

Natural Science and  
Philosophy

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Physics  
Biol  
Math

heavy  
or  
physics

Please allow me to introduce this course with reference to a little personal history;  
I  
I tell this to you because I think it's a clue to the times we're in. This is the reason why this area of study is important to you and to everyman who makes up the congregation of mankind. In high school after failing at basketball I turned to mathematics and physics. And really my first love affair with life carried me to the wild psychotic limits of reason itself and ripened me for assault of the theological recovery which began to impinge upon me in the last years of college issuing in the utterly incredible decision from all radical points of view of going to seminary. And then I was struggling with what in the Hell does it mean to be Gene Marshall. That was the only issue that was then essential - mathematics and physics were dropped somewhere out in the universe. Or selfhood was the second serious love affair with life. And through Kierkegaard, Bultman etc. this was the struggle of struggles so to speak. Midway in my tour of duty in the army as a Chaplain, I began to be awakened to a third love; that is the problem of social justice. American foreign policy suddenly came to me as a great huge, overwhelming reality and problem. The race question suddenly came to me as a huge, overwhelming problem. So it seems to me that for about 13 years there, my first love, mathematics and physics, though never wholly answered I suppose, was shot clear in the backwash. And selfhood and society, occupied my being- they were the preoccupation of my mental energy. Now, some of the naivety has been hammered out of my skull, a new passion for mathematics and physics has emerged with a brand new kind of relevance. Its as if my very concern for self and for social justice drive me back to a reconsideration in a whole new way of the natural sciences. Other people who are having a similar experience make me believe that this is not just a personal quirk, but rather that the total situation is pushing all of us to look in a new way at the human meaning of the natural sciences. And that will be the subject of the lecture this morning. The human meaning of the natural sciences. This is not a lecture on physics, biology, or mathematics; it is a lecture on the human meaning of physics, biology, and mathematics. Now, of course, this lecture is on physics

biology, and mathematics, and intends to be true to these disciplines, falsifying them in no way. But this lecture will not compensate for your having a void in science in college. It will not make mathematics easier; or suddenly clarify all the enigmas of the physical and biological universe. If you are an accomplished person ~~and want~~ in one of these areas, don't leave because you assume that this is going to be unavoidably elementary; for I discovered that being an accomplished physicist, biologist, or mathematician does not make you clear about the human meaning of physics, biology, and mathematics. Last Sunday morning we talked about human meaning of psychology, and before that, the human meaning of sociology. We have looked at the human meaning of history, and the human meaning of art, and tomorrow, we will look at the human meaning of philosophy. The last three days, in the morning, of these last three weeks, have dealt with the practice area- this week we're going to deal with the family in three sessions. Last week, we dealt with the city, that intermediary reality between the family and the globe. The globe was the first week struggle in the classical area. Now human understanding or gestalt of the intellectual disciplines of our time is a necessary undergirding for competent, practical model building. It's necessary, I think, to divide between the theoretical wisdom of our time and the practical model building issues of our time. Yet, these two are intimately related and one cannot work without the other. In terms of practical model building, you need grasp of the overall theoretical wisdom of our culture. And few of us if any, got a liberating education in college. That is an education which allowed us to use practically the vast wisdom of our time. No one can be an expert in everything. But the revolutionary, must know how to use all the experts. And we do not turn our lives over to the experts through this. Most experts don't know how to use themselves, morally. It is the job of the revolutionary churchman to know how to use all of the experts morally. All the experts and all the intellectual disciplines are related in this way. <sup>if</sup> And this is not the way it is, then you had better come up with it if you're going to be a moral revolutionary. Let me work through this diagram. If you take all human knowledge, all theoretical knowing, all objective <sup>grappling</sup> ~~grounding~~ struggles, to get hold of reality - (the sciences are dealing with the objective construct of just raw bearing) The humanities are dealing with something like the personal images of your

reality relationships. The humanities, in that sense, feed off the work of the raw objective struggle the sciences are dealing with, and give the depth relationship that goes on. It's also an objective task to talk about the way man really is relating and struggling with the relationship to reality in any particular time in history. Theology grapples with the universal symbols of the spirit deed, the universal symbols that grab hold of what it means to be a man in every time. Yet, of course, monks do their work in relationship to the times in which they live in order to say something. Now if we put out here these dynamics of God, Christ, and the Holy Spirit, we have rather well set our structure here. In science - put natural science up at the top, social science over here, and psychological science down here. Over on this side - put philosophy at the top and art at the right. What this is saying about the natural sciences and their inter-relationship is something like this. That the raw science is in one sense social science; that the humanity of science is psychology and that the theology of the science is natural science. Or - this is the eerie one, this is the mysterious one, this is the one that goes into the far reaches of mystery itself. And the relationships also go this way; natural science and philosophy relate to the fundamental question of the awe and mystery of being itself. Sociology and history relate to the communal dimension in which this final word is articulated. And the holy spirit deals with the art and psychology or the struggle out into the very loose and the deep of the human spirit and it's manifestation back through all of the other structures. To look at just the lower part of the diagram sociology and history we have put together as dealing with the communal structures of man; psychology and art, the personal and natural science and philosophy now deal with over the all. Psychology is fun, I think, because it polls your personal life and shocks you with your most personal - ---- . And art is fun too, because it tickles your personal life and turns you on with new intimate awareness. It may not be fun if you're running away from certain things that it painfully shows you, but generally it's fun. Sociology analyzes the social structures and how they change and is far less fun. History is a little more fun. It enables you to locate your own personal existence in the universal sweep of things.



