AN INDIAN AMONGST THE CHIEFS

Disucssion at Raja Rao's House April 9, 1983

Amongst the chiefs as to how being a scientist in contemporary times is effected by my being an Indian. In general of course people say science is universal, there is only one science that there is no such thing as Chinese science or Indian science or Western science. There is only one science, after all 2 + 2 = 4. There is also a popular conception or a caricature of science which says after truth that one experiment can disprove a whole set of theories and that one theory which unifies all the things will suddenly make us see very much more. But actually this is very much an oversimplification in the same sense that the administration of law is to provide justice and to render justice. Yes in a certain sense, but in practice one more law very often does not render. If fact there is such a close similarity betweenthe practice of law and the administration of justice and a preview of science because both of them are high structured methods of researching for the ends that it arrives at. It does not tolerate any departure from particular method of inquiry. To give an example, at the present time it is considered a very serious scientific question to ask when was the universe formed? To ask the question why amongst the chemical elements one finds so much of silicon gold or platinum. What is the composition of various isotopes? What is the size of various galaxies? Systems, stars, planets, things of such kind. What is the nature of the composition of earth's crust. Why is it that we have behavior of certain kinds among the comets on one hand and behavior of planets on the other hand. The notion of evolution within planetary systems and then within life? However, it is not considered a reasonable question to ask how come people are born with certain intrinsic abilities? Unless that particular question already has

an answer in terms of the existing genetic ideas about imprinting about in_____ by the genetic information in the new born child. So it is not a case of asking for all questions. In fact the scope of inquiring is very strictly limited and anything which is outside this particular region is not only considered not worthy of science but is considered as hostile to science. Anybody who deals with those things or any inquiry into the question of the thing is itself considered unscientific. So by and large scientists would consider any question of ESP, any question of the nature of ultimate reality, any question of soul or any such aspect of the universe, any question of purpose of human existence individual or collective existence etc. as to be not only not scientific questions but anti scientific questions. And instead of examining evidence for the theory and pronouncing on the evidence one would say any study of such question themselves in fact is showing a certain tendency away from science. so much so that at the present time one would like to maintain the fiction that all men are born equal because in certain sense all electrons are the same all protons are the same, all matter is the same. Therefore how could human beings be different? Except by the accident of the history of that particular piece of material very much like annealed iron is different from raw iron. A fatigued piece of metal will have a lower strength than an unfatigued or fresh piece of metal. Except for these changes the idea is there is no real intrinsic difference. That all differences could be traced to physics chemical content of the things. There is one point I wanted to bring to your attention because very often the idea about science and the functioning seems to be at variance. Because the idea of science is that science is after truth. Science is interested in empirical evidence. Science is interested in all questions of nature. Science is universal. Science is the same for all people.

None of these statements are true. Nevertheless science is after truth, science is universal in the sense that it does not depend on the kind of civilization which is dealing with it as long as it deals within a certain particular fashion. The other point that I wanted to bring to your attention is that there are different kinds of physical laws that are involved. One kine of physical law that says ice melts at a certain temperature, water boils at a certain temperature. If the pressure is increased the behavior of the boiling point as a function of the pressure is varying in a certain fashion that a particular metal has a certain strength, if heated it expands in a certain fashion or a certain chemical element behaves in a certain fashion, detailed empirical properties of these things and this could be in a realm like boiling of water which is an everyday phenomenon or it could be an obstruse area where very few people are able to do the experiment like for example the discovery of a new particle or the behavior of the cross sections at 1 billion or 1 trillion electron volt energies. But in all these cases there are detailed facts and I'm interested in exploring those detailed facts. This part of physics is called phenomenology. It is for those of you who are familiar with the notion of phenomology in philosophy it is precisely the opposite of the level of sophistication in philosophy. In physics phenomenology is in a sense more like technical trading in the stock market or someone who is building engineer, who is a supervisor rather than an architect who is designing things and this particular area is a very legitimate part of physics which ever area of physics it is because whater discoveries you make, it is directly tested by experimentalists. The theoy does not involve any new conceptual truth. Only involves implementation, study expertise rather than depth or great insight. Another kind of physical law deals with very general principles for

