

S.N. TRIPATHI

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Dear Dr Varma,

Many thanks for the time you spared for the interview and the sincerity with which you tried to answer the questions. I am enclosing herewith a transcript of the interview.

A few things that you said are of special interest. One was about raising new questions. You emphasized its importance. It could be considered as a differentiating characteristic between those who remain vigorous in research in spite of age and those who become stale. Another interesting thing was your mention of intuition. It so happens that so far during the interviews that I have conducted no scientist mentioned intuition. You have combined intuition with feeling and that is very interesting. Feeling seems to be an important component of intuition.

I have been feeling that the use of the term 'high level of motivation' does not fully convey how a researcher feels when he becomes occupied with a problem all the twenty-four hours. I have been calling it 'having a mission in life,' but then it conveys the ~~impt~~ impression of being engaged in some kind of social work. The word 'passion' that you have used while describing Raman is ~~va~~ very appropriate.

Scientists are generally introverts. My finding has been that there are several who are not ~~extremely~~ introverted. They may be called extroverts. From this point your mention that you enjoy social occasions

if you can afford the time, is interesting.

Another scientist whom I interviewed told me that that he did not offer Physics in the Lucknow University because teaching was very bad. He offered chemistry instead. If teaching at the M.Sc. level is not satisfactory it can have very bad consequences on the career of students who want to do further work in the subject.

With kind regards,

Yours sincerely



S.N. Tripathi

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INTERVIEW WITH Dr R.K. VARMA

(Director, Physics Research Laboratory, Ahmedabad)

The interview was held on the 13th March, 1991.

My date of birth is 31st March, 1935. My father was a private medical practitioner and my mother was a housewife. My father was working in Sardhana near Meerut, This was my birth place and here I grew up. My early education was in Sardhana. It is a small ^e Tahsil town. I had my early education in a Mission School named St. Charles School. It was a good school and was housed in a palace which once belonged to Begum Samru. She is a historical figure and in the early 19th century was a leader of this region. The palace was later converted into a school. Considering the small town in which it was located the school was very good. The teachers were dedicated to their work. I had a good foundation laid for my education there.

We were four brothers and three sisters. One of my brothers, third in line, died of an accident. He was working in a sugar factory. We are now three brothers and three sisters. I am the eldest.

Q. Did the environment of your family help you in becoming a scientist?

Yes! my grandfather played an important role in kindling my interest in science. He was a vaccinator by profession, but parttime he used to work as a compaunder to a doctor and so he was very knowledgeable. I used to accompany him in his morning and evening walks near the Ganges canal. He used to give me examples of chemical reactions : 'If you mix this thing with ^{that} this then a gas comes out.' or the colour of the mixture changes.' Such examples used to fascinate me. He used to talk about many other things. This was an informal kind of education. that led to the development of my interest. Both my a father and my uncle who was elder to my father played an important role in my education. My uncle was a school teacher. My primary education was under him in his school. He used to take personal interest in me. He was very strict. Even after I came out of his school, I used to ask questions to him about whatever came to my mind. He would tell me interesting stories from mythology and literature like the story

about Amir Khusro and his poetry.

My family was technically oriented. Though my uncles were not highly educated that had a knack for doing practical things or repairing machinery. My father could do many things like carpentry, masonry, sewing, opening and repairing armature of fans, and repairing radio. I grew up in this environment and I learnt many things as I grew.

Q. Are you a theoretical physicist or an experimental physicist?

I turned out to be a theoretical physicist inspite of all these experiences. Somehow my mental make-up was such that I was interested in concepts. My education was concept oriented. This may be the reason why I became a theoretical physicist.

Q. Did you receive any encouragement in your scientific pursuits from your teachers?

Well! I cann't say. Some of my teachers were very good. Though they did not give n any special attention to me their teaching helped me in learning things. I must point out one teacher specifically. He was my teacher in Delhi. In 1946, I moved from Sardhana to Delhi and jo8ned the eighth class. in A.S.V.J. Higher Secondary School in Daryaganj. It is also known as the Sanskrit School. At that time this school had a very high reputation. There were two people who left their mark on me. One was the physics teacher Sri Ved Pratap Singh and the other was the Principal Sri Amarnath Dukhal, a Kashmiri gentleman. The physics teacher was remarkable. I do not think you get that kind of teachers any more. I would say ~~xx~~ that he was a rarity. He went into the depth of a topic and his teaching was superb. He used to demonstrate in the class anything that he taught. It is he who laid the foundation of my career. He was a very strict teacher. Students had to take down notes of his lectures and he used to see the notes of his previous lecture when the met. As he would see the notes I used to spend about two to three hours in making a fair copy of the notes. This not only improved my understanding of the topic but also my expression . Another person, as I said earlier, was the Pricipal Sri Dukhal. He was totally dedicated to the students and the school. Both these two persons

real gems and they played a very important role in my life and career.