Philosophy however, is a numbing thing, like a calculus course, or like what I'm doing now. I have to work hard to make it fun, unless of course, you are an intellectual bug who ~~needs~~ tingles at arid clarifications of the progresses of reason and ontological structures of human existence. Philosophy is generally kind of a whooey subject. And natural science is even more arid and eeiry than philosophy. Basic rational order withing which all of our psychological and social takes place. Oh, that basic rational structure up against which the philosophical system building tumbles and re-constructs itself. Natural science is the comprehensive. It is comprehensivly covered in these three dimensions which I'll put up here. Mathgoes at the top, physics, and biology. Now if you thing something is left out there like chemistry, geology, statistics, computer science and ~~st~~ astronomy, all that is in there, it's part of the proliferation of the sciences and they all happen to think they needed a separate department on the university campuses. But chemistry is either physical chemisry or else it is biological chemistry. Geology is either physics, or else it's a tool of the social sciences. And astronomy, that's physics and so on and (has?) so on. The reason that we've had so much trouble here is that no one ~~has~~?come up with the kind of model that gives ontological grounding to all of these. Let me read to you a little bit from Kazabtzakis. "WE come from a dark abyss ( P. 43) ..... and with this vision to modulate our thinking and our aciton." Now this striving toward death, toward matter is the symbol for the physics. The coaling off of the stars in great cosmic drama where even the possibilities of building complex atoms for supparting life finally comes to an end. And then the struggle toward life, the struggle for organization we'll point to as a kin d of reality that biology is struggling with. Theclimb in the complex atom, the climb in the complex molecule, the birth of the living organism. The birth of the self-conscious living organism - the birth into global humanity. Brash consciousness will engulf the very stars and keep them burning. I'm sure it would if it could. Biology is the objectivy analogy of this fantastic force. The rational construct that holds these forces present to our understanding the fundamental/ <sup>rational</sup> construct in obedience to which all the other oonstructs ~~in~~ civilization must come to terms. The whole of knowledge is built out of and on top of the fundamental way in which man images these utter fundamental natural forces. Now what is mathematics? Let me give a quick ontological grounding

again. I'll read another very brief passage from Kazantzakis. "I am the worker of the abyss. ....(p. 48) Within these limitations the mind is the legal and absolute monarch." Mathematics is the invention of order itself. Mathematical invention is the invention of reason itself. Mathematics is reason itself. Abstracted from all concrete reference./ Again. Mathematics is the setting of rational relations themselves; Mathematical invention is the invention of order. Mathematical invention is the invention of reason itself. Mathematics is reason itself, abstracted from all concrete content. Mathematics is a natural science related to these other two as forming a fundamental rational construct or fabric out of which all other thinking goes on. I find this picture a very helpful one. Here is the over the all dealing with life and within that sociology and personal struggle goes on. It's always presupposed; it's always out there. So let us adventure into natural sciences. Wipe all victim? images away, relax the rigorous hold that taken for granted stereotypes have on our fogged imagination and gird up your wits for a journey into the fantastic. Perhaps I had better give you an outline of the lecture. I've just finished the introduction. That was on, what is natural science? Now the first point is an overview of intellectual history. And then, we're going to deal with physics biology and math. And here, relatively briefly, just trying to show forth a structure of what each of these disciplines are, where some of the edges are in our time - where the struggle against where the sheer mystery is in physics, biology and math., and of course for the human meaning of that, of those images that are being struggled with. I'll try to give us an overall picture of the ways these are functioning in our own lives and their crucial importance for us. And then the conclusion will be how the natural sciences relate to the spirit dimension. Now an overview of intellectual history - I want to go way way back. This is a map of time. Here is zero and here is the year of 4000 B.C. And on this end is 4000 A.D. And we're somewhere in this spectacular interval right here. About the time when this whole intellectual context just collapsed into the ground and in the midst of the time when this whole intellectual way of looking at reality is just getting out ahead of this other one. As you go clear back here, you begin to see the kind of inventions that took place there that enabled this whole thing to come into being. One is shocked almost at the way in which this has come into being. It was a group of people called the temple priests.