example: the statement that the second law of thermodynamics which says you cannot decrease the entropy of a system by itself, you must really every process you have has a preferred direction it cannot be made to go in the opposite direction or if you convert heat into work, there is only a max amount of efficiency that you can convert, anything beyond that thing, could not be done. These are very general principles and it is not a case of somebody being clever and being able to overcome it. If a man invents a machine which could do it better than this one, you know that our understanding of science is completely wrong or the man is a fraud, or most probably he is really confused about what exactly is being achieved. So if you have found a person who has invented an automobile engine which runs on water you don't really have to examine it you know ahead of time that unless almost everything you know is wrong, it could not be done. It would be very much like saying a person, who lives just on air, he has lived that way for the last 25 years that it is very unlikely and you dont have to investigate the matter in great detail. This kind of law could be again in the realm of large scale and every day phenomena like efficiency of an automobile engine or the amount of work needed to run a refrigerator or anything of that kind as in an esoteric area like for example the behavior of the physical law at extremely high energies, but in both cases the principle is based, the law is based on a very general principle of nature and it is therefore not a case of whether a detailed experiment is necessary to test it but rather it is a systemization of physical laws in terms of other general physics principles. So it is second level of sophistication. The subject matter of the thing the raw experimental data for this level of sophistication are the empirical laws which are arrived at an earlier stage and relating those empirical laws.

The third kind of law is in a sense what is loosely called modelling in physics. It is particularly important in the cutting edge of physics for example in cosmology or in particle physics where in a sense the question is not so much of what is the law which is being observed but really what is the system that we are dealing with. How can we talk about it? Is it to be talked about in terms of a collection of objects which are moving around or is it to be thought of in terms of a relationship between various things? When you are talking about the origin of time and space, of the universe being created what do you mean by this particular statement? What happened to time before that? When you talk of an expanding space what is space expanding into? Clearly it cannot be expanding in the sense the gas bubble is expanding. And yet in some sense we must write down equations we must write down descriptions which is making use of this one. Similarly when you find a whole lot of particles, many many particles, many many species of particles we would like to talk about them as being due to some particular cause. Why are there so many particles? Why is it that some particles are heavy and some are light? Why is it that there is a neutron and a proton? Why is it that LIGHT is light and matter is heavy? These questions are in a sense questions which cannot be answered in the old fashioned sense of the term because old classical physics for example dealt with the motion of a given object. It did not ask the question what was the object. If simply said given this object, given these forces, how did the system move? Now the question is why are these objects there at all? Why are there these many species of objects? In say one or two centuries these questions were not questions of physics at all these were considered questions of chemistry. Why are there so many different objects? The answer is there are many differend kinds of chemical objects in the world you did not expect this question to be a physical question were physical

questions were when did it melt? How does it move" What is the structure of the thing? But the question of why this variety is not a question ever answered w. t. t the thing. R. Rao used to ask his class always this question and give the answer also. If the whol universe is one why the variety? If the world is all one why all the variety? and in some sense the same question is asked in physics also. on the one hand one would like to have more and more unified description of nature. on the other hand you would like to have a description which allows for variations because the world contains various structures. and again this question can be asked in the esoteric domain as in the every day domain. In the every day domain we know that when the ice is melting it will become water, when water is boiled it becomes steam, so that the material of which all these things are composed is the same object but then why are there three different state of the thing and what governs the transition from one to the other one? What decides when the temp goes below a certain level something should solidify. This question is the question of the change of the association of the various objects from one form to another form but it must all be governed by the same equation. It must be the same for all between the molecule whiob is determining whether something behaves as a gas or as a liquid or as a solid and this transformation from one phase to the other phase is an example of the kind of question on the one hand we want to say it is clear they are all the same. on the other hand water and ice are very different things. Water and steam they are very different things. Why this variety . In the domain of particle physics there again is a cutting edge one could ask why are there so many particles? That is one question the second question is if you have all these particles how can we unify the description of all of them. Light travels with the speed of light most other things travel slowly most other things are heavy. Light has no weight at all. How come that these two

interact with each other. How come first of all these two objects are there, second if these two objects are there how come they are different in structure. How can you unify taking account of the differences and it is in these two areas what is called as the transformation of phase and the unification with differences that there have been tremendous advance during the past 2 or 3 decades so much so that physics in this area has changed its character completely. I want to emphasize to you that this particular thing in a sense a new kind of science, because previously the question of science were always asked about phenomenon the very nature of things themselves were not a question.

