Conversations with

Joshua N. Goldberg (1925…)

I Beginnings

Kamesh: Let us begin with your family background, your early life, and your early memories.

Josh: My father arrived from Russia in 1905 when he was sixteen years old. His name Isador Sclaroff was changed to Isador Goldberg by the Immigration officer. He met with one Mr. Nathan Axelrod--- in New York. Together they moved to Rochester to work in the clothing Industry. In 1906, Axelrod's sister, Rose, sixteen years old arrived and four years later married my father on Labor day of 1910. My oldest brother was born in 1911, followed by a brother and two sisters (1913, 1916, and1918). I was born on May 30, 1925. Out of them, one born in 1913 died from Polio at the age of 2 and the other born in 1918 died from Cancer at the age of 15. Obviously, I never knew my second brother, but I knew my younger sister very well. She played card games with me and we spent time talking when I was sick at home and after she became sick.

Kamesh: Would you like to say a little more about, who your father left behind? What was Russia like in those days. Did he leave because of anti-Semitism.1906 was before the Revolution in 1917.

Josh: Anti-Semitism certainly played a roll. My grandfather was killed by a neighbor during an anti-Semitic altercation. But the main reason boys under 18 left for the US was to avoid service in the Russian army.
My father got out at 16, but my uncle Nathan Axelrod was over 18 when he left. He was first hidden by the family and then smuggled out of Russia into Austria and Germany. I don't know how he got visas or other documents. Nathan arranged for my mother and younger brother Sam to come to the US and my father did the same for his sisters and his mother. In fact, his mother brought over my mother's youngest brother Jacob Axelrod.

My earliest memory was when I was four years old. My father bought an automobile. I recall going to the automobile showroom and I recall the showroom was quite beautiful with beautiful cars on a marble floor.
It was an exciting experience.

Kamesh: How did you go to school? What role did your parents play in your education?

Josh: I walked to both grade school and high school. Initially, both were about 15 minutes from home, but from the 11th grade on it was 30 minutes' walk. As I recall, I was a slow learner in the Grade school from Grades 1-7. My parents encouraged reading and learning. As soon as I

could read, my mother took me to the library to enroll and take out books. The library was a 5 minute walk from the house, maybe less. In my early teens, maybe about 12, I worked at the library shelving books.

Kamesh: When did you become interested in science?

Josh: In the Junior School years, grades 9, 10, I became very much interested in science and mathematics, particularly geometry. The idea of proof was very fascinating to me. I found very satisfying the orderly way in which theorems and axioms were used in Euclidean geometry. In High school, I had an excellent physics teacher. He and demonstrated the existence of atoms by showing us a glass tube containing air and some dust particles. We could see the dust particles bouncing around and showing their random motion under collisions with the air molocules. I drew up a diagram for perpetual motion by hooking up a motor to a generator. He told me to figure out why it wouldn't work. Of course, ideally, it would. I was very excited. By the end of the 11th grade, I had decided to study physics. My brother had given me a toy microscope to study biology. I didn't find it interesting.

Kamesh: You mentioned your brother had studied chemistry. He had gone to Washington, but returned to Rochester

Josh: Yes, my brother earned an MS in organic chemistry at the University of Rochester in 1933. He was asked to go on for a PhD, but he wasn't interested. He wanted to go into business. At first he classified fingerprints for the FBI in Washington. Eventually, he used his chemistry background first as a salesman for CRC and then in establishing the NALGE Corporation for the manufacture and sale of plastic laboratory supplies.

Kamesh: What kind of neighborhood you lived in? What were your other activities in your High School Days?

Josh: We lived in a working class area. I took part in the Labor Zionist movement.

Kamesh: In what way?

Josh: We were not Jewish in a religious sense – enjoyed the festivities and so on, but did not observe the Sabbath every week or go to the temple, but had a strong Jewish identity. The partitioning of Palestine by the British into Jordan and Palestine mandate had left no homeland for the Jewish people. The Zionist movement had as its goal the establishment of a Jewish State in Palestine. Supposedly, this was also the goal of the British Mandate. My parents belonged to the Labor Zionist Organization. I was part of its youth group, Habonim (the Builders), that worked for this end. In fact, my major friendship group came from this organization. We were a base group of 7 or 8 boys who remained in contact until we began to die off. Three of us are left – one in Rochester and I in Syracuse and possibly another one still survives in Florida. Most of the women in that group are still living.

Kamesh: How were the family circumstances? You lived through Depression.

Josh: We had no problem as far as living comfortably. Neither did the community we were living in, as far as I could tell. However, it was a working class neighborhood so there must have been hardship in some of the families of schoolmates. We had a comfortable four-bedroom house with a separate building in the back that was set up for tailoring. The clothing industry was doing well.