that got this started. They were religious men but religious in a strange sense. They were mathematicians and they invented all kinds of things. They invented the king, they invented the city, they invented social classes, and so on and so on. But even before they invented all those things, the structure of the universe itself which enabled this invention and this invention and this invention to be invented. They were greatly concerned with numbers. The number 10 was a very handy mechanical number. But there were other numbers much more holy,  $\neq$  much more divine. The number 360 was an especially holy number because that's how many days there were in a year. And we use 360 degrees in a circle to this very day because of that error back there. And the number 4 was a very magic number. You think that it's an accident that we have four directions? North, East, South, and West got invented back here. And maybe to show the picture of that invention, you have to see a great pyramid which has four sides. And those four sides of that pyramid determined the directions of the universe. East, north,  $\neq$  south and west. But not only did they get that set, but they also set what was up and what was down. Up was divine - up was the star - up was where the cosmic forces operated - up was where the divine numbers of seven, like seven heavenly bodies operated. Up was where the structure of things was that they then finally called the order of heaven. Down at the base here was the base. That was the nitty gritty. That was the bottom. The whole social pyramid was also constructed out of this. The king sat on the top, and the peons stood down here at the bottom. The king mediated the divine order of society and these people participated in it as their only hope of living in an overall type of structure. They had grasped in other words a whole vision that enabled them to organize society in a whole new way. We might call that new vision, in retrospect, something like eternal realism. The idea was every time is not entitled to its private system of looking at things. No! There is an order in heaven to which everyone must bow. Now, on the other side of this radical revolution, you have to write another word. I'll call it relative realism. This is not a re-occurrence of the anarchy of private tribal opinion but a depth understanding to the bottom of reason itself. Society must now march forward in terms of a gigantic social consensus. The best model of the overall is the most adequate to predict the future because of the big construct, in terms of which you worked.



\_\_\_\_\_ science back here in the 16th century began in this context. They worked in this overall view that there was an eternal order of heaven to which all men must bow. And all the critical idealism tried to hold in one system of understanding this struggle with science and the old, old, philosophy which goes way way back, back, but science in the 20th century broke through the frame, and demanded the whole intellectual community to reconstruct the whole frame of things. Scientific thought in our day is understood as a threat still for the rational grasp for the hard objective reality. But the hard, objective truth of our time is that objective reality is beyond our grasp. That objective reality is beyond our -- well there is none. The raw objective thereness is not rational order, it's sheer mystery. But rational order, though a human creation, is our only hope to get at working with things in a context without disintegrating into chaos. And the mystery of existence we now know is most adequately experienced by those who push out to the rational end of the struggle of society where the limits of raw mystery are known to be subjectivity. And the awe breaks through to the very center of the highest most incredible creation of the human mind. Now, this kind of an overwhelming shift in our basic intellectual way of coming at things, I think is a context to work at what we're going to talk about in physics, biology, and mathematics. One more thing, before I go on. If you had to choose two periods in history which were such radical turning points, you'd choose the one that we're in, the present which begins back with the 17th century and moves up to our time giving, of course, special emphasis to this last phase in which you and I live. If you had to go back earlier, you'd pick out the period of 750 to 500 B.C. In this strange, wierd period things took place all over the planet; that is the Hebraic prophets lived in this period. Greek philosophy got it's edge in this period. Buddha lived in this period. Confucious lived in this period. Taoism got it's start in this period. Zoroaster lived in this period and gave a whole new thrust to the Persian culture. And in a sense the whole social structure had begun to crumble loose in deep crevices and enabled a brand new probe into the bottom of individual olfe to take place. And ever since then, we have with the overall ~~struggle/ individual~~ <sup>intellectual</sup> grasp with which we've~~s~~ been struggling, we've been struggling more with the individual. Back here the fundamental turning point of civilization was getting brand new social vehicles in being, that could get beyond the structures of the past. And now, clear on down to our time, the

