AUM

Compilation of Documents.
Initial period 1931-1961
Middle period 1961-1991
End period 1991-

Initial period 1931-1961

The School, College and University

This period starts with the so-called birth and ends in 1961 when I obtained my Doctorate degree in Theoretical Physics. I can recall the significant events that led to this event. It is the connecting link that enabled me to remember the events. In my case the connecting link was the skill of teachers from whom I leant about the world. They made me get attracted to learning. Each teacher left in me a permanent mark that was always of great value.

I was attracted by the way Euclid theorems regarding identity of triangles was proved in Middle and High school in Kakinada. I understood that there is something called **proof of a mathematical statement**. This remained permanent in my mind for the rest of my life. In later years (1961 onwards), I discovered that the way (manner) in which Euclid's theorems were proved was comparable to what was denoted by the words *Aparoksa Anubuti* in Vedanta. This kind of certainty was achieved in several other occasions during lessons in physics when oscillation of a pendulum was explained in Intermediate classes. The physics teacher whom I respected whole heartedly was Sri V.Suryaprakasam garu (known as V.S.P garu). He became my friend philosopher and guide in later years. I passed Intermediate examination in 1947 with I class marks.

I joined Government Arts College for B.Sc degree in 1947 with Physics as the main subject and mathematics and chemistry as subsidiary. One of the Physics teachers was Sri. Pingali Venkararamiah garu, He was an excellent teacher. My love for physics was deepened by him. We were introduced to the subject of calculus and differentiation and integration of functions of a real variable in B.Sc classes. The subject was a very difficult one for me. It is so different from what I leant in the High School and Intermediate classes. At first I felt hopeless, but thanks to the eminent teacher, Sri Kesiraju Satyanarayana garu at the Government Arts College Rajahmundry, I could grasp slowly the subject and could solve most of the problems given in the text book of Caunt which was prescribed by the college. His method of teaching confirmed my concept of proof of mathematical truths. Because of my grasp of solving problems of calculus, I scored 100% in mathematics which enabled me to stand first among the B.Sc, physics graduates of Andhra University in 1947.

I could easily get seat for M.Sc classes at Andhra Universtiy and opted for Geophysics which was a new subject for specialization. I took this decision on the basis of advice given by my teacher Sri V. Suryaprakasam garu. I passed the final examination in 1951 in First class but second in rank among a group of five students. As I chose Geophysics for specialization, my

knowledge in Physics and Mathematics was less than that of students who opted for Pure Physics and/or Pure mathematics. But my love for mathematics and physics did not diminish at all.

Search for a Scholarship

At the Andhra University campus

I met my professor in Geophysics in M.Sc classes, Prof. B.Sundara Rama Rao garu, and requested him if I could be given a scholarship in the University for doing research in Geophysics. He was a very kind person, soft-spoken and friendly towards all his students. He said that he could not give me the first rank among the students because I made one error in stating the properties of salt-domes in the earth. Such a mistake should never have been made by a student of Geophysics. He said that he can only recommend a candidate who obtained first rank for Geophysics. However, he promised that he can recommend my application for a scholarship to Ahmedabad or Delhi University to do research in Physics. I thanked him for that promise and submitted an application for Research in Physics and left the choice of the place to him. I did not specify the place where I would like to go.

As an alternative to this, I followed a suggestion of Sri Rallabandy Venkata Subba Rao garu who was a friend of my father and to whom my father introduced me when I sought entry into Arts College at Rajahmundry. He showed me an advertisement from Raman Research Institute calling for application from prospective students. Accordingly I appeared for an interview for a scholarship in Raman Research Institute at Bangalore. Sir C.V. Raman interviewed me with some questions in physics. I answered them according to my limited knowledge of physics. Sir C.V.Raman finally said these words: “Mr. Murty, you were not taught physics well. I am sorry that I cannot offer you research scholarship. Here is the travel allowance for coming to the interview. Let me show you my laboratory.” He got up and led me through various rooms filled with equipment that was used in optics. He was already awarded Nobel Prize for his research in optics. I understood nothing of what he showed. I thanked him and took leave of him and left the laboratory.

I was brooding over what Sir C.V. Raman said: ”*You were not taught physics well*.” I wondered why I did not say to him that I specialized in Geophysics and not Physics. I simply did not have courage to open my mouth before him. But I learnt an important lesson from him – that I should learn more of physics. Already I learnt in B.Sc. classes that a scientist called Einstein predicted mathematically that mass and energy are equivalent. That fired my curiosity how one could show mathematically that mass and energy are equivalent and the formula is $E= mc^2$, where E is energy and mass is ‘m’ and c is the speed of light. But, I learnt in physics classes that mass is a carrier of energy and the formula is $E = ½ mv^2$ where ‘v’ is the speed of the moving mass. If the mass is at rest its energy is zero by definition. . That was the question uppermost in my mind. I felt I have to learn more of physics. Bu how?