My father learned tailoring when he came to Rochester. He bought a house with tailor shop in back around 1920. His older sister's husband, Morris Phillips, and he formed a partnership in the tailor shop: Goldberg and Phillips. They were contract tailors. Before the big clothing factories were formed, many men bought suits make to order. The stores that sold them sent the measurements to contractors who made them. G&P were such contractors. The business died during the depression when the large clothing factories were able to produce men's suits at a very low price with which the made to order business could not compete. As a result, G&P went out of business in 1938. My father then went to work for one of these factories, Bond Clothes and retired 15 years later at the end of 1953. After my brother built a factory for his plastics business, my father would go there and do odd jobs – helping with shipping and cleanup.

II High School and College Days

Kamesh: What year did you graduate from High School? What do you recall from those days, friends, sports?

Josh: I graduated from Benjamin Franklin High School in June 1942. I used to play tennis, touch football, basketball, softball, and sledding, but no skiing. I recall an interesting experience during those days. When I was 14, I felt I should find a job**.** I applied at several stores and was turned down. But I got a job in women's shoe store for after my school day and Saturday. My job was as a stock boy, to open boxes and shelve the shoes at appropriate places. Eventually, I went to work at a Men's store for more money. It had a Children's department and on weekends I would be sent there to help out with sales. And sometimes, when the store was very busy on weekends, I waited on customers in the men's department. I continued on this job in the following years. During a school break in 1944, I got a higher paying job at Eastman Kodak monitoring the photographic paper. This was shortly before being drafted into the Navy.

Kamesh: World War II started in 1939. Did it have any impact? Do you recall any specific activities?

Josh: I used to follow the news, go to mass meetings, heard about the Spanish Civil War. We used to have discussions in the family.

Kamesh: After graduating from High School, you entered University of Rochester. How did that come about?

Josh: As I said before, I had decided to go to college and major in physics. I had good friends, about six of them, all Jewish from the working class community. We were all bright and did quite well in High School and wanted to pursue higher education. Going out of town for all of us was not feasible. So, one day all six got together and went and met with the Admissions officer at the University of Rochester. He asked us several questions and we explained our circumstances. At the end he said "I think you all can do it." So, in September 1942, we all enrolled in the University of Rochester.

At the time, the University had two campuses, the one for men at the present location of the University of Rochester for both men and women at the southwest end of the city and the other for women and the school of Music in the center of the city.

Kamesh: What do you remember of your undergraduate years?

Josh: I entered the university with the intention of majoring in physics. At the time Du Bridge was the head of the department, but he was away at the Radiation Laboratory at MIT. I remember a couple of names of those who taught physics: one was Gerhardt Dessauer, who taught Electricity and Magnetism and Modern physics; the other, a Hungarian named Bela Lengyel who taught Intermediate Mechanics. Dessauer worked on the Manhattan Project and was in charge of monitoring radiation in the first atomic bomb tests at Bikini. He later was the Director of the physics section at the DuPont Savannah River Laboratory. He is not the Dessauer associated with Xerox. Lengyel later wrote a book on lasers and became the first chairman of the Cal State Northridge physics and astronomy department. One interesting thing I remember is that the University allowed us to do lab experiments on our own without requiring a supervisor. Another student, Walter Siegmund, and I worked together. We would spend a long time on the telephone discussing the write up of the experiments. I recall one day, we spent a long time, alone in the laboratory, measuring the sodium fringes with a Michelson Interferometer and measured the wave lengths in very close agreement with what was expected. We were thrilled. I also recall Herbert York who was a T.A. in my freshman year and was very inspirational, making us interested in physics. Rochester had a small cyclotron. He was in charge of it and took his class to see it and told us how it worked etc. He made us interested in elementary particle physics. I recall, later he worked on the Manhattan Project, was the first Director of Lawrence Livermore Laboratory, and twice served as Chancellor of University of California, San Diego. Another thing I recall is that the University provided a speedup opportunity of taking courses during the summers. So by July 1944, I had officially completed two and half years instead of the regular two years. On July 14, 1944, I was drafted into the Navy. A number of us went into the Navy because there was a special program called the Eddy program which trained us to repair electronic equipment such as radios, sonar and radar etc. It was basically a one year course but we had to spend the first six weeks at Great Lakes Naval Station for boot camp that involved the regular basic military training.