bottom of the individual struggle- We have finally shoved the individual dimension clear on down to the bottom and in our time we call that the secular revolution. And we also see that we are in the midst of a brand new birth of an entire new social vehicle unprecedented in all of history- and we call that the urban revolution, by which we mean the very vast and overwhelming thing. ~~And the whole force of~~ But equally overwhelming, in the whole force of human history is what we've called the scientific revolution. And if you want to say - Newton was the first scientific revolution, and Einstein was the second scientific revolution - there's great wisdom in doing it that way. What I want to say is that One great intellectual revolution that pushes out man into a whole new way of living down on out as far as we can see into the future, In intellectual history, the invention of Einstein's order is prior to seeing it in nature. That's crucial. Intellectual revolutions begin in mathematics and then move on to physics and then they move on to biology. Let me illustrate back here. These fantastic new mathematical ideas that enabled them to put forth the concept of the order of heaven, enable to come into being these kind of structures. And probably one of the great happenings in the history of mankind took place again in this period in which plane geometry came into being in which triangles and circles and squares and so so forth. What this did to the whole human history is just astonishing. Domes were possible, cathedrals with all the towers were possible, Christian theology was possible. Science and physics dealt with trigonometry and this was basically these eternal forms as they called them of Euclidian geometry forged fundamental axioms out of which mentality operated clear on down at least until 900. And here from new sciences mathematical inventions took place. One of the things that was invented was the concept zero. That concept did not exist before then although that seems incredible. And also the concept infinity got itself born here. At the same time was born abstract notation which is really what these are examples of. Abstraction of notation that moved the abstract of mathematics out of the raw concrete number into abstract number. ~~We know this as~~ It enabled algebra to come into being. Homolithic (?) philosophy and all this kind of intellectual endeavor would never have been possible had not these kind of abstract mathematical inventions taken place. Now just before the scientific era got going another great deed of mathematical invention took place in maybe 1300 or something like that. They began to occupy themselves with quite un-Aristotlian ideas -



like periodic movement, and periodic motion. And these made it possible ~~for~~ to talk that way - something rotating through zero and back through zero forever. That was a fantastic new concept that came into being; It enabled Copernicus to build a new structure of the universe, Galileo to see pendulums- pendulums had never been seen before in human history. It enabled the clock to be invented. Before that time, all you had was sand dropping grain by grain - substance by substance through a little narrow opening. Suddenly there was a whole new way of grasping time of measuring time came into being. And a little later, all the breakthroughs of the scientific revolution - these ideas were carried on into inventions like the calculus, inventions that had to do with continuous variables. Without concepts like abstract notation, periodic motion and the pendulum there would have been no modern world. These ideas enabled the physics of the mechanical machine that went round and round and round and on and on and on operating by these kinds of ideas. It enabled the huge edipus to come into being. Now in the 18th century around 1800, the late part of the 18th century another incredible occurrence took place in mathematics. We call it now non-euclidian geometry. You have to get the shock of that to go way on back to here and call into question fundamental axioms that have to do with the eternal forms of the universe - it's a shocking notion. That you do not have to construct your algebra that way that there are a couple of other ways to construct it. Only consistent algebra; and which one fits reality best nobody knows. This was not the only mathematical invention that took place here. It called into question the whole edipus of continuous ----- by raising the question of how many numbers there are on a continuous line. The meaning of the whole of mathematics came into chaos several times. And mathematical reconstructers are still working at the fundamental concept that number series call into question. They're trying to reconstruct what on earth mathematics is and what on earth order is. Now without this radical mathematical invention you wouldn't have had physics. Einstein could never put together theories of relativity without non-euclidian geometry which enabled him to do that. And the use that quantum mechanics has made of number theory and all is equally phenomenal. Following the work that takes place in physics you move into biology. Let me illustrate that in just two cases. Back here biology was the hyphen-names of things. But after the Smithsonian machine hit the imagination of man, then there had to be a Darwin to come along. To create the concept of evolution or a continuous

continuum hypothesis that held meaning together in the evolutionary process. And in a way the post-Einsteinian physics, a new conceptuality in biology is also born. Let's take a look at the structure of physics and where the edges are breaking in upon us and the importance of these images to our lives. Aristotle said physics was something like this. It had to do with form and of course these were pretty well eternal forms or relatively so, substance, and mechanics. Or interaction. Interaction of substances of which there were four and the forms that held rationality into the substance structure and into the mechanical structure. Just this form moved into the 20th century. You might compare it this way. Here the mechanics is the construct of the macrocosm and over here the construct of the microcosm. Now what I mean by macro and microcosm is in a sense, man sort of standing in the middle of the order of things and he looks down into the depths of things and it gets more minute and minute. And as man has struggled with what substance is in the 20th century - atoms and atoms electrons, and protons - I mean it gets frightfully minute. It's been an incredible revolution in that direction. And in dealing with images or in rational structures of the microcosm, it is being pushed in the same manner. In a big picture, in the way the stars function in relationship to one another, the way automobiles function in relationship to one another, etc. etc. there is where the revolution in Einsteinian physics primarily relates. Now of course these two are deeply inter-related and consistently move back and forth between each one. But mankind has never existed without a construct of the naturalcosims - the big order of things - and move down to man's size and tell us how things work. How they function in relationship to one another. And what are things finally composed of, how does that work. Physics has to construct concepts in both of these areas. And what's this third area of construction that the 20th century \_\_\_\_\_ It's the construct of order in the universe. The fundamental order and here is where the great debates of physics goes on. What physical concepts are adequate? The classical physics and the concepts and the meaning of those concepts were radically called into question. To get a feel after this, let's look at it in three stages. We'll let Aristotle be our symbol of the ancient - he was a great systematizer who pulled together all of the wisdom of the ancient ages. Newton was a part of the new invention of experimental science and Einstein's relativity formed the end product of that process. Now, here we look at Aristotle's way of looking at these three dimensions of life these forms up