Q. Did you do any special work in the school that indicated your special aptitude for science?

I did not take part in any science exhibition or prepare any model as, at that time, such facilities were lacking. I used to raise questions in the class to clarify my concepts. I also did not do any project work. When I came to B.Sc. I did something that can be considered as a small piece of research. I posed certain questions on latent heat of vapourization and tried to find an answer. If you take any liquid say water you can boil it at any temperature that you choose by reducing the pressure. You can boil it at 100° , or 90° , or 60° . The only thing that you have to do is to reduce the pressure. The amount of heat that is given to convert one gram of liquid into vapour form is known as latent heat of vapourization. The latent heat at lower temperature is greater than the latent heat that is required at higher temperature. This fact I came to know from some book. The question came to my mind, "Why is it so?" This is the essence of science. Pursuing it I was able to derive an algebraic relationship which explained the phenomenon in simple terms. This is given in advanced books but the relationship that I derived was simpler.

Q. Do you think that it would have been better if you had been given rapid promotion in your school classes.

I was already ahead by one year. I passed the Higher Secondary Examination at the age of fifteen, while the minimum age for admission in the B.Sc. class in Delhi was sixteen. I feel that I should have had better opportunities for learning at the college stage. After passing Higher Secondary Examination I could not continue my education in Delhi due to age restriction. I did not want to waste one year, and so I went to U.P. and took admission in an intermediate college in Muzaffarnagar. I was admitted in the second year as I had passed Higher Secondary Examination. I could complete intermediate in one year. I did my B.Sc. in two years with chemistry, physics and mathematics as my subjects. The college^s where I ~~was~~ studied at

Muzaffarnagar, both for intermediate and B.Sc., were very ordinary. If I could have got admission in a better college, where teaching could be commensurate with my drive and interests, I would have done much better. After B.Sc. I worked as a Demonstrator for one year in my old intermediate college. I was good at teaching and enjoyed it though the students were almost of the same age as mine.

Then I joined M.Sc. in Physics in a university in U.P. It was not a good department. At that time it was very bad. If I tell this they would be unhappy but much of my time was wasted. Still, I continued to learn on my own regardless of what they were teaching. I had my own time-table. I had my own way of doing things. I completed my M.Sc. at the age of twenty-one. Then I was selected as a Research Assistant in the Tata Institute of Fundamental Research. This was actually the start of my research career. I joined TIFR in 1956 and stayed there till 1961. This was the period when the environment was very good at TIFR. I did some research work and published papers. This was entirely my own work.

In 1961 I went to San Diego, California. There was one professor there in Plasma physics. The university had just started the physics department and there were some outstanding professors. I spent four years there. It was a turning point in my career. Two years I spent in course work along with some research and the next two years were devoted entirely to research. From 1965 to 1966, one year I spent at NASA. This was also a good year though not a very productive one.

Q. What is your major contribution to science?

This is a very difficult question. Still, out of a number of papers that you write there are a few that you value more than others. There are two contributions that I have made. One was a paper published in 1967. It was part of my thesis work. It pertains to Plasma in a particular state of configuration known as mirror machine configuration. This pertains to some plasma instabilities in a particular magnetic field configuration. I predicted a certain mode of oscillation of plasma in that mirror machine. This was experimentally observed. There are certain other behaviors of the plasma machine that were later observed which could not be explained without taking my theory into account. Several papers on that aspect have been written by other people. My work is cited and with my name and several models and equations are referred to.