In September of that year, I returned home for a week's leave. I recall we had a Fraternity dinner and dance event. At the dinner, on my left was my date whom I had known from high school days. She was of my age, sophisticated, and had a very nice singing voice. On my right, was a young girl, whose name was Gloria. She was cute, but too young. I met Gloria again the following year. She looked more grown up, more interesting. But when I was discharged from the Navy and returned to school, I still had the other girl in mind, who I had invited the first time, and called her. She told me she was engaged and getting married. Then, I got in touch with

Gloria. We started going out. We saw each other often and by the time I graduated and ready to go to graduate school, we were committed to each other. Gloria was in her junior year at that time.

Kamesh: You completed your undergraduate degree in 1947 and chose Syracuse for graduate school. Did you try any other school? How were you supported?

Josh: Yes. I had applied to several places, may be half a dozen. It was after the war. Many students wanted to take physics. Graduate schools were flooded with applications. It so happened that my brother at the time was a salesman for the Chemical Rubber Company that made laboratory supplies. On one of his travel stops, he was at Syracuse. He went to the office of the physics department of Syracuse University and picked up an application. I was at the time quite innocent, didn't know much about physics departments in the country. Of course I knew of some, University of Chicago, Cornell etc. I applied to **Syracuse** and was accepted. That was it. I decided to go to Syracuse. Also it was convenient because Gloria was at Rochester in her junior year. Another interesting thing was that a friend of mine from high school was at Syracuse working with Siegert. However, when I arrived in the fall, Siegert had left for Northwestern and my friend went to Rochester.

Kamesh: How were you supported?

Josh: I had an appointment as a TA and the GI bill covered tuition and books and gave me a stipend of $60/mo. before I got married and $90/mo. after our marriage in 1949. With that and with an assistantship from the department, we had a comfortable living.

Kamesh: Who were there on the faculty in the physics department? Who was the chairperson?

Josh: As I recall, the physics department had just started a PhD program soon after the war ended. Before that the highest degree offered was the master's degree. Fredrickson was the chairperson; Peter Bergman, Melvin Lax, John Triscka, Johanna Brunnings, Bachmann, Nathan Ginsberg, and Henry Levinstein were some of the faculty members.
The first two years I had to work for the MS degree before starting research for the PhD. In my first year one of the courses I took was Quantum Mechanics taught by Brunnings (a student of Casimir). She was a very good teacher. I liked QM and wanted to do a problem making use of QM for my MS thesis. I approached her for a problem, but she was reluctant to be a thesis advisor. Then, I went to Bergmann. He said he didn't know any problem requiring QM and advised me to talk to John Trischka. Trischka, who was doing molecular beam experiments, agreed to take me on, provided Bergmann would be willing to look into the theoretical part of my work. Bergmann agreed and I worked on the interpretation of Trischka's data, but unfortunately just about when I was ready to publish, we learned that a physicist at Yale had worked on the same problem with identical results and had just published his work. So I had to work on a different problem with Trischka in the same general area, By the time I finished the MS, I was beginning my fourth year and in 1950-51, I started working on General Relativity with Bergmann.

Kamesh: What about course work?

Josh: Yes. I took courses, advanced mechanics, Quantum field theory, Statistical mechanics and relativity (taught by Bergman). I also took courses in mathematics, Differential equations and complex variables. Syracuse had an excellent group of mathematicians, at the time, possibly the best in the country -- Charles Loewner, Lipman Bers, Milgram, Goheen, Gebhardt, and two or three others whose names I have forgotten. Donald Kibbey was the chairman.

Bergmann had a nice group of students working in general relativity that included Henry Zatskis, Robert Penfield, Ralph Schiller, James Anderson, Robb and Alice Thomson. Peter would not assign a specific problem to each individual. We used to get together, discuss the general area of quantizing the classical general relativity. Each one of us chose a specific aspect on which to write a thesis. I wrote my dissertation on the conservation laws and equations of motion for localized sources of the gravitational field.

Kamesh: What do you think of your graduate years - life in Syracuse?

Josh: The graduate years were important years of learning. Two years in the Navy gave me independence. Graduate School and my colleagues gave me knowledge and culture. My courses and colleagues gave me knowledge of physics and an introduction to serious music. During these years, the long playing record came out. We bought records and exchanged them among us. In 1949, Syracuse Friends of Chamber Music was formed and we went to those concerts at the old Everson Museum. Furthermore, in my first year, I lived with a student in psychology, Ted Landsman, who had friends in that department as well as in foreign languages and social work. In the second year I lived with Irving Kofsky who came from New York. So I was introduced to people, many of whom came from New York City, with different experiences and social outlooks. My life was truly enriched. However, together with our wives, Jim Anderson, Ralph Schiller, Alice and Robb Thomson, students of Peter Bergmann, and Rubin Braunstein, student of John Trischka, formed a particularly close group.

Kamesh: What was Gloria doing? Have you kept in touch with the other members of the group?