here or the concepts of order, there was a static, linear, geometrical order in the universe. It was just there. And we look down into the construct of the macrocosm- everything sought it's goal, it's end was the fundamental motif things fell because things sought their rest. And here in substance, there wasn't any empty space, there was just substance - air substance and water substance and so on. Now as you move into the Newtonian physics and it's consequences again you have a sort of a static concept of order - maintaining that's there's some static order in the universe to be found somewhere but great changes were coming into it, the infinite variables, the periodic motion and all give a whole new feel to the nature of that order. And the machine is the fundamental concept that grabs hold, everything is like a great body, everything works like law and order. And here you move down into the particle, the particle the particle. The little particles that relate to one another and so on. Maybe this image holds it for you. Everything has a rotating center and then things rotate around it. You think it was just a natural discovery that they found an electron rotating around the atom. The truth is that nobody ever saw an electron rotate around an atom. This is the model they came with. They discovered it looking at the planet. And they used it. In other words, to interpret what was going on, they thought, down here in the depths of the structure of the atom. No longer is this really very adequate or very helpful in the post-Einsteinian physics. I'll characterize this way, There's something dynamic about the whole order now and dynamic about the whole of existence. The stars are dynamic entities. the whole reality of the universe is a dynamic entity that exploded back here somewhere, came into being, and burns out, in the end of things, in an expanding dispersion out into sheer darkness and abyss. That's a whole new concept of things. And here, with the theory of relativity, and the fundamental concept  $C$  or the speed of light. And here the quantum theory has determined our work and another incredible concept of  $h$ . Now we look at those very briefly in order to see the awe and the incredible being is broken loose. Newtonian physics was built to deal with marbles, and pool balls and automobiles and things. And electromagnetic phenomena like light and electricity, X rays and so forth gave Newtonian physics headaches from the beginning. But they kept everything pretty well in the system until the 20th century and then all the structures broke loose. One of the first ~~was~~ happening that was so clear so that you couldn't avoid it any more was some experiments



with the nature of lighth- the speed of light. Everybody had discovered that light travels very fast, I mean it really moves out, 186,000 miles a second and that is moving. But it was not an infinite velocity, and it had limits on velocity. So they began to do some experiments that would give them great clues into the structure of the whole order of the universe. If light ~~is~~ travels at a finite speed, then light rays must travel through a medium, you know kind of like you drop a pebble in the water and the waves spread out and the water moving down stream causes the waves to move down stream. So they said let's see how fast the earth is moving through the universe. Because obviously there is a stable structure to the universe through which the stable earth is stably moving. And so let us see what that stable structure is by measuring the speed of light and all the rest of it. And that will tell us about what they call the ether wind. That is the ether was that physical conceptual substance that light migrated through at a fantastic rate of speed. And so if the earth is moving through the ether like this then the speed will be different measured that way than if you measure it this way. The chagrin of the whole experiment was that the speed of light was the same no matter how it was measured. They did that over, and over, and over and finally just quit. They looked at the whole structure of physics and said that this can't be. Either the earth is the stationary thing in the universe or else something is radically awry in our whole way of looking at things. Einstein took the latter, and proceeded with these two suppositions. One, all motion is relative to some system of reference. And what he meant by that is the simple thing that you know when you're on a train. You're sitting in the train, you look out the window and see the train moving, you have to ~~decide~~ decide whether you're in a train moving in one direction or the other train is moving the other direction. And to decide which references you're going to work into. Usually we find the ground somewhere and work in that reference system and decide that whichever train is moving in relation to the ground is moving and whichever one is not moving in relation to the ground is not moving. We discover that they're both moving when they're both moving and they're moving in respect to the ground and they're moving in respect to one another in a different speed, and so forth. All motion is relative. That is simple enough. The thing that bugs us, the whole in the whole structure of physics is the second presupposition. The velocity of light is constant

