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The Numerical Language of Physics

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1. "The Nature of the Physical World"

*translated
by John Baldovin*

"The Nature of the Physical World" is the title of a well-known volume of Gifford lectures by the physicist Addington. The social, religious, political, and spiritual problems encompassed by natural science are refracted for us through this engaging title as though by a prism. Although it may sound harmless and scientific, it is in fact neither harmless nor purely scientific. The aim of this section is to determine its place in our society.¹

1. Compare Moriz Sondheim, "Das Titelblatt," 1927. The oldest known title page was printed in 1463. Of course, there were handwritten title pages, such as the Wernigeroder Mattaeus, as early as the ninth century.

We will see that the religion of the physicist, and not only that of the physicist, is revealed in the book title. The religion that stands beneath all science and the religion that these scientists have in common with the peoples of the world will become apparent. On the basis of this religion the people permit, even demand, that a generally valid natural science may be effective over all political boundaries. From 1440 to 1946, that is up to the point in time when scientific research came under state control, natural science was truly international and therefore an inroad into national sovereignty which nations tolerated.

Only rarely is a book title so meaningful. One may assume that a book title is often symptomatic of the faith of the society in which it is published. Books are like the children of their authors. And when we give our children

names, we necessarily express in them our faith or lack of faith. Our words may be uttered in an instant, but names last a lifetime. If I name my child "Trifle" then I unmistakably betray a certain cynicism about the value of the human soul that can never be retracted. Names last longer than one generation. This name I give my child must mean something not only to the spirit of my own lifetime and to that of his, but also to the spirit of his children's time. Always, however, when we find ourselves in face to face confrontation with more than just our own generation, we are forced to reveal our own faith. In our own time we may place our light under a bushel and adapt ourselves. In the spiritual context of many generations, however, we must give light vigorously and discover what our unique light is. A man illuminates with his faith or with his cynicism, be it his own personal faith or a conventional one. He gives light, representing and transmitting his entire era and its spirit to other unknown generations. When these other generations hear the names he uses, they draw conclusions about the spirit of his time. Therefore names are our confessions of faith, whether or not we acknowledge the fact. Accordingly, "The Nature of the Physical World" discloses the belief held pridefully by natural sciences and the peoples of the Renaissance era. The average academically educated reader may already wish to protest. He knows how book titles are made by publishers. The charlatanism in the book business fills him with mistrust toward all book titles. A physicist and personal friend was really angry because I thought I saw more than accident or arbitrariness in a book title! Many researchers take our spiritual life to be just that lawless.

May I say that these skeptics -- be they ever so intelligent -- are simply not intelligent enough? For the objective observer of the pranks and fashionable clichés of book titles knows how to combine total scorn for this huckster mentality with high appreciation for the flow of spoken testimony soiling this overstrained journalism. It is the curse of the academic mind that it simply will not honor those names which it must use in order to be esteemed by society. And yet doctor, professor, natural science, Plato,

truth, research -- all these names are absolutely essential prerequisites for the mere existence of this science in our barbarous society. It must be seen now, at the beginning, that a book title can secure only slight and unnoticed influence through its thought if it is treated with frivolous indifference by enlightened intellectuals. Even those who open, examine, write, or plan books, or search after books that treat a certain problem - and these activities are really not so independent -- boast about not taking careful note of or fussing about names. In other words they do not become entangled in the spirit, or evil spirit, of living speech. "Not all who scoff at their chains are free."

I can not help it if a few readers withdraw right here. Today hordes of scientists and literary men zealously investigate every footnote, word, and technical term inside a book in minute detail; nevertheless they would characterize as absurd my opinion that book titles may be the most explicit means of expression for the religion of a society. These people point to the din of words and slogans and the arbitrary invention of book titles by enterprising publishers and agents. And they really believe that the abuse of our good faith in book titles reduces the right usage. In truth, these facts over which they lament demonstrate my opinion precisely. Corruptio optimi pessima. The most decisive element of life will be misused most often. This abuse will be discussed at a later stage in our investigation.

Now that we have regrettably lost a group of readers, I return to the starting point in earnest: "The Nature of the Physical World" is the subject on which the reputation of natural science rests. While maintaining our justification for taking this book title seriously, a surprising admission may be made. Books with such and many similar titles have become part of our religion. They are expected and desired by the public and they are written. They are an ingredient of our living beliefs. In other words, the belief in our right and even in the obligation to produce books about the nature of the physical world is and has been a part of our religion since the Renaissance.

It is a vital part of a living faith in which the Cardinals flying to Rome and the Japanese ~~suicide~~^{if} pilots find themselves united. Now comes my admission: this faith in technology constitutes only a small fraction of the religion of a Cardinal or Japanese. This is therefore the provoking truth: faith in a "Nature of the Physical World" may never be more than a fraction of our faith, and yet may ~~be~~^{be} seen as nothing less than a religious act.

We have testified today on both sides. One demands that we have unadulterated natural science, even if humanity is misused as a commodity or weapon, while the other makes clear that it is precisely this faith in natural science which we all use. A dangerous decadence menaces the natural sciences today as they make one aspect divine while considering the other to be without religiosity. Sectarian science and science seen as a commodity are both unfortunate; they both demolish scientific progress. The most orthodox churchman today must ~~have~~^{be} sympathy ~~over~~^{etic toward} these dangers to natural science. And I step forth here as an orthodox thinker of the Christian faith who must disseminate the religion of natural science as an indispensable part of his religion against its misuse.

I would like to unfold the true faith of Renaissance Christianity ~~from~~^{no} this book title, "The Nature of the Physical World". To further this aim I will take the following steps: First, we want to analyze the name of the book. Something strange is suggested through it to readers. Second, we will examine a workpage, a computation sheet and a page of scratch paper that stemmed from a few hours of laboratory work. On them one can see what violence a beginner with respect to the nature of the ~~physical~~ world may do himself. Things which a good man expects of himself betray best of all the beliefs of the experts. Indeed every faith ~~itself~~ forces the believers to terrible acts. This sheet of paper should disclose to us the self dedication of the new convert. In the third step, the spiritual attitude of a leading intellect over decades should become apparent for us in Michael Faraday's journal.

These three steps display the contemporary living faith in the nature of the physical world. The fourth step will lead us to discover parallels to this book title in completely different regions of natural science, and to derive the common law for its formulation. We will compare the spoken form of the "expectation," the faith of the last 400 years since the Renaissance, with the religious mode of speech of antiquity. And finally we will understand somewhat better our own beliefs and our faith which demands of us such an irritating, mysterious, and senseless book title.

That the title is irrational, mysterious, and senseless must be examined. "Nature of the Physical World" - yes - but why not "The Physics of the Natural World" or "The World of Physical Nature?" We have a right to ask so naively, for the three words which form the title express in a casual way exactly the same thing three times. It is one and the same unknown "x" whether we name it world, physics, or Nature. Physics in Greek is the same as Nature in Latin and world in German. If we should define the unknown behind these concepts we would say that world, Nature, and physics are different expressions for the Universe, the All as far as we apprehend it as dumb, unintelligent, and mute. Nature is the Universe minus its self assertion through language.

The three-fold repetition of the same concept from three linguistic domains is apparently a sacrament or a mystery. Perhaps not for our blunted academic perceptions which are so easily deluded through magnificent Hegelian categories. But it would enlighten a minstrel of the wilds, a child of the wood, or a simpleminded herdsman. He would compare the title at once with the magical formulas known to him, because both are repetitious. Each magical formula works through emphatic repetition, and in such a way that the reality of the repetition is in itself a part of the formula. Usually the "Open Sesame" is pronounced thrice. In MacBeth the three witches sing

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A Roman prayer, the oldest extant Roman prayer, developed from a Greek prayer form of the same time, is structured in the same way on three-fold repetition. Since we will have to say more about this prayer below, the complete text is reproduced in section 5. The forcefulness of three-fold repeated times will be apparent.

"The Nature of the Physical World" speaks thrice on the the same reality, the mute Universe. The main words utilized are equivalent synonyms. The Greek Heraclitus expressed by physics exactly what Cicero and Lucretius^{us} did by Nature and as we would by world. Through the self repetition of the book title, the formula has magical force on readers. But we of course know that it is not merely "black magic" confronting us, but rather a legitimate white art called natural science. Therefore the deliverance from phantoms must lie in the variation among the three linguistic strata -- Greek, Latin, and German. That is actually the case. We neither accuse Eddington of an indecent superstitious appeal ^{nor} charge science with black magic. Yet we cannot ignore the fact that whenever natural science is directed toward a legitimate but unscientific public, the kinship between natural science and magic steps forward into prominence.

We know also that, however natural^{al} science may appear, it possesses a definite thought antithetical relationship to magic. It exercises an oath and works like an enchantment. We might take exception, since it is a thoroughly legal oath and the consequences of such a spell are so desirable. But that is beside the point. I would submit that natural science is magic made true. Just now this is not the issue; it is important only in so far as we have admitted within our horizon this magic ennobled as the truth. We permit its entrance into our spiritual household.

