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VALENTINE BARGMANN

(with ALBERT TUCKER)

This is an interview of Valentine Bargmann at Princeton University on 12 April 1984. The interviewers are William Aspray and Albert Tucker.

Aspray: Could you tell me something about your earlier career and about how you came to Princeton?

Bargmann: I was born in Berlin of Russian Jewish parents. I went to school in Berlin and started studying at Berlin University. In 1933 Hitler came to power, and it was to clear to our family that we would have to emigrate as fast as possible. My parents went to Lithuania, where my father had his business, and I went to Switzerland and continued studying at the University of Zurich. In 1936 I got my Ph.D. degree. I could not stay in Switzerland; they didn't accept any immigrants. Instead I went to Lithuania to visit my parents. Luckily a close friend of my parents was a secretary at the American Consulate. By his intervention I got an American visa almost immediately. I hardly knew of any case where it went so easily.

I did not have any connection with American mathematicians or physicists, but before coming to America I asked my professors in Switzerland for letters of recommendation, in particular Wolfgang Pauli, who had been in Princeton in 1935. He also advised me to consult Rabi in New York, which I did. Rabi said, "I would suggest that you go to Ann Arbor. There is now a summer symposium, where you will meet many American physicists. I did this, and indeed I met many American physicists, among them [Gregory] Breit, who was then at Wisconsin. I had a letter to Breit, but he told me that he could not help me, he didn't have any funds. He suggested I try the Institute for Advanced Study. Well, after the symposium was over I traveled to Princeton. It

was just the time of the summer vacation. Nevertheless it happened that John von Neumann was in town, and Miss Blake, his secretary, suggested I talk with him. This I did, and he accepted me, so to speak, on the spot. I had seen him in Berlin, but I was not acquainted with him.

Aspray: What did he arrange for you?

Bargmann: I became a member of the Institute. He didn't offer me a stipend, but I didn't want everything. It was marvelous. After I was accepted I began to get acquainted with the members of the Institute.

Tucker: Was this in the period when the Institute's School of Mathematics was still in the old Fine Hall?

Bargmann: Yes, it was the summer of '37.

Aspray: Weren't you at one time one of Einstein's assistants?

Bargmann: Yes. It was like this. When I came, his assistant was Peter Bergmann. During that academic year I got acquainted with Einstein, and Einstein suggested that I come to see them. "Them" is Peter Bergmann and the Polish physicist Leopold Infeld. I got acquainted with what they were doing, and I could participate in their discussions. Then Einstein asked me if I would like to do it on a regular basis. The Institute had already offered me a stipend for the coming year. Things were looking up. It is difficult to say whether there was any difference between the position of Peter Bergmann and my position. We were simply collaborators. After a year—I think Peter Bergmann had already been assistant for two years or so—we switched so that I was officially the assistant. It didn't mean anything substantial.

Tucker: What was Einstein and company doing at that time?

Bargmann: There were two projects. One was the problem of motion, the other was unified field theory. The first had been started with Leopold Infeld and Banesh Hoffmann, and it was a question in general relativity. The second was the construction of a unified field theory.

Tucker: That was Einstein's chief interest at that time.

Bargmann: It was a major interest, which would occupy Einstein to the end of his life. But the problem of motion had also occupied him for many years and had, in Einstein's view, not been adequately resolved.

Aspray: Were there other people, besides Einstein, Bergmann, Infeld, and you, in the Princeton community working on these problems?

Bargmann: No.

Aspray: Was there much interaction between these people and the other people at Fine Hall who might be considered physicists?

Tucker: Bob Robertson, Ed Condon.

Bargmann: Condon wasn't around then. Robertson, of course, knew about it, but I think he was more interested in the impact of Einstein's work on astrophysics. Occasionally we talked to Weyl to get advice about the solutions of partial differential equations.

Tucker: Von Neumann?

Bargmann: I don't think so.

Aspray: Wigner?

Bargmann: It was a period when Fine Hall and the Institute were still relatively small, and we talked to each other constantly. I told people what I was doing, they told me what they were doing, but they didn't try to produce new ideas for the solution of my problems.

Aspray: We ask these questions because neither of us has much knowledge of what the mathematical physicists were doing at that time, so we're interested in the whole range of mathematical physics at that time, besides in your own and Einstein's activities.