Things were there and they behaved in a certain fashion now we are asking the question first of all why are these things there? Secondly, if these things are to be described by one how come you happen to have many different varieties of objects. Once you have a variety of course you can build up all kinds of things between them and you can build up elaborate structures. Most of my work comes in the area of model building and their unification on one hand and also on the question of general principles. Philosophic principles as applied to physical laws so that in principal though I am technically competent occasionally I dabble in things in which I do deal with actual phenomena. I really am not interested in precisely how things are, leave it to accountants in physics to deal with those things not because it is unimportant ones task differs and I personally prefer to deal with general principles paint with a big brush rather than do the fine precise things you have to do.Before I proceed at this point I should ask are there any questions which need immediate clarification can give otherwise I can tell a little more about what I am interested in.

First question: the scientists are hostile to the idea of the science going in a particular direction. Who are we talking of? Is there a body

of scientists, is it a statistical statement

Ans: majority of scientists. It is not only a statistical statement it is the official line. It is very much like saying in this country everybody thinks communism is a bad thing and democracy is a good thing. The question is, is it true for everybody? obviously not.

2 voices

I differ, but on the otherhand I too, when somebody else is doing I will be skeptical. The point in the mehtod of science says that be very cynical don't believe everything you hear. It is possible that if someone invents something out of the way it being true useful and valid are rather limited.

Question: Scientific questions are more on the side of how than on the side of why?

Ans: that again is an over simplification because if you ask the question why are some particular chemical elements acid forming while the others are base forming or why is it somethings are chemically active while others are not active that question is both a question of physics and chemistry that would be an answered question. It is answered not by saying why in the sense of a purpose but why in the sense of asking why did this phenomenon happen and explaining it in terms of how it comes about so that would be like an economist being asked why is it we have suddenly plenty of oil or why is it that there are economic cycles and they would give an explanation in terms of mechanism how it comes about, not why are human beings behaving in a particular fashion.

One kind of question about the structuring of science, as to how it differs from what we normally mean by ordinary language, just like lawyers writing long complicated language with many, many things illustrating the thing physicists also have to resort to a technical language to talk about the thing. Let me illustrate one little situation. Normally if you have

a lot of molecules which are running around we would like to think most orderly phase is one in which there is most symmetric, that all things are equally good, that would be the most orderly one it would be disorderly if you would allocate things. However, we know that as the temperature goes down and the order increases the system instead having a soluation in which all the particles are flying up they form into well defined crystalline forms. The crystalline form is a reduction of symmetry. The most symmetric thing is the thing in which all directions are equally good. A crystal which contains things at very well devined places even though we think it loos very regular, it is regular but it is not the most symmetric configuration it has many symmetries, but the symmetries are highlighted by not having all the symmetries. If you have a gas it is very symmetric. Symmetric under reflection, translations, rotations all kinds of things. All possible forms of the gas look essentially the same. An orange is more symmetric, or a ball is more symmetric than a tetrahedron. but we are much more struck by the symmetry of tetrahedron because it has only well defined symmetry. So we can see symmetry so it is in fact the detraction of the symmetry which we see as the symmetry. So what we usually refer to as order is in fact destruction of symmetry. order is not the creation of symmetry order is the destruction of symmetry. in a way one may say that creativity is always a destruction of symmetry. new order is being created But in common parlance, these two words mean the same thing to us Something is retular is symmetric, something is more orderly, but technically when you look at it if you precisely define, what you mean it turns out order and breaking of symmetry are going together. That if you took a very simple example which occurs which is much more dramatic liquid to solid transition is a transition of a ferro magnet. A ferro magnetic material like iron or nickel, when it is at a room temperature, if you put in a strong magnetic

field it will also have a little magnetism. As long as the magnet is there the iron will behave as little magnetic and you can attach other things to it. Remove the particular thing, the order disappears. so it does not stay. It is only a temporary thing. But of course, there is a very well defined direction for the magnetic effect because it is the same direction as the magnetic field which is put on. But cool such a material to temps which are well below room temp, when it cools below certain critical temp, called curve temp, you find the thing spontaneously becomes a magnet. You don't have to do anything, you don't have to bring a magnet near it, it becomes magnet by itself. The question is which way will it become a magnet? will it point N, S? E, W? Would it be at 10° or would it be inclined to the earth? If you have earths magnetic field, that will decide a certain direction. But if you had simply shielded it completely still it will become a magnet because that is the most natural configuration, that is most orderly configuration for it but which direction would it form? Well nobody knows. Whatever direction it forms that the original ideas of symmetry all directions being the same is no longer satisfied. I usually tell my class the story of Rabbi of Minek to illustrate this particular breaking of symmetry. The breaking of symmetry is always realized. Symmetry is in concept breaking of symmetry is in practice. The rabbi of Minek was a very wise man with many assistants who worked with him and once one of the young rabbinical students and great Rabbi went to dinner and only things available were 2 fish. So the resturant keeper made the 2 fishes and brought before the two, one was a big fish and the other a small fish. After sometime they were telking and the young Rabbi was waiting for the great man to taste his share and the great Rabbi took the big fish and the young man simply could not believe it. He said, "But Rabbi, I can't believe you did it, you took the big fish. The Rabbi said "what should I do?" If I were given the choice I wouldn't have