By saying this I have admitted that natural science was introduced by the children of God, although God created no "physical" world and we as his children know nothing of it. If this seems surprising, we must analyze the second

characteristic of our book title: its senselessness. If a "physical" world exists, then one or more non-physical worlds exist. This one adjective "physical" encompasses the world; it is in common with it. We immediately consider others: the spiritual world, the political world, yes, finally, even the strangest -- the Christian world. The spirit of the Renaissance has seriously encroached past this boundary. Natural scientists frequently look down on people who speak of God's countenance or of God's signs, as though they were hopelessly superstitious, while they themselves have the power to speak without hesitation about God's mind. But the mind of God is just as much a metaphor as his elbow. Our mind is no nearer to God than our body -- however much the division of the world into physical and spiritual parts has blinded many of us to the fact that our spirit is no more Godlike than our kidneys. The split into a physical, spiritual, and Christian world is absurd to the most fundamental within me, because on the basis of my confession of faith I hope and believe that God created a single world which encloses me entirely, body and soul. But to my "re-search" mind each division is completely natural. It believes in a physical and a political world. It has no sense.

I find myself compelled therefore to maintain both positions. It is true that God created one world of heaven and earth. On the other hand there is the hard fact: there is a physical world, a special world as the base of all natural science. We men from Christian nations have become persuaded that we must permit ourselves the division of a unified totality of one world into physical and non-physical parts. We have been convinced that we will profit in the end from this division, because we underestimate the insanity of a disunion between physical and spiritual worlds and because we make the one, the physical, the object of the other, the intellectual world.

This on first sight is the apparently agitating paradox in that noteworthy and absurd booktitle. We in our community

have introduced a process which the first section of our confession of faith repudiates, a process sharing a common formula with all magical religions.

Now for the second step which brings us to a laboratory. The work page reproduced relates to research I participated in during the war. It reflects the self sacrifice of the physicist on the altar of natural science. These paper pages the reader holds in his hands are like the separation voucher for God's world, the divorce record which is displayed whenever we research. The world is split up into countless compartmentalized worlds, but always at least in two: a physical world, which becomes the object of metaphysics, and a ~~ph~~ spiritual world, the lost ~~su~~ subject of physics.

2. Our Division into Body and Mind

We observed above that painstaking research produces two fruits unknown in the nonscientific community. Only in an experiment a new subject and a new object arise; but for the experiment they have no existence.

The reader finds two workbook pages together. They open to form two sides. On the right side are reported the date and, in neat order, the headings (A), (B), (C), (D), and (E). On the left side one finds scribbling.

We now wish to pay attention to the difference in character of the writing on the two sides. For the same man simultaneously during one and the same experiment inscribed both. Neither the content nor the result of the experiment interests us. Nor are we graphologists, interested in the handwriting on one or the other side. The manner of the inner connection between the two sides astonishes us. Is a regular fluctuation displayed there through which both acts of writing evoke necessarily reciprocal reactions? The right is allotted for data, the left for calculations. With that format two activities are initiated. One is supposed to lead to an objective

result. The other is supposed to clear for the experimentalist the way to a worthily and totally objective mind, the proper enunciator of scientific statements. The first activity is extraverted, reported as an external result; the second is introverted, for it abstracts to an inner relationship.

The data are data of observation. They are given quantities which flow to us through the five senses; they come to us either through an instrument or an apparatus whose signals we hear or read, or directly from the world of matter. They act on one of the five senses of an individual, visibly, audibly, ~~ad~~idiforously, or through taste or touch. Each datum is observed independently. Otherwise it has no value. On the left this relationship is reversed. Each individual numerical entry taken by itself signifies nothing at all. The figures at the left make sense, as long as they are all valued together as components in one calculation process. They are added up or multiplied; the numbers or symbols are manipulated arithmetically or algebraically just as required. They are members of a whole in both calculation systems.

The handwriting on the right shows that the observer records his sense perceptions with a confident hand. He looks the facts of the experiment in the eye, like a man meeting other men. The determination is unambiguous; its written form is correspondingly clear and definite. The observer remains a sentinel on watch. He stands in full uniform and in possession of all his capabilities, maintaining a sharp lookout. He also shows corresponding hindsight and foresight. For instance, the reader finds that under (A) or (B) three or four different readings are recorded. A soldier on watch doesn't shoot before he has challenged the suspected deserter several times. In the same way the sense data may not be merely guessed. Therefore the scientist repeats his readings in an experiment several times. Through this cautionary rule modern physics overturned the perpetuation of magic. In antiquity a word

or formula was repeated three or four or seven times, thereby making its force on the outer world inescapably certain. We repeat the readings rather than the magic formula. Our mistrust of the intractable arises not in the outer world, but in our own senses. We test and retest our results. The three or four readings of one and the same phenomenon check the reports of the outside world rendered by our senses. Thus we can enunciate a law: one time is no time. A single observation is no observation at all. The first once-determined indication is still pre-objective. A series of results goes beyond mere impressions. A single impression is just not a real finding; the list of readings counts as the first genuine result. One finds therefore, as shown on our page, behind every result there remains an uncertainty, a ± 0.01 cm (0.39 %). This is the stigma of unreliability adhering to the senses.

Pre-objective impressions are never complete. A remainder of error still persists. Through these small errors the entire series of observations falls short of perfection. Pure science, of course, must often be content with such imperfect results. It depends all the more on a set of observations rather than on a mere one-time impression which cannot even acquire the stature of one member of a series. Thus science may weave only repeatables into its results. Since several readings taken together form one result, all unique occurrences are fundamentally unsuited for observation by science. They just cannot form a part of a result; their structure as unique occurrences prohibits it. He who uses the word "unique" is unscientific. And much that is true is unscientific.

Three steps are taken. First, the series of sense impressions to a secured is planned. Second, every individual sense impression is observed in accord with this plan. Third, an average is calculated and the probable error is figured to be so many percent. The layman -- and often the experimenting physicist is a layman in this -- would have expressed the three steps differently: a single sense impression is registered, a series of such entries is

formed, and ^{from} the series the probable error is calculated. This amateur presentation prevails and it obstructs insight into the purification of magic through science. For in this conception, repeatability is not recognized as the controlling principle, and it appears therefore as though no sense impressions are excluded from scientific observation. Not until the formation of a series and the corresponding mistrust of our senses, analogous to the repetition of the formula, is grasped as the basic attitude, does it become clear that natural science cannot comprehend universally all events. Its own method presents that. Only the repeatable can become the object of its method. The non-repeatable rightfully seem to it as "unnatural," for they evade its examination.

Now to look at these three steps: single observation, series formation, and error calculation. It follows that every originally individual sense perception of a child is about three steps removed from the actual "observer" in the experiment.

Now consider the other workbook page. At first glance its character reveals a dramatic contrast. With the results we had so to speak the naive character of the format; here we have sentimental fiction. The hand that wrote so definitely and firmly on the right side behaves here hastily and nervously. It has not sustained the horizontal and vertical lines on the pages. I may remark that the majority of important operations in the calculation were written down, but I have deliberately refrained from selecting an extreme example. The reader may rest assured: the contradiction presented to him is really a moderate case. In spite of this cautionary moderation I expect the objection "That is chance." I reject this smokescreen. Each worksheet in hundreds and thousands of cases brings out the same contrast in style. And the style of every spontaneous utterance has the importance of a material truth, a verbalized fact.

We have here a valuable evidence for the grammatical dualism prevailing in every situation before the passing of sentence. The left side is the subjective side, for calculations are purely mental operations. And precisely because this is so, the bodily symptoms which accompany them do not manifest a man on watch or in strict deportment, but one relaxed, indifferent towards his outside, introverted -- one might say, in slippers and housecoat. For higher grammarians this mathematical operation is entirely uninteresting in content. Only the form which it assumes interests us. Here the reader may become irritated and angry, and recall the physicist who felt offended when I began to investigate Eddington's book title. Naturally the sovereign mathematician considers me just as bad as that physicist because I analyzed something quite far removed from him. I'll have to put up with that. But they should not rebuke me unjustly. You see, I pay attention to something which they disdain. With the physicist I care about the particular names and the ~~is~~ spell each science perpetrates ^{through them} on the public. This time I am concerned with something the mathematician disdains: the different handwritings. With the great Faraday we will pay further attention to the grammatical forms of notebook records. Well, that sounds vulgar, and I am irksome. But at least the reader sees that the diverse refuse of actual natural science research -- its names, with which it decorates itself before the public, the character of writing in which it indulges when unobserved, and the grammatical form in which it makes known its own proceedings -- feeds my laboratory.