~~It was experimentally observed.~~ It was done during the four years ^{of other people.} of Ph.D. work. It may have taken me about one year. ~~It~~

The other was published in 1971. I am continuing to work along those lines even today. I have done other things but I am particularly proud of this. It is about motion of particles in a homogenous magnetic field. It includes the mirror machine as a special case. This is something which is very unique. The formulation of the problem in the form that I have given is something entirely new. No one has given it in this form and for some time ^{even} people did not/believe in my work. It was a theoretical work which led to certain predictions. We carried out certain experiments to check the predictions. People did not think that it would turn out to be so. Experiments done here have confirmed that the predictions were true. These are very surprising kind of results. Even today people don't quite understand why it is so. In 1985, fourteen years later, I have again published detailed versions of my work. The earlier derivation was more heuristic, more intuitive, which came out ^{three} after ~~four~~ years of work. That is something that I really pushed. I had some idea ^{with} that this kind of inscription we should have to a problem like this and I pushed on that idea for about three years. The only thing that I could give at that time was only a heuristic derivation and not a deductive derivation. It took me a long time before I could give some deductive kind of derivations. Even ^{that} has certain peculiar predictions and properties that are not easy to ^{set} understand. The other ~~kind~~ of predictions on which we are carrying out experiments, have turned out to be true. There is no easy explanation in conventional terms.

Q. You have used a very interesting term intuition. Would you elaborate a little on it.

Intuition plays a very important role in a creative venture. (that this must be so). You get a feeling/ You cannot get this by doing any number of calculations. You must think of the problem all the time -- before going to bed, getting up, and so on. The problem continues to haunt you. Unless you get to that stage where the problem haunts you you

will not get a feeling for it. Your mind is constantly at work. One must question that idea which comes through intuition. If you give it up on the way you have lost it. If you discuss with somebody, as happens in my case, people will say that it is nonsense. But then one shouldn't be discouraged. If you have confidence, if you have conviction then you have to pursue. This is what precisely happened in this case. Somehow I had a deep seated conviction that it must be true inspite of the odds/^{viz.,}what everybody said. Some people (foreign an scientists) say that it is/Indian magic. Today I can challenge them to explain those results without the ideas that I have given. They have not been able to do so.

Q. How do you combine your administrative work with your research work?

The administrative work does take away a lot of time. But once you have an idea that you have been pursuing, then you can always take out some time for it. For instance, before coming for the interview I was in the laboratory looking at those experiments. This experiment itself has been going on for seven years. Starting from scratch we are now getting results. Previous set of experiemnts sarterd in 1974. From 1974 to 1982 we did the first series of experiments/ on the first aspect of this theory Since 1983 we are doing this experiemnt on the second aspect of this theory. Both of them have turned out to be correct. There are no quickies in science. You have to work very very hard. You have to pursue your ideas. Somebody said there are more failures than successes. Successes are very flew. You do not know how many failures are there behind one success. If you really want to do something that will stand the test of time you have to work very hard.

Q. Do you have a group of persons working on the problem?

The theoretical part is my own. Experimentally there are people who have collaborated with me. First there was a student who collaborated and then there is a colleague of mine who is collaborating now. Experimentally they have collaborated but the theory is my own.

Q. Did you ever have this ~~ever have this~~ experience that a solution or solutions emerged all of a sudden?

Things do not come all of a sudden. What happens is that you are thinking about it and you get an idea that may be this is what you should do. I do not call it all of a sudden. You have been thinking about it for a long time, and somehow ^{your} mind has given that ~~this~~ is something that you might try out. In this sense things do happen at a certain instance of time but it is the result of long hours of thinking, ^{sometimes,} or/one may say, long years of thinking. You go on thinking and sometimes you take the help of analogies and then you say that may be this is it. I don't think that solutions come all of a ~~an~~ sudden, they may appear to come all of a sudden.

Q. Do you keep a record daywise or weekwise of how things are progressing?

I do not keep a record. That way I am very much disorganized. But everything is in my mind. I keep a record in my mind and I am very clear as to what I should pursue and what I should not. What I should do and when depends on my mood and disposition. Sometimes I have done things and put them away. Sometimes I forget what I have already ~~was~~ done. Sometimes when I am going ~~thru~~ through a paper I realize that I have already done this thing. Then, of course, I pick it up.

Q. Do you have images in your thinking or do you think in terms of symbols?

Images are there. Even when your thinking is abstract you always think that the particle is going like this and thus you correlate your thinking with what happens in the laboratory.