I began travelling back to Kakinada from Bangalore. I had to change the train at Bezwada (now Vijayawada) station. While I was waiting for my train I saw a party of devotees of Haranath going to Sonamukhi along with Sri Nanna garu. He was popularly known as Nanna garu by his admirers. His name was Rallabandy Virabhadra Rao. He was the District Educational Officer, I

met him occasionally at Kakinada during my school days and also at Rajahmundry. He subsequently became my spiritual teacher. But at the time I met him at Bezwada station he was a source of inspiration to me because of his lectures he delivered about Haranath at Kakinada during my school days. I felt that I should change my plan to go to Kakinada. I bought a ticket to Sonamukhi and travelled with Nanna garu to Sonamukhi.

At Sonamukhi:

It was an entirely novel experience to be in the house of Haranath sitting before Kusuma Kumari along with Nanna garu and other members singing in chorus "*Jaya Haranatha Jaya Kusuma Kumari Jaya*". The whole party stayed for a period of seven days. Some time we spent our time in the Mandiram near a tank prepared by Haranath and called Ananta Kundam. We had food in the home of Haranath or from a hotel some times. It was a thrilling experience in the company of those who knew Haranath personally. After a stay of four days, we left Sonamukhi with the blessing of Kusuma Kumari who was pleased with us and suggested that we should meet every year once during Dasarah and sing the names *Jaya Haranatha Jaya Kusuma Kumari Jaya*.

I returned to Kakinada and when I reached home I had to face angry words for not informing my family about the travel to Sonamukhi before going there. My mistake was that I did not write any letter home about my whereabouts after I left for Bangalore for interview of scholarship. I had no explanation for my mistake. So I kept quiet.

A few days later, a letter came to me from Ahmedabad offering a scholarship of Rs. 100/- per month for pursuing research at Physical Research Laboratory and that I should report at the Laboratory immediately. I understood that this offer came in response to the application submitted through Prof. B. Sundara Ramarao garu. I felt at that time that there is an unseen hand guiding every step in my life. I had to accept that the failures or successes in life are not completely random accidents. They are part and parcel of learning.

At Physical Research Laboratory, Ahmedabad 1951-1955:

After an arduous journey of two days from Kakinada to Ahmedabad, I reached Physical Research Laboratory located in Navarangapura in September 1951 and reported to the Director of the Laboratory Dr K.R. Ramanathan. He arranged for a room in the hostel and next day he introduced me to Dr. Vikram Sarabahi, the founder of Physical Research Laboratory. Dr Sarabahi said that I should work in a project for the study of cosmic rays, about which I heard something but knew very little. He asked me a few questions in physics in general and particularly about atomic structure. He asked about nuclear properties, a subject I did not know well. I do not remember now the specific questions. But I remember that he asked specifically whether an electron can exist in the nuclear structure. I said 'Yes'. I did not know that I was wrong. Immediately Dr Ramanathan told Dr Vikram Sarabhai that I was a student of Geophysics but not nuclear physics. That saved the situation. Thus I started my research career in Ahmedabad.

Soon I was associated with a senior scientist to assist him in the laboratory which sends balloons into the upper atmosphere with a set of instruments that measure the variation of temperature and

pressure up to stratosphere daily and tabulate the results in the prescribed format for future use in correlation of cosmic ray intensity variations. Though this work was interesting to learn, it had nothing in common with what I learnt as a student of Geophysics!. I began disliking it slowly but I could not tell this to any body because my scholarship was given for working in this project of the Laboratory.

However I gained new insight into physics, regarding **the experimental skills and interpretation of data**. Later I realized that such knowledge is absolutely necessary for a physicist. After a few months I acquired necessary confidence to carry on the work myself. I was promoted from research student level to research assistant level with a salary of Rs 160/- per month. So my monthly income rose from Rs 100/- to a salary of Rs. 160/- plus Rs 50/- dearness allowance. My senior was transferred to another project. I was made responsible for the section to continue the work on hand with a skilled helper to do the routine work in the laboratory.

Most of my duties were to be carried at night time due to the condition that balloons could be sent into stratosphere only at night time. So I could devote the day time in studying subjects which are needed for advanced study in mathematical physics. So I took help of a well honored text books which were followed by teachers of Methods of Mathematical Physics. The subjects covered Elasticity, Wave propagation, Hydrodynamics, Electromagnetic theory, Thermodynamics and Kinetic theory of gases. These subjects involved firm basis of mathematical knowledge also. I studied some topics in Functions of complex variable. I could attend regular lectures in the laboratory on quantum mechanics also. One of senior members, Dr Vachaspati, gave a series of lectures on Hamiltonian dynamics and its relation to Quantum mechanics. I was interested in his lectures and so he asked me to make notes of his lectures. Thus my time was shared between my regular duties of experimental work at night and also theoretical studies in day time. I felt I was unable to do both simultaneously satisfactorily.

