birthday as well as do all sorts of problems in arithmetic. Later on he received instruc-

tion in Latin and Greek from two priests in a neighboring town who had been pupils of his grandfather.

By the time of his first communion at the age of thirteen Stallo's education had so far advanced that he could attend without charge the teachers' college in Vechta. He also had the privilege of studying in the nearby gymnasium. After two years more he was ready for the university, but his father lacked the means to send him there. Confronted by the prospect of adding one more to the long line of country school-teachers in the family, the boy chose to take his chances in a new country instead. In the spring of 1839 he emigrated to Cincinnati, armed with numerous letters to important persons in its large German community from important persons at home, many of them Catholic clerics. To a certain extent the ground had been prepared for his coming by the emigration there in the early 30's of his father's brother, who, after various initial misfortunes, had risen to a position of some prominence as an inventor and printer.

Once in Cincinnati, Stallo faced the difficult problem of finding a suitable occupation. His education had given him no manual dexterities. He very soon found a position as teacher in a local parish school, a somewhat ironical circumstance, since he had left Germany to avoid teaching as a career. It would appear that the young man regarded teaching as merely a steppingstone to something better. In the parish school his principal duty was the teaching of the German language, a task to which he addressed himself with assiduity. He was impressed by the lack of suitable texts for use in the German-American schools, particularly by the lack of a suitable primer or "spelling book." He set himself to rectify the deficiency, and in 1840 published anonymously (in German) his *ABC, Spelling and Reading Book, for the German Schools of America*. This went through numerous editions and was widely used by schools all over the coun-

try. In later years Stallo was accustomed to refer to the book ironically as his most brilliant literary success.

At about this time a private high school in Cincinnati, the so-called Atheneum, founded by German Catholic priests, was taken over by French and Belgian Jesuits and converted into St. Xavier's College. This institution was in need of a teacher of German. Stallo applied for the post, with the stipulation that in addition to his teaching duties he should be allowed to continue his studies of Greek and mathematics. He was accepted on his own terms and began his duties in the fall of 1841, when he was only eighteen years old. He continued as half-teacher, half-student at St. Xavier's until the fall of 1844. During his last two years there his duties were chiefly the teaching of mathematics rather than German, a task for which he had in large measure to prepare himself. The college had an extensive library in physics and chemistry and also a laboratory that was at least adequate by the standards of the time. For three years Stallo devoted his spare hours to the study of physics and chemistry under the direction of one of the Jesuit fathers.

His studies were so successful that in the fall of 1844 he was called to St. John's College at Fordham, New York (now Fordham University), as professor of physics, chemistry, and mathematics. Here he remained until the summer of 1848. During his stay at Fordham he found opportunity to resume his philosophical studies, to which he had been much attracted while in Germany but which he dropped on reaching this country. He read extensively in Leibnitz, Kant, Herbart, Fichte, Oken, Descartes, Spinoza, Newton, Hume, Schelling, and Hegel.

As a result of all this reading Stallo wrote while at Fordham a book in English entitled *General Principles of the Philosophy of Nature*, published in Boston in 1848. Stallo's ostensible purpose in writing was to make the American public better acquainted with the main currents of German philo-

sophical thought. In this respect the book was a flat failure, a failure that Stallo ascribed, not without a little bitterness, to the incapacity of the American (or any English-speaking) public to take the idealistic interest in things of the spirit that characterized the German people. Stallo himself, however, later completely repudiated the work, saying of it in his preface to the *Concepts* that it was written when he was barely of age, while he was under the spell of Hegel's ontological reveries, and therefore while he was infected with the "metaphysical malady which seems to be one of the unavoidable disorders of intellectual infancy." Nowadays the book does, indeed, make strange reading. Yet one cannot fail to be impressed by the verbal skill of the presentation. Stallo wrote with an ease and smoothness that never suggest English was not his native tongue. The only hint that English was not his birthright is a noticeable frequency of unusual words — words he must have picked up in reading, and highly erudite reading at that. This verbal facility appears to me to have been one of Stallo's outstanding mental characteristics and to have colored his whole outlook and activity. His verbal facility appeared early: before he left Germany he had already written a fair amount of verse. This linguistic ability may well have decided his later choice of a profession — the law — for he was capable of eloquent and forceful oratory as well as of fluent and graceful prose writing.