Now back to the self observation on the left side. Have no fear: the reader does not have to verify any of the calculations! It is sufficient that he regard how two equations (1 and 2) are structured. He sees without

$$\text{Eq. 1} \quad R = 0.2525/2 \quad + \quad (2.57)^2/2(0.2525)$$

$$\text{Eq. 2} \quad R = 13.20 \text{ cm} \quad + \quad 0.13$$

calculation that the two fractions of the first equation are raised to different powers; only the second fraction bears the squared sign "superscript 2". One fraction in the equation is raised to the first power and one to the second power. Again the objection may be raised, "Well, so what?" To go back is our daily bread. But this daily bread of the physicist, through which he reduces various expression to a unit, is as wonderful and full of mystery as real bread. Does the daily exercise of a profession bear responsibility for our failure to see into the full significance of this transformation?

It is of course in the reduction, in the *reductio ad sensum*, that something within the unit has to be thrown overboard. And for the grammarian who bends down over just this jettisoned discard with the greatest zeal the physicist's *reductio ad sensum* is a *reductio ad absurdum*. "Yes, you have now reached your physical simplification. But what have you gained?" In the special case on our page, the expression "to the second power" in $(2.57)^2$ among others has been thrown overboard. That rings a bell. May it be that reduction to the common denominator means exactly what it says: sacrifice of the uncommon denominators -- a name here, an expression there, each time a particular "noun"? Mathematics keeps redefining its terms patiently until a larger unit of the term becomes possible. The thought on the left page sacrifices terms. And on a single page we may come across as many as a hundred such sacrifices of thought.

What is gained? The subject who as an American student talks in private life only of inches finally says "13.20 cm" and reveals thereby his innate vocabulary and word usage. Through this refinement his thought is transcendental, free from the change of birth, understandable to all other people whose consciousnesses receive impressions anywhere in the world. For it befits an I, the transcendental Ego, which must come to the same result

for all time and all places. Every time and place requires special nomenclature from native history. The transcendental I that evolves on the left side has left behind its common bonds of heredity. Its civic duties are owed to the republic of the physicists. In this republic a special language is whispered, the language of mathematics. It is really whispered; it is not spoken but rather gets along through symbols. That must be because it chops off names. It is therefore one of the aspiring nameless languages.

Because it is an effort that resists progress in language, this whisper-language is always secondary. It can only appear after others are spoken by name. We write down compulsorily the word "namely" when we have gone too far in our abstract namelessness. Namely just means by name. When we have reduced too many named happenings to their common denominator, then we suddenly jump up, forsake the second ^{ary} language level and thrust again into the original language layer with the help of this "namely". We give then, namely, an example by name to comfort our listener. And he knows once again at last what all of the talk has been about.

The language of mathematics is senseless as soon ^{er} as it fails to grow out from ethical language and grows over it. The ^{er} sample calculation on the left side must accommodate expressions which may be reduced. Or its method has nothing more to accomplish.

Assume that on the right side the results are given partly in inches, partly in centimeters; then we would read at the left the relationship between inches and centimeters or vice versa. It is clear that through this means "inch" or "cm" would be sacrificed temporarily. The terms of the formula $0.2525/2$ and $(2.57)^2$ are two signs like "inch" and "cm" in another sense. All formulas are names which await sacrifice in the search toward uniformity. If they are not relinquished, they remain

in^a accessible to others. We have to reduce and decapitate them before they may be incorporated in an arrangement. Computation requires amputation. Why? Through these amputations the natural scientist becomes of one mind with all other men in the whole world who also calculate. The spirit which dwells in these calculations has been pledged only to the international republic of the learned. Calculation sacrifices terms incessantly for the sake of the unity. I have given in my book "Out of Revolution" the history of the decimal system, introduced by men in the year 1789. It is surely a highly dramatic struggle between two value systems, the scientific and the social. It is indeed an actual conflict, because names serve now and then to become solid content.¹ Reductions of Dante and

1. The struggle in France raged until 1840. The particulars were often comic, for falsification of names became necessary.

Milton to a list of their words may still go on. Mario Praz reduced d'Annunzio's renowned poem "L'Onda" to a set of spots from the Italian dictionary which the poet simply had set in verse form. But d'Annunzio was blamed for it. For these reductions for a genuine poem are entirely inadmissible, simply because names signify something for the poet. Why may not they mean something in physics?²

2. Compare Volume 1, p. 194 ff.

For the sake of mutual participation I wound myself. Although this by itself sounds like a contradiction, it is correct. The duty of my mind in the commonwealth of science, in which all are of one mind, and that of my five senses with respect to the perceptions in which they are grounded, immediately brings out a split in me. ~~It~~ First of all, ~~the~~ senses and the head contradict each other. Since the experiment requires time in which material observations and mental reduction oppose one

another, the split body-mind commands our attention. Always when men undertake such experiments, they begin to split their own being into body and mind for the sake of an attractive peace with other men. However they largely overlook the fact that their own bodies and their own souls are shattered in the scientific process. Our two sides show much more the true story of such a division into mind and body. It is perceivable when the mind ~~the~~ ~~mind~~ enters into the society of another mind; the perception is registered only when the body bows before the object and before other bodies as an organ. Man creates two new communities in scientific experiments, one for his senses and one for his mental forces. In fact the scientist, hung up like Prometheus on the rocks, can not desert this overstrained and dismembering position between perception and calculation until he has exercised his capabilities to bring together into relation the world of mathematics and that of material nature one with another again. Mind and body are means to one end result. Man divides himself into them at times for a definite purpose: to compell the world into sense, to arrange it into a unity of material and number. With that the mind becomes more and more mind, the body, the more faithfully we observe, more and more body. There are no subjects and objects; they are rather poles which arise through the strain which is supposed to lead finally to the unity.

A given diversity and the desired unity contradict one another at the beginning. The physicist obviously underestimates the split in himself in order to resolve the difficulty. With his body he reforms himself into an element of the physical world; with his mind he becomes a part of the spiritual world. And so he forces them to draw apart from one another. Thus, the separation into mind and body, to a unique mind which becomes a part of The Mind and a unique body which is embedded in a physical continuum of materiality, is a means in our manifest exertions for the thoughts of unity, wholeness,

uniqueness. A bridegroom, a soldier, a daughter must ignore this split -- otherwise mankind perishes. Their whole being must remain in the organic state of the creation, without yielding to such a division of mind and body. Research men are split men who serve the unsplit men.

Natural science sacrifices our unsplitness. Man becomes a means to produce the polarity and opposition dissolving the unique man into the two focal points of an ellipse. For all his observations strike him in one and his calculations in the other direction.

3. The Secret of Michael Faraday

We have illustrated the work sheet format for an experiment. We now proceed to the next stage in time, to the life work of a researcher over a few decades.

In Faraday's many volumes of daily entries we have entrance to the whole life of a great master. The last section of his seventh volume of work-calculations bears the number 16,041. And one of his last public statements was "For all the phenomena of Nature lead us to believe that the great and governing law is one."¹

1. E. L. Youmans, "The correlation and Conservation of Forces," New York, 1867, p. 376.

W. H. Bragg, "Michael Faraday," 1931, p. 22 ff.

T. H. Gladstone, "Michael Faraday," p. 123 ff.

16,041 and one, the unity against the ocean of 16,041 particulars; this is the polarity of his grammar. Both poles are stressed and should be stressed. Tyndall said of him, "A good experiment would make him almost dance with delight."² However, Lord Rutherford could

2. John Tyndall, "Faraday as a Discoverer," London, 1870, p. 136.

also write, "When we consider the life work of Faraday it is clear that his researches were guided and inspired by the strong belief that the various forces of nature were inter-related and dependent on one another. It is not too much to say that this philosophic conviction gave the impulse and driving power in most of his researches and is the key to his extraordinary success in adding to knowledge."¹

1. Report on the Faraday Celebration, 1931, p. 39.

Because Faraday spent his life between the one of Nature, which beckoned from the future and his daily 16,041 experiments, it was written of him, "His contemplation and his own relationship to Nature brought forth in him a kind of exaltation."² The workbooks show this

~~2. Report on the Faraday Celebration, 1931, p. 39.~~

living process of the active mind divided between 16,041 carefully thought out doubts and the one faith. The following quotes are only a few illustrative examples.

"Surely this force (gravity) must be capable of an experimental relation to electricity, magnetism, and the other forces, so as to bind it up with them in reciprocal action and equivalent."

"I must look at Weber's result to see how they build in with these considerations and what the results are."

"Astonishing how great the precautions that are needed in these delicate experiments. Patience. Patience."

"Query these results."

"Must clear all this up by further experiments."

"The hypothesis is not so much mine as one renewed from old times. Look at Euler's letters and what he says."

"Let the imagination go, guiding it by judgment and principal, but holding it in and directing it by experiment."

"Consider for a moment how to set about touching this matter by facts and trial."

"To point out or lead to a knowledge of what it either cannot explain or has not explained, is quite as important for the progress of knowledge as to establish what it can do."