I approached Dr Sarabhai and expressed my desire to devote my entire time for theoretical studies. I requested him to relieve me from experimental work. He agreed on the condition that I surrender my Research Assistant post and accept a scholarship of Rs. 200/- to continue theoretical study plus responsibility of library maintenance. I agreed to his condition. So my income decreased but I got what I liked most – study of theoretical physics.

Lectures of Dr Vachaspati:

Dr Vachaspati was a very kind person, whose lectures inspired me to approach him to accept me as regular student to work for obtaining a doctorate degree in Theoretical Physics. He agreed to accept me as I was already attending his lectures and preparing notes for his later scrutiny. He asked to me to study a paper written by Einstein in collaboration with Podolsky and Rosen which was published in the year 1935 just a few years before I came to this earth. After reading it I was to give a lecture summarizing the contents of that paper.

I did not have any idea of that paper but I could locate it in the library. Physical Review ser 2. Vol 47. pp 777-780[1]. So I studied it for a couple weeks. The Title of the paper is: '*Can*

[1] This paper is also referred to as the EPR Paradox, online link can be found here: EPR Paradox. Also find this described further in Wikipedia, here: Wiki-EPR Paradox

quantum-mechanical description of physical reality can be considered complete?' That paper is later referred to as EPR paradox.

I studied the paper and could grasp some of the arguments because of the advantage I had attended the lectures on quantum mechanics. I could give a lecture summarizing the contents of the paper. The director Dr. Ramanathan was also present in the audience apart from other senior members of the Laboratory. It appeared to me that they were satisfied with what I spoke,

A few days later, Dr Vachaspati gave me a research problem which is an extension of his theory of scattering of electrons by a nucleus. There was an unexplained result in the backward scattering of mesons by a nucleus. Dr Vachaspati suggested that the method, known as Born's approximation can be followed to higher degree than the first one and examine its convergence. I worked on this problem for more than a year or so. But I could not arrive at any definite conclusions since the numerical work was tedious and complicated. At that stage a paper appeared in print in an Italian Journal showing that the problem could be solved by what is known as WKB approximation. Hence I had to discard that work. Further a new complication arose. Dr Vachaspati got a Fellowship in a foreign country and he wanted to go on leave for some time. So I faced a question –What am I to do in his absence? Already it was four years since I came to Ahmedabad.

I approached him for an advice about my future. He said that Tata Institute of Fundamental Research (TIFR) at Bombay is expanding its activities and so I can try for some place in that Institute. Accordingly an application was submitted to TIFR. I was called for interview at TIFR.
I was interviewed first by two experts and later I was interviewed by Dr. Homi J. Bhabha. It was a tough interview. The questions ranged from classical physics, quantum mechanics and geophysics. The last question was, 'How do you prove that the earth is spinning?.' I said: 'By the movement of stars'. Dr Bhabha said; "All the stars are removed and you have nothing to see. Then how do you prove?" I kept silent not knowing what to say. He asked me, "Do you know about Etvos pendulum?" I said, 'Yes, I heard about it but …..I did not understand what it does. 'All right, you can go', he said.

I was exhausted and I was sure I have no chance here. After two weeks a letter came from TIFR giving me an appointment as Research Assistant with a pay of Rs. 250/- plus DA as per rules. I left Physical Research Laboratory and joined TIFR in Mumbai (called Bombay at that time) in September 1955.

At Tata Institute of Fundamental Research, 1955 – 68:

TIFR provided excellent opportunities for the employees to carry out research and specialization in the most modern subjects. The main subjects are mathematics and physics. I was put the theoretical group headed by Dr Singwi who is a specialist Nuclear physics, Astrophysics and Solid state physics.

My supervisor Dr Singwi gave me a problem to develop a generalization of Fermi-Dirac equation of state from classical to relativistic mechanics. My stay for four years at Physical Research Laboratory at Ahmedabad did not go to waste. I understood the problem and could develop it in a matter of six months. It was published in the year 1956 in Progress of Theoretical

Physics[2]. Vol. 15 #5, pp. 475-479. That was my first scientific publication in a refereed International Journal. He asked me to read some books in Astrophysics in order to study the problems of stellar structure, a topic of much interest at that time. The main thrust to these subjects came in the wake of a need for fundamental knowledge of matter in states of extreme heat and pressure. These regions of physics cannot be simulated in any laboratory. Hence the only available way is through theoretical understanding of states of matter based on the then available knowledge of quantum physics and relativity physics.