About the time he must have finished writing his *Philosophy of Nature* at Fordham, the course of his life took an abrupt turn. Perhaps this was simply a consequence of the psychological let-down following the composition of the book, for certainly the disappointing reception it received later could not have influenced him then. Whatever the reason, Stallo began in the winter of 1847, while he was still at Fordham, to attend a so-called law school. He resigned his teaching post, left Fordham in the summer of 1848, and returned to Cincinnati where he continued his legal studies in

the law office of an older lawyer, passed his bar examinations at the end of 1849, was admitted to the bar, and then began to practice. In discussing this change in his career with his friend Rattermann much later, Stallo spoke of the change as something he would rather not talk much about, but he said: "I desired primarily to make sure of a secure living for the future, so I came back to Cincinnati. I wanted to become practical, as the Americans are." Stallo at one time hesitated between medicine and law, but chose law at the advice of a friend who had found the practice of medicine among his German compatriots in Cincinnati neither pleasant nor lucrative.

Now began a full, successful, and distinguished career both in the private practice of his profession and in numerous side excursions into public affairs, occasioned by the many opportunities that offered themselves naturally to a public-spirited and liberal-minded lawyer. I shall make no attempt to reproduce the details here, since they may be found in any one of the several biographical notices on Stallo. His private law practice was interrupted in 1852 through his appointment by the governor of his state to an unexpired term as judge of common pleas; he was elected to this post by popular vote on the expiration of this term. He continued as judge until his resignation in 1855 when he resumed private practice, for he found it impossible to live on the exceedingly meager salary of the post.

In politics Stallo was at first a Democrat, being a great admirer of Thomas Jefferson, in whose honor he delivered an oration in German at exercises commemorating Jefferson's birthday in 1855. Under the increasing pressure of the slavery issue, however, Stallo changed his political affiliation, became a supporter of Lincoln, and was instrumental in raising a Civil War regiment among the Germans of Cincinnati and vicinity known as the Stallo Regiment.

Increasingly disillusioned by the corruption in the Republican party after the war, Stallo finally broke away in 1872 to become one of the leaders in the short-lived Liberal Republican party, which tried to nominate Charles Francis Adams. The attempt was frustrated by the inept tactics of Carl Schurz. This so disgusted Stallo that he broke with Schurz. In 1876 Stallo rejoined the Democratic party and took an active part in the Tilden campaign. Always an opponent of the philosophy of high protective tariffs, he supported Cleveland in his successful campaign of 1884, but apparently not actively. Cleveland's election was nevertheless followed by Stallo's appointment as ambassador to Rome, on the insistence of his friends. The natural post for Stallo would have been that of ambassador to Germany, but the post at Berlin had been assigned to a less worthy candidate having greater political claim. This appointment so incensed Stallo's friends that, as a result of their hue and cry, Stallo's appointment to the Italian post was made in short order. His friends claimed that he was the most distinguished German-American in the country. Stallo's appointment to the embassy automatically terminated in 1889 upon the defeat of the Democratic party in 1888.

Instead of returning to this country to resume the practice of law, Stallo chose to remain in Florence, where until his death in 1900 he lived the life of cultured leisure for which his tastes well fitted him and that he had been able to enjoy only partially in Cincinnati. His only known creative effort of this period, if indeed it can be called creative, was at the insistence of his friends to assemble and publish in 1892 thirty-three of the more significant of his ephemeral writings, all in German, under the title *Reden, Abhandlungen und Briefe*. The range of topics, which is wide, betrays the catholicity of his interests and the versatility of his talents. The book includes orations on Jefferson, Humboldt, and Gari-

baldi, and articles on the English language, materialism, Negro and woman suffrage, the German victory in the Franco-Prussian war, and the protective tariff.