Q. Are there some special conditions when you are able to do your best?

Well! I think one should have the freedom of mind. There should not be any worries. Worries interfere with thinking. If you are free and do not have any worry about pressing matters, then that is the time when you can do your best. But what is most important is that you must be constantly trying hard, and all the time you must be wanting to do your best.

Q. What are the hours that suit you best for your work?

I generally like to work late in the evening. I do not like to get up early in the morning. Night time you have total silence, tranquility, and peace. There is no disturbance.

Q. Do you follow any regular routine?

~~Frankly~~ I do not follow any regular routine. I am very irregular in my work-habits.

Q. Do you experience any effect of age on your work?

Frankly no! You get more experienced but I do not think that there is any alteration in the intellectual capability. Memory is the earliest to be affected, but it is mainly memory for names. As far as science is concerned I do not experience any forgetting as a result of age. I look at the things I have written in the past. I do not notice any change. So long as one wants to achieve something the mind remains sharp.

Q. Younger age is probably helpful in taking a fresh view.

Do you agree?

I was coming to that. It depends upon your attitude. One must be prepared to take risks. If one thinks that one might make a mistake then this acts as a kind of block. One must be constantly asking new questions. That is actually the secret of continuing to do active work. If you stop asking new questions then you are gone. But somehow with me it happens that I go on moving from one field to another, from one problem to another, and that is very exciting. Being bogged down with one thing leads you no where.

Q. Have family responsibilities come in the way of your work?

Ever since I started to work I had family responsibilities. I had sisters whose marriage I had to arrange and look after my father in his old age. But these are things that are there in any family. They do affect one's work but one has to face them. At times they even help in your work in the sense that if you have too much time you tend to relax, but when you have other things to worry about and only a limited time then you try to utilize it and do your best. It gives you a kind of challenge. I am not of the view that one must be totally relaxed to do creative work. You must be to some extent on the edge to do creative work. There must be a burning

desire to do something

Q. Are you able to find time for social life?

I have some friends. Whenever I meet friends I am very social with them. I enjoy their company. But on day-to-day basis I do not go to places. Whenever there is opportunity I enjoy the company of others.

Q. Did you ever find a solution ~~to~~ to any problem in your dreams?

This is very rare.

Q. Do you see colour in your dreams?

I have never thought about it.

Q. Have you ever had a sensory experience of something that was not really there?

No.

Q. Did you ever have a mystical communication?

I don't know. I had sometimes a feeling that ~~there~~ ^{there} was something wrong somewhere. It may be that at that time one of my relatives was unwell. I have experienced a telepathic communication but not anything mystical. Personally I do not believe in God. My conception of God is very different. I believe ^{more} in ethics. I should not do anything that may harm my fellow-being. I should not be harsh. These are the values that I believe in and that is my religion.

Q. Did you ever have an imaginary companion?

I cannot say. I was a very imaginative child. I would be absorbed in my thoughts. I had my own company.

Q. Did you ever have a moment of inspiration in which things became very easy?

I would say that there are moments of ~~inspiration~~ intuition. You get some idea that ~~this~~ this is the way that you should do things. You pursue it and see what happens. In science nothing is done with ease. It takes a long time and many a times there can be failures. An occasional idea may turn out to be correct.

Q. Which scientist foreign or Indian has inspired you most?

Among the Indian scientists S.N. Bose and C.V. Raman. Bose revolutionized our thinking in science. He should have been given Nobel Prize for it. He introduced an entirely new concept that was

not existing before. Major work in Bose-Einstein statistics was that of Bose. Einstein extended Bose's ideas. Raman was a very different character. He was a multifaceted personality. He was very colourful. He had that passion which is/rare. Then I would add the name of Bhabha. I did not get an opportunity to meet Satyendranath but Bhabha I actually saw. His erudition was inspiring. I was in TFIR and Bhabha used to come in seminars and colloquia and ask questions.

Among the foreign scientists I admire very much Einstein, and before him there was a German scientist Hertz. People do not fully realize the importance of his work. There is another scientist Helmholtz. Among the modern scientists there is who evokes great respect in me and that is P.A.M. Dirac. In recent times the person whom I like ~~is~~ is Fineman. He also is dead. Most of all I like E. Schrodinger. He discovered plant mechanics but his sweep was very wide. He also did some work in statistical mechanics. Reading his book is a pleasure.