Bargmann: The wider picture is this. Wigner was still in Wisconsin. He produced a very important piece of work on the Lorentz group, and we discussed this in great detail. Later on, at the suggestion of Pauli, who in the meantime had arrived in Princeton, I started to work on the Lorentz group too. So we had some very strong common interests.

Tucker: John Wheeler?

Bargmann: Wheeler at that time was doing nuclear physics.

Tucker: He got into that, as I recall, by working with Niels Bohr.

Bargmann: Yes, he had been a visitor to Niels Bohr's Institute in Copenhagen, and was later called to Princeton. When I came to Princeton in '37, Wheeler was here as a visiting professor here. He gave an excellent course on nuclear physics.

From then on he stayed in Princeton. In 1939 Bohr visited the Institute. He and Wheeler wrote a famous paper on uranium (specifically, uranium fission).

Aspray: At the time that Fine Hall was opened, how close were the mathematical and physics communities?

Bargmann: The way I remember it, the focal point was the common room in Fine Hall.

Tucker: It was the focal point of most things.

Bargmann: Whenever I had a moment free, not teaching or not going to lectures or whatever it was, I went to the common room, sat down, and asked what was going on. Therefore one knew very well what people were doing. I found it extremely attractive.

Aspray: Did the physicists in Palmer Lab come over to the common room regularly?

Bargmann: Maybe not so regularly, but they did. There was formally tea for the mathematicians and coffee for the physicists in Fine Hall every afternoon. I knew quite a number of the physicists.

Aspray: I understand from talking to Al that some people object to the term 'mathematical physicist', that they would rather be considered a theoretical physicist.

Tucker: I mentioned this about Wigner; he would much prefer to be called a theoretical physicist than a mathematical physicist.

Bargmann: I see. It is true there are some people who will choose a problem, not because it is of particular interest within physics, but for its mathematical interest. This Wigner doesn't like, so he stresses the distinction.

Tucker: I can remember that he declined to take some students for theses because he felt they didn't have sufficient grounding in physics.

Bargmann: Yes, maybe.

Aspray: What's behind my question is the fact that the Jones Professorship was in mathematical physics, and a stipulation made when Fine Hall was built was that the mathematical physicist be over with the mathematicians.

Bargmann: Yes. Now I want to emphasize that in the past, maybe in the dim past, people talked about mathematical physics and even had professorships in mathematical physics. My teacher in Zurich, Gregor Wentzel, before he came to Zurich had a professorship in mathematical physics, I think in Leipzig. He knew mathematics very well, but his interest was physics, there was no doubt about it. In the same way, in England physics was called natural philosophy for quite some time.

Aspray: Did the way things were arranged at Princeton have a bearing on this? Did the physicists somehow resent this involvement with the math department?

Bargmann: I don't know how sensitive I am in that respect.

Aspray: To ask a positive question, did this arrangement bring about more interaction with mathematicians than might otherwise have been the case?

Bargmann: I don't think a title means much. What means very much is the living tradition.

Tucker: Before Fine Hall existed, the mathematics department, as far as it had a home, was in Palmer. When I arrived here in 1929, there was no Fine Hall; there were a couple of rooms in Palmer. The ones that you encounter on your right as you enter. The mathematics seminary, as it was called, was there. That was the library and a place for the mathematicians to hang out. The mathematics secretary shared an office with the physics secretary. Down at the end of the hall was Palmer 222, where all the mathematics graduate courses were taught. That's where Veblen had his seminar. Veblen had an office up on the next floor, and Alexander had an office there. I don't know whether any of the other mathematics professors had offices.

I don't know when all this started. I think it started when Palmer was built. I think that until that time the mathematics seminary had been in the University library, the old library. It was then moved because the physicists wanted to have their books down in Palmer. The mathematicians went along, so that it was a marriage that had existed for a long time. It was certainly one of the stipulations of the mathematicians, Veblen and Eisenhart, that when Fine Hall was built it should be immediately adjacent to Palmer. There were, of course, other reasons for mathematicians and physicists being good friends, but at Princeton this goes way back.

Bargmann: What you just said concerns what I wanted to say. There was a tradition, a living tradition, that mathematicians and physicists talk to each other, and it can't be done artificially. I think at Chicago—Eckhart Hall—and at San Francisco, math and physics are in the same building, without any considerable effect.