Among these articles are a couple growing out of his most famous court case, a defense of the Cincinnati school board in abolishing the requirement of Bible-reading and hymn-singing in the public schools. This requirement had been strenuously opposed by the Jews, the Catholics, and the atheists, who did not like to pay taxes for the support of practices against their convictions, but was ardently supported by all the local Protestant denominations. Stallo lost his case in the Cincinnati Superior Court, but won on appeal to the Supreme Court of Ohio.

Toward the end of his life he began a correspondence with Mach, which had important potentialities but which unfortunately proved abortive. Mach became aware of Stallo's *Concepts* through a chance reference to it by Bertrand Russell, recognized a kindred spirit announcing views very much like his own, and started the correspondence, which was almost immediately interrupted by Mach's serious illness. Mach's recovery, sufficient at least to resume letter-writing, was followed almost at once by Stallo's death.

The Concepts and Theories of Modern Physics did not appear until thirty-three years after the ill-fated *Philosophy of Nature*. What was going on in Stallo's mind during this interval can only be conjectured. His many other interests could not apparently have left him much time for sustained work on the theme of the *Concepts*. Doubtless the first essential in the process of preparation was thinking himself away from the spell of "Hegel's ontological reveries and the metaphysical malady" that had motivated the earlier book. The details of this intellectual pilgrimage are not now clear. Perhaps it is significant that about this time (perhaps in 1855 or 1856) he had, according to Rattermann, broken with the Catholic church, married a Protestant, and had his children

baptized as Protestants. His reaction away from Hegel led to a violent repudiation of all sorts of metaphysical thinking — metaphysical, that is, in its bad sense. One of the chief points of the *Concepts* is that the thinking of contemporary physicists contained remnants of old metaphysical systems to a greater extent than was realized, and that it is the task of scientists to get rid of these metaphysical elements.

In evaluating the book it is important to understand clearly what Stallo means by metaphysics, a term that has been used in many senses by philosophers. On page 159 he says: "Metaphysical thinking is an attempt to deduce the true nature of things from our concepts of them." He lists what he calls the four radical errors of metaphysics. These are:

1. That every concept is the counterpart of a distinct objective reality, and that hence there are as many things, or natural classes of things, as there are concepts or notions.
2. That the more general or extensive concepts and the realities corresponding to them preëxist to the less general, more comprehensive concepts and their corresponding realities; and that the latter concepts and realities are derived from the former, either by a successive addition of attributes or properties, or by a process of evolution, the attributes or properties of the former being taken as implications of those of the latter.
3. That the order of the genesis of concepts is identical with the order of the genesis of things.
4. That things exist independently of and antecedently to their relations; that all relations are between absolute terms; and that, therefore, whatever reality belongs to the properties of things is distinct from that of the things themselves.

Stallo's purpose in writing the *Concepts* is stated in the opening lines of his preface: "The following pages are designed as a contribution, not to physics, nor, certainly, to metaphysics, but to the theory of cognition." Failure properly to appreciate the expressed purpose of the book was one of the most potent sources of misunderstanding by the reviewers, and provided a subject of legitimate complaint by

Stallo. At the same time it does not appear to me that Stallo's own description of his book is apposite in all respects. We would today call the book a contribution to the philosophy of science, but in Stallo's terms it would seem that the book could be better described as a critique of contemporary physics in the light of the theory of cognition rather than as a contribution to the theory of cognition. Just what Stallo understood by this "theory of cognition" is not clear, and has to be judged by the way he talks about it incidentally. It is emphatically not the same as "epistemology," a term for which Stallo had little use.