taken the big fish, I would have taken the small fish. So the great wise Rabbi said, My son you see, that is precisely what has happened? I have the big fish you still have the small fish. But the point is you would like to say that whoever is given the choice should take the small fish, so that the other one will get a big fish. But in fact, anytime you have chosen you have made a choice. That symmetry is already destroyed you have a selection of apples with varying distributions and you know when they say grant apples it does not mean all of them are large. You put you hand and pick one. Having picked one you have already frozen the thing. You may get a big one or a small one. So in many instances in every day phenomena we know the realization of the particular case breaks symmetry which was inherent in the conceptual form. Something had to happen, anythin was equally probable, but one thing happened and that having happened cannot unhappen. So the kind of breaking of symmetry is an example of a situation in which the more the order is the less the symmetry. But in every day language it looks as if more symmetric means more orderly so physics has to work with a very technical language. If you use ordinary language, it is not only the calculations are not always possible but also there are problems, that things are not very well defined. This also illustrates a very important principle which when it was first pointed out . Aah - But who cares what is this one? it is true in everyday life. It should not happen in case of fine phenomenon such as physics. If you have a symmetric law alone, which says all directions are equal, all alternatives are equal, it does not follow that realized situation has this property. Realized situation may not have the full symmetry. Technically spoken, the ground state of a system need not necessarily have the full symmetry of the theory. If you happen to have a situation in which you have 3 species of particles all of them completely equivalent, a,b, & c all completely equivalent, normally we would say: in the natural state of

affairs all species of particles should have the same mass that would be the most symmetric one. But it could happen that it need not be so and when a situation like this happens, we refer to this as spontaneous breaking of symmetry. This is at the edge of causability because up to the present time whenever something happens, whenever there was a physical explanation the explanation was a complete explanation. If accounted for it step by step. Why did this happen? It happened because this was so. But in this case when the magnet forms, when the crystal forms the direction in which the crystal axes are pointing there is no particular reason why it was formed that way. It could be any one of those directions when the 2 fish were brought there was no guarantee which was going to be taken. Having taken it that defines a certain direction so there is no particular choice as to what is to be made. There is no reason behind it cost is absent for the system.

Q: Does it imply reandomness?

A: It does not imply randomness because randomness is a value loaded word. It is because of the fact either there was disturbing it or some complete information is not available it simply says all things are equally good but only one is chosen, many are called but one is chosen.

Q: How is this reconciled with the idea of entropy?

A: Again the situation that all of them are equally probable is a situation in which entropy is large because I have many possibilities having chosen one and there is only one state therefore the entropy is low. Though we would in common language _____ the entropy should be higher because we have chosen at random. The point is you have chosen. The operative word is not chosen, at random but chosen.

Having chosen that is the ground state. Acrystal would not form with a direction of its crystal axis unless it was of lowest energy state. That is the most natural state. That state having formed the directions chosen.

There is no randomness left behind. Amongst all possibilities one possibility is realized. But no reason is given for that possibility. Now physicists are somewhat ambiguous unwilling to commit themselves How they would like to understand it. One way of understanding it is to think of it as a catastrophe. A catastrophe is technically defined as a situation in which the inertia of a system is made very very small normally whenever a system is defined we have a notion of inertia need to have some influence on it. Some stress on it to produce strain something must be done to move the thing We also have the notion that there is a finite constant of proportionability between them. The same force acting on two things the more inertia a system has the less accn it produces. Now in Newtonian physics the inertia of a body was a constant was an intrinsic property of the system Inertia did not change. But in a dynamical situation you have a very complex object. We know the inertia is not as uniform as like that. For an ordinary body in newtonian physics inertia is the same in all directions whichever direction you want to move the inertia is the same. If you have a shelf like this which is overloaded you know that inertia is quite different in different directions. If you press it down nothing very much happens. But give a tangential push the whole darn thing falls down. So inertia is different in different directions. In fact an irretability will result as inertia in certain directions is 0. In this case for an infinitesimal change you can have a finite influence and whenever that happens you say that it is the last straw which broke the camel's back. It is the thing the load was enough to buckle the pillar, put one more thing the whole thing buckles down. Between the transversly loaded bar and longitudinally loaded bars the inertia never goes down. Loading it more and more it will bend more and more. But the longitudinally loaded one with a particular load nothing happens. But after the whole thing buckles down. There are many situations we are familiar with