The investigation up to here has shown that the real, that is the new future in which Faraday believed assumed the form of commandments. While the grammatical form through which we project past results into the future is the so-called future ("The sun will rise tomorrow" or "Tomorrow the letter will arrive") Faraday's grammar knew the genuine future form which shines forth in the shape of the imperative ("Ponder, query, must clear up"). The command distinguishes the vital from the mechanical future. The latter predicts that the past will run further. The imperative directs that something new should interrupt the predictable run of results.

The curse of our time is the thought that the apparent mechanical future of the predicted uniform type is like the imperative for the "future". Accordingly one usually analyzes the grammatical form "it will be" in place of the significance of the expression "future". The cornerstone of the genuine future, however, is the imperative which we read in Faraday's and in every creative life; in these cases an imperative contradicts each causative process as it affects a breach in continuity. This is embodied in the grammar of Faraday's journals. The pure future comes over us as a command; the predicted future of "it will rain" is second-rate compared with the imperatives "Drop the atom bomb," "Take this route," "Don't go to school." The essential character of the future -- as fully separate and independent of the past -- towers up from these imperatives in elemental clarity. We may employ a paraphrase and say "I will not go to the university any longer" but this is simply a statement to

a third person about an imperative already obeyed within. When the 90 year old Chief Justice Holmes ceased to perform his duties and said simply to the doorkeeper who helped him into his coat, "Tomorrow I will not be back," he used the apparent future of reflection and declaration. But on the same day he wrote to the President: "I submit to the inevitable." He had fainted in the court that same morning. In his letter of resignation he disclosed that he had perceived the clear imperative: "Step back!" Without his imperative neither his famous remark to the doorman nor his letter to the President ~~was~~^{was} sensible.

Another grammatical obscurity is embedded in the present tense of human language. The present condition of the mind for Faraday is one of uncertainty and strain. "It was almost with a feeling of awe that I went to work, for if the hope should prove well founded, how great and mighty and sublime in its hitherto unchangeable character is the force I am trying to deal with, and how large may be the new domain of knowledge that may be opened up to the mind of man." Or, "After all, there is much which renders these expectations of similar ones hopeless ..." "Such beautiful delicate indicating curvatures." "Strange." "Of a sudden all wrong and I see not why." "I begin to despair."

The normal form of his present is excited and exclaiming. It is therefore only an apparent and indirect present tense, the so-called present indicative. The subjunctive is the normal approach to our present mental condition. It is true even though Germans and German grammar books don't admit it. They maintain that the transcription "this is pretty" possesses the same ring of truth as Faraday's honest cry "Such beautiful ... curvatures!" The genuine speech-forms of the present, however, are not indicative; they are excited statements or affirmations. As Faraday wrote: "How great and mighty and sublime ... is the force I am trying to deal with." That is the present of the man, he stands in awe and he

shudders -- for he doesn't stand opposite the grammatical instruction of the logicians of the university but rather opposite the forces with which we are supposed to separate ourselves. Our present is a cry and an uncertainty. A thousand darts pierce through us; they puncture our skin. For what we are called to do must be penetrating subcutaneously.

The indicative of scientific grammar for a real man like Faraday is located neither in the future nor in the present. Listen to this rich series of indicatives:

"There was a fire on Thursday evening in Broad Court, Anny Lane. The clouds were low and received strong illumination from the fire beneath them. The angle taken from the top of the Royal Institution by a quadrant formed by the clouds, the Institution, and the fire, was 24° . Hence the height of the clouds will be ... equal to ..."
Or, "Soon after sunset .. observed a cloud forming just the brow of Shakespeare cliff. It streamed inwards, increasing in size, but all seemed to pour nearly from the same spot; the air which came from over the sea there taking on a visible form and passing in to the interior as a cloud. By degrees the generation of clouds took place along the whole line of cliff from Dover to Folkestone Hill, ~~with~~ the wind still carrying the portion formed over the land. We ascended the cliffs about 1/2 mile beyond Folkestone Hill about an hour after sunset and found all above developed in dense, moist mist, so as to deposit water on our clothes; the temperature also low to the feelings." What magnificent ~~indicatives~~ -- but all narrating the past!

The real living personality comes towards the future through commands, meets the present in exclamations and the past in narratives. The unscientific mind mixes all together. We hear Faraday: "What a weak, credulous-incredulous, unbelieving-superstitious, bold-frightened, what a ridiculous world ours is, as far as concerns the mind of man. How full of inconsistencies, contradictions and

absurdities it is. I declare that taking the average of many minds that have recently come before me (and apart from that spirit which God has placed in each) and accepting for a moment that average as a standard, I should far prefer the obedience, affections, and instinct of a dog before it."

Faraday himself could raise above this canine mentality of the typical human mind, thanks to his sure control of command, exclamation, and narration and his recognition of the three styles of future, present, and past. He expressed this when he wrote: "Electricity is often called wonderful, beautiful. But it is so only in common with the other forces of Nature. The beauty of electricity or of any other force is not that the power is mysterious and unexpected but that it is under law, and that the taught intellect can even now govern it largely. The human mind is placed above, and not beneath it, and it is in such a point of view that the mental education afforded by science is rendered super-eminent in dignity."

Here we have the terms "super-eminent, dignity, above and below" as attributes of the intellect. We have to explain this climb to Olympia, these upsourings to a "higher" position above a canine mentality. We will do this when we return to the religion of the book title, "The Nature of the Physical World." Now we have to elucidate the olympian frame of mind of the researcher. It results from the godly freedom in which he rejoices.

The great thing in science is the right to error systematically. This right frees the researcher from the consequences of the errors which the common shepherds of sailors meet when they make a mistake. The shepherd in Montana ~~is~~ or the seaman is ruined if he errors seriously about the weather. In the life of an average worker the permissible tolerance for failures may be taken arbitrarily as perhaps 5 %. Of Faraday's 16,041 experiments about 1 % were successful and the rest were failures. Why is that so? Natural scientists are sent out to error

systematically. Natural science is a systematic and voluntary relapse of society into all possible failures. The shepherd cannot permit lapses in his discernment. Neither can an airplane pilot or a professor before his class or President Roosevelt on the day of Pearl Harbor. In these cases the life struggle is direct. Faraday in his laboratory may error a thousand times and still go unpunished. He uses the perfect isolation of a laboratory to exercise his privilege: permission to commit unnumbered mistakes. We may not experiment with war -- we have to win or be destroyed. Research begins where the errors cease to be important, or are less important than in direct life. If we have shown that the number of failures may be great, we have removed ourselves from the path of common transactions. As long as we may be permitted no more than 20 or 30 % mistakes, we still stand under the pressure of a life struggle and therefore may not be entirely objective. We set about in the province of science in earnest when we know that we have the freedom to make countless mistakes. The innumerability of errors is necessary for science! In the poetic realm the purgatory experience of suspended judgment is repeated in unbounded number. As Kant said, every research is "riotous." Scientific doubt is not ~~doubt~~ doubt between good and evil. Scientific doubt can elude a thousand and one clarifications. It is always a poor science which believes in white or black solutions. The number of possible solutions must exceed the purely logical level of an either/or if we want to speak at all of scientific research. The experiments of physicists are not reactions of the past; rather they look ahead and advance to a future. Faraday's experiments were therefore no mere experiences because they were undertaken in light of his faith in the unity and infinite order of Nature. Accordingly, his work created in forty years was not sanctioned and valued by the past but by the future. Science is stimulated by the faith of a society toward a free and different future.

Science is the entry room to a coming sanctuary of mankind. Faraday's laboratory is one such entry room as far as a genuine future deviating in its characteristics from the past is believed in and at the end materializes. The scientist in his research is taken out from under the Laplacean law which oppresses nature. "We should regard the present stage of the universe as the result of the previous stages and the causation of what will follow."¹

1. Théorie Analytique des Probabilités, 1902, p.3.

This law of Laplace is not valid for the man of science. Faraday's present was not at all caused by the past. In fact the whole past before him contradicted his faith. His vision of nature was not one out of some past or other; it went before and soared above him. In English writing "Nature" with a capital N signifies something. He who writes it sees Nature as a force of the future beneath which we can congregate against the past. The researcher makes himself free of the past.

The future of mankind logically goes ahead of its present. For we have no present as soon as we loose our faith in the future. What we call the present is the experience of a conflict within us between the future and the past. Mechanisms are repetitious; science is no such mechanism or it ceases to be science.

The scientist is "the wonder in the world of appearances" (Kant) that bars the course of Nature or interrupts its direction. The laws the physicist finds are causes and effects which have always obtained. The physicists who discover them, however, never existed before. Their faith emancipated their present from their past. The power of their faith "can lead mankind to the things of their destination" (Scheler).