On the one hand he writes of the principles of the theory of cognition as well established and implies that they are accepted by all thinking men, but at the same time he speaks of them as having only recently been established and accepted. Thus on page 10 of the introduction to the second edition he speaks of

. . . the modern theory of cognition — a theory which has taken its rise in very recent times, and is founded upon the investigation, by scientific methods analogous to those employed in the physical sciences, of the laws governing the evolution of thought and speech.

But on page 156 of the text he declares:

. . . it is of the utmost importance to bear in mind the following irrefragable truths, some of which — although all of them seem to be obvious — have not been clearly apprehended until very recent times.

He then goes on to state in three paragraphs, of which I quote only the initial sentences, what these irrefragable truths are:

1. Thought deals, not with things as they are, but with our mental representations of them.
2. Objects are known only through their relations to other objects.
3. A particular operation of thought never involves the entire complement of the known or knowable properties of a given object, but only such of them as belong to a definite class of relations.

He gives no authority for this formulation of some of the

newly discovered principles of cognition, nor are there adequate suggestions among his usually copious references as to what the source of these principles may be. The most pertinent are three allusions to writings on logic by Drobisch, Mansel, and Sir William Hamilton; and one to a treatise on psychology, the *Lehrbuch der Psychologie*, by Herbart.

It would therefore seem highly probable that these irrefragable and recently discovered truths, and the corresponding "principles of the theory of cognition," are Stallo's own formulation of conclusions he himself drew from his wide reading during the reflective years of his recovery from "the metaphysical malady of intellectual infancy." If this be the case, it puts the tactics of Stallo's argument in an exceedingly vulnerable position. For he was presuming to criticize the two-thousand-year-old mechanics and physics for failure to agree with principles so new that their mere formulation had not yet been widely accepted, to say nothing of agreement with regard to their validity. As a matter of fact it is apparent from the discussion by Kleinpeter of Stallo as an *Erkenntniss-theoretiker* that there would have been contemporary agreement with regard to neither formulation nor validity. This point is underlined by Stallo's felt necessity to criticize sharply some of the ideas of J. S. Mill with regard to the nature of concepts. There would have been no need for such criticism if the principles of the theory of cognition rested on the universally accepted scientific foundation that Stallo claimed for them.

It follows from all this, when we read today, that what Stallo says must stand on its own two feet, expecting assent only because of its intrinsic reasonableness, and without support from the authority of other disciplines. Personally, it seems to me that many of Stallo's "principles of cognition" have a very sensible ring.

The remolding of Stallo's outlook must have essentially matured several years before the final writing of the *Concepts*,

because in 1873 and 1874 he contributed four articles to the *Popular Science Monthly* that were later incorporated in the *Concepts* with little alteration.

What about the book itself? The chief object of Stallo's attention is what he calls the atomo-mechanical theory of the constitution of matter, which he claims was accepted by all the leading physicists and was fundamental to their thinking. In Stallo's time "mechanical" had a specific connotation, different from that which it has today. The connotation was that all natural phenomena ultimately involve only the principles of Newtonian mechanics. This in turn involved the thesis that all phenomena could be reduced to the motion of elementary masses. Stallo was able to prove by copious quotation that some such theory was, as a matter of fact, held by many of the most prominent physicists in spite of their complacent belief that physics had been purged of metaphysics. The theory could trace an unbroken line of descent back to Aristotle and the early Greeks, although it had received comparatively recent alterations at the hands of Newton, Leibnitz, and Descartes. In its purest form the theory was that the ultimate constituents of matter were minute particles, all alike, all massive, hard, and impenetrable, and with no other properties, being completely inert with respect to motion, which was a different sort of thing. All the properties of matter as it presents itself to our senses were to be explained in terms of different arrangements of the ultimate particulars endowed with different sorts of motion. At the hands of Descartes and others this picture of the constitution of the world was held to be necessary and the only one logically possible.

Stallo has no difficulty in showing that the arguments that led to the conviction of the necessity for this state of affairs are essentially "metaphysical" in the bad sense, and that in so far as physicists accepted the arguments, they were guilty of metaphysics. From this distance in time it seems to me