Josh: Gloria lived in Rochester until she graduated Magna Cum Laude with a major in psychology in June, 1949. Before that, I would go into Rochester some weekends and others she would visit me in Syracuse. That was the motivation for choosing Syracuse over other places I had been accepted. We married on June 19, 1949. After a week of honeymoon in Canada, we returned to Syracuse to an apartment we had rented through a relative of hers who lived in Syracuse. She decided that she did not want to do graduate work in psychology and got jobs first as a group worker and then as a social worker. She was pregnant when I got my PhD in June, 1952. We moved to Chicago for my first position. Our first child, Zachary, was born at the Chicago Lying In Hospital in March 1953 and our second child, Miriam, in April 1955.

As for the graduate school group, yes, we have kept in touch over the years. This is particularly true of Jim and Ralph. They both ended up at Stevens Institute of Technology in Hoboken and hosted periodic relativity meetings. Rubin was in atomic and solid state physics. His first position was with RCA in Princeton and then at the University of California in Los Angeles. Robb did a postdoc with Seitz at the

University of Illinois and became an important person in fracture theory. Alice left physics and became involved in American Indian affairs. Irving Kofsky built a business in photography and had equipment on the planes that observed the atomic bomb tests in the Pacific. I am still in touch with all of these people. Bunny Schiller and Alice Thomson have died. Jim, Ralph, and Irv Kofsky were here for the Joshfest in April 2012. Rubin and Robb said that they would like to come, but are unable to travel.

III **Post- Graduate years**

Kamesh : Let us talk about what happened after your graduation. What year was it when you got your PhD?

Josh: I got my PhD in 1952. I looked for an academic position. Not finding one, I looked for a situation in industry. I settled on working for a non-profit research institution, Armour Research Foundation in Chicago, which later became associated with Illinois Institute of Technology. It was supported by government contracts to work on various problems of interest to the Defense Department. The other members in the research group were Hans Eckstein, Thomas Gilbert, and Norman Rostoker. We each had different research backgrounds and interests: Eckstein, quantum field theory, Rostoker, hydrodynamics, Gilbert, magnetism, and I in gravitation. Although we were working for defense related projects, we had enough time and we were encouraged to pursue basic research. In fact we used to get together almost every week at Eckstein's home and discuss what was going on in physics and occasionally we would get people from outside to give talks. Once Murray Gell-Mann came and talked about the new elementary particles and their classification. Another time, Bill Davidon, a PhD student of Murph Goldberger came and talked about a new approach to Quantum Field Theory. We also invited S.Chandrasekhar to give a general talk at ARF. Also Joe Weinberg came and talked about cosmology. He was working at the House of Vision, making lenses. He had to quit Minnesota because of charges in Congress that he was a communist. We tried to hire him, but it was more than ARF could overcome because of the need for secret clearance. It was good for him in a sense. Soon he was hired by Western Reserve University in Cleveland, Ohio. Then in 1969, when you came, he came to Syracuse as a Kenan Professor.

Kamesh: What was your obligation, your work for the foundation? What about your basic research?

Josh: My principal work for the foundation was concerned with the sidewinder missiles that used heat detection to destroy enemy aircraft. I showed how the design worked and that the missiles were capable of detecting the heat from jet engines and destroying the adversary planes.

During the period (1952-54), I also wrote what I consider one of my important papers. It had to with General Relativity and the equations of motion of interacting particles. In 1938, Einstein, Infeld and Hoffmann had written a very interesting paper on the subject, confining themselves to

slow moving particles using the expansion of the Einstein equations in powers of 1/c. Their expansions involved even powers of 1/c. Infeld had worked on certain odd powers related to radiation effects and showed that they had no effect – in fact-instead of in spiraling, the trajectories were out spiraling . What I showed was the terms that Infeld was considering did not contribute to the Riemann Tensor and hence they had no relevance to physics. The important result was that gravitational radiation effects show up in only in the 11^{th} order in 1/c. [In the fifth order, I introduced an arbitrary function of time which leads to a non-trivial Riemann tensor. I should have taken the function from the generalization of the Lienard-Wiechert potentials of the electromagnetic field which are solutions of the linearized Einstein equations. I then began to think of an approximation for fast moving accelerated particles. I found that Peter Havas had the same idea. We pooled our efforts and, in 1957, published our results for the lowest approximation. Bad singularities arose when we tried to go to the next order. 20 years later these difficulties were overcome by other workers. It so happened that at the same time Felix Pirani show that the radiation of gravitational waves belonged to Class I (N) of the Petrov classification.

Kamesh: So, this was between the years 1952-56. What about your life like in other aspects?