There was a colloquium on every Wednesday except during vacation periods. There were lecture series on selected topics. The working hours were from 10 am to 6 pm, but the library was open 24 hours every day and any authorized academic staff was permitted (by the security officer at the entrance) to use the library. Most members were young and lived in the attached hostel and availed of the facilities freely. It was a place where Dr Bhabha invited eminent pioneers in physics to expound the modern theories like Quantum Mechanics and Relativity. I was fortunate to listen to the founders of physics like Dirac, Wentzel, Serber, Alfven and many others.

I was fortunate to be given the responsibility of writing notes of lectures given by Professor Hannes Alfven, who came from Stockholm University, to deliver a series of lectures on a subject of which he was the founder. That subject was called Magntohydrodynamics. It was the most recent subject just a couple of decades old (younger than my age at that time). It combines three fields of physics, the classical mechanics, hydrodynamics and electromagnetic theory. Hence it is one of the most complicated subjects of theoretical physics.

I compiled the notes of Alfven's lectures in collaboration with two other colleagues Ram Kumar and Gaurang Yodh. Prof Alfven was pleased with our effort. In addition he gave us a problem to be solved in connection with acceleration of cosmic rays. Myself and Ram Kumar succeeded in solving it and the results were published. A copy of Google search of that paper is given below:

[G. S. Murty and R. K. Varma
Tata Institute of Fundamental Research, Apollo Pier Road, Bombay, India
Received 8 August 1958; published in the issue dated December 1958 Physical Review 112(5),pp 1789-1793
Alfvén's model of discontinuous magnetic field variations for the acceleration of cosmic rays by the betatron mechanism has been generalized to continuous field variations, with special reference to sinusoidal fields. It is shown that the efficiency of this model is maximum when the "rate of randomization" is equal to the frequency of oscillation of the magnetic field. Also the maximum efficiency is comparable with those of Alfvén's and Parker's models.]

The most interesting part of the problem was that Professor Alfven also gave us an idea of how the solution would be like. It would be like a bell shaped curve. Professor Alfven was not a theoretician but he was an excellent physicist who could see the problem and also how the solution would be. That was the sort of pioneers in physics whom all members of TIFR were exposed to.

[2] On The Relativistic Thomas-Fermi Atom, online at http://citeseerx.ist.psu.edu

As a result of my duty to prepare the notes of the lectures I had to interact with him often along with Ram Kumar. He seems to have been pleased with our work. He used to say some of 'you' may like to visit our laboratory in Stockholm. In reply we used to say that it depends on the Director of TIFR. Later Professor Alfven left for Stockholm.

A few months later I received a letter from Prof. Alfven that he would offer me a visiting fellowship at Royal Institute of Technology for one year and that I should attend an International School on Plasma Physics, organized by him at Varenna, Italy in August 1959 for one week,.

This letter was exasperating to me. I am not supposed to seek any such fellowship without permission of the Director. I took courage to meet Dr. Bhabha and showed him the letter. He saw it and just said: "Let us see". A few days later a letter came to me from the Directors offices along with an itinerary for my journey to Varenna on 15 August 1959 to attend the International School at Varenna and to proceed later to Stockholm to be on deputation for one year. My monthly salary would be sent to my wife during that period. An air ticket covering the journey to Varenna. Italy and Stockholm, Sweden was enclosed. I left Bombay on 15 August 1959, to go to Stockholm

From India to Italy and Sweden:

Varenna School was organized in a hotel near Logo de Como, Italy

The International School on Plasma Physics was organized by Prof Alfven during 17-21 August 1959. The participants were from 25 countries including USSR, There was no participant from China. They were all active workers in the newly developing field of Plasma physics which is the study of physics of ionized gases in magnetic field. It is also called Magnetohydrodynamics if the material is a conducting fluid interacting with magnetic fields.

I was studying this subject since a couple years at TIFR and also at Delhi University in the Physics Department of Delhi University, The Head of the Physics Department was Prof Kothari who was an eminent physicist. So I had the necessary back ground to follow all lectures given by various lecturers from different countries mostly from Europe, United Kingdom and America.

After listening to the lectures I had a short discussion with Prof, Alfven and conveyed to him about my study of magneto-hydrodynamic stability of infinite cylinders. He understood the importance of that work and said that I could study and explain the results of observations in his laboratory at Stockholm. That was an important discussion. It decided what I would do in Stockhol after going there.

After enjoying the beauty of Logo de Como which is one of the most beautiful spots in Italy I went to Munich by train and boarded the flight to Stockholm.