in which catastrophies happen. But whenever catastrophies occur you say just before the catastrophies occur, there is a place where a very small influence will cause a charge. You say who knows what influences are there there are always trace influences waiting around in the world. Somebody may be sneezing 2 miles away and that may be just enough to upset the thing. There may be a piece of dust particle floating around, that is the thing which is causing the thing. So if you ever had such a situation then you can say that it is really not without cause but it is just below our ability to analyze. And there is no way of disproving such a statement because you could always say how do you know that it does not affect. There is still a _____ effect may be there was a magnet 2 miles away and it was enerting an effect that was the thing which caused the effect. The other statement is to stay. That is true but let us consider a situation where it happened spontaneously and if it happened really spontaneously there need be no cause at all. In practice the distinction between these two is not very much. IF there is a cause and you cannot find it, and if there is no cause at all as far as you are concerned they are the same. The attitude is different. The hope is that if it is a fine cause which is causing it if you refine your apparative, you may be able to find the trace influences. Now it turns out the same mechanism is trud for large scale behavior is also possible to be invoked when we want to describe the nature of elementary particles and that is the area most exciting at the present time. The statement is that if you happen to have a situation in which you have a system in which a catastrophe looking for a cause, an accident looking for some place to happen, for example if you have large no pendula which are suspended all over the place, if they are in ground state, if it is moving, small disturbances will return the thing back and it will oscillate. But the same pendulum or the same swing if you gather the maximum amount, at the top if you make a small dis-

placement it will never come back to the thing but it will turn around. In the same sense you could have a situation where a force in which normally we would think a system in which it will come to an equilibrium in which there is not motion. Everything will shut down. Ground state of the system where nothing will move. In quantum theory, the notion of this statement is not quite accurate because there are certain fundamental restrictions which says nothing can really come to rest; it is a restless universe there should be certain natural vibrations in the system. But one would still think that these vibrations are still very small. This would be true for a system like the pendula hanging down. But it would not be true for a system like a shelf which is overloaded because it could happen that it would topple over. If it topples over the direction in which it topples over we cannot predict. and in a practical sense it does not really matter because if it topples it will topple the nest one and you will have a domino effect and all of them will fall down in a certain direction. This is a case of spontaneously broken symmetry and this particular thing immediately will create a new order w.r. to the world because if there was particular direction preferred, particular species preferred that species would be treated differently from anything else. So even if you had started out with systems all of the same kind, spontaneous breaking down of the symmetry can make a difference between the various species.

Q: When you say spontaneous you are still assuming an infinite decimal cause

A: An infinitedecimal disturbance but you don't ask the question why this direction because to a large extent who cares? It has some direction and you call that direction the heavy one to be the one you are considering. Unfortunately, without big long lectures I cannot motivate the details of the thing. But this will produce a difference between heavy objects and light objects; between strong interactions and weak interactions. Therefore, given

a theory which was originally completely symmetric, the spontaneous breakdown acts sort of the way the abstract creator who creates a structure from something which was unstructured. That which was like previously the super cooled liquid, which was ready to crystallize but had not crystallized, some trace influence comes in and everything crystallized immediately and crystalizes the same way all over the place. And this is invoked to make the distinction between strong nuclear force, the electromagnetic force and the weak radioactive forces. So at the present time our understanding of why the variety in the world and yet how to unify them is based on that there is spontaneous breaking down of symmetry. Now comes an interesting component of the thing. If you happen to have a whole space containing all the spontaneously broken things and were many species you would expect that this is a domino effect here and if something happens here something happens there. Something happens there so the simplest such example is that exactly the same things happen everywhere, everything fell at 45° N by NW fell in that particular direction or with the abstract directions connected with the species of particular everywhere it happens to in the same direction. The physical laws will be apply. Seen in the same possible direction. If you have a library filled with lots of shelves and all shelves fell in one direction it will be easy to walk in one direction, but difficult to wald across the thing. So you have certainly preferred certain species and it will be the same everywhere. But you could have a very different kind of situation, say you could take a large volume and you could say, everywhere it is in the direction from the center to the periphery that in one place it is pointing very much like the vertical here it is pointling lik this somewhere else it is pointing that way and in Australia it is pointing the opposite direction. So it is true that adjacent places have very similar things. There is no way in which you can rearrange the thing. It is like the quille of a porcupine