Josh: Chicago gave Gloria and me an opportunity for further growth. It took some time, but we found an apartment in the Kenwood area, neighboring to Hyde Park. We became active in the Hyde Park Co-op. It had various committees including one for shared baby-sitting of which we took advantage as our children Zachary and Miriam (April 1955) were born at Chicago Lying In Hospital. One of our first activities was to go to a chamber music concert at Mandel Hall. There we met Hans Eckstein and his wife, Eva. From this encounter we became friends and eventually we moved into an apartment below them on 48^{th} St near Dochester. Gloria became active in the Education Committee of the Co-op and in our last year in Chicago, I was a member of the Board of Directors. Because baby-sitters were available through the Co-op, we were able to lead a very active life – going to concerts and plays and entertaining and being entertained by very interesting people.

In 1956, the administration at the Foundation changed. The new administration required regular working hours, arriving -and departing at definite times according to a schedule. Our usual arriving late and staying late or vice versa was no longer acceptable. So, all four of us decided to leave. Eckstein and Gilbert went to Argonne National Laboratory; Eckstein to the physics division and Gilbert to the Materials. Rostoker went to General Dynamics since he was interested in fusion.

I had an offer from the University of Chicago to teach in their undergraduate college. I liked life in Chicago. We began think about buying a house. After some thought and Gloria's persuasion, I chose to go to Aeronautical Research Laboratory (ARL) at the Wright- Patterson Air force base outside Dayton, Ohio. Besides financial considerations, it had the advantage of having the

opportunity of full time for research in GR. In addition, the only other responsibility I had was that of monitoring ARL research grants. That was very beneficial for me. I got the opportunity to travel, meet various people in the universities and institutions; it also provided me an opportunity to initiate and support new research. ARL gave oversea grants as well. So I came in contact with Pascual Jordan in Hamburg and three mathematicians, Geheniau and Debever in Belgium and Lichnerowicz in Paris. They were primarily mathematicians, but interested in GR. The Belgians had worked on the Petrov Classification of the radiation field and Lichnerowicz led a group that worked on understanding the structure of the Einstein equations and their solutions.

While I was at ARL, its name changed to Aerospace Research Laboratory since Air force became interested in Space. I should mention, when I went ARL, I was the only one in the research group working on GR. However, there was a mathematician Max Scherberg as assistant to the Chief Scientist who was responsible for hiring me. In the course of time, we had hired three more, Stuart Fickler (a student of Richard Arnowitt's at Syracuse University), Roy Kerr (a postdoc at Syracuse), and Joseph Schell (a student of Vaclav Hlavaty at the University of Indiana). Shortly after I arrived at ARL, Pirani sent me a copy of his application of Petrov's classification the Riemann tensor where he showed that the radiation field belonged to Class I, later type N. We conducted a correspondence for a time. The first thing I did was to organize a short trip to Syracuse to visit the Bergmann group, to Princeton to visit John Wheeler, and to Pittsburgh to visit Ted Newman who was newly appointed there. For the most part, that was general relativity in the United States at the time. After that, I was able to grant support for Peter Bergmann, Ted Newman, and Peter Havas in the US (John Wheeler did not want or need support from the Air Force) and Pascual Jordan in Hamburg, Germany and Hermann Bondi in London. In 1957, Bryce and Cecile DeWitt organized the Chapel Hill conference on the Role of Gravitation in Physics. I arranged Air Force support of the conference and for transport of participants who came from Europe. It was there that I finally met Felix as well as Bondi and Gold among others.

In 1960, a NSF Senior Fellowship was announced. I applied for that Fellowship, proposing to do research on two-body solutions for Einstein's equations. I had an idea or a thought about how to find such solutions by establishing the conditions relating two overlapping Schwarzschild solutions. I wrote the proposal that was accepted. I was granted leave from ARL and in the Fall of 1960, I went to London to work in the group of Herman Bondi. By the time I had left for London, I had submitted two papers, on gravitational waves with Roy Kerr based on Schell's work on the infinitesimal holonomy group. These solutions were type N in the Petrov classification. Between the time I wrote the NSF proposal and the time I left for London, Bondi came up with his asymptotic solution. It so happened that I visited Alfred Schild in Austin Texas in early May 1960. Herman Bondi was there. He gave a public lecture, a seminar I guess, in which he described his asymptotic approach using null surfaces to examine gravitational radiation near null infinity. He showed exactly what functions are involved in the radiation.

London was quite interesting. At King's College, Bondi's group was focused on developing that area. So, I postponed my idea of working on the problem I had originally proposed to work on. Ray Sachs was there at the time. We collaborated and wrote a paper establishing the necessary and sufficient conditions that a solution of Einstein equations be algebraically special in the Petrov classification. That is that there exists a congruence of shear free geodesic null rays. A solution that is asymptotically flat and falls off at most as $1/r^4$ has a shear free geodesic null congruence. A radiation field falls off as 1/r and a more general field at least as $1/r^5$.