At Stockholm August 1959 to December 1961:

I was welcomed by all inmates of Department of Electronics of Royal Institute of Technology. That was the laboratory where experiments were conducted with mercury columns carrying

electric with and without a magnetic field parallel to the mercury column. The experimental results were shown at the precious International Conference on Controlled Fusion. But a theoretical quantitative analysis was not yet available Professor Alfven gave me a room and the film containing the video-graphic of the instability of a mercury column carrying high electric current. My task was to measure from the video records the rate of growth of the instability and explain the results by theoretical understanding of the phenomenon.

I spent about three months to estimate the rate of growth of instability for all available data. I repeated the measurement three or four times to be sure of statistical variance between measurements is much less than mean value. Theoretically a result of measurement is not acceptable unless it is the same in each measurement. But practical errors that cannot be avoided must be minimized. With these precautions, I got the date that has to be interpreted theoretically.

The basic equations were known but one has to solve them and show theoretically whether the system is stable and if it is not stable, estimate the rate at which perturbation grows. A new feature of this particular problem is the finite electrical conductivity of mercury and therefore the equations valid for infinite conductivity case are not adequate, More features have to be incorporated to take account of finite electric conductivity of the medium,

I developed the preliminary form equation to be solved by what is called linearization. A perturbation is a small disturbance of small magnitude compared to dimensions of the radius of mercury column. Hence one has to find out the equations obeyed by the perturbation only. Before perturbation the system is assumed to be in equilibrium. In present case the mercury column is assumed to be stationary in the absence of perturbation.

All the time I was pondering to find a way to proceed ahead. The hurdle in the way the interaction among three variables one is the motion of fluid mercury, the second one is change in the current due to motion, and the third is the interaction of current and magnetic field. As usual I resort to prayer for a way out of the impasse. A thought flashed across my mind in the early hours one day to two separate steps. First step is to solve for interaction between current and motion and then substitute the result in the interaction between current and magnetic field. Thus, the three way interaction is split into two two-way interactions. This procedure is justifiable on the basis of principle of linearization. Shortly after this work was published, it was later confirmed to be correct by an independent study of this problem in Russia. I consider this clarification is definitely Providential. I have no doubt about this fact.

Having got this clue I went ahead with algebraic steps followed by numerical computation and I found to my satisfaction that the theoretically calculated numbers agreed with the observational data. When I saw that, that was peak of my gratitude to Haranath. But I did not rush to Prof Alfven immediately. I must verify the whole work for accuracy. Unfortunately I discovered a numerical error. That put me in utter confusion. But when I recomputed with the correction I found to my great relief that the agreement with observation is not disturbed significantly!

I reported these results to Prof Alfven some time during latter half of 1960. He asked me to give a seminar where all the members who participated in the experimental work were present, It was well received by them. A paper written by me was forwarded by Prof Alfven for publication. It

appeared in print in a Swedish Journal: '*Instability of conducting fluid cylinder due to axial current*' Arkiv Fysik, 18, 241 (1960).

Encouraged by this success I extended the method to different configurations and could get three more papers published in 1961. With this record, I requested Prof Alfven submit my work for a doctorate degree. Prof Alfven said, 'It is very difficult for foreign students. Our preliminary qualification to work for a Swedish Doctorate is a Ph.D degree, However I will consult Prof Oskar Klein regarding this.'

Prod Oskar Klein, who was one of the pioneering experts in theoretical physics came to my room and enquired about my work. He asked me to give a lecture at the Institute of Meteorology where the audience consisted of experts in various disciplines. I gave a lecture showing the details of theory and experiments of my work. Prof Klein was satisfied with the question-answer session after my lecture. Later he called me to his office and said that he would accept a part of my work as qualifying me for my eligibility and the rest of my work can be added for submission for doctorate degree. He gave me a certificate 21 March 1961 giving me Fil Lic degree of Stockholm University for my paper '*Instability of conducting fluid cylinder due to axial current*' Arkiv Fysik, 18, 241 (1960). Accordingly a four- page document, called Inaugural Dissertation- "*Theoretical Studies in some problems of Hydromagnetic stability of weakly conducting fluids*" was submitted to Stockholm University. That document was dedicated to Matru Sri.

The date for public discussion of my Thesis was fixed on May 16, 1961. After few days I received my Doctorate Degree in a colorful Convocation. After fifty years, I received also in September 2011 the Golden Jubilee celebration of Doctoral degree.

My stay at Stockholm was extended up to end of 1961 to complete the work. on force-free magnetic configurations. I had an opportunity of joining a group of scientists studying Noctornal Luminiscent Clouds near the Arctic Circle. Northern latitudes are famous for Aurora Borealis. They are moving pattern of colorful streams. There are also high level luminescent clouds which do not move fast. These originate due to interaction of solar flares with earth's magnetic field. Since our work is done mainly at night I had the whole day time which is more than 12 hours to write down my experience during the past. It written as a story of my Education in Haranath was published in *Divine Pen* magazine towards the end of the year 1961, I started back to India en route Switzerland, Italy, Israel along with Dr Nordlund who was one of my Swedish friends. I happened to meet him in a vegetarian restaurant and became my care taker since he was also an eminent medical doctor.