Not only the physicist must have this faith. Each Archimedes of Syracuse may be murdered by soldiers. Laity and scientists therefore must have the same faith. You believe that is unnecessary? That the facts uncovered by

science are of value for believers and nonbelievers alike? Don't delude yourself! Physics is possible only under faith! Faith in science is a condition for its existence. And this faith, "There shall be science," is in itself not at all a scientific claim. It is a social imperative of religion. There have been and there will again be societies which repudiate physics. Our society must learn first that physicists are not sorcerors. This would lead to a change in faith in people. Nature must first become a beacon of faith that brightens the darkness of the world ^{for} people before physicists with experiments can be tolerated. Fortunately people change their religions. There is an old saying that it is easier for a people to alter its religion than for intellectuals to rearrange their categories. The task of the XVIth century was to change people. But we have arrived at a more difficult time in history in which the scientists must change their categories. They must again acknowledge the religion which binds them with their fellow man before the first experiment in any sort of laboratory can take place. The contemporary conversion to faith is made difficult through the increasing entanglement of science in the world.

The founders of each science always live by faith alone. But the men in the opulently equipped laboratories don't need the valiant heart of the Curies in their garage or that of a Heinrich Hertz in his shed. The mass of employed scientists today endanger the future of science because they seldom know the faith which the founders had to share with society before the special city of science could be built. The imperative "Science shall be!" proceeds before all science. Faraday too experienced the imperative before he could call himself a scientist.

Where is this rare journeyman today who in the middle of history can suddenly proclaim that ^{there} ~~science~~ should be science?

4. The Forward March of Prayer and Science

With this odd question we return to Eddington because the Gifford lectures are directed straight toward this man whom we seek. He should be neither a scientist nor a fool: neither a man without necessity nor a man without gravity. When we discover the identity of this man who reads books about the nature of the universe or who one at least suspects of reading them, we will have found the true pillar of faith of science: the man who is both a scientist and physicist and with ⁱⁿ the lay-condition through which science is genuine.

We seek those who demand science of themselves, who have faith in their progress before the results are there. I may say in advance that the three-fold formula which makes so many of us create, the nearly magical formula out of which Nature, physics, and the world all re-echo must be used to speak of this man. Otherwise this man in you and me will not buy the book.

A real experimentum crucis may easily be found as an example for this strange law. Let's consider the following three booktitles: "Physics," "Nature," and "The World." What would we expect from them? The title "Physics" leads one to expect a physics textbook. The title "Nature" reminds one of Thoreau, Rousseau, or poetry. A book titled "The World" might be a geography or about politics. It is clear that the three books in each case are written for three groups of readers, because they aim at three entirely different interests.

It follows that "The Nature of the Physical World" must speak to a fourth man in you and me. He is not the matriculated student of physics, nor the romantic Rousseauian in us, nor the political man of the world. Who in the world is this man?

Faraday paved the way for an answer to this question when he said that through science the human spirit is placed above and not below natural forces. The man believing in science will stand up and get up above his future. The book, "The Nature of the Physical World" is written neither for the

practical man nor the idler nor the politician, but rather for the man of history who through his faith makes history. The other three, the practicing physicist, the romantic enthusiast, and the worldly politician are all his parasites. He is the man willing to take chances because he can both endure total discouragement and experience high exaltation.

The man who buys the physics text purchases of course permission to stand above the world without having participated previously in its darkness. The man who buys the book about Nature observes the law. The third layman who takes the world as it is prefers to remain in perpetual chance. But the living man finds himself in a continual process and is able to experience the exchange back and forth from one plane of consciousness to another. The true man can be overwhelmed by the wonder of the world and make use of it according to the laws physics provides and stand in awe as he contemplates the laws of Nature.

The complete man is neither the layman nor the physicist: he is instead the man who can at times be seized by wonder and can at others think temperately, without imagining that one of the two attitudes may be sufficient. He is the man who soars high over his own division into mind and body. Eddington's book is written for this man who by turns learns and doesn't learn, knows how to live split and unsplit.

This indicates our working curve; let us examine it once again most precisely. I maintain we have to reject the view that the left side has been written by the mind of the student and the right by his body. He is one and the same man; he wrote both sides. This man has no mind and no body, as we ordinarily speak. He is rather by turns all body and all mind. In his calculations he strives pitilessly to expell all other thoughts from his mind. And he attempts mightily to immerse his body in the observation of the cosmic continuum of the material world. He therefore splits himself up as well as he can. But he doesn't succeed completely. We reflect on the mystery: presumably the mind

at the left and the body at the right both must have scratched and written, if there be "mind" and "body". It is true that the handwriting on the two sides is different. Nevertheless in both cases the same hand moved over the paper; the same finger gripped the pen, the same shoulder was turned; his eyes observed, his elbows rested on the table, his seat pressed the stool at both happenings; his feet swung both times. His intelligence was involved when he registered like a pure sensorium. But his senses were still alive when he calculated on the left side like a pure mind. The same man uses the same capabilities when he registers as a body and when he calculates as a mind.

It seems that each one of us plays an unbelievable practical joke: we say that mind and body may be two different things, that a man should have a sound mind in a healthy body, and so on. In my opinion this is a hoax. This division in two doesn't exist. I am mind as soon as the ranked sequence runs intelligence, eyes, hands, fingers, seat, skin. And I am body when the ~~other~~ skin, seat, fingers, hands, eyes, intelligence obtains. I have no body and I have no mind. The same being only shows two different sides. Both handwritings prove that we have before us on the left side so to speak a man in house slippers, for he is as much mind as possible; on the right he is in full battle array, as corporeal as he can be.

When we speak of our minds and our bodies, we speak of different configurations. We may be alternatively mind or body. The whole man is present in both. Mind and body are modes of being of my self. They are not chance tendencies. They are ratifications of my own faith and decisions. I become both configurations and I withdraw from both afterward. I become mind and I become body, because I fluctuate between an outer immersion in the material world and the inner conversation with spirit. To each time in history this link between my outer and my inner being has existed.

In the science of the Renaissance these two contending ~~arrangements~~ ^{tendencies} attained their absolute and final consummation, ~~in order~~ to be a body or a mind. In mathematics my mind must agree not just with an adventitious mind but with all minds. In physics my body must be in step not just a small

corner of the globe but with the whole universe. The body of a physicist is immersed in a more complete world than, say, the body of a swimmer. The mind of physicists moves in a more perfect spiritual continuum than the mind of a casual friend. The terms of mathematics and physics have to be such that any man on earth can conduct the same experiments under the same conditions. In modern times the arrangement as body and the arrangement as mind are followed radically to the end: thus the body immerses into the entire universe and the mind shares with all other men of all times.

This discovery that mind and body are arrangements has consequences worthy of attention. If it is true that as I utilize my mind I go inward, and outward as I employ my body, then realizing this correlation becomes one of the vital central concerns of living men. To be able to go in from the outside and back again becomes the real problem of life. I can never wish or hope to be only mind or body. The nudist and the philosopher are both undesirable. My principle attention must be directed toward having free access to both configurations. My "I" may be the mind that obtains an immortal name like Ampère or Volta. My "it" may be the unknown body. But you, the person, are threshold and gate, the mysterious and ambiguous free creator of your body-spirit relationship. As I take the elements of my being into the outer and inner worlds I am both the I of the mind and the it of the body and even more than both together: I am the link, the this or that, the either/or. The soul of a man is door and gate. And it is never more so than when man introduces scientific progress. The soul is therefore the link permitting us to decide on our spiritual or physical form and making it possible for us to be scientific. In judging the title of Eddington's book we must come to this conclusion: The book was written for people who have a soul free to enlist itself as body in the world and as mind in the society of intellects. Otherwise the book is senseless.

From 1500 until 1900 one could not allude to the fact that man is such a gateway without making oneself ridiculous. And that made all other civilizations and peoples inaccessible to us. The modern western man seems so different from all other men because they emphasize the existence of doors and gateways. We smile about this; we may laugh no longer. The men of antiquity are our brothers.

Now when we discover anew this property of the soul as a precondition of science, we are able to reestablish our identity with men of other cultures. The men of the ~~the~~ other epochs recognized that man is lord over two spheres, one inner and one outer. All ritual and magic in the whole world attests to this belief. It all seems mere superstition. But it is superstition only in so far as its world was bounded by the Egyptian or Peruvian heaven which created the law for their heavenly world. Our redistribution of all heavenly worlds into one heaven-world χ of heavenly worlds, the whole physical world, seems superior. It is in fact the most radical of all arrangements of the two spheres: one of the spirit pointing inward and one of the body directed outward. Among the many conceivable gateways between a spiritual inner-sphere and a physical outer-sphere our natural science has been placed in the most universal position. It is the best solution among of its kind. But nevertheless it is just like the other solutions in having this distinction or fluctuating relationship of an external and an internal process. The world of the outer sphere exists in no way more than the world of spirit on which we insist. Existence and insistence are derivatives of our own arrangement of two spheres. As Faraday clearly states: "The mind is placed over the outer sphere" whenever there is formed an entire second world of intellects delegated as physical experts working together to cope with three-dimensional space.