During the time we were in London, Alfred Schild was also there, but he had other interests so we didn't collaborate. However, we did go to concerts and out to dinner together.

Kamesh : This was in 1960-61, I suppose.

Josh: Yes. My leave was officially was for one year, but ARL supported me for three months during the summer of 1961 to travel and visit various groups in Europe. I went to Hamburg in Germany, Brussels in Belgium, a month in Stockholm with Oscar Klein, and the summer institute in Lake Como. I gave seminars, talked to various people with whom I had contact because of my monitoring activities etc. I returned to London after the summer and back to Dayton in December of 1961.

Kamesh: During this travel and in London, Gloria, Zachary and Miriam were with you. Did they go to schools in London? What was Gloria doing. Do you have any comments about your life in England.

Josh: Yes. Miriam went to infant school. She had started reading. Zachary went to Church of England school. Gloria took both of them to the library in Twickenham and each had a library card. We managed to find good baby sitters, so we were able to go to concerts and the theater in the evenings. With the children in school, Gloria was also able to visit art galleries and other interesting sites. During the school breaks, we traveled around England and a bit in Wales. Most important, Gloria was able to sit in on a French class at King's College. The instructor allowed her to take the exams and evaluated her performance. That gave her start for her career as a teacher of French when we came to Syracuse.

Kamesh: You returned to Dayton and ARL, in December 1961. What happened next?

Josh: After my return, Roy and I worked on a paper exhibiting the reduction of the Petrov classification to the electromagnetic field. It was an interesting paper. Then, Schild invited Roy to spend a year at Austin. In September 1962, Roy went to Austin and I stayed at ARL. Then sometime during the fall of 1962, I received a call from Syracuse, asking me whether I was willing to consider a faculty position in the physics department. It was not an easy decision to make since I was free to do research and enjoyed some privileges of travel etc. But Max

Scherberg, who was responsible for my coming to ARL in the first place, advised me to consider the offer. In the winter of 1963, I paid a visit to Syracuse. Then I received a letter from Fredrickson, the head of the physics department, offering a position as full Professor with one year to tenure. After about a month of hesitation, I accepted and joined the Syracuse faculty in the fall of 1963.

In the meantime, Gloria had gotten a teaching certificate and taught English in the Trotwood High School. However, she did not want to remain a teacher of English as she really loved French. So that when we got to Syracuse, she enrolled for a teaching certificate as a teacher of French. She taught for over 20 years in the Syracuse and Westhill school districts.

IV **Physics Department, Syracuse**

Kamesh: You came to Syracuse in the fall of 1963, a decade plus after your graduation. Who were on the faculty?

Josh: When I accepted the offer, Peter Bergman was there, but when I arrived in the fall, I learned that Peter had left for Yeshiva. So I was a lone relativist. The other prominent members of the faculty were: Bill Fredrickson as chair, John Triscka, Arny Honig, Henry Levenstein, Jack Leitner, Nathan Ginsburg, Nahmin Horowitz, Marvin Goldberg, Erich Harth, Harvey Kaplan,…

I had come with the assurance from NSF that Peter and I would have their support. Since Peter left, there was a position open. I got permission from the administration to replace him. So I tried to get Bertil Laurent in Sweden who was working with Oscar Klein. He was reluctant to leave Sweden. He was hoping to get Klein's position after the latter's retirement. Anyway, while this negotiation was going on, Peter decided to return to Syracuse. The position disappeared. Later, we tried to get Ted Newman, but he was happy at Pittsburgh.

We had money from NSF for a postdoc as well as students. Also, the University provided special funds so that we could have short term visitors. These funds brought Roger Penrose, Andrzej Trautman, Ted Newman, Stan Bazanski, Robert Geroch, Basilis C. Xanthopoulos and others who I don't remember. Relativity became one of the strong parts of the department. In 1964, George Sudarshan joined the faculty and established a High Energy Theory Group with Lochlainn O'Raifeartaigh and Balachandran. Shortly thereafter, Alan Macfarland and Joe Schechter joined the group. They also attracted some distinguished visitors. Although George, Lochlainn, and Alan left for different reasons and to different places, that was the beginning of the theoretical high energy physics group in the department. That then developed under Kameshwar Wali. On the whole, I found in our department, a tradition of openness and an atmosphere of cooperation. We should credit that to Fredrickson, who was a member of the department for 43 years and the chairman for 26 years. He retired in 1967 and Nathan Ginsburg became the chairman.

Kamesh: You became the chairman 1975-1981. What are your thoughts about the Department during that period; your accomplishments.