Middle Period 1961-91

Back to TIFR

What had been said so far was my story or 'Mystory'. In 1951 Sir C.V. Raman said, 'You were not taught physics well'. Am I taught physics well now in 1961? I do not know. The rest of the story to be told is 'His Story', that is the 'history' of one known as 'G.S.Murty'

At TIFR, the situation was not the same as it was when I left for Stockholm. I was given new responsibilities. One of such responsibilities is related to the seismic array established at

Gauribidanur to detect seismic signals arising out of underground nuclear explosion carried out at any place on earth. As I had a M.Sc. degree in geophysics, I had to participate in discussions on Seismology. That meant complete discontinuation of Plasma Physics in which I had obtained a Doctorate at Stockholm. I had to learn advanced Seismology. I used to get paid by TIFR but worked at Bhabha Atomic Research Center (BARC). This was one of features in the interaction between TIFR and BARC. It worked well for some time. I was to give lectures to the newly recruited trainees on Statistical Mechanics, Electromagnetic Theory. I had no time for research but had a few Research assistants to whom I suggested problems for research. But the cumulative load of duties was reaching a critical state. To add to the problems the Head of Seismology died in a fire accident when he was abroad. Consequently I was made the Head of Seismology Section and was transferred from TIFR to BARC. Thereafter, my salary was paid by BARC from 1968 onwards.

At BARC 1968-1991

Responsibilities

My duties at BARC are more administrative than scientific. My colleagues in the Section were well trained and well educated persons. There were two field stations of Seismology section, one at Gauribibidanur, in Karnataka and the other in Haryana. These were established for recording seismic data round the clock to detect and identify the source of seismic wave/signal, an earthquake or an underground explosion. If the signal is identified as arising from an underground explosion, the information must immediately be transmitted by me to Director, BARC with a copy to the Secretary, DAE. Further, all the seismic data recorded at Garibidanur should be sent to BARC and from BARC, it should be sent to London UK according to a previously agreed-upon procedure. The maintenance of the field stations was carried on by scientists trained for that purpose. At BARC the staff included physicists and electrical engineers. Both experimental and theoretical work was carried on according to the abilities of the personnel. The junior members can take up research work to enable them to higher degrees from Bombay University.

I had to acquaint myself with varied staff. With hardly any experience in administrative problems it was not easy for me, but due to the fact of being a member of the section for several years by then, it became relatively easy to continue all the work without any break. Thus the transition from individual work to collective work was relatively smooth. In the words of Sir C.V, Raman, I came to know I was not taught ‘administration at all’.

This brought me a chance to know what ‘administration’ means. Soon I understood that it means **getting the best of all without paining any one**. Stated in that way it looks very simple but it is not so in practice. Why? The answer is simple. Each individual has a personality that decides the manner he / she executes his duties. Therefore, the person holding the responsibility for a section has to be very careful to honor the personal preferences of each individual member under his/her care. Because the Head of a section/ group signs the annual confidential reports of each member. Utmost care has to be taken in assessing a member’s work in the development of science for which the section is bound. .

Non-Scientific Publications in 1969 and 1970

Such thoughts took me to the question of an individual in a collection of individuals. What is meant by freedom and lack of freedom? What is meant by individual responsibility and collective responsibility? My duties for teaching statistical mechanics at BARC trainees forced me to read those subjects more carefully than I did so far. I found that there is a similarity between concepts in thermodynamics and social issues. I wrote a paper entitled *Constraints on Humanity* and it could be published it in Prabuddha Bharata in 1969. This was my first non-scientific paper. The monthly magazine Prabuddha Bharata was my favorite periodical. I used to read it every day when I had to travel long distances in local trains from home to office and back. Since I boarded the train at the starting point I could find a place to be seated and so I could read rather comfortably in spite of unabated gossip of co-passengers. It seems that random noise at low intensity has no effect while reading a book. One can easily become immune to it. It was a blessing in guise because, during many years of travel in local trains, I could read many spiritual texts and enlarge my vision of spiritual matters. Thus God educated me in an indirect manner. I mean that my education in a school was supplemented by education while traveling for livelihood.

At TIFR I had an opportunity of learning Fortran Language. It was really one of the marvelous inventions of modern technology. The concept of a flow chart was a valuable fruit of efforts to express a logical sequence unambiguously. I felt that such a logical representation could be adopted even for metaphysical notions. I could conceive of a cycle which was named *Man God Cycle* that expresses metaphysical notions and their role in our life. A paper was published in Telugu in 1970 which coincided with birth centenary of Shri Kusuma Kumari Devi who was respectfully called Matru Sri. It was translated into English and published again in the year 1994.