In '39 the European war started, and more and more mathematicians were removed for World War II. I was approached in 1941, I think by H.P. Robertson, to give a course in methods of mathematical physics. It appealed to me very much, and the next year I was asked if I would give a course on electrodynamics. So I was a kind of unofficial lecturer for the physics department.

Tucker: Methods of mathematical physics was actually a joint course.

Bargmann: Yes, but the next one wasn't; it was a course in the physics department. Now this continued. But during this time I was no longer an alien. In '43 I became an American citizen and could do war work.

Tucker: You also did some Army specialized training programs in teaching in '43-'44.

Bargmann: In '43, yes. But I started to do war work with von Neumann. When the war was over, he was already deeply interested in electronic computers, and he asked me whether I would like to continue. But I wanted to get back to physics, so I asked the physics department whether they could give me an appointment.

Aspray: What was the war work you did with von Neumann?

Bargmann: Gas dynamics. I was not sufficiently high up to know exactly what it was used for.

Tucker: Well, it was certainly used in connection with building the atom bomb.

Bargmann: Yes, but with the particular problem we worked on we weren't yet very far, so to what extent it was used, I can't say. But it's quite possible it was used.

I stayed in Princeton for a while. Then Elliot Montroll, who was a close friend of mine and who had gone to the University of Pittsburgh, recommended me for a position at the mathematics department of the University of Pittsburgh. So I went to Pittsburgh for one term. It was a tenured position, but after one term was over Princeton invited me back to a tenured position, and since then I've been at Princeton. This was 1948.

Tucker: This was the year that Robertson left?

Bargmann: Yes, essentially I got his position.

Aspray: I understand from Professor Tucker that you were responsible for most of the instruction in mathematical physics, at least in terms of course work, from then on.

Bargmann: Well, at the beginning. Then, of course, the younger generation came up, in particular Arthur Wightman.

Tucker: But you did this even after you retired.

Bargmann: That is correct.

Tucker: Do you remember particularly any of the graduate students working in mathematical physics? Feynman, for example.

Bargmann: Feynman I knew not so much as a student, but as a colleague. I mean he was then already doing his own work.

Tucker: We were talking yesterday with John Tukey, and he remembers Feynman well from the time Feynman was living at the Graduate College. At the Graduate College he mixed with the mathematicians, rather than with the physicists.

Bargmann: That's interesting, because he also wanted to make sure ...

Tucker: To be called a theoretical physicist, rather than a mathematical physicist.

Bargmann: I remember the graduate students, in particular the graduate students in the first year.

Aspray: Who were they?

Bargmann: In the first course I had Philip Stehle, who is now at Pittsburgh. He is almost retired; he has been chairman of the department. Then there was a mathematician whom I lost sight of, [Paul] Olum.

Tucker: He went to Cornell. I think that he is now at the University of Oregon; he is indeed president of the University of Oregon.

Aspray: Who else was there at the time?

Tucker: Did William Sharp work with you?

Bargmann: Not with me. He took courses of mine.

Tucker: He was with Wigner.

Aspray: Was John Bardeen here at that time?

Bargmann: No.

Tucker: That was earlier. Bardeen took his degree I think in '36. I have fun with people occasionally by telling them that someone who was a graduate student in mathematics at Princeton has won two Nobel Prizes. Of course I get the answer, "That's impossible; the Nobel Prize isn't given in mathematics." And I say, "But he got it in physics." When he was a graduate student at Princeton, he was in mathematics. He held a JSK Fellowship in his first year, and he took the general examination. I've talked to him about this. He is proud of the fact that he was a Princeton mathematician at that time.

Aspray: I was wondering if you could, considering all the people at the Institute and at the University in mathematical physics, compare that community in the late 1930s with the other centers of mathematical physics, both in the U.S. and in Europe.

Bargmann: This won't be easy, because I haven't traveled. Unless one lives in a community, one misses out on quite a bit.

Aspray: What were the other major centers of research?

Bargmann: I would say that after the war there were, of course, many more than just Princeton.

Aspray: But in 1937-1940 what were the other centers?

Bargmann: 1937-1940 is a different time, because the war started and the war-related work started.

Aspray: So it might be said that Princeton was one of the few really active groups, just because of all the disruption because of the war.