to all systems of reference. Now you first don't see that that's a radical idea. You look at the consequences of it for the whole of physics and you begin to see some incredible things taking place, which you'd believe weren't possible to be so unless you go out and look at them and My God, they weren't so. Here's point a. Point b is moving out from point a at ~~point~~ .99 the velocity of light. It's really moving out. It's not going the full speed of light but almost. Now point b is being moved out some by point c at the same kind of velocity .99 the speed of light. So that the speed of light/relative to a is .99c and the speed of c relative to b is .99c in the opposite direction. If you're looking at it from b it's moving out in this direction and this one is moving out that way at the same kind of speed. Now what is the speed of c from the reference point of a? Well old Newtonian physics would just add these two numbers and you see that it's 1.98c is how fast c is moving out from a. Well, in the Einsteinian universe, that's not the way it works out. c is moving out at .999c. Or to give you one more picture, Simultaneity, in the Newtonian context, if two things happen simultaneously hell, they happen simultaneously. And now you've got to ask simultaneous with respect to who? Because an event that's simultaneous with respect to c is not simultaneous with respect to b at all. There's interval time between them. An event that's simultaneous with respect to b is not simultaneous with respect to a. There may be an accident now and then where events that are simultaneous to one system are also simultaneous to another system. But the universe is not put together in this model. Now, one more quick picture, if you went out here to Argon laboratory and watched the protons go, they go round and round ~~and~~ in that four mile track and every time around a big electrical charge here gives those protons a boost, I mean it gives them a kick. So they go faster and faster and faster and faster and faster each trip around. And if you were working in Newtonian concepts, the more energy you gave them, the faster they would go on a very linear kind of progression. That is a unit of energy would give you a unit more of velocity and momentum. So that you could draw a graph that looked like this- putting the velocity of the proton out that way and the energy kick you gave it up this way. It would move out that way with a kind of equation: Force = ma. It was a very regular way of looking at it. But in this Einsteinian physics, that isn't the way the model works out. The model works out this way. You come out to this place where the velocity reaches the speed of light, something happens to this



straight line. That is, it was pretty well a straight line for awhile. But out here, it slows down, it went up like this. And no matter how much energy you gave that proton, you never got beyond the speed of light with it. And if you don't believe that's so just go out there and watch the protons. That's the way it worked. They can't accelerate them beyond the speed of light. They seem to get heavier and heavier and heavier every trip around. And that's what he means by a change in mass, it just takes a hell of a lot more force to get it going each trip around the track there. Now, with respect to the protons if you were riding on the proton, the changes are altogether different. He gets the same kick every time around as far as he knows and has the same increase in velocity every time around as far as he can tell. But his sense of time changes. That is his clocks work much slower with respect to the clock on the ground, of course. He would probably say that his clock stayed the same and that the clocks on the ground sped up. The effect was that his kick came more frequently according to his clock. And so on. And so nothing stays the same when you change systems. Now, you may have read some science fiction which takes ~~with~~ a man traveling out in space - he's two years traveling in space and when he gets back 80 years have passed on the planet earth. That's the kind of wierd reconstruction of physical concepts that the theory brought into being. One would never believe it. In fact, the experimenting with the structures of the functioning of the universe did not work that out. What this means for us is: Any objective analysis presupposes an observer to whom it is objective. Any objective analysis presupposes an observer to whom it is objective. And so you have to say with respect to who and with respect to where you're standing in the structure of the universe. What space, time point are you occupying when you say that? Or secondly, everything is inter-related in a dynamic concept. There is not static motion and substance through static time in a static universe but all is a dynamic network of relationships. And three, that there is a kind of a power in ~~that~~ <sup>mass</sup> and this we've been most familiar with in the atomic bomb- that the power of mass present, it changes the whole structure of things around. And when mass lends itself it has a phenomenal potential. Our very presence changes everything around. And the expending of ourselves releases fantastic power into the process of human evolution. What this means then in the deed, is that we have to grasp ourselves making a committment- having to be someplace, having



to occupy a position, as the beginning point for all of knowledge. Centering in me is a model of the whole universe. In quantum mechanics, the concept that broke loose here was the dimension of radiation was a discontinuous process. That is there are indivisible \_\_\_\_\_ of energy. And that violated the continuity concept, where you had a little more and a little more- you could only have half. Energy didn't come in indivisible parts; it came in packs and this constant  $h$  was figured into measuring those packs. What does this mean for our time? Many many things. One of the things that we've been very clear about in trying to think through this whole new relationship in the deeps of existence in the microcosm- is the recognitions that observation changes the object observed. Being there looking at something with a ray of light interacts with that thing with a packet of energy. And so when you get through looking at something it isn't ~~the/same~~ what you looked at. The light with which you looked at it has changed it. And forever after I'll have to be clear that there's no final objectivity. The only way you learn something about reality is to enter into inter-action with it. And when you get through learning, it's different than when you started learning. And another thing that has to be looked at that makes trouble with trying to look into the deeps of existence- we have to decide ahead of time what kind of a model to look at it with. You could look at the phenomenon of the atom with a picture of wave mechanics that is continuous theory and you saw what you saw. You could also look at it with a packet - particle theory idea and you saw it from another angle. And it wasn't that one of these was the real way of order, it was, my lord, they were complimentary theories with which you could look at the same reality and therefore more thoroughly expound the reality. And which way things were really ordered is no longer even an issue. Then what you've got is two ways of ordering what's going on -and what's going on down there is in one sense incomprehensible. You can use contradictory theories if you like to look and you see with them different kinds of things. This does something to our whole ideas of physics and to our ideas of objectivity. And we recognize that we have to sense a new kind of lucidity about the whole rational process and the way it operates. Now the models of physics -- the Einstein model gives us a way of ordering the whole structure of things, still when you look down into the microcosm you still encounter sheer mystery. And the particle physics of our time is an illustration of how the awe of reality breaks through- even these fantastic models of Einstein. And you've been reading perhaps about quasons moving out into the vast expanse

of the way things operate—we run into another enigma. I thought you'd enjoy this little poem written by an astronomer. Horrid quasar, near or far. this proves to you I must confess, my heart for you is full of hate, oh super star in floating gas, explodes crash. You're glowing speck upon a place, of Einstein's world you've made a mess."