The old societies assigned the same tasks to their priests. The priests of our science may be better priests, but they are only priests of the people's faith. One day

"we" -- the whole community -- decided that a certain group of us should be free over the centuries to move by turns back and forth between the two spheres. While the Egyptians allotted their priests for their observations and evaluations the Nile Valley, Christians don't believe in the Nile or the Valley of the Yellow River in China or the Gulf of Mexico. They believe in one world. And so from the new day of science on the physicist is under orders to ponder over no smaller world than God's whole universe. The physicists of the Renaissance received their assignments neither from the Greek tradition nor from themselves, but rather from the common Christian faith in the unity of the created world as one whole, as that "unending creation" of the "creatura infinita," as Cardinal Nikolaus von Cues called it and as the Creator ~~is~~ existence called and calls it into existence. While all the worlds of the ~~ancient~~ ^{ancient} Greeks, Hindus, Chinese and Mexicans were finite, the world which God created according to the first article of the Nicæan Creed is infinite. Infinity in every direction and unity characterize the world whose mysteries Faraday sought to elucidate from all earlier so-called "heavenly worlds" and from all non-Christian conceptions of the world.

On the other hand the modern physicists and the old priesthoods work under the same ~~condi~~ ^{condi}tions. The outer world of three dimensions -- length, breadth, height -- doesn't exist for an inner world in which all minds are united; it may be taken as an externally constructed reference system. This inner world in which scientists have banded together during the last four hundred years of physics does not have three spatial dimensions. Nevertheless this inner world and corresponding sphere have the same time as Nature. In the external world time may be viewed as a fourth ~~spatial~~ ^{spatial} dimension. We have seen that predictions of mechanical events make all time one dimensional, so that the whole predicted time-span applies only to the ad infinitum continuing past. The time which prevails within the republic

of scientists is antithetic to this. Here the present of physicist is separated from the past. No science can tolerate a conception of time as merely one of four dimensions. Scientists live through faith in a future which deviates in state from past conditions and create through their faith a present independent of the past. The time of the scientific world is composed from three time-forms: the drawing forward of the future and the pushing of the past are united in order to create a present scientific research. Time is therefore three-dimensional in the history of science. And only in history is time revealed in its true power.¹

1. See the Chapter on St. Augustine and the second power of time.

Society expects new disclosures about the three-dimensional space from the inner sphere in which all spirits may be one and on its three-dimensional time. The physical space which is investigated by the physicists is only one of the two spaces presupposed through the existence of a science of physics. The other space within us in which physicists write monographs, band together and share their ideas with each other has no overlap with the space of their objects. The science of physics is an historical commission which one group of men was given by Christianity in a particular moment and for a certain future. Eddington uses a language first created through this commission. In this quotation the language of antiquity projects through distinctly: "The physicist usually posits lines in many important models... These lines are a gateway through which understanding of the world about us is sought... The first step through this gateway leads to geometry, which masters these lines." (p. 160) Eddington has no other language for his decree than the language of religion: a gateway must be built. To take these commands as metaphors is a cheap evasion. They are indispensable metaphors. Therefore Eddington used them. Metaphors are older than words naming things; the soul's gate builds gates of stone. The faith of the laity on this gateway

is as much a precondition for a bounteous physics as the skillfulness of specialists.

Eddington appealed in his book title to the fundamental faith of society which called physics into being. We have found the key to his magic formula of WORLD, NATURE, PHYSICS.

The key to its clarification is in our hands since we understand the three time-forms and the rhythm between them in the life of science. Each of the three expressions signifies one of the three time-forms. The Germanic term Welt means the world before we really knew it. "A man goes into the world." Milton said of Adam and Eve, "The whole world lay before them ..." This world is full of riddles and powers; it may be full of surprises. World wars, world crises, world revolutions may remind you that the "world" still has unpredictability and hostility as characteristics. I am not equal to this world: no man is. The world causes me anxiety and drives me to action. Physics, physis, physical: these Greek expressions were used when this same world was successfully elucidated. This physical universe became predictable. The world which no longer contains secrets is the object of physics. We stand above it and examine or test it all in many ways. We have prodded it into speaking to us in symbols. The two expressions world and physics are the dual time-forms of reality, before and after science has done its work. There is also however an intermediate time between world and physics. For the man who says "Nature" is the man for whom the world is already an assignment or concern of his faith, but not yet a result of his work. He is no ~~more~~ ^{longer} ~~timid than the~~ individual unequal to the world. He has aroused himself to place one question together with others: What sort of powers and forces are these which destroy us when one of us comes up against them as an individual? "Nature" is the question about the universe which men in community have the courage to ask. As an individual no man has a choice: the world terrifies and conquers his mind. The community is the unit in which one looks the huge world in the face and can confront it for the first time. For the

one who considers the peculiarities of any thing has turned back from his flight. The "individual" is hunted by the world and is never in peace. It is a stubborn fact that the world keeps us in constant motion. Reflection itself therefore is already an act of faith through which we turn around. It is impossible outside the peace of a community.

The consequences of our confrontation when we say "Nature" are of course still unknown. The vivid contrast in the numerical statements of physics, Nature remains indecipherable. Nothing can be predicted. But the mere tendency to run away before the impression the world makes on us has already withered and a counter movement is developing. The man who seeks for the nature of war is not in the war. He has won time. He is on the point of securing the gates between the two paths, one in which he is pursued by war, the other within which he investigates war. "Nature" is consequently the threshold word of our language. It describes the power of men to turn toward a part of the chaos which surrounds them with the courage to confront it together. "Nature" is the turning point at which we reach the gateway between mere blind experience and impression on one hand and our inner answer on the other. This turning point says: previously each of us had to pass over his way as an individual. Now we observe and look about as a group. The point is, we reflect and investigate collectively. One can reflect only as a member of communal peace. The expression "Nature" creates space for inner reflection. It brings into equilibrium the idiomatic expression "world" which the timid individual employs and the learned term "physics" which the whole of mankind uses. It makes possible, therefore, a division of labor.

This fundamental tripartition of the objects of science corresponding to the three phases of their treatment by us is valid for all scientific research of the last five hundred years. To specify a few examples:

God	Deism	Theology
Housekeeping	Ethics	Economics
Numbers	Rationality	Arithmetic-
Healing	Medicine	Biology
Man	Humanity	Anthropology

I have written on the "Revolutions of the Christian World." In this case I wrote in exact agreement with Eddington. "Revolutions" corresponds to his "Nature," "Christian" to the word "physical," and "world" is the same in both cases. Or one takes:

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The same Greek root can serve to give names to different sciences; but the differences in their Germanic and Latin predecessors prove their deep inner distinctions. Compare, say, psychology and ~~psy~~psychoanalysis. They are often used interchangeably since both speak of the psyche. If one goes back to their Anglo-Saxon and Latin ~~ex~~equivalents they are seen to treat different objects. The soul and character preceed psychology. The naive individual believed in the soul and that character was ~~the~~^a common and societal problem. Psychology replaced soul and character with psyche and investigated that. Psychoanalysis however had nothing to do with soul and character. These had been comprehended as independent existences. The "psyche" of psychoanalysis was not at all independent. The men psychoanalyzed are fragments; a needy, obstinate, conceited mankind seeks advice. The series "perplexed - ego - phychoanalysis" is tested by the ~~ps~~psychoanalytical patients who hold something back. I find, in contrast, the two triangles "soul - character - psychology" and "perplexed or sinner - ego - psychog~~na~~lysis" especially illuminating. Another triad is "People - socialism - masses." Here the Greek "masses" didn't give its name to a science, but it is the motive of the ~~half~~^{etymologically} Greek sociology. Even the popular form of science obeys this law. Eddington might have written a so-called popular book about the "Secrets of the Universe." But his publisher would have sold it just the same since he placed on the dust jacket "By the Nobel Prize Winner and Great Physicist." In other worlds: the camouflage doesn't annul our law. The book was sold ~~because~~ because the author had the Greek name "Physicist." Miss Mead may write "And keep your powder

dry." But she sells her knowledge about mankind as a learned anthropologist. Beneath the most revolting striving after catchy titles there shows through the firm faith of society in, first, their scientists; second on their community with them; and third on its own vocabulary: the "physicist" (first) writes about the "secrets" (third) of the "Universe" (second).