Bargmann: But Princeton wasn't active. Wigner wasn't there. Robertson wasn't there. Von Neumann wasn't there.

Tucker: You're not talking about the period after 1940, but the period from '37 to '40.

Bargmann: But Robertson was already traveling.

Aspray: Was von Neumann also traveling by that time?

Bargmann: I would think so.

Aspray: That I wasn't aware of. Can you tell me a bit about the differences in the personal styles of work between some of the major figures that were here during that period?

Bargmann: That is a hard question. You see, I wasn't working with von Neumann on his mathematical problems. What I was doing was work that had to be done. "Here is the problem; see what you can do with it." It was not work as it arises in physics or mathematics.

Aspray: How much of a physicist was von Neumann as far as you could tell?

Bargmann: If one applies an appropriately broad view of physics one must say that von Neumann had a quite outstanding insight into the problems of physics. Because he has done first-rate work, and he was the man who succeeded in giving a correct mathematical formulation of quantum mechanics, and this was the major theory in physics in the first half of the century.

Aspray: Did he think the same way as some of these other people?

Bargmann: No, probably not, I would say tentatively. But I think you cannot point to a specific physical problem which John von Neumann solved. But I may be wrong. I don't remember.

Aspray: It's my impression that that's right.

Bargmann: Because what he did in quantum mechanics was the general framework.

Aspray: That's seems characteristic of his work in other areas as well. In set theory to a certain degree, in theory of computers, in operator theory.

Bargmann: I would not agree with operator theory. I think there are many things which he solved. This is typical, because this is part physics and part mathematics. For a time there was the problem whether the p - and q -operators in quantum mechanics are uniquely

defined—up to equivalence—by the commutation rules. Von Neumann gave the first proof of their uniqueness. This is a specific mathematical problem. In those days many of the great theoretical physicists knew every atom like a friend, and knew exactly what happens in sodium and knew exactly what happens in potassium and so on. This, I think, Johnny did not.

Tucker: That would be the difference between him and Wigner.

Bargmann: About Einstein. This is a bit more difficult. I would consider Einstein to be in the class of Bohr and Wigner, but Einstein was also in a way only interested in problems which are general.

Tucker: Was there any interaction between von Neumann and Einstein?

Bargmann: I wasn't aware of any, but it's difficult to say. I mean I didn't know everything that went on in Fine Hall. I know that when Pauli was here, he talked to Einstein frequently.

Aspray: Did Pauli speak regularly with von Neumann?

Bargmann: I don't know. But it's possible, because I remember a few times when Pauli said, "Yesterday I talked to von Neumann, and he told me..."—something about a mathematical problem.

Tucker: Was there ever any regular seminar in which Einstein participated?

Bargmann: No. That is, if you're asking about one in which Einstein regularly participated, the answer is no.

Tucker: But occasionally?

Bargmann: Yes. Occasionally he came to a physics colloquium.

Tucker: I don't ever remember seeing him in Fine Hall, except going to and from his office.

Bargmann: I remember Milton White. He came from California; he was the man who was to build the cyclotron. This was before I was here, but I know it from Milton. He gave a talk in a physics seminar or colloquium, I don't remember exactly. He had prepared it well. He came to the lecture room, and in the front row was Einstein. This he hadn't expected. So I know it happened occasionally, and Einstein was also strongly impressed when Rabi talked about his work on the moment of the neutron.

Tucker: But mainly Einstein worked with a few associates. That is my recollection.

Bargmann: Yes, correct.

Tucker: I remember that at that time I was helping with the *Annals of Mathematics*, particularly with papers that were being refereed up until the time that some decision was made with them. I remember taking one or two papers to Einstein at his office, and indeed I still have somewhere a referee's report that he wrote. He wrote it in German and addressed me as "my neighbor colleague". I don't remember ever hearing him speak in a lecture or seminar. I think that any time he did that it must have been kept under wraps so that the place wouldn't be mobbed.

Bargmann: By people who wouldn't understand anything.

Tucker: Out of sheer curiosity. I mentioned this to explain why I was never aware of occasions when he talked in a seminar.

Bargmann: It wasn't widely known, but I think I always knew, and not from him.

Tucker: No, but it would have been an inner circle.

Bargmann: Was it on the bulletin board?