Scientific Research at BARC

After I was made Head of Seismology at a research center like BARC, I cannot afford to write only non-scientific articles. I am expected to state clearly to my superior officer what new scientific contribution was made by me during the period of the report. Therefore I found that there were two fields of research relevant to Seismology. One was detection of signals embedded in back ground noise and the second was attenuation of elastic waves in layered elastic media. The literature in these fields was scanty. In addition there was a classical problem of elastic wave propagation at the interface of two elastic media. These three topics were chosen by for special attention in addition to the on-going routine work. Retrospectively, such decision proved to be successful because my colleagues could produce original results which fetched them doctorate degrees. I myself could also original papers which were published in international refereed journals. I was satisfied myself for what I could do. All colleagues, both senior and junior, gave me a very warm sendoff on 28 February 1991.

End period 1991-

This period was tumultuous for a few years for various reasons which are not relevant at the present context. Over a period of time, I could come back a routine by taking up topics of interest to me in the past few decades. I received from a friend in 1970 or so a Sanskrit book called

Purna-mimamsa darsanam. I found in that book a brief sentence: '*Vruttam Isvarah*'. It means simply a Circle is God. This sentence struck to me as wonderful, because it links geometry to metaphysics. I came across also a geometrical figure known Sri Chakram, which is a strange combination of a circle interlaced with triangles. Having known the sentence that Circle is God, I felt that a link may exist between Sri Chakram and a Circle.

I started to draw the geometrical form of Sri Chakram based on my knowledge of geometry during my scientific career. Slowly I could find the rules by which Sri Chakram could be constructed. I was also reading books written about Sri Chakram.

My knowledge of mathematics acquired during the period while I was working for my Doctorate degree in Stockholm helped me to understand the meaning of transcendence. This word occurs both in advanced mathematics as well as metaphysical language. I am surprised to see that the underlying meaning indicated in both fields corresponds to understanding the meaning of convergence of infinite series. Such a thought reminded me of vedic sentence *satyam jnanam anantam brahma*. Thus I found a sort of closeness between apparently unconnected mental disciplines.

My interest in the geometry of Sri Chakram forced me to read several other related subjects. One of such subjects was Lalitasahsranama stotram. I came across statements which have bearing on the geometry of Sri Chakram. I summarized my efforts in the form of draft with drawings indicating successive stages to arrive at the final form of Sri Chakram. This effort was appreciated by a learned person, Swami Paramananda Bharati. He kindly took the draft and got it printed in Ahmedabad in 2001.

At about the same period, I slowly consolidated my thoughts regarding a link between geometry and metaphysics in the form of brief Sanskrit sentences. Later I added explanatory notes for each Sanskrit statement in the for a text book. This was printed in 2002. By then, it was one decade after retirement. Not a bad bargain after retirement! That has a title, rather long, *Paratattvaganitadarsanam*, alias, "Egometry or Principles of Transcendental Philosophy of Mathematical Truth". Egometry, as a word, did not exist in any dictionary. I felt that it was appropriate for a book that attempted to bring together geometry and metaphysics.

There were other efforts made to consolidate my ideas in mathematics and physics. These were also completed and published in the same decade. Now I am in the second decade after retirement and still continuing to ponder on several metaphysical issues. I believe that **Life is a Long Lesson**. It started actually from my school days at Kakinada and continuing in Kukatpally. At Kakinada I learnt first from letters written by Haranath to His devotees that every one has the freedom to repeat Name of God and that is the only freedom we have by birth as a human being. That impressed me as a fine option. I heard much about destiny. But a question arose: 'Is that all?' I found the answer in the letters of Haranath. For me, the first teacher was Haranath and later I had many good teachers. What I am is the result of all their lessons.

List of Selected Publications

Scientific / Mathematical Topics

Relativistic Thomas Fermi Atom (1956)
Progress of Theoretical Physics. Vol. 15 #5, pp 475-479.

Acceleration of cosmic rays (1958)
[G. S. Murty and R. K. Varma
Physical Review 112(5),pp 1789-1793

Theoretical Studies in some problems of Hydromagnetic Stability (1961)
Inaugural Dissertation (Stockholm University, For Doctorate Degree.

On the parametric model of loose bonding of elastic half spaces (1975)
With A. R. Banghae and I.V.V. Raghavacharyulu, J. Acoust, Sov, Am. Vol 60. Pp 1070--1078

Reflection, Transmission and Attenuation of Elastic Waves at loosely-bonded interface of two Half Spaces. (1976)
Geophys. J. R. Asto. Soc pp 389-404

Application of FPE based AR Model for signal detection and Digital data compression (1982)
F. Roy and GSMurty.
Annals of the Insttute of Statistical Mathematics. Vol 34. 181-188

Enumeration of rooted Trees and its application to distributions of earthquake and acoustic-emission amplitudes (1983)
Physics of Earth and Planetary Interiors. Vol 32, pp 160-167.