Now let's look at biology— if you look at the structure of biology, you see in the microcosm of biology of the cell and in the macrocosm of biology the whole series of evolution if you like. And if you look into this dimension, maybe what you see here is self-hood and consciousness or the strange capacity of life to order itself. Now where is the mystery leaping into biology today? Where is biological fundamental concept running into wild reality that reality now always seems to be. You remember that we had a large continuous line of evolution constructed by Darwin, and now we're beginning to grasp there are curious leaps. There's a leap from un-life to life. And I mean that was a leap. At this point this is still utterly inexplicable and then, there was another leap from life to self-conscious life. That also is utterly inexplicable. All along this whole Newtonian continuous context there is the demand that we be able to explain the more complex things in light of the more simple things. And thus show a rational progression of how you can really make life out of unlife. You can really make self-conscious life out of life. But many attempts to render a continuum from one of these steps to another step have failed. We synthetically formed higher biological ~~molecules~~ molecules and we've been able to analyze the biological processes of life, take them apart and put some of them back together again. But we have not been able to synthetically initiate the life process from a process that was unlife. We have not been able to do that. It may be that we shall never be able to do that. One thing we know is that the natural history of this planet in a very short interval— life came into being. Out of the complex of this planet. And it is a phenomenon that has not happened since. as far as we know and one that we have not been able to reduplicate. It may well be that the jump from life to unlife may never again be reduplicated in this planet's history. And those who are disappointed by that are having a favorite imperative called into question there. Complex things derived from simple things by ~~natural processes~~..... The leap from life to conscious life is equally mysterious and probably unduplicatable also. And if these leaps could be synthetically instigated we have no idea what monstrous processes we might



BE STARTING. I mean by monstrous that they would be anti-thetical to the whole life process because of some different kind of a start. Our same conceptuality convinces us that life is probably developing somewhere else in the universe because these are naturally processes therefore life is developing somewhere else and it probably exists many other places. I don't know if this is true or not but I would say that where you and I would be most offended is if we discovered that we were it. If we discovered that we were the only happening in the whole universe of the birth of life out of unlife. That would most offend our paradigm. Of course, you know we have no support for either one. The process of evolution itself is not seen as a statistically probable theory of accident but the process of evolution of life itself is understood differently. It's as if the adult organism's experience with the environment enables the organism to decide how the new organisms are going to go. It's not that mutations come forth by pure accident, mutations come forth by decision in the adult organism. Now/~~we~~<sup>it's</sup> a very complex kind of ~~don't reflect upon that~~ decision, but it's the kind of process dispenses any kind of random possibility series. It makes the whole field of evolution something different- the life process is something like a ~~different~~ giant organism making experiments out in this direction and if that doesn't work, back~~track~~, and make an experiment out in another direction and if that doesn't work make an experiment out in another direction and so that the tree of life becomes a great series of rather unconscious intentional experiments if you like in all kinds of direction. Some animals like the dinosaur have gone too far in one direction and therefore were a dead end. And other animals like the shell fish adapted to the universe so well that there was no motive for evolution so they were at a dead end also. And it seems clear now that the really live end of the whole evolutionary process is man himself. And a third awesome edge that's present in this is that man has a self-consciousness about the very processes of evolution itself and is therefore able to exert incredible forces and enter into those processes and take charge of the whole life experiment on this planet. That is we are now in charge of it. Everything from the snails clear on through. Man who exists with such potentiality is deeply afraid of himself and his potentiality and of course may destroy himself rather than go on with the experiment. But this gives us a new insight into life itself. Life is the capacity to transcend time. Life is the capacity to remember and to anticipate and to intentionally relate to the future in a creative manner. That's what it



means now to be alive. Now where is the awe seeping through in the struggle of mathematics?