if you combed it, there will be some place something will be peculiar. This is a feature which is not connected with any small adjustments any _____ thing you can always make them look very similar by adjusting it but there is no way can you get them around. This is called the topological deformation. Because there is no simple way you can adjust it. But it is not the property of any particular region. Any region you look at it looks the same as if they could all be arranged in the same fashion. If you take the whole thing it cannot be fitted into the form of smoothing it out. You cannot smooth it out. And when this happens the mechanism is the spontaneous breakdown. If it happens in some regions it happens uniformly. It is automatically the consequence that in other regions it would happen. If it happens then it means now the physical laws are not the same all over the place. In these regions where the topologicall different things are there physical laws are not the same in all places. One of the consequences of the thing in terms of our present understanding is that matter as we know no longer be stable. That there is a possibility that if there is any region where these things are happening, in the vicinity of those regions matter will become unstable. And it is not instability caused about by a force law it is an instability caused about by fact things dont fit in the same palce. It is like a system made out of different kinds of metal different kind of things you cannot When weather changes it is like when you are travelling with different kind of clothes from hot place to a cold place to a windy to a rainy place, you cannot use the same kind of clothes. You can move small distances and you can adjust to it. But travel around a great deal, there simply is no way. Whatever you wear would be wrong and therefore matter would become unstable. And this kind of understanding connects one abstruse part of math to another equally abstruse part in physics. The abstruse part of math is called topology, which deals with the matter in the large as dis-

tinct from geometry. We normally deal with properties of space in small regions. But if something is completely curved something behaving in terms of not local behavior but in terms of whole thing taken as it tightens no way can you deal with the whole thing. That kind of property is different kind of geometry, different kind of math not mathematical dealing with small things old fashioned newtonian physics was very different kind of physics because it said this being so this is what would happen, given these forces given these positions, things will move in a certain fashion. Now these questions are not really completely different for example we know in newtonian physics, Newton himself was able to talk about orbits of planets and he showed under newtonian forces that the gravitational forces would be closed curves. Statement that the orbit is a closed curve, a curve which traces it back again and again that is the statement which is not described in terms of behavior in small regions. That is a property which can be seen only when you deal with the whole motion. And this kind of property is becoming more and more important because part of the modeling is done not in terms of individual forces but in terms of overall global structure. Those things which are toplogically different from other things these are sometimes called monopoles, and they are very interesting things to do. There is another interesting topological behavior comes in which comes from gravitation and gravitation deals with curvature of space and curvaline of space itself is a statement of the geometry and in this case the very special behavior which is getting into the newspaper is called Blackholes. Blackhole is a special modification of the geometry of space.

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everything at the same time and leave people to deal with gravitation let them deal with these things-- Unfortunately at the present time one cannot afford to leave anything behind. It is like having to know about income tax, inflation, money market funds, There is no way in which you can

say you wont be interested in it. Similarly here the unification of the forces went on very well for a certain time but of course the very first universal force we knew was the force of gravitation. But gravitation until fairly recently was treated very different basis from other laws. Gravitation was truly universal. Everything moved with the same accn in a gravitational field and Einstein pointed out it really was not a reasonable way of talking about it. Instead of that everything is going in as straight a path as possible but space itself is crooked and everythin goes the same way, if you watch a road in the night from a hill far away and if you see a curve in the road you will see all the cars curving around it is much better to say not that people are exercising their right of free will but if everything is going all in a curve, the road is probably curved Similarly you say if everything travels with the same accn, it is better to say the force which is acting on it which makes the move with the accn, force which varies with different masses bacause larger the inertia, the larges should be the force to make - - of the accn. It is better to say the space itself is curved. So gravitation was treated in terms of the space while matter was simply the thing So gravitation very much like the stage on which other particles were playing, so gravitation was universal. Everybody whoever came to the stage had to play in the same fashion. While the other things were the forces between the thing, you said, these actors are interrelating in a certain fashion. But the unification has proceeded to a stage that we feel that it has not enough unification, we must really unify everything. And these kinds of theories are called supergravity in which gravity is combined with all the other things, like a supermarket in which very many things are sold which don't have to be sold similarly. Supergravity theory also relates gravitation, electromagnetism, weak interactions, nuclear interactions all together in the same bucket and this