Power Laws and Application to Earthquake Populations (1996)
With A.R. Parsa
PAGEOF Vol 147, No, 3, pp 455-466.

Is there a Kinematical of space-time encompassing classical, Quantum and Relativistic Mechanics, Journal of Indian Academy of mathematics, Vol 29. No 2 (2007) pp 505-522.

On the Notion of a Rest-Frame in Theory of Special relativity, Journal of Indian Academy of Mathematics, Vol. 38, No. 2 (**2016**), pp. 251-270

Metaphysical / Philosophic Topics

The Constraints on Humanity
Prabhddha Bharata, Vol 74, pp 347-351 (1969)
Advaita Ashranma, Mayavati U.P.

The Man God Cycle

Divine Pen (1970) Birth Centenary of Matru Sri Kusuma Kumari
Divine Pen June (1994) Reprinted (with minor changes) 125th Anniversary Sri Kusuma Kumari

Haranath The Teacher of Teachers
Divine Pen. Vol 27, June-July (1987), pp 11-13

Sri Kesiraju Satyanarayana garu- A philosopher and philanthropist
Anhali' Kesiraju Commemorial Vol, (1989). Pp16-17

Haranath - The Mystic Householder
125th Anniversary celebration Matru Kusuma Kumri a Baruch (1995)

Mathematical View of Quintuplication (Telugu)
Sri Samkara Krupa. Vol. 34 # 8, (1995). pp 33-43

Geometrical View of The Five Kosas (Telugu)
Sri Sankara Krupa, Vol 38, #4 (1998), pp 18-23.

My Education in Haranath,
Divine Pen Vol 41 Sept. (2001) pp 2-47.,

Lord Krishna in Letters of Lord Haranath
Divine Pen Vol 43. March (2002) pp 8-14

Nanna garu as we know (Telugu)
(Rallabandi Virabhdra Rao garu who was life long spiritual teacher)
Kusums Haranath Brundavanam page 1.
Publ. R, Narasimha Rao. Hyderabad (2003)

Publications – Books

Sri Chakram – Its Geometry and Metaphysics.
Publ. Pranav Bharati Foundation,(2001). B-9 Serene Park, Judges Bungalow Road, Ahmedabad 380016
It shows systematic construction of Sri Chakram and discusses its significance with respect to Lalithasahasranama Stotram.

Paratattvaganitadatsanam
(Alias, Egometry or Principles of Transcendental Philosophy of Mathematical Truth)
Publ. Motilal Banrsidass, 41 U.A. Bungalow Road, Jawahar Road, Delhi (2002); pp. 395
Contains a Preamble followed by 108 Aphorisms in Sanskrit and Commentary in English. The subject is presented in the form of a dialogue between a Mathematician and an Advaitin.

Two Facets of Geometry

Publ Institute of Scientific Research on Vedas (I-SERVE) 279 m Rd # 8 Alakapuri , Hyderabad 500035. (2010)
A collection of four articles.

(1) Theory Behind Mathematics, (Revised version of article presented at National Conference. Organised by JNTU and ISERVE in 2005, Hyderabad)
(2) Advaita is Mathematical Truth (Presented at International Conference on Indian Science in the Pre-Sankara period) organized by ISERVE and Neuland Labs Ltd. Hyderabad 2007,
(3) A Mathematical View of Quintuplication (An enlarged version of Telugu paper published in Sankara Krupa, Vol 34#8, (1995)
(4) What can we learn from Science? A paper presented at National Conference on 'Advanced Technology –Need for Global Ethics. Organised by MAGNIRSA, Hyderabad 2006,
This paper argues that an individual human being is akin to a Node in space-time in the sense that during the period of existence of the individual the entire past is linked to the entire future. And therefore an individual has to be educated in a suitable ethical mode of conduct. It must be such an individual is self-regulated entity. It is not a like a monolithic structure but a voluntary self controlled unit. In a sense this talk is an extension of the ideas expressed in my article *Constraints on Humanity*.

All India Radio Talk, Hyderabad on 1 January 2005: At This Point of Time.
This talk echoes ideas similar to those covered in the paper 'What can we learn from Science?' mentioned above. .

Unpublished Manuscript: 'Rationale of Varna Ashrama Dharma

It is an attempt to explain the tradition in Hindu society based on the principle of division of disciplines. It is assumed that an individual has limited capabilities. Therefore, it follows a probability law can be accepted: In a society of large of individuals, 'less is the number of people the larger their responsibility', It is a version of division of responsibility according to the capacity to discharge responsibility.

Learning continues …….