~~One of~~

One of the places is that that I mentioned earlier - seeing the phenomenal role that mathematics is having in human history. The second might be hinted at by pointing to what I would call the computer illusion. Mathematics is struggling with foundational concepts. How mathematical order emerges and what are the tests of consistency and so forth. The popular concept, we might get at it through the idea you often hear said, that the computer is becoming such a wonderful thinker ~~at~~ that it one day will be able to do anything that man can do better and quicker. Have you ever heard that? Computers will eliminate the need for man. They could repair themselves, make their own program adjustments and so on. Now indeed, the computer can do many things. And do them better and quicker and so forth than the human brain can operate. But the computer will never replace man and those who say that the computer will replace man obviously have a very high understanding of the computer but have a very low understanding of man. That's the problem. Anyone who says that has a reductionistic understanding of man and the way man is able to create order. And at the deeps of the mathematical order that's really where the debate is. Let me put it one more way - the computer is an incredibly potential invention but it's finally nothing more than an extension of the mechanical processes of the human brain. The computer maker man cannot be replaced or reduced down to the mechanism that he is able to reduplicate in his computer. Man is more than that. Even in the deeps of his thinking process man is more than he has been able to reduplicate in his computer. Man can make inventions of order.... A computer can do so on the basis of a program of random selection- it can do trial and error, and because a computer moves so fast it can do a lot of trial and error in a hurry and therefore beat man in that kind of process. But man can beat trial and error. Man has intuition out of which he creates order. He beats any mechanical process he's ever been able to invent. The whole mathematical history is inexplicable in terms of just chance, trial and error. And maybe the structure of mathematics here will quickly show how that debate is going on. One whole area of mathematical foundational theorists are called intuitionist. And they are really pushing mathematics is able to work in itself ~~that~~ out of its own deep intuitions of before. Another group is called the formal and they work out of the understanding that math is really disguised empirical relations or abstracted empirical relations. For mathematical order comes into being and the fundamental criterion for its existence would be the relationships in natural

order. Another group in logic, and they understand that *logic*/ mathematics derives *that* from language or linguistics processes and man the highly abstract thing and finally finds it's test in human comprehensive ability. If you push back against this, you'd finally have to say that these all are true, That mathematics does develop in *struggle* dialogue with physical struggle in the natural environment. And here of course with relationship to the scientist in all these rational structures mathematics is interpretive and so on. But the truth that these people are blasting for over against these is that math in the deep eerie sense of the human being itself - he is able to create order out of nothing. And it's these creations of order that finally determine the logical structures of human society and of course finally give possibility to order in nature out here. Man is the order maker who makes order out of nothing, and order out of nothing in a way the computer can never do. Likd Aquinas's model: he says form comes from nature. in another of his sources, forms comes from the mind of man. and ~~another~~ source of form is the mind of God. Which is another good way of putting that. It comes ~~from~~ nowhere, it comes out of the sheer being of nothing. YOU see how fantastic the arguments can be, with these kind of depth issues going on at the foundations of mathematics. Now let me quit. Just this statement in conclusion. The human meaning of the natural sciences is that man only knows order through constructing order and if you go on out to the edge of the order of society, that's where you get to the sheer mystery of things. The research scientist in one sense knows more about the sheer mystery than anybody. I think all of us hope in our order loving way, that the scientist was out there explaining everything. And now we must learn to use the scientist as a vehicle to get out from the unexplicable. To get out from that which has no explanation. There's no more hiding back in the safety of what was rational yesterday. We must learn to accompany the scientists out into the very premises of reason itself. We must learn to take rational courage and venture out into the deeps of irrationality where reason itself dies, and ~~is~~ reborn. And the second thing I would say about the spirit dimension of the natural sciences~~s~~ is that we learn by negation. It is when our order of things runs into crises or runs into chaos, runs into the ~~un~~explicable that the possibility of reordering brings forth a new to take place. And thirdly, that in the very structure of the natural sciences is built



the principle of perpetual revolution. And maybe a quick picture or two. When you look at theoretical wisdom, you're looking at what you might call relative universals. That is they're universal in the sense that they're more universal than my family plan. Or other rational constructs are less universal than the universals of our whole social order in our times and dialogues between this are written into the very structure of even these very final models that hold together reality itself is the principle of perpetual revolution. These final rational structures are but the fortress of the society in which we're attempting to anticipate the tomorrows of mankind. While these are stable in the sense that you don't just change them every afternoon, there is in the deeps of them this principle of perpetual revolution. And so also, that means that all rational thinking has this kind of dimension to it. This means that when you build rational forms, you build a stance about the whole of reality. When you build a model for your family you do so in relationship that anticipates the whole context of the social environment. And your decisions to give order to the world are not just private endeavor. When you give order to the world you give order to the world. And it's your responsibility to fight for your stance. To give all of mankind, your intellectual vision. Intellectual life is incredibly social. It has to do with the whole social process. Relativity does not mean that my opinion is ok because everyone's opinion is relative. That's defensive privatism or tribalism. The responsible man argues over against the whole field of thought. He shows how this one is true, but this one is true but this one is true but and this is what holds reality together and this is true period. And that's what you mean by relativity. But tomorrow you put it together again.