Josh: You came in 1969 with Maurice Blackmon and as I believe did Joe Weinberg with the Kenan Professorship. There were no further appointments until after I became chair in 1975. Then in 1977, with Herb Berry's retirement, we were able to hire Ed Lipson in biophysics and Carl Rosenzweig in theoretical physics. Apart from them, my major hiring was Abhay Ashtekar. I want to point out that by hiring Ed I doubled the number of faculty identified with biophysics – the other faculty member being Erich Harth, of course. But, Erich was a high energy experimentalist who switched fields and my decision to hire Ed was a desire to move the department in that direction. The other major accomplishment as chair was the redesign of the Physics Building. When the old Archbold stadium was taken down to make room for the Dome, physics lost undergraduate laboratory space and research space. Initially, the administration wanted to distribute us in other buildings on campus. When I refused to move without knowing what space we would have eventually, the administration began to think in terms of remodeling the Physics Building. It was painful, because we lost the architectural beauty of the building, but it brought our activities together in the building. Not everyone agreed with that decision, but I believe it was the best decision we could have made.

In physics, there are a few papers I can pick out where I think I made a contribution. There are several papers on conservation laws based on Noether's theorem. Somewhere I have a letter from Pauli about one of them. Probably my most significant contribution was to show that using generalization of the Einstein, Infeld, and Hoffmann slow motion approximation, gravitational radiation appears in the 11^{th} order in v/c – 3 ½ post Newtonian in Chandra's method of counting. This was followed by a fast motion paper with Peter Havas as mentioned earlier. Shortly after this work, I received the Senior Post Doctoral Fellowship from NSF which allowed me to spend a year with Bondi's group in London. There I was able to work with Ray Sachs and we wrote the paper showing that the existence of a shear free geodesic congruence of null rays was both necessary and sufficient for a space-time to be degenerate according to the Petrov classification. In London I also wrote a paper making use of Bondi's asymptotic null coordinates to define energy in terms of the conformal tensor. At the time, I didn't realize that it was equivalent to what Roger Penrose had done with spinors. Ted Newman came to Syracuse as a Visiting Professor in the spring of 1967. He pulled together George Sudarshan, Alan MacFarland, Fritz Rohrlich, and me to produce an important paper discussing the spin weighted spherical harmonics. This work has become important in the numerical calculations of gravitational waves. After Abhay Ashtekar developed his new variables for the Einstein theory, I began to use them in my work. I constructed a Lagrangian with the Ashtekar variables whose variation led to the Einstein equations. I also tried to formulate a local energy in terms of local null cone variables, but no one liked my ideas. In the '80s, people picked up on the work I did alone and with Peter Havas. Gravitational radiation has been calculated beyond the 3 ½ post Newtonian order. With numerical work, templates have been calculated for the search for ongoing search for gravitational waves with LIGO, VIRGO, and other gravitational observatories in the making.

Kamesh: When did Abhay, Smolin, and Sorkin come? Abhay was in Paris 1983-85. You got a special appointment to get him.

Josh: Abhay came in 1980 with the help of a special five year grant from NSF to support his salary. I wrote the proposal laying out the argument for the grant and committed the university to making a position for him at the end of the five years. In the summer after he came, Abhay and I discussed asking for two positions to hire Rafael Sorkin and Dmitri Christodoulou. They

received outstanding recommendations and we were granted the positions for the '83-'84 academic year, although Dmitri was half time in mathematics. It was fortunate that we did so as that year both Abhay and I were on leave in Paris. For Abhay it was a chance for him to see whether he would like to leave Syracuse for the University of Paris. Abhay was unhappy in the academic system in France. He felt he did not have the freedom available here. So, in the fall of '84 both he and I returned to Syracuse. However, while in France, Abhay completed the formulation of the Einstein equations with his new variables. As a result, a large number of graduate students, postdocs, and visitors came to work with Abhay. Syracuse was a very lively place until Abhay and Lee left to go to Penn State in 1993. In the meantime, we had hired Peter Saulson who was working on LIGO. When Abhay left, I would have been happy to hire another experimental person to work with him on LIGO. However, at the time, Peter didn't feel ready to have another faculty member in his field. So, in 1996 we hired Don Marolf, who was interested in quantum gravity and in 2000 Mark Trodden with interests in astrophysics and cosmology joined the department. Unfortunately, in 2002 Don was lured away to Santa Barbara and Mark left for Penn State in 2009. In the meantime, Rafael left for the Perimeter Institute. That ended, in the department, theoretical gravitational research related to the Einstein theory or its extension to string theory.

Kamesh: Any broad reflections on your Life?