Our observation of these three phases puts the scientific process in the historical domain of a three-dimensional time with a future free from the past, a present created daily through faith and a past which may be investigated ruthlessly. This is the first explanation for the application of the strange words "under" and "over", "higher" and "pre-eminent." Never has anyone tried to show how this ascent from under to over is attained; no one has paid attention to the necessity of a reorientation from mankind to anthropology, from fire to pyrotechnics. One may hear the music of Wagner about the fire about Brünhilde. The opera tries to recreate the wild fire "beneath" whose impressions we are held in fear. Science on the other hand is pyrotechnics which looks down "from above" on fire, manipulates and subdues it. Both states of the spirit acknowledge our faith that art and science ~~as~~ belong ~~to~~ to one another. One brings forth the other incessantly or life dies. Incidentally, the weakness of Eddington's book is that he doesn't comprehend this interaction of art and science at all. He has a static and logical conception of both states of the spirit. Art and science, however, serve one another; Eddington doesn't consider this. The world lies before us, Nature is with us, physics lies below us. And who is this "us?" The eternal creature man, he who in every moment of history must be able to be ~~not~~ terrified by the wilderness, to turn himself to a crusade and to assign work to the specialist. If we wish to live at all we must allow continuous correlation among all three time-forms. The next future science under this law will have to be a science of war. Only a soulless man could not cry out, "O World War, First World War, Second World War, and now, perhaps, a Third World War, O Destruction, O Atom Bombs - Let us break with them! Come to our rescue, O Nature of War!" Is the nature of war something other than the

fratricide in all of us, the same combativeness which lets me battle through this writing? The state of war, patricide, and struggle have until now forced their game with us; we should treat them together through a science of polemics and direct our action toward opposing war. Yes, we are fratricides. War, fratricide, polemic may very well be the next trinity on the way to progress. ~~It~~ ^{would} ~~turn~~ ^{that} out ~~way~~ only if we were to not just avoid war but overcome our own lust for war. The League of Nations and the United Nations were and are helpless because they cast out war as war without simultaneously stopping and turning about completely. Every nation denies its own lusting after war and calls itself peace-loving. It is therefore outwardly pre-scientific and religious. The nations exhibit the diad of war and peace rather than the triade of progress. They are terrified and panic stricken by war. They want to be pacifists but they don't recognize their own polemical natures. And so a third great conflagration may come to pass. The one who does not put the fact that Cain is in his own heart first can never attain to policies creating peace. The science of war and peace doesn't develop naturally. This science is an unnatural response to necessity and a solution to the emergency in which the community has confidence.

The unanimous voice of history is on our side. The ancients knew about the practicality of contemplation. Now I want to risk the good impression I may have made as a thinker as I display and illustrate the pagen prayer of Greek origin which for seven hundred years from four hundred years before Christ on was prayed annually for the pacification of the municipality of Rome. It is pre-scientific in the eyes of the physicist but it stands on that threshold over which even today the way toward a future science of war would go. In this prayer the Arval brothers flee to the god Mors ~~to~~ ^{to} avert plague, pestilence, and thirst, and ~~the~~ ^{to} Mars to avoid death. I don't need to be reminded that the gap between their prayers and modern science is profound. Admittedly it is.

But they and modern science have in common a most significant point which modern man must find again: they knew and accom-

plished the turnabout as a group; our run of the mine scientist, hypocrite, and political shrink back from this crucial step. Their faith created through this turnabout the way to a freer and better future, just as Faraday's faith created his 16,041 experiments. Don't disdain examining the similarity! Our whole university training system following the war has become stale and insipid for we fail to recognize our humanity as a group which must be turned about. In physics or chemistry an individual can stand alone in the laboratory and nevertheless be certain of his solidarity with colleagues. But in "polemics" the solidarity of those who turn about together on the basis of a shared sorrow must be explicitly proclaimed!

1. I have formulated in the "Geheimnis der Universität", p. 99 ff, the formula for the social scientist as "respondeo etsi mutabor." Now I am ready to say "respondemus etsi mutabimur." This statement of the grammatical method supercedes the Cartesian error of "cogito ergo sum."

The text of the prayer is simple. Every element is repeated three times. The heart of the prayer is the abrupt verse in which the god is challenged to reverse himself. Up to this verse Mars leads the attack of all evil powers against the borders of the city; now straightaway he is supposed to become a savior. How can the god be turned?

Now he is employed to stand firm by the doorways. When this rearrangement or new deployment is complete, the evil will be transformed into a blessed element of comfort. Now god is for those whom he once slew.

The lord of death, an ominous and unhealthy power greater than and beyond our field of vision, is conjured. Through calling him by name and analyzing him they feel they have already drawn him toward their own side to a certain degree. The same Mars who shortly before rampaged through their fields as a destroyer now gave the Romans something of his own wildness. That is the significance of their triumphal

songs. On the other side the god altered his direction in this significant act and now looked from their thresholds toward the outside; previously he unleashed himself against them toward the inside. Death replaced Mars and Mars became Triumph.

We can't grasp the requirements of the hour by going along with our natural tendencies or impulses. The fashionable word "naturally" just means the law of gravity, or more accurately, the law of decadence and decline. In contrast, in a laboratory experiment a "natural condition" is altered; through this interference the valuable things that research can uncover are realized. The rare turnabout of a brave fellowship lifts us to the task of the hour. We create a change in the world as often as we dare to stop, to confess our own natures as constituents of the world and to give new names. War presses us, panic pursues us, the lusting after war is an element of our being -- especially in many pacifists. Combativeness is an element in every form of life of "nature" which we can apply for good or evil. It is indifferent to moral judgments. Now ^{when} ~~and~~ a group succeeds in giving a Latin name to such a "blind" drive -- the drive of course is not blind, but many people, lady pacifists for instance, are blind and don't see it -- and thereby see it emerge from the flux of the world, they become free to manipulate it.

The difference between warrior and military man is instructive here. The military is a material apparatus; some lawyers would even apply civil law to it. Warriors have altered the character of the people. A warrior people in the heart of Europe must be a thing of the past. For warriors can not be manipulated like the military. They are blind, they no longer view Nature from the outside, they are a relapse of a bygone era. The latinization of the warlike attitudes through military, soldier, general secures a threshold which enhances consciousness. It always requires a change of spirit to build such a threshold amidst the flood of our inner life. Faith, that is the power to create space for the future beyond one's own dumbness and wickedness, operates through

speech. Through it every part of blind experience can become sensible. As soon as we dare to speak to one another where formerly we have been plagued by ~~the~~ miserably cowardly figures of speech like "But such thing can't be said!" or "No German says so-and-so!" or similar God forsaken words, ~~These~~ trash speeches and the filthy inner character are transformed through conversation in which each one of us may say something different. When the military arose from among the serfs of Miles Perpetuus, the relationship of army to "population" was altered. The new word made listeners quiescent. The dragon of a mob licked our hands because of the magic word.

But it has to be true and genuine magic. Why do the learned deny that we may and should cast spells? In a gripping, deeply felt psychical convulsion the new word is raised up and exalted. The genuine magical word is no logical deduction. It is an act of faith because in it we confess to our share and participation in a property of the spirit. The partial identification with the world in expressions like "Nature", with God in "Gottheit", with material interest-groups in "work," with war in "frat^ricide", with sins in the arrogant "ego" of us all is the bold moral act in the ~~in the~~ depths of each science. The scientists have to tell their students that each next science comes from faith. And if there are no new sciences, all earlier ones will wither and decay.

Wherever we still have not turned ourselves about and have abandoned our own true nature again, we may still resist the external destruction. Because physics is so developed we have difficulties understanding that its birth in about 1500 occurred through just this kind of emphatic act with a leap of whole men, bodies and souls, out from under the hardchips of the world of that time. Insanity, wars, and degeneration still await expectantly for their equivalents to physics. We must pray that ~~the staffs of~~ the older sciences will help us supply the ethical mettle and the religious intensity which once brought about the ascent of physics.

The progress of science does not depend on insane discourse about atomic bombs, but on the progress of a reasonable prayer. Before we ^{have} confronted the nature of war in vain; we misinterpreted the theory embodied in the progress which ~~has~~ led us from the world to Nature and on to physics. This religious intensity is reflected once again in the real fundamental triad of the title "The Nature of the Physical World." Therefore this book title is a rejuvenating act in the history of physics. It sets the triad out so brightly before us in its whole extent that we too are able to take heart for the future. The men who created physics were no specialists. On the contrary, they exemplified the full magnificence of our race. Ever since the name INRI was affixed on the cross in the three languages Hebrew, Latin, and Greek, mankind has not been permitted to sink down to monolingualism. From nation to state and to the planets the churchly-worldly road to realization progresses. The creative power of speech of the human race is triune.

It is no happenstance that in the three words nation, state, and planet three language realms are prominent. Nation is Franch, state, state, ~~st~~ Latin, and teaching about planets stems from the Greeks. We live differently depending on which of the three is invoked in conversation. I have traced the progression of Greek, German, Latin, and Greek traits of the most Germanic word "Diot" and its adjective "deutsch." The church ^{which} spoke from the Greek spirit -- the New Testament and the word church themselves are Greek -- gave the first name to the French parliament. It was called synod! When the Franks considered themselves equal in rank with the Byzantines, synods disappeared. German rose up and lives in English as "Diet" for the German Reichstag. The Germans however cling to the Curia. And in the epoch of democracies the ring of greekification came full circle in joyous misunderstanding as detailed in my "Frankreich-Deutschland."