Tucker: I don't think so. I don't ever remember such a thing being listed on the weekly-seminar bulletin.

Aspray: I believe you told me, Al, that at one time Einstein's office had to be moved from the first floor to the second floor. Is that correct?

Tucker: I think that when Einstein arrived the office he was given in Fine Hall was on the first floor. Then there were people who came and peeked in the windows, so that his office was moved to the office that Wigner subsequently had. I myself had an office at the time that Einstein first came. I was an instructor sharing an office with E.J. McShane. This was 108, on the first floor. It is my recollection that at that time Einstein had the adjoining office, 109.

Aspray: When you first came to Princeton was there still a problem about preserving Einstein's privacy?

Bargmann: Well yes, but I would say it wasn't as bad as one might have expected.

Tucker: Of course it was terrible in 1933. There were reporters and photographers in town for weeks trying to catch him in an unguarded moment.

Aspray: This effort to protect his privacy, did it mean that thing had to be more formal for the inner circle to get to see him? Did you have to make appointments or do anything like that?

Bargmann: No.

Aspray: He was accessible to you.

Bargmann: I would say Eistein was utterly accessible. For example, in Fine Hall and at the Institute, to anybody who was genuinely interested in science—I mean if you came as a colleague.

I arrived here today asking myself a question, 'What in Fine Hall or in Princeton impressed me most?' The answer is, that the library was open 24 hours a day. This I hadn't seen anywhere. These were good times.

Aspray: And I assume that going in it at just about any hour you'd find somebody there?

Bargmann: Of course.

Tucker: The common room and the library were occupied constantly.

Bargmann: Yes, of course. I remember particularly well, because I came from Switzerland, where they made an awful fuss about the library. Zurich had two institutions, the University of Zurich and the Federal Institute of Technology (abbreviated 'ETH' from the German 'Eidenoessische Technische Hochschule'). On the door of the ETH library was the following notice: "If you knock at this door it will not be opened."

Tucker: Well, I had the experience in reverse, because I had experienced Fine Hall in the last year of my graduate study, and the following year I had a National Research Council Fellowship which I used in Cambridge, England, because I wanted to go to the international congress at Zurich in the fall of '32. By taking the first part of my fellowship at Cambridge, I was able to go to Zurich as part of my fellowship. But what I wanted to say is that at Cambridge I found it utterly impossible to use library facilities. I could go to the library, but I had to go to the catalog and order a book, and then read it in the reading room. I couldn't go to the stacks and browse, and that's the only way for a scholar to use a library.

I realize that the same thing is generally true throughout Europe. That a library's main objective was to preserve books rather than to have books used, because if they're used, this leads to their not being preserved. After Cambridge I was at Harvard, and I found this almost as bad at Harvard. I could get into the stacks there, but it wasn't particularly agreeable. There wasn't any place there to work, which was the great advantage of the Fine Hall library. I had a chance to stay on at Harvard as an instructor, or to return to Princeton as an instructor. I had no doubt about my choice, because the conditions for working were immeasurably better here than they were at Harvard at that time.

Bargmann: Yes, Fine Hall was quite new.

Tucker: What you said about the common room and the tea and coffee, this was in some sense the heart of the life there. And this, you know, was due to Oswald Veblen. He was the one who introduced the

afternoon tea to Princeton. He had it in his office at Palmer, using a Bunsen burner to prepare tea, but it was really only for the small group of people who were working with him. And, of course, he was the one who more or less designed Fine Hall. I mean, that it should have a common room, that it should have a professors' room, that there should be a library, and all that. He worked with the architects on these things. It was his idea from the very start that the common room should have tea.

In the first year of Fine Hall I happened to be put in charge of the afternoon tea. On a voluntary basis, we served the tea and cleaned up and washed the dishes and so forth. But then the janitor, Mr. Hahr, whom you probably remember, objected to Dean Eisenhart and asked that he be paid two hours overtime to stay on and serve the tea and clean up. That's the way it was, of course, when you got here. It was rather chaotic the first year, but even to putting me in charge of tea, it was the work of Oswald Veblen.

Bargmann: Yes, I understand.

Tucker: So he should be given a lot of credit for the atmosphere that this created. As Dean [J.D.] Brown loved to say, "Men create institutions and institutions create men."