particular mix we have put in a very different structure because one cannot separate the stage from the action and then say in fact it is the same thing because as far as we are concerned we are dealing with the whole picture. Who cares whether it is the actor who is cotributing to the stage or the stage who is contribution to the actor. Maybe it is the actor lending something to the stage so in that kind of study, probably, they all will be related. My own work is in the general area of---------doing the thing I am fascinated by the idea that unification is coming now really only believable kind of unification/ Unification is not a unification if it does not talk about the differences, and the cause for the differencies, the descriptions of the differences. Something which says all religions are the same, all people philosophically are the same. Obviously is not a useful thing because we now are different. So if we cannot also account for the differencies by the same theory something is missing from the thing. This is the kind of thing I am interested in. So that is the end of what I wanted to say.

Q: traditional physics - space & time in Einsteins physics we have space time as continuum and the fourth dimension of _____. Please clarify.

A: That is again a caricature because it is not ture that E discovered the 4th dimension. The description previously was the same If I wanted to look at a chart cost of living in Austin, cost of living plotted as a ___ of time if you want to plot a motion of anything alone the road draws a chart of this kind. The two coordinates you happen to have are really (1) is time the other is space. If on the other hand if I wanted to draw a map I would plot a road again. I would draw the same thing. But in this case there is no temporal revolution the 2 directions are N, S & E,W. So in both cases you have the same kind of thing. But in Newtonian physics it was a thought that time was the same for every person. But right and left,

front and back was depended on how you oriented yourself. That two people could disagree which is right and which is left which is front and which is back. But 2 people could not disagree which is future and which is past. So time was considered to be the same for everyone. What E did was to say the four dimensional worl of space time, is such that whatever we do in space namely that by changing your orientation changing your frame of reference changing the manner in which you look at it, you can alter the amnner in which you measure. Movement to the right one person will say this is simply L-R, the other person will say no-no l right + a little front back. Variation and E pointed out there is a difference w.r to the time. Time is not measured in the same fashion by different people so that is the only difference that he meant. The fact that the time was another dimension in which things were plotted was there already. And this difference in some way was an indoctrination because if nobody had thought about time in any sophisticated fashion, and a person had never really thought about L-R, top and bottom, past and future, if you asked him about the thing Is time the same for all the people, he will say No. Time is different for different people. We have indoctrinated ourselves to say time must be the same for all the people. E said that was not a good convention. That is not the best way of understanding the world. The best way of understanding the world is to say that time is dependent on the state of motion of the person. That when a person moves it is a more convenient way of doing things. The statement time is the same for all people under all conditions is not a part of our direct experience. It is part of our indoctrination and what E pointed out was that that was not the best description. The best description is a slightly different description.

Q: Time is simultaneous instead of being inclusive of past, pre and future

A: No. I would not put it that way. Let me go back to the statement If

I am crawling on the floor, there are 2 directions in which I can go and that is an invariant statement. Everyone on the floor will see that situation - - - - - - - - or it is like telling a small child which does not know right hand from left hand right had is this hand, child would point out to the nearst hand. It requires some degree of sophistication to say that like 2 steps forward is not an invariant statement. It depends on the orientation of the person. Two dimensions are not the same for 2 people. The fact that there are 2 independent directions in which you can move is a statement which is true for everyone. But we would think that the passage of time, 2 min later would be the same for everyone independent of whether you are pointing to the E or W, you are running or not. 2 min is the same for everyone. What E pointed out was that it is not really the best way of looking at it. That it is much more satisfactory for the simplification of the physical laws, to say you measure time in a fashion different from me-- when a person is in motion, compared to one who is not if measurement of time means different things to the 2 people. One consequence of that thing is that our ideas of addition of _____ are not the same, our ideas of how the world will appear when you move gaster and faster will not be the same. But it is only with regard to this thing. But for a single person sitting--- in any state of motion and observing the world, the world is still very much like Newton talked about it except for some technical differences. By and large time is still infinite, back and forth. In general relativity or cosmology time is not that way, space also is not that way. In Newtonian physics as well as in E's earlier theory of relativity. Space is infinite You can go forward as rar as