The nationalistic linguistic experts deny such a cycle running through the various "languages" and so they miss the

significance of their own national name, "Deutsch."

X?
The uplifted community that has the right to delegate specialists and to reverse themselves to correct an evil, must meet each time in the middle, halfway between the _____ of the people and technical capability.

He who can not break out from the mold of his nature is no man; a people who can't is no nation. ~~We he~~ ^{He who} does out of love from his fellowman he is an upright man, and for the first time he speaks with full meaning because he speaks for the others as well.

5. The Carmen Arvale of the Romans

Prayer of the chorus of priests
of the
Fields of a Roman village
To the lord Mar or Mars¹

1. "Mars is the power that can do harm or ward off harm."
W. W. Fowler, *The Religious Experience of the Roman People*,
1933. See too Eduard Norden, *Acta Regiae Societatis Humaniorum
Litterarum Lundensis XXIX* (1939), 170-280; and my
"Vollzahl der Zeiten" (= *Soziologie II*) p. 185 ff concerning
Mars as successor of Horus and Seth; and "Das Geheimnis der
Universität", p. 207 ff.

I

Our field-meadow spirits, save us!
Our field-meadow spirits, save us!
Our field-meadow spirits, save us!

II

Let neither pestilence nor landslides, Mar, Mar,
destroy the people more and more!
Let neither pestilence nor landslides, Mar, Mar,
destroy the people more and more!
~~For the people~~
There has been enough of pestilence and landslides,
Mar, Mar, for all the people.
Be satisfied, savage Mars, stay in place, stay in place
beside our door.
Be satisfied, savage Mars, stay in place, stay in place
beside our door.
Be satisfied, savage Mars, stay in place, stay in place
beside our door.

Your twelve elements:
Blight and fruitfulness
Decay and protection

Pestilence and health
 Terror and rule
 Invasion and defense
 Pitilessness and fidelity
 should be invoked by our twin groups in alternating chorus.

Your twelve elements:

Blight and fruitfulness
 Decay and protection
 Pestilence and health
 Terror and rule
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 should be invoked by our twin groups in alternating chorus.

Your twelve elements:

Blight and fruitfulness
 Decay and protection
 Pestilence and health
 Terror and rule
 Invasion and defence
 Pitilessness and fidelity
 should be invoked by our twin groups in alternating chorus.

III

May this come to pass, O Mar Mars save us!
 May this come to pass, O Mar Mars save us!
 May this come to pass, O Mar Mars save us!

(Thereby the god enters into us. We call him no longer.
 He now speaks from within us in the shout:)

"Triumph, Triumph,
 "Triumph, Triumph,
 "Triumph, Triumph."

5. The Laity's Knowledge and the Researcher's Faith

Our sciences function in a three-pronged lingual nexus. In the higher grammar of this lingual pattern the valid laws are different from the grammatical rules learned in school. The first new law of this higher grammar is: substantives are also time-words.

World, Nature, physics, and war, military, strategy, are time-substantives because they designate phase differences to the person who comes upon them and has to deal with them.

This law is valid for all Romance and Germanic languages. It is inscribed in their higher grammars. Therefore the seemingly senseless book title "The Nature of the Physical World" has good sense; moreover it has great historical significance contrary to the intent of the researcher.

The possibility of constructing a tense-sequence from nouns of different roots stems from the church. A heathen filled with anxiety about death learned to observe quietly the world and its demons and magic in the refuge provided by the community of the Latin church. As church people congregated together one could view the sinister and bewitched world in common with a peaceful soul. Since this happening has been forgotten by the neo-heathens of Europe I will remind them of it once more in the analogy of the "American Language" after this analysis of the "Nature of Physics." From there a further step was taken: individual members of the community were entrusted with the mastery of this or that partial world (physical, national, juritical, psychological).

In order to hold the propagation of new branches of knowledge on a course our society must also keep in mind the contradiction involved. There is only one world, the creation of one God. There are countless partial worlds, the exercise-grounds for many specialists. Where the creation in its inviolable unity towers over us, there the unity is valid. Where it lies beneath us, subdued and discovered, the multiplicity of many departmentalized worlds obtains.

X? Therefore a child ought not to hear of professions, and many professional people as divisionalized people _____ against the unity of creation. There does exist a contradiction between faith and knowledge. But it is arranged differently than in the old division of these twin forces. One presumes that from 1100 until 1950 religion communicated faith and worldly wisdom propagated knowledge.

We have just reversed this trivial division. We have laid the foundation of our investigation on the knowledge of the faithful people and the faith of the researcher. We found that the man in all of us knows that there is only one creation calling us, but the many researchers in all of us believe that there are many worlds to cultivate. We who know allow ourselves the jest of believing as specialists in many partial worlds. ~~The opposite attempt seems more tempting -- to take from the~~ For since we've known better for a long time, our learned game of make-believe remains undangerous for the unity of creating. The title of Eddington's book is classic: he doesn't undermine the truth that there is one unique creating within which both the physicists and their physical world rest uncleaved.

In contrast a title like Haeckel's "World Enigma" brings danger. For in it that wide separation gaping between a series of experiments and the unique appearance of Haeckel himself or of Michael Faraday through the title "World Enigma" is dissolved in thin air for the laity. The title is unambiguous: the zoologist Professor Dr. Haeckel has disappeared in the primeval forest of German unambiguity. The reader thinks that Haeckel is specking German with him, but in truth he is led down the garden path with Latin and Greek. If Haeckel had written a "Metaphysics of the Enigma of Nature," readers would not have formed monastic orders. Compare Karl Marx's "Capital." It is an honest economic book; it confesses candidly its trilingual character from start to finish.

It never seems easy to find a path between divisionalized science and blind faith. Our investigation showed that the difficulty may not be avoided by acquiring our beliefs through blind faith or our facts from the researchers. The opposite

attempt seems more tempting -- to take over from the simple faithful souls their considerable knowledge and understanding and from the researchers their enormous store of faith.

That has a practical aim too. The best men let the faith of their youth accompany the works of their old age. And these men are the ones who count. The atomic bomb has already had the consequence that the best men no longer grant faith to research. Research seems to be prospering without them. There are such shapeless and pointless "Sciences" getting along today, to the horror of every God-fearing heart; they have grown to an avalanche which will strike our human village just as Ramuz depicted.

The faith of the learned and the knowledge of the people together would be more than enough to drive out faithlessness from the people and schools. But to do so they must find one another and unite. They can do so if they learn to understand the churchly character of our knowledge and the secular character of our faith. For the conclusion of peace between the parts of our generation always occurs in the name of the indivisible Trinity. We may never speak in less than three languages of God, World, and man if we are to have real peace, peace in which men may without hindrance afford the extravagance of splitting themselves temporarily into body and spirit. This is the second law of the higher grammar we have discovered: body and spirit, it and I, are grammatical figures of your soul. You may polarize yourself into it and I, belly and mind, in order to avoid a transitory contradiction in the world. But woe to you if you give yourself so fully to the tendency to split in two that you fancy you have a body and a mind. Your kidney is just as intellectual as your head. Your ~~cerebellum~~ cerebellum is just as corporeal as your lips. God disciplines us through our kidneys. Our lips praise Him. The horrible notions of the Enlightenment, which misplaced our participation in creation in the head, I counter with the old Egyptian proposition: "There is no part of my body that was not part of a god." (Guide ~~to~~ to Eg. Rooms of the British Museum 1924, p.20, Papyrus des Nebseni).

In "Heilkraft und Wahrheit" I have made new contributions to this teaching. Polythesiam is a thousand times truer than deism or atheism.

The third law states that the modes of grammar and the times of grammar hang together inseparably. The future approaches us as imperative, the present as optative and subjunctive, and the past as indicative. The classical beauty of Faraday's journals results from the perfection with which he made modes and times correspond throughout with one another.

The fourth law runs: the names amputated by the computations of natural science constitute the force-field explored by the higher grammar. A name witnesses a time-consuming tension between at least three speakers. A name requires a caller who pronounces this name. It further necessitates a bearer, the one addressed who calls himself by the same name as he has been called and who demands that we continue to use this name for him in his absence. Descartes and Cartesius, _____ and Copernicus, Faraday's refusal of a noble title are a few better known examples.

See Goethe's poem on the name Klopstock. The tension of every name lasts a lifetime. For up to the end name bearers are anxious and concerned; other "responsible" men sneak off behind aliases. Whenever all men call a man both to his face and behind his back just what he calls himself, then a life goes to ruin. The name-forcefield is itself a bearer of our lives, a power which either sustains us in life or murders us. Names are frightful noise and smoke, as frightful as an eruption of Etna. The higher grammarian has to do with names. Because these names are highly explosive stuff, the new grammar is no play with words. Such play may be left to the logical positivists. It is the teaching of the politics and polemics of powers which spit out or incorporate us.