Josh: Reflections! On the whole, I consider myself very lucky. I wanted to do physics, wanted to be a Professor of Physics, and eventually I did achieve both. I got support for research, didn't do great research, but did some good stuff. I married happily and had two children. And I still have an office in the Physics Department where I can still do some work, loosely keep informed, and meet with colleagues.

Kamesh: Your other activities? You mentioned your life long interest in music. Your contribution to SFCM, Civil liberties.

Josh: When I arrived at Syracuse University, I joined the American Association of University Professors (AAUP). After a couple of years, I started going to the Wednesday lunches and became an active member. The four main activities of interest of the group were examining the governance of the university – e.g., faculty input to administrative decisions, academic freedom, and issues concerning tenure and promotion, and an annual faculty salary survey. In 1972, the local chapter decided to organize the faculty in a union. At the time, Travis Lewin from the Law School was to be President during the campaign and I would be Vice President. As it turned out, the Law School had the option of not participating in the NLRB election and chose not to participate. Therefore, Travis decided that he could not lead the campaign. He resigned as President and the job fell to me although when I agreed to be VP, I was told that I would not have this responsibility. A lot of time was taken up in organizing the campaign, writing appeals for support, and speaking to the various departments, colleges, and schools. The election in the fall of '73 was very close, but the AAUP lost.

This was fortunate because had we won, we would be busy with first organizing the union and then defending it in court against a challenge by the university that the election was not legal as faculty, through their involvement with hiring, are part of management. Nonetheless, some good

things came from the election. The Administration was more respectful of the decisions of the University Senate and faculty salaries improved. As a member of the Senate, I served on a number of different committees. The most important committees were the committees on Academic Freedom, Promotion and Tenure, and the Agenda Committee which sets the program for Senate meetings. In time, I was chair of both committees.

My principal activity outside the university has been as a member of Syracuse Friends of Chamber Music. SFCM sponsors 7 professional concerts of quartets, trios, and chamber groups roughly in the eight month period from September to April. I served as President in the '75-'76 season and as the fund raiser for roughly the 10 year period 1995-2005. I also volunteer to serve on the program committee, but, when necessary, I leave room for other people to participate. I also have spent 11 years on the board of the local chapter of the NYCLU. In the 60s I was active in the DeWitt Democratic Party and helped organize a shortly lived group, the Onondaga Democratic Coalition, the liberal and anti-war wing in the 1960s and early '70s.

I am also a member of two book reading groups. One is composed of 11 men. Most of the books we read are political, e.g. Robert Caro's books about Lyndon Johnson. But we have read some prize winning novels like Atonement by Ian McEwan. The other group has four couples and we discuss a book over dinner prepared cooperatively. The dinner is usually very good, but sometimes the discussion is even better. In this group we also read novels and political books, e.g. The Generals by Tom Ricks. We are currently reading read My Beloved World, by Sonia Sotomajor.

From 1996 to 2010, I served on the Board of the Central New York Chapter of the New York Civil Liberties Union. There are always incidents of violation of civil liberties in central New York. The Executive Director brings a report to the Board which discusses appropriate action or lack thereof.

Apart from trying to keep up with important developments in physics, I am engaged in two major activities in the physics department. For the past seven years, I have been editor of a newsletter, *PHYSICS MATTERS,* for the department. There is usually a report by the Chair, an introduction by the editor, two research articles, research news, a portrait of a member of the staff, news about undergraduates, and whatever correspondence comes in. I plan the newsletter to come out in September. Although I start thinking about the next issue after publication of the current issue – the collection of new items begins almost immediately – serious work doesn't begin until the spring term. Penny Davis has made this job possible. Her big input begins in July and carries through publication in September.

When Arny Honig died on February 26, 2012, I felt a great loss since we had interacted almost every day. Even more, I felt that I only knew part of him and was unhappy that I had not asked more questions about his life – early as well as scientific. Therefore, in June, 2012 I started interviewing the emeritus faculty. I record the interviews as an MP3 file and then write the biography from the information. Unfortunately, the recording of the first one with Fritz Rohrlich got deleted before I could save it on the computer. But, I took copious notes and was able to write the biography. The biography is not comprehensive. It focusses on the early formative years to try to understand why or when the person became interested in physics. Then it

discusses the education leading to the PhD and the career that follows. The focus there is to identify what the person feels was his contribution to physics. To round out the biography, the wife and children are also introduced. In addition to the interview with Fritz, I have completed interviews with Giancarlo Moneti, Nahmin Horwitz, Kameshwar Wali, and Erich Harth. Kamesh is in the midst of interviewing me of which this is part. Balachandran has come for a month long visit and I am now taking advantage of the opportunity to interview him. I also have on my list to do, Marcel Wellner, Alan Miller, and Harvey Kaplan.